Beyond buttons: Explorations in creative storytelling

Dominic Amatore
Beyond Buttons: Explorations in creative storytelling
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Rochester Institute of Technology

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Chapter 1. Introduction
This thesis report culminates the body of my work as a graduate student in the Computer Graphics Design program at the Rochester Institute of Technology. On a more personal level however, it also serves as a record of the period of my life in which my artistic interests were branching out in new directions. It marks the first tentative steps I took towards exploring the possibilities of a new career.

The statement above requires a little background information in order to be fully understood and appreciated. When I first began studying at R.I.T., my undergraduate degree was in graphic design, yet I was also very interested in illustration. Throughout my undergraduate courses, I had always possessed a deep respect for artists and designers who could visually communicate an idea on a page, or within the confines of a static image. However, although I felt I had learned a great deal in these courses, and was sufficiently trained as a competent designer, something seemed to be missing. I began looking into graduate studies and discovered the Computer Graphics Design program. The concentration on interactive media and animation intrigued me, and since my computer skills at the time could have used some refining, I enrolled in the program and began studying directly after completion of my undergraduate courses.

I have always loved the art of filmmaking and storytelling, so while majoring in computer graphics, I minored in 3D computer animation, which was affiliated with the film and video department. These classes exposed me for the first time to the many production process involved in ‘real world’ animation. Working in an SGI environment, and viewing the final piece in a linear form such as videotape, became an eye-opening experience, and from then on I began trying to emulate those same techniques in my interactive projects. Interactive media, before this point, had allowed me to apply the things I had learned in graphic design and illustration, and take them a step further. Now, by attempting to infuse these elements with a sense of cinematic motion, I was able to establish a consistent goal and direction in all of my studies.

A short time later, the other students and I were introduced to a program called Adobe After Effects, from Adobe Systems. Formerly called COSA After Effects, it was purchased by Adobe, and quickly became the learn the software, and found that it allowed me to incorporate all of the techniques involved in designing graphics and animation, only now they could be composited with live action video footage. This marked the earlier stages of the desktop video revolution, and it also began to shift my focus from interactive media to broadcast video and film production. I began to realize that the same animations and composite scenes that I had been creating for desktop speed presentations, could now be created for playback on standard videotape, while working within the familiar Mac-based environment. All of these realizations had transpired during the development of my thesis project, and so I concluded that I would delve deeper into these concepts and focus on desktop animation and compositing as the subject of my thesis.
Statement of the problem
The final version of the thesis project is an exploration in combining 2D and 3D animation, graphic elements, and live action video footage in a series of scenes using desktop software. The scenes are documented on videotape in order to show the results of a wide range of compositing techniques. Initially, my intent was to use a narrative structure in the form of a short story, involving all of the elements of a basic storyline: conflict, climax, resolution, character development, etc. (eventually this format would have to be abandoned due to time and budget constraints). In order to begin development of this particular project, I had to become familiar with the process of pre-production; the planning stages that take place before any shooting or animation is begun. Upon completion, the entire project would entail developing a storyboard and shot list, days of shooting in various locations with the assistance of about ten other individuals (very compassionate and understanding individuals), a few hundred dollars, countless hours of production in varied media environments, and most of all, unlimited patience.

On the software side, the project would require the use of many different applications. In the realm of 3D modeling and animation; Strata StudioPro, Form Z, and Electric Image Broadcast were implemented. Elements were modeled in Strata and Form Z, then rendered as full length animations within Electric Image. These elements would later have to be combined with video footage as well as still imagery created in Photoshop and Illustrator. After Effects would inevitably become the 'hub', where all of the various elements would be composited and manipulated. The mainstay for most of the production of the thesis project, After Effects would prove indispensable as a tool for marrying all of these disparate images.

Another issue to bear in mind during this process; which at times is overshadowed by the technical aspects, is the concept behind the imagery itself. In some cases, it was more important to achieve a sense of realism, while in others, a 'dreamlike' quality was more ideal (I use the term 'realism' quite loosely, see Results pg.51). Essentially, the scenes are intended to convey one man's introspective visions which occur to him over a short period of time, during which he undergoes a startling emotional and physical shift towards a type of enlightenment. Inspired in part by Buddhist theology, the story's main theme is the awakening of the human spirit, and its rise against monotony and greed. Basic formulas were used whenever possible, such as portraying a white collar businessman as the protagonist, who later endures the inevitable transformation. I felt that this theme was humbly similar to the basic concepts that form the tale of Buddha's quest for enlightenment. One big difference, however, aside from the setting, is that the main character in this piece finds enlightenment 'thrust' upon him, and is forced to undergo a profound change. With these principles and ideas established, the next step was to evaluate the most efficient and successful methods of production and presentation.
Significance of the problem
Aside from studying 3D animation as a minor, almost all of the processes and theories that I explored during my two years as a graduate student dealt predominantly with design for interactive media. Initially, the work focused on object oriented programming and the basic development of the graphic elements involved. A good example of such a graphic element would be an animated 'button' which might flash or bulge as a user passed the mouse over it during their interaction with the presentation. Although devised for a simple purpose (in this case, prompting the user to click on the button) and easily developed, the basic techniques used in creating such effects intrigued me. Through exposure to these methods, motion became the singular focus in almost all of my projects thereafter.

Coincidentally, around this time in the class curriculum, the focus began to concentrate on cell-based animation within Macromedia Director, and key-frame interpolated 3D animation within Strata StudioPro. In hindsight, this quarter of study was essentially a turning point for me, for these were predominantly linear animations, with little or no focus on eventual user interaction. Navigation theory and other related issues were no longer a consideration, and the traditional premise of the 'audience' was once again an important factor. I began to feel more confident in my production skills than ever before. I began trying to fuse many more cinematic techniques found in filmmaking into most of my work. Techniques like multiplanning (from traditional animation), and rack focusing (used more frequently in cinematography). As I became more and more comfortable with these methods, the computer screen began to resemble a movie screen, or more accurately, a frame of film. Interactivity for the sake of interactivity began to no longer hold an interest for me. It was during this time that I had begun to finish my 3D animation project, and upon editing it, had screened it in the film and video school's quarterly screenings. Having my work played back linearly, and not in control of the audience suddenly became more appealing, and it was this experience that made me realize which direction my thesis project should take.

But it was not an easy decision to make. At this stage, I had already begun developing a proposal for creating an interactive movie, which would be presented on a desktop computer. An "on-screen" CD-ROM presentation where the user would choose the actions and therefore the destiny of the characters. I did not quite realize it at the time, but I was greatly limiting myself by including interactivity as a factor in the project. Even though the two years of graduate study involved a wide variety of media development, such as linear animation, web design, etc., the main form of presentation throughout these courses was predominantly interactive.
It was this precedent which momentarily led me to believe that an interactive presentation of my work might be necessary, and that all of the final thesis projects in the show should conform to one medium for presentation, the desktop computer. The significance of this assumption is that when it came to achieving the desired results of my final piece, an interactive presentation would prove to be both unsuccessful and inappropriate. For example, the scenes I would eventually create called for a clever mix of 2D images, 3D animation, and live action footage, all resulting in several minutes of playback. The issue of image quality due to compression notwithstanding, the load time and inconsistency in playback would have been the first area of difficulty. The current equipment in the CGD lab at this time consisted of Apple PowerMac 7100's running at around 70 MHz, and operating with a maximum of 64 Megabytes of RAM. Although this equipment was still state of the art in 1995, the prospects of playing back digital video on a bare system with no hardware assistance left little to look forward to. Even if the clips were accessed directly from the hard drive, and were reduced to half of their original resolution, the playback would still creep along at a rate of about 12-15 frames per second. Load time would also be an issue. At the end of a long clip, or when the user made a selection, the following Director movie containing yet another large clip would have to be loaded into memory. This would drastically interrupt the flow of the presentation, and distract from the established mood. Also, Cinepak compression (which is an asymmetrical codec commonly used to optimize video playback for desktop presentations), would introduce many artifacts and affect the quality of the footage. As if all of these factors weren't discouraging enough, there was also the issue of reducing the clips to an 8-bit color palette, in order to expedite screen redraw and loading of graphic elements. This color reduction process would have introduced unacceptable dithering within each frame of the clip being played back, as well as white 'flashes' when Director switched between movies using different palettes.

These were the issues that eventually convinced me to avoid the obstacles of an interactive computer-based presentation, and focus my attention on the development of interesting animation and visual effects techniques using the desktop computer as a production tool, rather than a complex VCR. Upon making this decision, I revisited my original thesis proposal, and found that the first paragraph encompasses my goals and intentions rather nicely:

"The focus of the thesis is the use of computer technology as a medium for creative expression in storytelling, with an emphasis on the utilization of experimental desktop video and animation."
Limitations
There are many facets involved in production. Whether an interactive project, or a feature film, proper planning is necessary before execution even begins. This phase is typically called “pre-production”, where the various steps of the production process are carefully planned, from equipment use, to location scouting. But even the most carefully planned project can run into a few limitations along the way. This section discusses those limitations regarding equipment, time, money, the challenges they posed, and the means by which those challenges were met.

This project required much more than just graphic elements created using the computer. It also required the shooting of live action footage using actors and various locations. Therefore, the first step was to obtain a video camera. I looked into renting one from a local video supply facility, but the amount of shooting I needed to do was such that it made it quite an expensive option. Luckily, I was able to borrow one from Mat Johnsonbaugh, a friend of mine that was studying film and video production at R.I.T. The camera was a $3000 SONY VX-1000 Hi-8 camcorder (Fig. 1.1), a favorite of consumers and professional alike, it was the last Hi-8 before the release of the now ubiquitous digital video cameras. The image quality using this particular camera was by far superior to shooting with VHS-C or an 8mm videocamera (which was the one available in the CGD lab). I was also able, with his assistance, to gain access to a $10,000 SONY professional grade videocamera (Fig. 1.2) and tripod as well. Using these two cameras, I was able to capture great looking footage. The only real limitation in this case was that access to this equipment was limited, and this consequently affected the shooting schedule. The SONY VX-1000 was frequently in use by its owner for his projects, and the SONY EVW-60 professional camera was more difficult to obtain due to its frequent use by other students in the film program that had priority. Although this was not a severe limitation, it made for a shooting schedule that generally became more spontaneous, as it was determined by daily negotiations between my schedule and Mat's. In the end, however, the quality of the resulting footage was well worth the extra effort.

