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Anterior medial orbitotomy utilizing the carbon dioxide laser

Scott Edward Williams

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ANTERIOR MEDIAL ORBITOTOMY UTILIZING THE CARBON DIOXIDE LASER

By

Scott Edward Williams

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Approvals

Adviser: Glen Hintz ______________________

Date: 6/26/92

Associated Advisers: Robert Wabnitz ______________________

Date: 6/30/92

Associated Advisers: John Kennerdell, M.D. ______________________

Date: 6/23/92

Special Assistant to the Dean for Graduate Affairs: Philip Bornarth

Date: 6/26/92 ______________________

Dean, College of Fine and Applied Arts: Peter Giopulos Ph.D.

Date: 6/30/92 ______________________

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PREFACE:

This thesis is an account of the processes and techniques used in the production of a medical videotape. The text has been divided into sections describing all aspects of production. The script and storyboard have been included making it unnecessary to view the videotape before reading the thesis. A gallery of illustrations and stills from the videotape have been included as a pictorial reference to the text.

ACKNOWLEDGEMENTS:

At this time, I feel it necessary to mention the following people to whom I attribute the success of this thesis. They are: John S. Kennerdell, M.D. , Director of Ophthalmology at Allegheny General Hospital, Mr. Robert Wabnitz and Mr. Glen Hintz for their patience and understanding, Mr. William Casey to whom I owe special thanks for narrating the video-tape, and Rochester Institute of Technology's Departments of Computer Graphics and Film and Video for their technical support. Finally, I would like to dedicate this thesis to my wife, Mary Jane, my parents, and to the memory of Mrs. Marilyn Schwark.

PURPOSE:

The purpose of this thesis was to develop a videotape for physician and resident education. My goal was to illustrate principles of laser physics, biophysics and the surgical application of a carbon dioxide laser in an anterior micro-medial orbitotomy, a modified version of the Galbraith and Sullivan Technique. This procedure was developed by John S. Kennerdell M.D., Director of the Department of Ophthalmology and Joseph C. Maroon M.D., Director of the Department of Neurosurgery, Allegheny General Hospital, Pittsburgh, Pennsylvania. After viewing the videotape, the audience will have been exposed to concepts of basic laser physics and biophysics. They will also understand how the carbon dioxide laser was utilized in a subtotal excision of a metastatic carcinoid tumor of the left orbit. The completed thesis consists of a videotape which includes portions of the surgery and computer-generated graphics for the clarification of surgical anatomy, laser physics, and biophysics.

RESEARCH METHODS:

In the preliminary conceptualization of my thesis topic, I decided to develop a patient education videotape which illustrated various methods of outpatient ophthalmic laser therapy. To accomplish this objective, I utilized a synthesis of computer and video graphic technologies. My desire to work with this subject and media developed from my formal training as a fine artist and interest in the visual process. To fully realize the importance of such a synthesis, one must examine this media as it relates to biomedical communications.

Historically, Videography's acceptance by the health care industry occurred in the early 1970's. This acceptance as an instructional and research tool was based on the following abilities: (1) to record clinical and surgical procedures, economically, (2) to provide immediate play-back capability for the analysis of complex technical procedures, (3) to permit the recycling of videotape and, finally (4) to provide a corresponding increase in image quality and decrease in equipment cost[1]

Computer graphic's acceptance occurred in the early 1980's in the form of large dedicated graphic workstations. These were primarily designed for the production of 35 mm slides and 2D animation.[2] Personal computer systems or PCs were not accepted because of their high costs. They suffered from hardware and software limitations related to processing speed and resolution. These limitations have since been eliminated with the development of faster processors. The acceptance of the PC as a production tool was founded on the ability to manipulate, store, display and image complex visual information swiftly and economically. Functionally, it is apparent that both Videography and computer graphics were

ideally suited to such a synthesis. I applied this synthesis to this project as a means of maximizing communication, interest and the retention of the viewers.

In the preliminary stages of this project , I conducted research in the concept of visual instruction and biomedical audio visual production techniques. In the area of visual instruction, I found Dwyer's numerous studies in Motion as an Instructional Cue, and Audio-Visual Communications and Effect of Method in queueing Televised Instruction which suggested that both realistic and semi-realistic visuals were most effective when used with motion.[3] The creation of animated queueing such as: arrows, titles and highlights proved most effective.[4] In a related study, Effects of Questions on Visual Learning, Perceptual and Motion Skills, it was implied that realistic visuals had a net effect of distracting the viewer. Dwyer reasoned that the amount of information in such visuals was too great for the viewer to effectively assimilate during a set viewing period.[5] Dwyer concluded that an increase in the realistic detail within a visual would not produce a corresponding increase in the information assimilated by the viewer.[6] From these studies, the following guidelines had been derived for the creation of the instructional imagery: (1) visuals should explain physical and conceptual information, (2) they should act as a memory aid, stimulating retention, (3) visual types, realistic or schematic, should be determined by its function, (4) the client determines the visuals function and (5) the graphics must serve to attract attention visually and aesthetically. These factors were applied in the concept development of the video.

At this point in the research process, it became apparent that a content expert would be necessary to bring this project to completion.

Having already familiarized myself with the various methods of outpatient laser therapy, I realized that this individual should have a purpose for an instructional videotape and specialize in ophthalmology. In July of 1986, I met with Dr. John S. Kennerdell, the Director of the Department of Ophthalmology at Allegheny General Hospital. During this meeting, we discussed the merits of such a project and came to the conclusion that this subject had already been fully documented. Dr. Kennerdell suggested the research he and Dr. Maroon, Director of the Department of Neurosurgery, were conducting would be ideal. The meeting concluded with an agreement that I would produce a videotape illustrating their combined neurophthalmalogic technique. In return, I would be given access to the operating room, receive technical support of surgical reports, patient evaluations (pre and post surgical), pathology reports, radiological reports and any journal articles on the various techniques, etc.