Oddly enough, the limited access to the camera equipment only compounded another problem, that of actually shooting the live action scenes with actors. Several friends had agreed to help out and appear in the video (see credits on videotape), the main benefit of this was that I could not afford to hire professional actors ( I also felt that the sporadic shooting schedule would have hindered the project even more if paid actors were involved), but I also didn’t feel that it was necessary since there was no dialogue. All told, I had the help of about nine or ten friends during the production stages. Some were even in scenes that never made it into the final video, but for scenes which required the main character’s presence, I turned to my roommate Erich Lehman for assistance. The limitations brought about by a tentative shooting schedule required that I choose someone to whom I would have optimum access, and since we lived in the same house, it made the whole experience a little easier. As a matter of fact, quite a few of the scenes in the video were shot in our house late at night, when we both arrived home from classes. Although the shooting of the main character was not as much of a problem (even though on a few occasions he probably wished he’d reconsidered), the location shooting of the other actors proved to be a little more troublesome.
During the course of production for this video, there were essentially two different environments in which I worked. The first was the Computer Graphics Design lab in Rochester, and the second was a professional video production house in Binghamton, NY where I was later employed and was allowed to continue to work on my thesis project. The second facility was by far more technically suited to my needs, and the project was eventually completed there. While the CGD lab had acted as the initial point of production, the disparity between the two working environments was so evident, that I was forced to recreate many of the effects and scenes that had already been produced in Rochester. The work that was done during my stay in the CGD lab constituted about half of the entire production, and it was around this time that I encountered several of the limitations discussed below.

Digitizing the footage in the CGD lab was the first technical limitation I ran across. The second facility employed professional AVID non-linear editing systems which took advantage of specialized hardware and software, and were ideal for capturing full frame video footage at 30 fps. The equipment in the lab, however, was primarily used for creating desktop presentations, and the codecs, and stock A/V cards favored the capturing of video for use in interactive presentations only. At this time I was unable to digitize clips from the Hi-8 camera at their full resolution and frame rate (640 x 480, 30 fps), so my only option was to capture the footage at half the resolution and frame rate (320 x 240, 15 fps), and double it’s size later in Adobe After Effects (initial tests of this method would later prove to provide poor motion when rendered and transferred to videotape). Another solution to this problem was to capture only one frame at full resolution for use in scenes in which the background didn’t have much activity. This fixed the stuttering of the playback, but the awkward stillness of the background image looked very unrealistic.

Another limitation was rendering time within Adobe After Effects. Although a great software package for compositing, it still requires quite a bit of hardware assistance to work with full resolution video clips. Given the processor speed of the 7100s and the limited RAM, rendering in After Effects and Strata StudioPro was quite laborious. Since the resolution of the final renders from both applications was the full NTSC 640 x 480 standard, rendering overnight was a given even for some of the shortest scenes. A relatively complex ten second scene averaged at around twelve hours of rendering time. Strata StudioPro rendered at an even slower pace, due to the complex calculations involved in 3D animation. Since almost all of my scenes ranged from ten to thirty seconds, these slow renders posed many problems. The project’s workflow was hindered considerably because I only had full access to one computer, and was unable to do anything else on the computer while it was rendering. The only solution was to try to expedite the rendering process by streamlining some of the files, and omitting unnecessary calculations that the software had to make. This was accomplished by pre-rendering stills and Quicktime movies, as well as choosing less complex effects. Once this was done, the rendering of each scene was divided amongst several machines. I accomplished this by transferring the After Effects file and all of the the various footage used over the network to as many machines as were available.
This solution did not cut down the project's true rendering rate, but instead, greatly shortened the total production time, depending on how many computers were used. The main disadvantage of rendering in this fashion, was that there were many instances in which the rendering process had to be stopped, so that another student could work on his or her computer. This meant that the file had to be saved, and the last frame completed had to be noted, so that rendering could commence at a later time. As if it wasn't confusing enough to have a scene split into three or four sections, now those individual sections were being split yet again. This made it very difficult to keep track of the final rendered PICT sequences, because they had to be consolidated in their original frame order and grouped by scene, so that they could be stored on disk. (the rendering of PICT sequences is laborious in its own right, and was a result of a limitation that is discussed later in this section.)

This brings me to discuss the limitations that were encountered involving storage capacity issues. The main hard drive on my 7100 held a total of one Gigabyte, and most of this was used by the applications and system software. I also had an external 730 MB LaCie hard drive on which I would initially store each rendered scene. Since I was rendering PICT sequences, a twenty second scene would consist of around 600 individual PICT files (30 frames per second x 20 seconds). Each uncompressed 24-bit PICT file contained approximately 1 MB of data. So it became evident rather quickly that I was only going to be able to store one or two rendered scenes at any one time on my external hard drive. Removable media storage at that time was not an appropriate solution, since the memory capacity was typically less than adequate, and would have resulted in dividing scenes into two or three sections. Another issue in dealing with removable storage, is that the media on the disk is rewritable, and always vulnerable to accidental erasure. It would have been quite a pity to lose months worth of work in a matter of seconds. So, the only logical solution at that time was to archive the rendered scenes as well as the project files and original footage to CD-ROM. Capable of holding around 650 MB, the media written to a compact disk can never be deleted, and can be accessed an infinite number of times. This storage medium suited my needs nicely, but there are factors that made it quite an arduous undertaking. The process for recording media to a CD-ROM (or 'burning', as it is commonly called), on the equipment at that time took around an hour for each 'session'. I eventually ended up archiving about ten to fifteen disks, which would eventually add up to approximately ten to fifteen hours of merely transferring data from hard drive to disk. Another limitation of this method that would have been unavoidable regardless of which storage medium I used, was that all of the elements that were needed in a particular project could rarely be accessed from one disk. This meant that sometimes clips and files had to copied back onto the hard drive so that other files could be accessed from the CD-ROM drive at the same time. Invariably, because of these many limitations encountered during the course of production, devising solutions to storage issues comprised almost one third of the labor involved.
Earlier, I mentioned the process of rendering PICT sequences from After Effects. Typically, when rendering a final animation, a Quicktime movie is generated. Compressed or uncompressed, it consists of a single movie file, that can be played from within almost any application that recognizes the quicktime format. In the case of the post-production house where I worked, Quicktime files were typically rendered using the AVID codec for compression, and then imported into the editing software, where they are ‘cut’ in real time. In the CGD lab, however, we had no video cards in any of the systems at that time. Therefore, I had no means of recording the playback of a Quicktime movie to videotape, or of viewing the final renderers I had created in After Effects. Upon reaching this obstacle, I turned to the 3D animation lab in the film and video department for assistance. The techniques involved in creating 3D animation in that class proved to be quite beneficial when it came to getting the rendered scenes of my thesis project onto videotape.

The animation would be rendered out as individual PICT files, each representing one frame. These PICT files would then be uploaded over the school’s network to a central 4 GB hard drive in the animation lab, where they would be individually recorded frame by frame onto a large capacity optical disk. This was accomplished by running software on the SGI INDI that displayed each frame in a window, and the monitor’s output was then sent via an S-video cable to an optical disk recorder (ODR). The optical disk recorder is capable of recording an average of 36,000 individual frames, and playing back approx. 30 minutes of real time video. Once the PICT files were recorded in sequence, the entire scene could be played back and recorded onto videotape from the ODR. This videotape was then used in editing to a final master.

At first, I was quite enamored by this process of being able to see full frame animation play back in real time. When it came to the efficiency of the process, however, the limitations were abundant. Once the PICT sequences had been rendered in the CGD lab, they needed to be sent over the network to the 4 GB hard drive. Each scene took up about 1 GB of storage space, and since the students in the 3D animation needed the space to store their projects, I was only able to send one scene at a time. Of course, sending 1 GB of data over any network takes some time, and I invariably had to wait until all of the files made it safely onto the hard drive before I could work on them. Once they were sent, however, I still had to obtain access to the SGI workstation on the fourth floor animation lab. Since the animation students had priority, I usually had to sign up in advance and wait my turn. This waiting was quite difficult, because I was using a quarter of their storage space, and the longer it remained there, the greater the chance was of it being deleted to make room for someone else’s project. Finally when the time came to record the scene, I had to wire the ODR to the monitor, and record each frame to the disk. This was probably the most tedious process I encountered in the production of the project. The application used to record the frame utilized a window in which the image of the frame was displayed, and a window that acts as the ‘live’ 640 x 480 recording area. This window had to be positioned perfectly over the animation frame, otherwise the background image of the desktop would be recorded along with the image. If the frame moved at any point during the process, there would be a recognizable shift in the animation.
Since the ODR could not be re-written, any shifting of the image would ruin an entire sequence, and the process would have to begin all over again. Beginning this process from scratch was nothing to take lightly, since it sometimes took about four hours just to record a ten to fifteen second scene to the ODR. The tedious nature of this process was due to the fact that each frame had to be opened in sequence by a keystroke, and then recorded to the ODR by pressing a button on the deck. A very simple process, but repeating these steps 500 times was quite difficult, and mistakes were easily made. You could spend an entire evening recording your scene, and then notice upon playing it back that one frame was skipped, which caused a jump in the motion. This was probably the most nerve-racking phase of the early stages of production.

Once I was satisfied that the scene was properly recorded onto the laserdisc, I then had to delete all the PICT files from that particular sequence in order to make room for the next batch, and the process would start all over again. When all of the scenes were completely rendered, and recorded to laserdisc, they then had to be recorded to videotape. This was accomplished by sending the output of the ODR to the same SONY VX-1000 that I had used in shooting the footage. The animations were payed back in real time from the disk, and recorded onto a Hi-8 tape, which would later be used in editing the final piece. The editing of the video was initially done on Hi-8 editing decks, to which I had a reasonable amount of access, but the effects scenes and the original footage were very difficult to match seamlessly, since the image processing between the analog and digital systems created noticeable differences. Eventually, the final stages of editing would be carried out at the post production facility, where scenes could be matched more effectively using high-end non-linear editing equipment.

There were quite a few limitations that merely had to be accepted during the production of this thesis project. Certain technological issues present themselves as obstacles, and therefore the challenge becomes how to work around those obstacles. But there were many instances in which I had made several correct or incorrect assumptions about how the process would unfold. Issues dealing with the matching of footage in the editing session, issues of storage, and many others. However, one simple assumption that proved most inaccurate was the time factor involved in many of the various steps. Shooting, compositing, rendering, storing, editing, and essentially every stage of the production met with very difficult time constraints and complications. Even though during the pre-production phase, the timeframe was sufficiently mapped out, equipment issues and other factors extended the production phase far beyond my initial estimates.

There were also several issues regarding image quality, in which I assumed a WYSIWYG mentality, not realizing the various pitfalls inherent in the NTSC video signal, and its limitations in the realm of color, noise, and saturation.
Definition of terms
**A**

**accelerator**
A circuit or device that speeds up some operation. Such devices perform some of the tasks that ordinarily would be done by the CPU, thus freeing the CPU to do other things. For example, most graphics adapters use some form of acceleration to speed up the presentation of the display.

**access time**
A measure of performance for disk drives, referring to how fast an item of data can be retrieved from the drive. Two important components of access time are latency and seek time.

**adapter**
Generally, a printed circuit board that plugs into the computer’s I/O bus or local bus and that provides the necessary interface with some external device.

**algorithm**
A set of instructions to be executed in sequence.

**aliasing**
Defects in the picture caused by too low a sampling frequency or poor filtering. Usually scene as “jaggies” or stair steps in diagonal lines.

**alpha channel**
If matte information is included in a ‘normal’ image it is stored in the alpha channel. In color images the alpha channel is the fourth channel after the red green and blue channels. In black and white images it is the second after the luminance channel.

**analog**
Describes a signal that changes value continuously, that is, without discontinuities. The signal usually represents a physical property such as pressure, temperature, etc.

**anti-aliasing**
A group of methods used to avoid image resolution artifacts, such as jagged edges on diagonal lines or high-contrast contours. Anti-aliasing is accomplished by interpolating between the colors of adjacent pixels using sub-pixel techniques.

**AppleTalk**
A LAN from Apple specifically for Macintosh computers. Similar to Ethernet.

**application**
A program that runs on a computer. Specifically, a program that accomplishes a task for the user unrelated to the computer, such as a word processor, an accounting program, or a spreadsheet.

**artifact**
A visual effect caused by an error or limitation in the system. In the case of digital video, it is usually signified by aberrations in the pixels that make up the individual frames of a particular clip.
aspect Ratio
The ratio of width to height in a picture. Theater screens generally have an aspect ratio of 1.85 to 1, widescreen TV (16x9) is 1.77 to 1, and normal TV (4x3) is 1.33 to 1.

B

betacam SP
A superior performance version of Betacam. SP uses metal particle tape and a wider bandwidth recording system.

binary
Describes a number system that has only two values, a one and a zero. Computers use the binary number system because electronic devices lend themselves to a system that uses only two states, such as on and off, high voltage or low voltage, current or no current.

bit
A single number in a binary number system, just as a digit is a single number in a decimal number system. A bit may have a value of either one or zero.

bit map
A representation of an image that records the value (color and intensity) of each individual pixel. Bit map files often use the extension .BMP.

bit Rate
The amount of data transported in a given amount of time, usually defined in Mega (Million) bits per second (Mbps). Bit rate is one means used to define the amount of compression used on a video signal. Uncompressed D1 has a bit rate of 270 Mbps. Mpeg 1 has a bit rate to 1.2 Mbps. HDTV has a bit rate of 1.5Gbps (Giga bits per second).

blue screen
A blue background used to chroma key people. It is of a special shade of blue which is not usually present in the colour of the human skin. So often used that blue screen and chroma key today are almost synonymous.

bump mapping
Mapping is directed to effect on the surface normals, so that the object looks bumpy and rough. White areas in the texture image turn the surface normal to the opposite direction than black. This is only pseudo effect: it applies only to rendered images. Also, the contour of the surface remains smooth.

bus
A conductor or array of conductors (wires) to which various devices may be attached for the purpose of sharing electric signals placed on the bus (by one of the devices). A computer has several buses: I/O, address, memory, etc. The term is also used to describe a logically equivalent (to the hardware bus) interconnection of software modules.
byte
An 8-bit binary number that is frequently used as the basic unit of computer information. Computer memory capacity is given in bytes, such as "8 megabytes of RAM", or a "540 megabyte disk drive". Since one byte may be used to encode one character of text (using ASCII), a measure of storage capacity in bytes can be more readily understood.

cache
A type of memory used to speed up memory reads and or writes. Main memory cache is made of fast static RAM or synchronous DRAM. Information from slower dynamic RAM is moved into the faster cache in anticipation of its being needed by the processor.
camcorder
Combination of camera and video tape recorder in one device. Camcorders permit easy and rapid photography and recording simultaneously. Camcorders are available in most home video formats: 8mm*, Hi-8*, VHS*, VHS-C*, S-VHS*. etc.
camera angle
Field of view (fov) in degrees. 30 corresponds to the normal lens of 35mm still camera.
CCIR 601
The standard for digitizing component video. Also sometimes called D1 after the VTR format that first used this signal.
CD-ROM
Stands for Compact Disk-Read Only Memory. Originally, the CD (Compact Disk) was used for the recording and playback of digital audio; hence, the medium consisted of a single continuous spiral track of optically recorded bits intended to be streamed off at a constant rate of 150 kilobytes per second. When the format was extended to data (and ROM was appended to CD), the data rate was soon accelerated.
CGI
Computer generated imagery. A broad term referring to any digital image output.
character generator
Device that electronically generates text which can be superimposed over a video signal. Text is usually entered via a keyboard, allowing selection of various fonts, sizes, colors, styles and background colors, then stored as multiple pages for retrieval.
chroma key
The process of overlaying one video signal over another by replacing a range of colors with the second signal. Typically, the first (foreground) picture is photographed with a person or object against a special, single-color background (the key-color). The
second picture is inserted in place of the key-color.

chroma noise
Noise which manifests itself in a video picture as colored snow.

chrominance
The color part of a video signal.

color correction
A process in which the coloring in a television image is altered or corrected by electronic means.

component Video
A video signal in which the Luminance and Chrominance signals are kept separate. This requires a higher bandwidth, but yields a higher quality picture.

composite video
The luminance and chrominance signals are combined in an encoder to create the common NTSC, PAL or SECAM video signals. Essentially a form of analog video compression to allow the economical broadcasting of video.

compositing
Creating an image by combining two or more images, often with the aid of mattes to mask off unwanted areas of images. In the film industry, compositing was used to be done on an optical printer, but today it is accomplished almost entirely on a computer. This is largely due to the fact that in digital compositing it is possible to produce successive generations of images (process the same images all over again) without any loss of quality.

compression
The process of reducing the number of bits used in the digital representation of something. Most files maintained by on-line services or bulletin boards are compressed in order to reduce the storage requirements and to lessen the amount of time needed to download. Many files can be reduced to a half or third of their original size by compression.

compression ratio
The ratio of the amount of data in the original video compared to the amount of data in the compressed video. The higher the ratio the greater the compression.

contrast
1. The degree to which the various luminance values in a picture are mapped to very dark and very light values. A high-contrast picture is dominated by black and white and few values between. A low contrast picture has a lot of middle tones without many very dark or very light areas.
2. A control on a television or monitor which adjusts the white level of the picture.

controller
An electronic circuit or device (such as a disk controller or a graphics controller) that is used to control another device.

CPU
Central Processing Unit
Definition of terms

curve
A sequence of straight or curved lines connected to each other by control points i.e. control vertices(cv).

D

D1
Digital video tape format using the CCIR 601 standard to record 4:2:2 component video on 19mm tape. Currently the highest quality video tape format generally available. The first digital video tape format, hence D1.

depth of field
The range of objects in front of a camera lens which are in focus. Smaller f-stops provide greater depth of field, i.e., more of the scene, near to far, will be in focus.

difference matte
A matte pulled from the differences between two images, in which the computer compares sequences image by image, pixel by pixel, and produces matte only for the pixels that don’t match.

digital
Describes a signal that can assume two (or more) amplitudes that are used to represent binary data (ones and zeroes).

digitizing
The act of taking analog video and converting it to digital form.

directory
A listing of the files stored in the part of the disk (or tape) that is currently in use.

disk drive
A computer peripheral that stores information on a rotating magnetic or optical medium. Three types of disk drives are in common usage: the fixed, or hard disk; the floppy disk; and the CD-ROM.

displacement mapping
Like bump mapping, except that the object surface is affected for real. Displacement mapping is only a render effect. In some cases, however, it is possible to write out the 'carved' geometry.

dissolve
A process whereby one video signal is gradually faded out while a second image simultaneously replaces the original one.

distortion
In video, distortion usually refers to changes in the luminance or chrominance portions of a signal. It may contort the picture and produce improper contrast, faulty luminance levels, twisted images, erroneous colors and snow. In audio, distortion refers to any undesired changes in the waveform of a signal caused by the introduction of spurious elements.
Definition of terms

driver
A (usually) small program that provides the interface between application software and a physical device such as a mouse, a graphics board, a sound card, etc. Drivers are loaded into memory (RAM) when the computer is booted and stay resident.
dolly
Moving the camera along the line of sight, i.e., close and far from the target. Term originally refers to the carriage under the camera stand, pushed on wheels along rails.

DVD
Digital Video Disk. Also Digital Versital Disk. A new format for putting full length movies on a 5" CD using MPEG-2 compression for "better than VHS" quality.
dub
A duplicate copy made from one recording medium to another.
DVE
Digital Video Effects. A "black box" which digitally manipulates the video to create special effects. Common DVE effects include inverting the picture, shrinking it, moving it around within the frame of another picture, spinning it, and a great many more.

e
edit control
A connection on a VCR or camcorder which allows direct communication with external edit control devices.
EDL
Edit Decision List. A list of edit decisions made during and edit session and usually saved to floppy disk. Allows an edit to be redone or modified at a later time without having to start all over again.

Ethernet
A network developed by Xerox that evolved into the IEEE 802.3 specification. Ethernet and 802.3 are identical except for minor differences in the data link frame fields.

F
fade
The act of dissolving a video picture to either a color, pattern or titles. Fading a video image is often used as an artistic tool in video productions, most commonly seen as a fade to black.
field
One half of a complete video picture (frame), containing all the odd or even scanning lines of the picture.
file
Usually, file is used to refer to data stored on a disk. A file may be a document, or an image, or a program, or any number of
flicker
A strob ing picture artifact, similar to an old-time movie effect, mainly related to vertical syncs and video field display rates. Some flicker normally exists due to interlacing, but is more apparent in 50 Hz systems (PAL*) and when converting film (24 fps) to video (30 fps). Flicker may also be a problem when static computer images are transferred to video.

flip
Special effect in which the picture is either horizontally or vertically reversed.

floppy disk
A storage device consisting of a thin rotating magnetic disk made of plastic. The disk is contained either in a flexible paper envelope with holes to allow access to the surface of the disk, or in a semi-rigid plastic housing with a protective door that slides open when inserted into a floppy disk drive.

frame
One image. Live or animated imagery is displayed with the rate of either 25 (PAL video), 30 (NTSC video) or 24 images (film) per second, although other speeds may be used. Today, frame is pointedly a display term because, in addition to video, the new digital storage methods do not necessarily deal with frames per se anymore.

freeze frame
Special effect in which the picture is held as a still image.

function curve
The timing (speed) of animation is controlled by function curves. The steeper the curve the faster the animation. Flat fcurve results in no animation.

FX
Film and video special effects.

generation
The number of duplication steps between an original recording and a given copy. A second generation duplicate is a copy of the original master and a third generation duplicate is a copy of a copy of the original master, etc.

generation loss
When an analog master videotape is duplicated, the second generation copy is usually inferior.

garbage matte
A matte that needs retouching before it can be used. Methods that pull mattes automatically (such as difference matte) often create garbage.

ghosting
A weak, secondary, ghost-like duplicate video image in a video signal caused by the undesired mixing of the primary signal and
a delayed version of the same signal.

Gigabyte
1 Billion bytes.

H

head
The component of a disk or tape drive that reads data from the recording medium or writes data to the recording medium.

hertz
The unit of frequency. One hertz is the same as one cycle per second. Abbreviated Hz.

HI-8
An improved version of the 8mm tape format capable of recording better picture resolution (definition). A higher-density tape is required which provides a wider luminance bandwidth, resulting in sharper picture quality (over 400 horizontal lines vs. 240 for standard 8mm) and improved signal-to-noise ratio. Camcorders using this format are very small, light and provide a picture quality similar to S-VHS.

horizontal resolution
Rating of the fine detail (definition) of a TV picture, measured in scan lines. The more lines, the higher the resolution and the better the picture. A standard VHS format VCR produces 240 lines of horizontal resolution, while over 400 lines are possible with S-VHS, S-VHS-C, and Hi-8 camcorders.

I

icon
A graphical symbol.

interface
The point at which two systems or devices connect to each other or interact with one another. Internet a global network of interconnected networks supporting a set of common protocols.

interlacing
A method of using video display techniques to improve the output quality of fast animation. One video frame is divided into two fields of equal amount of scanlines. Every one line belongs to the first field, every other to the second. The image is refreshed with the nominal rate of 25 times per second (PAL), but the fields are actually shown one at a time. This doubles the refresh rate to 50, which reduces image flickering. This feature can be used effectively to diminish the strobing effect often produced by fast moving objects by rendering every frame twice, one field at a time, producing two images that are half the resolution in height. For example, at the frame 10, frames 10,0 and 10,5 are calculated and then merged together, field by field, to produce an image of
normal dimensions.

interpolation
Change of state of an object over time between two consecutive keyframes.

interrupt
Signal that causes a computer to suspend what it is currently doing so that it can perform an action required by the interrupting device or process. After satisfying the interrupt, the computer returns to what it was doing.

K

keyframe
The state of an object explicitly defined in one frame. The state includes object's position, rotation, size, shape, etc, which can be all specified together in a single frame or separately in different frames. Animation is achieved by giving different values for a particular parameter (such as position) in two different frames. The computer then automatically calculates (interpolates) the change over time.

key light
The term used to describe a subject's main source of illumination. When shooting outdoors, the key light is the sun.

kilobyte
One thousand bytes. Actually 1024 bytes because of the way computer math works out.

L

layer
An image carrying information from one specific area of depth in the scene. Compositing is started with the layer furthest off the eye, i.e. the background. In an outdoor scene this is often the sky. From there it is proceeded forwards, layer by layer, until the image with the information nearest to the eye (such as the face of an actress) is reached.

linear editing
Editing using media like tape, in which material must be accessed in order (e.g., to access scene 5 from the beginning of the tape, one must proceed from scene 1 through scene 4).

luma-keying
Like chroma-keying, except that the matte is derived from the differences between the luminance of the background and the object to be masked. Not so versatile, and thus less used, than chroma-keying.

luminance
The black and white, or brightness, part of a component video signal.
Definition of terms

M

Matte
An image or a part of an image containing transparency information. The matte is usually a black and white image (1-8 bit) where the white areas are opaque and black areas transparent. This is suitable for compositing, but if it is used to produce transparency on a model in a 3D software, it has to be inverted first. At rendertime, 3D applications automatically generate masks for the objects in the scene. In successful compositing the quality of the matte is crucial.

matte painting
Film special effect: to paint background images for live action scenes. They were previously hand-painted on glass, but are today created digitally on a paint program.

megabyte
1 million bytes.

memory
A device or apparatus used for storing information. Memory exists in many forms and can be classified in several ways. Memory is either volatile or non-volatile, meaning that its contents may or may not be lost when power is removed. Volatile memory includes DRAM and SRAM; non-volatile includes ROM, CD-ROM, and rotating magnetic media.

MIDI
Musical Instrument Device Interface. MIDI is a serial communications port for controlling MIDI-compatible musical instruments such as keyboards. In addition to playing the instrument, notes may be recorded from the instrument as well.

modeling
The process of constructing 2D or 3D elements in the computer (cartesian) space.

moiré
A distracting wavy effect produced when converging lines in a video image are nearly parallel to a monitor's scanning lines.

monitor
Usually refers to the display device of a computer. The most common display device is based on the cathode ray tube (CRT) in which a beam (or beams) of electrons is (are) directed at a transparent surface coated with phosphors that glow in primary colors when struck by those electrons. The image created by those excited phosphors are viewed through the transparent surface (glass) by the computer user.

motherboard
The main PC board in a computer that has on it as a minimum the CPU (the microprocessor and its associated support circuitry), sockets for main memory, the BIOS, the CMOS RAM, a set of I/O bus connectors, and a keyboard connector. The
motion capture

External devices can be used to capture movement data from various live sources. This data is then transmitted to the computer, where 3D simulation software displays it in real-time applied to a virtual actor. Or 3D animation software records it in real-time and creates function curves from it. The capture devices are usually divided to two categories according to how they sense the movement: electro-magnetic, where the sensor continuously scans its position and orientation in relation to the static field transmitter, and to photometric systems, where 1-3 cameras scan the movement of reflective or fluorescent pads. 3D signal can be created on a system with three cameras. Motion capture is most often used to sample movement of human body, such as dance. The sensors are attached to the body near the joints.

motion control

Similar to motion capture, except that motion control is a two way system: data can be output from computer software to hardware devices. Often used by special effects houses to match live and software camera motions to get perfect line-up. Zoom may be transmitted through one channel, pan through another, etc. Motion control requires special hardware to carry the tasks given by the computer. For example, a motorized camera head, a 'memory head', uses little servo motors to adjust zoom, pan, etc. according to the stream of commands coming from the animation or simulation software.

motion tracking

Matching computer animation to live action on the frame by frame basis. Often used to line-up software camera action to the live camera. Laborious and time consuming method because almost every frame has to be tweaked and keyframed separately on the computer. Used as a last effort if there is no motion control system available. Used by special effects facilities.

mouse

The most commonly used pointing device for interfacing with computer software. Typically the mouse consists of a captive ball roller that drives two internal rotary position encoders perpendicular to each other.

multimedia

A somewhat ambiguous term that describes the ability to combine audio, video and other information with graphics, control, storage and other features of computer-based systems. Applications include presentation, editing, interactive learning, games and conferencing. Current multimedia systems also use mass storage computer devices such as CD-ROM.
Definition of terms

N

network
An interconnection of computers and other devices for the purpose of sharing files, data, programs, and other resources such as printers.

noise
A general term used in electronics to indicate any unwanted electrical signal, unrelated to the original signal. Video noise is generally manifested as snow, graininess, ghost images or picture static.

nonlinear editing
The process of editing using rapid retrieval (random access) computer controlled media such as hard disks, CD-ROMs and laser discs. Its main advantages are:
1. Allows you to reorganize clips or make changes to sections without having to redo the entire production.
2. Very fast random access to any point on the hard disk (typically 20-40 ms).

NTSC (National Television Standards Committee)
Standard of color TV broadcasting used mainly in the United States, Canada, Mexico and Japan, featuring 525 lines per frame and 30 frames per second. (See PAL and SECAM)

O

off-line editor
A low resolution, usually computer and disk based edit system in which the creative editing decisions can be made at lower cost and often with greater flexibility than in an expensive fully equipped on-line bay.

on-line editor
An editing system where the actual video master is created. An on-line bay usually consists of an editing computer, video switcher, audio mixer, 1 or more channels of DVE, character generator, and several video tape machines.

operating system
Software (or firmware) present on a computer that provides the interface between the application programs and the hardware (or the routines that operate the hardware known as the BIOS). An operating system provides to the application program services like opening and closing a file, determining the state of the mouse buttons, writing data to I/O devices, etc.

optical fiber
A long strand or filament of glass or plastic through which an optical signal (or beam of light) can be sent.
overscan
Video images generally exceed the size of the physical screen. The edge of the picture may or may not be displayed, to allow variations in television sets. The extra area is called the overscan area. Video productions are planned so critical action only occurs in the center safe title area. Professional monitors are capable of displaying the entire video image including the overscan area.

Definition of terms

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P

Pan
Rotating camera along vertical axis, i.e. moving camera target sideways.

particles
Non-volume, non-surface 2D pixels in 3D space, often used in multitudes. Particles' behavior is affected by the natural forces such as gravity, winds, collisions to other objects and group dynamics: all properties of a group of particles can be defined by a mean value and a deviation, resulting in flock behavior. Useful in visualizing 'non-material' natural phenomena such as snow, fire, smoke, grass and hair.

partition
A portion of a disk drive's storage space set aside for a specific purpose.

path
The descriptor of a file stored on disk. The path includes all the directories between some point in the directory tree and the file. A complete path starts with the logical drive name and includes all directories starting with the root directory.

Phong Shading
Calculates normal separately for every pixel on the surface and also processes the relation between normal, direction of the light source and the direction of the camera's point of view. This method gives a much better surface curvature. Phong suits best for plastic materials. Though much more computationally expensive than lambert or gouraud, phong is the most popular shading method today. Developed by Bui Tuong Phong in 1973.

pixel
Stands for picture element, the smallest element of a two-dimensional image. The basic unit from which a video or computer picture is made. Essentially a dot with a given color and brightness value. D1 images are 720 pixels wide by 486 high. NTSC images are 640 by 480 pixels.

plate
Synonymous to layer. The term clean plate refers to the background layer.

pointing device
A device used to manipulate a cursor or otherwise select information for entry into a computer. Examples of pointing devices
Definition of terms

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**Definition of terms**

- **post-processing**
  - Refers to various tasks that, due to their nature, can only be carried out after all the material is available. In the world of CG these tasks often include compositing different layers of animation, and merging CGI and live action. Image enhancement, such as gamma correction, also typically takes place here. Because of the nature of post-processing, many of the terms used here belong exclusively to the special effects vocabulary.

- **post-production**
  - All production work done after the raw video footage and audio elements have been captured. Editing, titling, special effects insertion, image enhancement, audio mixing and other production work is done during post-production.

- **program**
  - A set of instructions for a computer.

- **progressive scan**
  - A scanning system for video screens where each line is displayed progressively (1, 2, 3, 4...) as opposed to interlaced (1, 3, 5, 2, 4, 6...). Computer monitors use progressive scan.

- **projection**
  - In 3D animation, a method describing how the texture is wrapped around the object.

---

**R**

- **RAID**
  - Redundant Array of Inexpensive Drives, a mass storage system utilizing multiple disk drives and usually employed on network servers.

- **random access memory (RAM)**
  - A storage device organized in such a way that every element stored in it is as accessible as every other element. Each element is identified by a unique address. In the PC, main memory is random access memory, and is physically constructed with integrated circuits known as dynamic RAMs which in turn are built into subassemblies called SIMMs or DIMMs.

- **raster**
  - An array of lines drawn to create an image. A computer monitor and a TV both use a raster display. The intensity and color of each line varies along its length to make its portion of the image.

- **raytracing**
  - Rendering algorithm which incorporates shadows, reflection and refraction, and is the most widespread rendering method.

- **Read Only Memory (ROM)**
  - Refers to any kind of memory or storage device whose contents cannot normally be changed. This includes the mask programmed semiconductor memory, and write once devices like the recordable CD-ROM.
rendering
Generating the final image(s). Rendering refers to the calculation of the scene by the computer. Rendering usually takes place during the adjusting of materials and, finally, after all human labor on the scene has ceased, i.e. at night. Render outputs image files (usually 24, 25 or 30 per one second of animation) to the hard-disk.

resolution
A term used to describe the detail of a displayed image. The resolution of a monitor is inferred from two specifications: the number of pixels in the image array, and the dot pitch.

resolution independent
A term to describe equipment that can work in more than resolution. Most equipment can do film resolution or video resolution, but not both. Resolution independent equipment can work in both.

RGB
Red, Green, Blue. The primary colors of light. Computers and some analog component devices use separate red, green, and blue color channels to keep the full bandwidth and therefore the highest quality picture.

roll
Rotating camera along the line of sight. If animated, a swaying effect is achieved.

rotscoping
The last resort: if there is absolutely no other way to extract a mask you can naturally do it by tracing the contours of an object by hand (frame by frame). As well imagined, this is an extremely laborious and time-consuming method.

S
safe title area
Generally, the center 80% of the entire overscan video image area or that area which will display legible titles regardless of how a TV monitor is adjusted.

SCSI
Small Computer Systems Interface. A high speed bus for connecting peripherals to a computer. SCSI comes in several flavors: the original 8-bit wide clocked at 10 MHz; Wide SCSI which is 16 bits wide and clocked at 10 MHz; Fast SCSI, which is 8 bits wide and clocked at 20 MHz; and Fast and Wide SCSI which is 16 bits wide clocked at 20 MHz.

server
A computer that provides services and information to programs called clients running on other machines. Among others, there are file servers that maintain data files shared by multiple users, and application servers that maintain programs that are run by the clients.
shading
Assigning surface properties to objects.

software
Another term for program or programs.

soundcard
An add-in device for a computer that enables it to create or play back sounds from various recorded media.

special effects
Artistic effects added to a video production in order to enhance the production by creating drama, enhancing the mood or furthering the story. Special effects may vary from the limited addition of patterns or the mixing of several video images together, to sophisticated digital effects such as picture compression, page flipping and three-dimensional effects.

split screen
An electronic process which allows the viewing of two video images, side by side or above and below, on-screen simultaneously.

storage
A term describing long-term and non-volatile memory. Storage of data can be accomplished on disk drives, CD-ROM, or tape.

superimpose
To place in front of video, e.g., placing text over a video signal.

texture mapping
Method for wrapping 2D pattern or image around the 3D surface. Texture mapping can dramatically add realism even to a most rudimentary geometry.

tilt
Rotating camera along the axis perpendicular to the line of sight, i.e., moving target vertically. If animated, a nodding effect is achieved.

timecode
A time reference recorded on tape to identify each frame.

titling
The addition of text, symbols and graphic elements to a video image. Titles may be added to a video scene during shooting or in post-production. Sophisticated titling devices allow the user to prepare text and graphics in various sizes, fonts and colors to be triggered later, one-by-one, at appropriate places within a production.

tool bar
In a Windows program, the tool bar is a collection of buttons with icons placed along one side of the screen. The buttons are short cuts to functions that could otherwise be performed by a series of mouse or keyboard operations.
travelling matte
An approximated, moving matte that isolates an object from the background. Most useful in masking flying objects that never get too close to each other. Often travelling mattes need to be perfected by hand or by combining it with other matte-pulling methods. Then it is a garbage matte.

ultimatte
Synonymous to blue screen. Originally the name of the company manufacturing chroma-keying systems.

unix
An operating system developed by AT&T, usually found on workstation class computers such as those made by Sun Microsystems, Hewlett Packard, Silicon Graphics, and others.

VHS

video projector
A display device which projects a video or computer image onto a large screen. The classic video projector has three primary color video tubes which converge on-screen to create the full color image.

VRAM
Stands for Video Random Access Memory. Memory on a video adapter composed of dual-ported RAM chips.

window
A rectangular region of the display in which a task can be viewed. Each window has separate controls for sizing, positioning, scrolling, etc.

wipe
Special effect in which two pictures from different video sources are displayed on one screen. Special effects generators provide numerous wipe patterns varying from simple horizontal and vertical wipes to multi-shaped, multi-colored arrangements.

wireframe render
Wireframe display of the camera preview window rendered. No shading, lights, etc. is calculated. Objects appear as transparent wireframe models.
Chapter 2. Review of related literature
Review of related literature

Being a relatively young artform, the bulk of the references used in the production of this thesis project were predominantly periodicals that have been published in the last ten years. Some of the source materials used were standard manuals, like the Classroom in a Book series, which was indispensable in discovering some of the more esoteric functionality of the software. Also, the Real World After Effects book was of great assistance, mostly due to its clear and concise explanations and examples, as was the official user guide that comes with the software.

Outside of technical studies, the most information was found within current or relatively recent magazines that deal with the industry of filmmaking or the graphics arts. Print magazine, a publication about graphic design, published two very interesting articles in the early 1990's about the use of graphics and effects and digital technology in film production. One of the articles discussed the work of Industrial Light & Magic (ILM), a prominent special effects house working in the feature film industry. Upon further reading about ILM and their techniques, I began to realize that while the scope of the projects and the quality of work were in a league of their own, they were still based upon fundamental theories and logical approaches. Other articles dealt with hardware and software advancements and other new technology. American Cinematographer, a staple publication in the filmmaking industry, also published several articles in the early 90's discussing the exciting new world of digital effects and non-linear editing, which at that time was just beginning to become more and more of a reality. It was most interesting to read the reactions of many in the film industry at that time in regards to the new technology, and the emergence of a new breed of artists. There seemed to be a majority that had their doubts about the success of such an unorthodox method of working, and longed to keep the realm of film editing in the comfort of the familiar film bench. The best synopsis that describes the exciting growth of the medium is an excerpt from an article on feature editor Rob Kobrin and the future of non-linear editing:

"A century of razor blades to the contrary, Kobrin predicts that this method of feature editing will be standard in five years. "I know of a number of significant editors who are attempting it now," he reports. "I think there's going to be a transition period where everybody struggles and is very tentative. A lot of people think it can't be done, that it doesn't work, but we've had no significant technical problems; we've done it. Avid's just been tremendous, and all it's taken is some telephone support. We're actually downloading new versions of the software by modem. We're going to continue to evolve." (1)

The most interesting aspect of obtaining these sources is that they describe the gradual dominance of computer graphics and editing in the field of filmmaking, and during the course of production on this thesis project, I have had the opportunity to watch many of the predictions and assumptions come to fruition.

(1) "Computers in Filmmaking" American Cinematographer (Sept '93) p.59
Chapter 3. Procedure
The next several pages describe the various methods used in the production of the scenes that make up this thesis project. The steps discussed are based on the software and hardware that was made available to me through my employment at a professional video post-production facility, and are similar to those used in the production of high-end broadcast graphics. Previously in this report, the procedure covered dealt primarily with the Computer Graphics Design lab and its equipment, which posed many interesting obstacles (for more details, see Limitations, p.7). The availability of an AVID non-linear editing system, PowerMacs with a vast array of graphics and animation software and 150 MB of RAM, and an extensive amount of analog audio and video equipment, helped to greatly increase my productivity and the quality of the work as a whole.

Before discussing the desktop techniques of creating the graphics and effects, the actual methods used in shooting the video footage has some bearing on the project as well. The biggest aid in the process in using both the consumer and professional SONY camera systems, was the small color SONY NTSC monitor. While shooting the action, the camera's output was sent through the monitor, so that the composition and exposure of the scene could be viewed more easily, without having to rely on a small black and white viewfinder. This method could not always be used however, since some shooting took place outdoors, and a second power source would have been required. Another facet of the production that made everything much easier was the lack of audio captured with the live action. There was no scripted dialogue, or synchronous sound in the entire video. All shots were to be cut to music in the final piece, and if any extra sounds would have been needed, they would be added after the fact, in the post-production process.

For the most part, the shooting was relatively easy, yet time consuming, including a few minutes of footage that was shot on 16mm film. This was accomplished with the help of the same film student that allowed me to borrow his camera, and other film and video equipment. The roll was shot indoors, with a modest lighting setup, then sent away for processing. Once the processed film arrived, it was screened by myself and the cinematographer, then sent away yet again to be transferred to Hi-8 videotape, so that it could later be edited into the piece in the Hi-8 editing suite. This was of course, before I finished the project at the higher end facility, where the final piece was mastered to Betacam SP, a much higher grade of videotape, with superior resolution.

In order to get the footage into the computer, so that it could be both edited and treated in various graphics applications, it first had to be digitized, and brought into the AVID. The AVID is a non-linear editing system, in which video footage is captured at full resolution using advanced hardware and software, and is then edited within the computer. The Hi-8 footage was gathered, and transferred to Betacam using the analog Beta deck to record the output of the Hi-8 camcorder. This was necessary because the AVID was hardwired to another Betacam deck, which was used to digitize video, audio, and timecode by means of a remote connection that controlled the playback of the deck. The timecode was required by the AVID to log and digitize the footage, but also so that it could later batch digitize all or some of the clips if any were inadvertently deleted, or wound up missing. The Hi-8 tapes that I had shot had no timecode, and that is why they had to be transferred to Betacam, so that running timecode could be added during the recording process.
Once the footage was captured in the AVID as separate cuts, each clip that needed effects work was consolidated into a bin (where footage is stored in the AVID's interface). From there, it was exported as Quicktime files via Ethernet to the graphics workstation, where a variety of animation, compositing, and graphics software was used to enhance the footage. It is this part of the procedure that will be discussed scene by scene in the pages to follow.

The bulk of the graphics work was executed using Adobe After Effects, and essentially every scene was composited in some fashion using this software. Other applications were utilized as well, however, such as 3D animation and image manipulation software. Once these tools were used to manipulate the prepared footage, the final scenes had to be edited to videotape using the AVID. The system has several advantages over traditional analog editing, one of which is the ability to make changes to a sequence of any duration, and see those changes almost instantly. Since the computer is randomly accessing each frame of video stored as bytes of information, a clip can be played back, cut, or deleted at any point in time, and on any frame. These advantages made the editing of the final piece a much more productive experience than if I had chosen to continue to edit using an analog Hi-8 format. Once the final rendered Quicktime movies were completed, they were imported into the AVID directly as media files, and were edited to form the final sequence. This digital master was then played back and recorded to a Betacam tape, from which dubs were made to the final VHS copies.
Flashback photo transition scene

In this scene, a photograph of the main character and a woman from his past acts as a transition into a flashback sequence. The photograph was shot of the couple (fig. 3.1), then scanned into the computer for retouching and enhancing using Adobe Photoshop. The image size was adjusted to 1000 by 1500 pixels, to allow for an artificial tracking shot which would require the image to retain its quality as the image was scaled to a larger size. This first step was accomplished by importing the final PICT image into Adobe After Effects and scaling it from 65% to 100% over the duration of the scene. This created a simulated in camera tracking shot in which the image fills the frame (approx. 720 x 675), then ‘zooms’ forward until it reaches full size (1000 x 1500). This element was then saved as a self-contained composition, then was used as the first shot that would eventually transition to the flashback sequence.

The flashback sequences was shot on 16mm film, then transferred to Hi-8 videotape (the format I would eventually be editing on), at a professional teleciné house. This footage was used throughout many of the other scenes, as recurring flashbacks. The first shot to be revealed of this sequence was of the main character and his girlfriend strolling through the park on a picnic (fig. 3.2). This clip was also imported into After Effects, where a ripple effect was applied, and the overall contrast was boosted slightly. The ripple effect was used in order to exaggerate the natural movement within the clip, and the contrast was adjusted in order to achieve a greater isolation between the light and dark areas of the image (to help in pulling a more distinct luma key from the image later). A third composition was then created, and both the photograph composition and the live action film sequence composition were brought into the timeline of the third. The photograph shot was placed first in the timeline (since it was the shot I was transitioning from), and acted as the lower layer underneath the live action composition, the in-point of which was set to coincide with the near completion of the tracking shot in the first shot later in the timeline (fig. 3.3).

The next step was to not merely dissolve between the two shots, but to slowly reveal sections of the image over the original shot. To accomplish this effect, a luma key was applied to the live action composition, and was set to make the brighter areas of the image transparent, while keeping the darker areas of the image opaque. The transparent areas of the clip then acted as edge information for a Final Effects Light Blast effect, which was set to interact with the alpha channel information on each frame of the clip, thereby using the luma key data applied before it in the effects hierarchy (fig. 3.4). This interaction with the constantly changing alpha channel, derived from the combination of the ripple effect and luma key filters, creates artificial light rays that become dynamic as the image changes from frame to frame (fig. 3.5). The final step was to add a solid white layer to the final composition, the opacity of which was key-framed to become fully opaque during the last few frames of the dissolve. This accentuated the ‘flash’ of light, and allowed for the scene to be easily edited later. This technique proved useful as a method of consistently revealing information through flashbacks without totally replicating a standard transition, and was used in some later scenes also.
-Colorized liquid scene (medium shots)-

This scene was devised in order to prepare for a transition into another flashback sequence. The main character stares intently at a glass of alcohol that he has busily been emptying, and as he continues to drink, the liquid in the glass becomes the only part of the frame that is in color. The entire effect takes place over eight separate shots, with varying angles and types of action, but the technique is the same for all of them. The close-ups that occur in the scene have an added element that complicates the effect, and is discussed on the next page. The effect doesn’t deserve all of the credit, however. It was the actor’s believable reaction to something that was in fact not happening, which aided in the completion of the illusion. The example here discussed consists of only one of these eight shots.

The idea behind the effect itself is quite simple, although the execution was incredibly arduous. The effect required only the original footage to execute (fig 3.6). This was placed into a composition and a color balance effect was applied, and the saturation was dropped completely. This converted the clip to a grayscale image, so that it would match the body of black and white footage throughout the piece. The same clip was placed again from the project bin into the same composition, above the previous clip, and at the exact same in-point, so that the two clips matched timing precisely. The clip residing in the upper layer retained its original color, and no external effects were applied. The upper clip was then divided into three separate sections, wherever the shot changed to another angle (fig 3.7).

Next came the most difficult part of the process, rotoscoping a mask on every frame of the footage in the upper layer. Rotoscopying is a method of tediously manipulating an element in a scene frame by frame. A keyframe was set on the first frame of the clip, and a freeform mask was ‘drawn’ around the liquid in the glass using the bezier pen tool (fig 3.8). This mask was set to reveal only the image information within the confines of the bezier shape, and a slight feathered edge was added. This successfully accomplished the illusion that the liquid in the glass was in fact the only colorized part of the scene. Since all of the shots combined to account for over one minute of footage, approximately 1,800 separate frames had to be fine tuned by hand. This laborious process of adding, deleting, and adjusting several control points on each mask on every frame, required several days of intense work, and was compounded by the fact that the image being masked was in fact a liquid, and sometimes changed shape dramatically from frame to frame. The end result is hopefully proof that the time was worth spending.
-Colorized liquid scene (close-up shots)-

The second half of the colorized liquid scene, this effect utilizes the exact same techniques as the previously mentioned scene. However, it has an added element that serves to reveal to the character the nature of his visions. As he peers further and further into the liquid in the glass (fig.3.9), he begins to see a flashback of the day he and his ex went on the picnic. At first, it is difficult to discern exactly what the image is, and eventually it becomes clear and sharp only for a moment, before fading out again.

The method used in this effect involves re-importing the picnic clip into the project (fig.3.10), and then placing the clip inside of a new composition. The clip is then scaled to match the size of the glass in the corresponding live action shot. A ripple effect is applied and animated over the duration of the clip, so as to emulate the flow of the liquid in the glass (fig.3.11). The picnic composition is then placed into another composition with the original clip, where it resides as an upper layer. The animated mask keyframes created earlier are then copied and pasted into the picnic composition, which reveals only the elements of that composition that exist within the mask (fig.3.12). The opacity settings of the picnic composition are animated along with a blur effect, to simulate the gradual increase in clarity of the vision of the main character. There are three of these types of shots in the entire scene, each closer to the glass than the last, which build to the completion of the scene, as the main character enters a world flooded with memories.
-Smokestack scene lead-in-

In this scene, the character settles down for the evening while reading the paper, but slowly becomes more and more disturbed by ominous feelings and visions. As he looks about him, the room slowly starts to take on a new look; that of an eerie chamber, emitting steam and hissing noises. I had to approach this effect with an understanding of what was and was not possible. Since I was unable to shoot real chroma-keying or utilize motion control, I had to keep camera movement very simple and constrained, while still revealing a sense of the changing environment. In order to accomplish this, A single light source was used in the shot, and the camera panned from center to right, and center to left. As the camera pans, the darkness envelopes more and more of the scene, since the objects in the scene are less illuminated by the central light source. This was pre-planned in order to enable a simple composite in After Effects, where a feathered animated mask was applied to the footage over a completely black background.

The initial step was to import the original footage of the character seated in a chair (fig.3.13), and other image elements created in Adobe Photoshop. These images consisted of a photograph of a brick wall (fig.3.14) that had been manipulated using lighting effects and adjusting the color balance, giving the photo an overall 'eerie' green look. Once these elements were imported, the real trick was to mimic the motion of the camera pan, and simulate a shot that moves from the main character, into the eerily transformed room, and back again. This was done by placing the brick background frame into the corner of a composition that was twice the width of the image (fig.3.15), to allow for a small area of black to come between the live action and the digitally manipulated background. Then, to heighten the effect of being in the dank base of a smokestack, particle systems were placed along the bottom edge of the brick background image, and adjusted to create a dense, steam effect. After the completion of this composition, it was placed into another composition, where its position was later animated to match the camera movement in the live action shot. This is where the subtle shift in the background of the live action footage helped in avoiding a 'jumpy' transition into the brick wall composition (fig.3.16). The steps involved in creating this effect were repeated several times in about four separate scenes, and in both directions, where the camera pans both right and left. Each time he notices the odd events around him, the character becomes more and more agitated and frightened. The timing of these effects build in intensity, until they eventually lead to the climax of the scene, which is discussed on the following page.
-Main smokestack scene (climax to previous scene)-

There are many facets involved in the creation of this scene. It included the production of a 3D animation in Strata StudioPro, with an alpha channel that would later be composited in After Effects with the live action footage. The footage consists of one camera angle above the characters seated position. The scene picks up from the previous one, where the character is frantically looking to his left and right as he finds that the walls are closing in all around him. As he looks up, the camera tracks back, pulling through a long steam filled tunnel, and finally revealing the smokestack that traps the main character.

This scene required quite a few complex composites, which eventually were combined in one final composition, and rendered as one final scene. The first step was to model the smokestack and clock base in Strata StudioPro (fig.3.17). Once the objects were modeled correctly, texture maps were then applied; a brick texture (the same photo used in the previous scene) for the smokestack, and one for the clockface. The color of the texture maps on the inside was altered to match the color of the interior of the tunnel seen in the earlier scene, while the outside was left to look like natural brick. The camera was then animated from the base of the smokestack to the opening, then tracked back, revealing a wide shot of the entire scene. The final touches to the 3D animation required a large green light placed at the base of the tunnel to fluctuate over the duration of the clip (this would later be matched in After Effects with extra lighting effects). The final phase of the 3D work was to render the final animation at video resolution (in this case, 720 x 486 pixels), using the native Quicktime animation codec, which allows for rendering animations with alpha channels. The alpha channel embedded in the final 3D smokestack movie enables any area that does not contain model information to reveal background layers that lay behind it during compositing.

Once rendered, the 3D animation clip was imported into After Effects, along with two other live action clips, and an animated sky composition (fig.3.18). The first live action clip, with the top view of the character panicking, was placed as the bottom layer of a new composition. The 3D smokestack clip was then added to the same composition, only it was placed so that it began right after the actor turns his head upward in the live action clip. The embedded alpha channel in the 3D clip allowed for the live action shot to be visible during the artificial tracking shot that takes place. At this stage, the live action clip had to emulate the tracking shot in order to be remotely realistic, so the scale factor of the clip was animated from 100% to a smaller value for the duration of the shot (fig.3.19). The key at this point was to try to match both the timing of the camera motion, and the perspective of the image (the relationship of the foreground to the background).

As the 3D camera begins to tilt up and out of the top of the smokestack, I wanted an artificially green sky to fill the frame. Earlier, I had created an animation in which various layers of clouds pass slowly by in a blue sky. This composition was imported into the project, and placed as another layer behind the other clips in the original composition (fig.3.20). Once in place, a color balance filter was applied, and the green values were increased, until they matched that of the earlier scenes.
Another finishing touch to the scene was to add an artificial glow to the inside of the smokestack, one which matched the timing of the animated light source used to render the clip. This was accomplished by placing a bright green solid layer over the 3D clip in After Effects, and setting the layer mode of the solid to 'Add'. This setting combines the color values of the layer and other layers beneath it, creating an intensely bright image due to the combination of the layers of bright green. At this stage, the opacity of the solid was keyframed at various increases and decreases in value, to match the fluctuating light source in the 3D clip. Once this was done, the last part of the process was to make the transition from the 3D scene to another live action sequence. In the scene, the entire image fades back into the mouth of the main character, as the camera tracks back to a medium shot of the same room at the beginning of the scene. To create this effect, the new clip was placed in the composition as the new bottom layer (by this time in the scene, the other live action clip had reached its end-point), obscured by the full frame image of the 3D clip and clouds background. At the beginning of the live action shot, a keyframe was set for the opacity of the clouds layer, and as the camera tracked back in the clip, the opacity was animated until it reached zero value (transparent). This left the image of the smokestack over the image of the actors screaming mouth as it decreased in size. The opacity levels of the smokestack clip were also dropped to zero, until only the live action shot remained. Finally, the camera tracks back all the way out of the actor's mouth before coming to rest, and the scene ends.
-Main title sequence-

The title sequence consists of two essential sections. The first is the main title graphic, which is then followed by the opening credits. The purpose of the main title is to establish the mood for the story to follow, a prologue of sorts, in which the basic theme of the story is conveyed through imagery and music. This is done so that the viewer may ‘ease in’ to the story, and its mood. In this particular title sequence, graphic elements and photographs were used more often than live action footage, which was only used in the opening credits. A photograph was taken of the main character with his eyes open, and another with his eyes closed from the same position. These were then imported into Adobe After Effects, along with a few other graphic elements; an arrow image created in Adobe Illustrator (fig.3.21), a large, vertical PICT image of a random grain pattern, and a video clip of a running stream. Text elements were also created in Illustrator, so they could eventually be scaled to any size in After Effects, while still maintaining a highly defined edge. This is accomplished by the software itself, in a process called ‘Continuous Rasterization’, in which any graphic element is converted from its original vector, path-based format to a rasterized, pixel-based format at every stage of geometric change. In other words, instead of rasterizing an image once and having the quality suffer if large scaling is later applied, the image is continuously ‘re-drawn’ after every parameter change. This method came in very handy when scaling the arrow and type elements in the title sequence. If continuous rasterization was not an option, then the graphics would have to designed more accurately at their final size, and free experimentation would have been much more difficult.

Once the elements were brought into the project, the photo with the eyes closed was colorized, then passed through an invert filter, in which the RGB values were reversed. This photo then acted as the bottom layer, and its position was animated so that it moved from the bottom of the frame, to the center over the course of the animation. The grain layer was then placed above it, and its position was also animated, but this time across the frame horizontally. The arrow image was then brought into a separate composition and placed above the stream Quicktime. There, it was passed through a ripple and blur filter, and its scale and position parameters were animated so it would move forward from the forehead of the actor, in a slow zoom (fig.3.22). It was then used as an alpha mask to reveal the Quicktime movie of the stream beneath it. This made the arrow more dynamic, and the narrow mask it created helped to make the stream footage more ambiguous and abstract. This composition was placed over the one containing the photographs and grain. Since After Effects compositions have a default alpha channel, the background is automatically transparent, unless designated otherwise. This meant that the arrow appeared directly over the forehead of the actor in the photo. Finally, the text elements were animated over the background, and as the arrow scales forward at the end of the title sequence, the photograph of the actor’s open eyes was placed in position over the old photo, which helped to create the illusion that he suddenly opens them, and is aware (fig.3.23)
-Opening credit sequence-

Similar to the main title sequence, the opening credits continue to carry the theme, while providing important information about the main people responsible for the production. The information presented during the opening credits is sometimes limited due to time constraints, and usually only deals with the key people involved. In this particular project, since it really isn’t a full-blown professional production, only my name and the names of the two main actors were shown. This was done primarily to fulfill the purpose of an opening credit sequence, while at the same time keeping it within a manageable duration.

The imagery used in the credit sequence is similar to that used in the title. The stream footage was placed into the background and colorized to appear in a golden hue, and its duration was looped so that it would fill the full thirty seconds of the scene. The arrow was once again imported and used in the animation, only this time it was repeated throughout the scene, and its motion reversed to form a tunnel into which the other elements seemed to be ‘drawn’ into. More text elements were imported from Illustrator, and their scale values were animated, so they would appear to shrink back into the vortex, blurring and fading as they did so. The two most interesting elements used in the credits, however, are a floating clock, and a ‘ghost’ of the main character running in place away from the tunnel. The clock element appears to have 3D perspective, yet it was really a 2D photograph which was manipulated in Photoshop. The image was cropped using a path created by the bezier pen tool, and was then divided into three components; the minute hand, the hour hand, and the clock face. These individual components were placed within separate layers, so that they could then be animated independently as a Photoshop composition in Adobe After Effects. Once imported into After Effects with its transparency settings intact, the hour and minute hand layers were animated to rotate rapidly around the clock face (fig.3.24). This was accomplished by repositioning the anchor point of the hand layers so that they rotated fully around the center of the clock, as normal hands would. The next step was to apply a Basic 3D effect to the clock composition within the main animation (fig.3.25). This effect was used to help create the illusion that the clock had true perspective by independently animating the rotation of the layer around the X,Y, and Z axis. The position and scale values were then animated, to create the appearance of the clock spinning off into the vortex.

The other interesting element within the credit sequence, is the running ‘ghost’ of the main character. This was created by digitizing live action footage of the character running at night illuminated with a key light. Originally, this footage was to be used in the final piece, but the footage was much too underexposed to be usable. I decided to incorporate it into the credits by importing the shot, masking out only the running figure, inverting the RGB values of the clip, applying a ‘Find Edges’ filter (to create edge definition). Finally, it was placed over the background footage using the ‘Add’ layer mode setting. This combined the golden color of the clip with the golden color of the stream footage, creating the effect of a running spectre (fig.3.26). Once all of the elements were in place, then the final animation was rendered at full video resolution (fig.3.27).
'Zoom' into basket scene

The character finds himself drawn into a type of dimensional 'portal' when he examines the interior of a seemingly innocent picnic basket in this scene. As he lifts the lid of the basket, he notices a strange pulsating glow, and before he can react, he is quickly pulled inside. The shot itself was obtained by cutting out the bottom of a picnic basket and placing the camera inside facing out towards the actor. The effect was accomplished by later digitizing and importing the live action footage of the actor peering into the basket, and applying effects which simulated a quick 'pull' towards the center of the frame. Once imported, the clip was placed inside of a composition in which a particle system solid was added as a top layer. The particle effect was set to emit diamond shaped 'sparkles' in order to create the sense of an intense light source at the bottom of the basket (fig. 3.28). The clip was then duplicated and placed over the original, where the layer mode was switched to 'Add', and a compound blur applied, so that the clip layer itself acted as a blur source. This adds a diffused look, or 'glow' to the scene when he peers into the basket. I then implemented a method used in other scenes to create an undulating and fluctuating pulse of light. Two white solid layers were added to the composition and their layer modes switched to 'Add' and 'overlay' respectively. The opacity settings of these two layers were then keyframed to jump from high to low levels over time, simulating the dimming and glowing of a light source.

This entire composition was then placed inside another, where a light zoom effect was applied. The ray length settings were then animated to increase from a low setting to a higher setting, thereby blurring the clip, and simulating the look of the actor being drawn quickly into the basket. The most crucial aspect of this otherwise simple effect was to time the animation parameters with the action on screen, since the recorded image of the actor lunging forward in combination with the effect was key in its execution (fig. 3.29).
Smoking basket scene

In this scene, a very simple, yet arduous rotoscoping technique was used to create the illusion that the picnic basket in the previous shot emits a puff of smoke after engulfing the main character. In order to achieve this effect, the actor held the lid of the basket open for a few seconds, then quickly pulled his hand away, letting it close (fig. 3.30). I then digitized the shot, isolated those few seconds, and exported an Adobe Filmstrip file. This Filmstrip file was then opened in Adobe Photoshop, where it was retouched frame by frame. The image of the actor in every frame is removed using the cloning tool, leaving only the basket to appear as if it is closing on its own accord when played back in full motion (fig. 3.31). This tedious process is efficient only as long as the duration of the shot is no more than a few seconds, since one second equals thirty frames, and cloning out an image by hand over two hundred times isn't a very entertaining prospect.

Once the rotoscoping portion of the scene is completed, the clip is then imported into Adobe After Effects, where it is place inside a new composition. Another solid layer is applied above the clip, and a particle system is generated from that solid. The particle system settings are then animated and given certain parameters so that it appears that smoke is billowing from the lid of the basket (fig. 3.32). After this effect is timed correctly, and the settings are adjusted properly, the smoke must react to the force of the wind created by the closing of the lid. This was accomplished by adding a bulge effect after the particle system, and animating its center at the appropriate moment when the lid falls shut (fig. 3.33).
Lurking clock scene -

The main character awakens to find himself in the dream-like world (where he later encounters the basket), and decides to look around. As he wanders aimlessly, a giant clock floats ominously behind him. He runs back towards it, to get a better look, but it has disappeared. To create this scene, it was more important to plan the shooting than the post-production and digital effects involved afterwards. The actor simply had to walk towards the camera, and slowly out of frame, and then immediately back into frame again, with a look of astonishment on his face. Once the footage was digitized, it was imported into Adobe After Effects, and placed into a composition. The time between when the character leaves the frame, and then returns, is measured in the layer window. Then, Strata StudioPro was used to model and animate the clock (fig.3.34). The camera was placed in a locked position in Strata, and the clock was rotated about the XYZ axis, while it remained in the same position. Then a texture map of the scene was created by capturing a frame of the live action footage, and saving it in Photoshop. This was used as a reflection map, so that as the clock turned in space, the trees and grass in the shot appeared to reflect off of its surface. The animation was created so that it would fill the space in the live action in which the actor leaves the frame. Once the animation was completed, and all of the settings were correct, it was rendered with an alpha channel as a full resolution (720 X 486) Quicktime movie.

After a long, overnight render, the Quicktime movie was then imported into After Effects, and placed in the same composition as the live action shot. The first frame of the animation was moved to begin right when the actor leaves the frame. Since the 3D animation was rendered with an alpha channel, the background was visible, and only the clock object was opaque. The clip was then moved to the left of the frame, where a keyframe was set for its position. Then the clip itself was moved out of the frame to the right a few seconds later in the timeline. This automatically set the animated position of the clock, and since the rotation was completed in 3D space, no other animation was necessary. The only thing missing from the scene at this stage, was a shadow. This was accomplished by creating a solid layer of a dark color, and placing it inside the same composition. A elliptical mask was created for the layer, and its layer mode was set to 'Overlay', which kept the darkness of the solid, but allowed the grass behind to show through, thereby creating a more realistic shadow effect (fig.3.35). The solid's position was then animated using the same method that was applied to the clock layer, and the effect was complete. Now the actor appeared to be chasing an object that was actually never really there (fig.3.36).
Standing on clock scene -

This scene made use of a method known as ‘motion tracking’, in which an area of footage is followed by the computer, and a single pixel can be tracked and its position logged into memory. This information can then be used to animate other objects, layers, and clips within a scene. In this case, the character is standing alone on what he slowly realizes is a giant version of the same clock that has been haunting him in his visions. Since the clock’s scale in this scene is enormous compared to the actor, an artificial clock had to be created in Electric Image (fig.3.37), and then imported into AfterEffects with the live action footage. There were many problems to solve in this scene, one of which being the fact the actor was never shot as a ‘Chroma-key’, or ‘green screen’, so he couldn’t easily be extracted from the background in the raw footage, without extensive roto-scoping. Rotoscoping the shot would entail creating a mask for every frame of the shot, and would be quite time-consuming. A solution to this problem was to grab only one frame of the actor, and create a freeze frame that would hold during the entire duration of the scene. This would normally be an unacceptable method, since there would be no movement in the image of the actor. In this case, however, the character appeared to be extremely small in the frame, and would not be noticed as a still image. The actor was placed in the composition with the animated clock in the background, but the new issue was how to anchor the image of the actor to the clock as it moved away into the distance. The answer to this dilemma was to re-open the Electric Image animation file, and create a tracking object. The tracking object was a simple white cube, which was very small, and was anchored to the clock model, following its motion away from the camera. White was selected as the color, but any high-contrast color would suffice, as long as it separated the cube from the background, so that its pixels could later be easily identified by the tracking software. The clock’s visibility was then turned off in the project window, leaving only the small cube, which appeared only as a dot in the frame. The animation sequence was re-rendered at the exact same duration, but with only the moving dot.

This clip was then imported into the After Effects project, where it was placed in the same composition with the other elements. The motion Tracker was selected, and the position of the dot was tracked using the sophisticated tracking cursor (fig.3.38) which examined every frame throughout the duration of the clip, noting and logged into memory the position of the isolated pixel. Once the entire shot had been tracked, the position data was applied to the still image of the actor after it had been properly positioned. This automatically keyframed the movement of the center of the layer to match the movement of the dot position. The only thing left to do at this stage was to also adjust the scale of the image layer, so that it would appear that the actor was vanishing off into the distance with the clock. Once this was accomplished, the final version of the composition was rendered, and the scene was complete (fig.3.39).
Trance particles finale scene -

These scenes were relatively complex in their construction, but the most challenging aspect was applying the same effect to various camera angles, while maintaining a consistent appearance in the effect. In this scene, there is a climactic moment in which the character observes millions of glowing seedlings falling all around him. In the first shot however, only a single seedling falls from an intense light above, and into the character’s hand. As the scene progresses, the particles begin to fall more abundantly, and the camera begins to track out, finally revealing an extremely wide shot of the man under a flowing stream of light and glowing particles.

As usual, the first phase of this process was to plan the shot. This is done so that the most elements of the effects can be obtained naturally in the camera. For instance, to obtain the effect of extreme lighting, I would eventually have to digitally simulate a brilliant light shining from above, but to add a sense of realism to the shot, I lit the actor from above in an attempt to create the right types of shadows. The shot was then added to a composition in After Effects, where highlights were enhanced. The artificial ‘fog’ that appears in the cone of light, is actually a solid layer with a difference clouds effect applied. The position of this layer is then animated across the screen to suggest a floating veil of dust and smoke being caught in the light. In the first shot of the sequence, the actor is first startled by the light, but is then more surprised to see a glowing object falling gently towards him (fig.3.40). He holds out his hand to catch it, all the while following it with his eyes. This aspect of the shot took a little refining of the motion of the particle to achieve the illusion that he was actually watching a falling object. With a little patience and the right adjustments, the illusion was accomplished with exceptional results. The particle itself was a very small solid with an elliptical mask, which was duplicated and set to different layer modes to achieve the luminous effect of a glowing core. The pulsating light effect was again accomplished by animating the opacity settings, as well as an added gaussian blur filter. This particle was then enlarged and copied into another composition, where it was animated to continue falling into a close up shot of the actor’s hand (fig.3.42). Here the attention to detail was a factor since the shot was much closer than the previous one. The continuity between the scenes was also a consideration, because the fluid movement of the particle had to continue as the new shot came into frame. After these establishing shots, I was ready to implement the full series of particle effects. A particle solid was added to the following shot, and the birth rate was set to emit hundreds of particles showering onto the actor (fig.3.42) as he stares agape in surprise. In the rest of the shots, the same particles were applied, but the solid was animated to scale back in sync with the movement of the camera as it tracked back to a long shot of the actor reaching out to all of the falling particles (fig.3.43). Finally, in the last shot, the actor is seen seated on the clock in an extreme long shot which establishes the setting (fig.3.40), and the particles are again scaled to match the perspective of the scene as the camera rests.
Chapter 4. Results
The final version of this thesis project was edited to videotape as a series of scenes which showcase a wide variety of visual effects. However, it is also intended to convey some of the emotional impact of the original story treatment. The story eventually became cumbersome and unwieldy, and due to the time constrictions and budget, the narrative idea was eventually dropped. Instead, the solution was to create a ‘trailer’ for what would hypothetically be a fully produced, longform film. This trailer was developed with the intention of capturing the basic mood of the original premise. In editing this trailer, I tried to isolate the scenes that I felt were most important in providing the audience with just enough visual information to grasp the main thrust of the piece. These scenes were then cut to music, which helped to drive the emotional content in the right direction. The duration of the trailer is slightly longer and is cut much more loosely than those that are typically seen in theaters today, but this was done in order to properly draw out the melancholy and introspective tone and mood of the piece.

The second piece on the tape is a collection of all the original scenes that were not essential to the development of the trailer. These were compiled in an arbitrary order and also cut to music. This method of presentation was chosen simply as a means of documenting the production on all of the effects driven scenes. It is also intended to bear a resemblance (aside from being cut to music) to ‘dailies’, a process that occurs during filmmaking in which scenes are reviewed while the film is still in production. Although there are several hours of original raw footage that was not edited onto the final tape, it was decided that this footage was extraneous, since the focus of the thesis is the application of visual effects and computer graphics in video production. Overall, I feel that the effects work and level of experimentation in the piece at some times met and exceeded my expectations. There were initially a few shots that made me begin to doubt the possibility of their execution, whether due to the lack of equipment, etc. However, during the course of production, I began learning ways to overcome these obstacles by using interesting and sometimes even unorthodox digital compositing and animation techniques. Realism, and matching the graphics with the original footage, was a big issue that confronted me throughout the project. This was due in part to the fact that I had not yet learned how to implement optimal color settings in order to prevent artifacts such as color ‘bleeding’, and oversaturation. Fields became an issue as well, and experimentation was necessary in order to avoid nasty moiré patterns and field disturbances. Yet another technical issue that is simply an inherent limitation of the software, is the color banding that occurs when trying to simulate a broad range of tones within a gradient in After Effects. This is a result of the inability for an 8-bit graphics system, which can only produce 256 shades of color per channel, to smoothly replicate the subtle shift from light to dark. Most 10-bit systems, like Discreet Logic’s Flame, do not encounter this problem, since they can provide 1024 shades per channel (1). This limitation is one of the obvious areas that need to be addressed in the future, if the desktop market is going to compete in the realm of effects and graphics for broadcast and film.

(1) “8-bit vs. 10-bit color” DV Magazine online (July ’98)
Chapter 5. Summary
The world of digital art is constantly growing and changing, affecting artists all over the globe, and how they approach their craft. Whether it's the world of digital filmmaking, photography, music, or any other art form, computer technology has evolved from simply a tool of production, to a tool of expression. Coming from an illustration and fine arts background, my main interest has always been in the expression of ideas through inventive and thought-provoking imagery. After experimenting in many forms of media (print, interactive, web design, photography, and illustration), I have found a medium that allows me to express my ideas through moving images and music, while at the same time working with state-of-the-art tools as a professional artist in a field I find very fascinating.

My experience with this project has enabled me to more fully understand the fundamentals as well as the complexities of digital filmmaking, and where it's future lies. Even at the time of this writing, some of the techniques and technology that were implemented in the production of this thesis project have been surpassed by even faster and more effective tools and techniques. This project was developed as an example of how ideas and imagery can be made into a tangible reality through the use of these production techniques in digital animation and compositing, even on the slimmest of budgets, and most modest equipment.

The implementation of computer graphics and animation in the world of high-end feature films and commercials is becoming more prevalent every day, and the market for talented artists is growing accordingly. The opportunity to pursue a professional career in these fields begins with the understanding of fundamental design and production issues and how best to implement them through the use of computer technology, or, "knowing the right tool for the job." Since hardware and software are constantly shifting variables on any platform, mastery of any production techniques are best gained through constant experimentation with a broad range of applications. However, the fundamentals of design and filmmaking are still equally important, and should be addressed with equal vigor.
recommendations

As the production of this project waged on, several important factors became increasingly evident. One obvious factor is the dramatic impact that hardware and software have on the production quality of any project. Ideally, digital filmmaking has been promoted as an opportunity for artists, who have become empowered by the availability of low cost animation and editing software on the mid-range desktop platform, to create their visions. Unfortunately, quality plays an equally large role along with content in broadcast media and filmmaking. The standards that currently exist in developing graphics and effects for broadcast and other mediums are very high, and in some cases exceed the limitations of current desktop software and hardware. Also, deadlines and well edited animations typically require the ability to work in 'real-time' (a term which implies the ability to see the results of your work instantaneously). This means that at some point, an artist will eventually have to obtain access to high-grade, professional equipment, such as video cards, fast and spacious hard drives, NTSC monitors, and many other professional grade tools, which can be an incredibly expensive undertaking. Until that time, it is best to keep in mind that the same principles apply to the development of graphics and effects on a low end desktop system as a high end workstation at a state-of-the-art facility. Working with the limitations of an inexpensive home system can actually provide challenges that stimulate logical problem solving and creative solutions to the very same problems encountered by professionals in the industry.

Aside from hardware and software equipment issues, the most important advice I can give to anyone is learn the value of patience and persistence. Discovering the endless possibilities of digital media still entails a great deal of experimentation and willingness to make mistakes, before finally coming upon the best solution to the problem at hand.
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