In October of 1986, I received an invitation to attend a Neuro-ophthalmologic Laser Workshop hosted by Dr. Kennerdell and Dr. Maroon. This invitation allowed me the opportunity to observe various formats used in presenting the cases, and accessing the audiences' reaction. During the workshop, a majority of the information was presented on videotape. As an indication of its success, many of the participants requested copies of the presentation for future review. These requests were granted easily and inexpensively by simply duplicating the master file to 1/2 inch VHS videotape. In contrast, a 35 mm slide presentation would have been more expensive and time consuming to duplicate. The facilities where the slide and video presentations took place, were well equipped for these media types. The conference area was capable of seating approximately 30 comfortably. The audience was mostly composed of

neurosurgeons, ophthalmologists and residents of both disciplines. Also in attendance, were representatives from the various manufacturers of surgical lasers utilized in the workshop. Observations made during the workshop inspired me to incorporate information on both laser physics and biophysics along with the surgical portion of the videotape. The process of observation enabled me to tailor the final videotape to Dr. Kennerdell's specific needs.

PRODUCTION PROCESS:

The following discussion will present chronologically the processes involved in the creation of the surgical videotape. Although the thesis features new technology in the form of computer generated graphics, the use of video special effects were minimal. The rationale for not having used the full range of video special effects available was based on the reality that a majority of biomedical audio/video departments lack these capabilities. It is important to realize that for a comparable cost of adding these special effects, such as A-B role, a personal computer capable of generating video graphics, character generation, simple animation, and 35 mm slides could be purchased. With a general understanding of the computer and video aspects of this project, it is appropriate to mention the most important element of the project, its organization. The project is organized into three production sequences: preproduction, production and post production.

PREPRODUCTION:

The preproduction sequence can be characterized as the planning stage of the project. In this stage, all aspects of production are addressed through the following questions. (1) What are the instructional objectives? (2) What media would best facilitate the conveyance of this information? (3) Will the nature of the information require the use of color, sound or motion? (4) Who is the intended audience? (5) Will production facilities and equipment be available, capable and compatible? (6) Will the necessary production skill and knowledge be available? (7) What is the budget? [7]

Observations made during the workshop were used to determine the instructional objectives. These objectives define the skills to be learned and the conditions in which they are to be utilized. The objections are as follows: to illustrate the surgical application of the CO_2 laser in a combined neuro-ophthalmological technique and to demonstrate general principles of laser physics and biophysics. These three objectives were organized into distinct sections on laser physics, biophysics, and the surgical application. The compartmental approach taken in this project supports a partial or total review process. The selection of video as the production media was based on several factors. The first was an ability to capture complex visual processes in full motion, sound and color at an economical cost. The second factor was Dr. Kennerdell's desire to present cases in this media. Computer-generated graphics were selected because of its ability to produce striking imagery promoting audience retention. The nature of this information warrants the use of color, sound and motion. The audience was composed of physicians, surgeons, residents and

interns of both neurosurgical and ophthalmological disciplines. The viewing facilities consisted of a conference room equiped with multi-format video equipment and large color monitors as the viewing devices. My production skills and knowledge were acquired at Rochester Institute of Technology and Edinboro University. Access to both video recording and editing equipment were provided by RIT's Film and Video Department and The Singer Laser Center, Allegheny General Hospital. Access to the Artronics computer system was provided by RIT's Computer Graphics Department. The budget was one of the most important concerns of this process. Due to the free access of both video and computer graphics equipment, the production costs were minimal. The actual expenses incurred were those for 3/4 inch and 1/2 inch videotape and double sided double density 5-1/4 inch floppy disks. Realistic expenses of a project such as this would have included the cost of rental equipment and a video editing suite. This would include the video editor and engineer, the script and story boarding, computer graphics, consultation fees, materials and traveling expenses. At the time, the cost for producing an instructional video at an industrial quality would have been approximately $8000.00 dollars for an eleven minute videotape.[8]

The scripting and story boarding are additional areas of the preproduction sequence. In this stage, a well-written script with special attention to the coordination of visual and narrative elements was essential to the success of the project. The best integration of these elements could only be achieved when live action was recorded to fit a well-planned script. In the production of a surgical videotape, the script must be written around the video footage with an awareness of its important points.[9] If we look at this process sequentially, we would see that scripting occurs in the post

production stage after the surgical procedure has been recorded and the footage reviewed. In most cases, this review process is conducted by the physician who controls the content of the videotape. In contrast, this project combined both traditional post production scripting techniques in the sections on laser physics and biophysics. The surgical portions of the video were scripted in the post production stage after the footage, pathology, radiology and surgical reports had been reviewed. A rough script was drafted in the preproduction sequence. This script was finalized in the production sequence. During the process, the questions addressed earlier were continuously referenced as a way to ensure that the instructional objectives were achieved.

The storyboard acts as a cartoon or visual script. The format varies with production needs (see Appendix A). The role of the storyboard was to illustrate the important elements or key shots of the production. This visual outline helped develop the feeling of continuity between the various pictorial elements throughout the project. Similar to the script, the storyboard was developed from the surgical footage. As a developmental tool, they determined the editing sequence and served as a proofing device for the client, Dr. Kennerdell.[10] As production tools, storyboards are not always used due to the lack of sufficient staff and time.

PRODUCTION:

The primary focus of the production stages was the recording of both the surgical procedure and narration. An overview of how the computer graphics were created and recorded to videotape was also included in this stage. This portion of the project was the most anxiety ridden of the production. The frustration diminished when I received a call from Allegheny General Hospital which informed me that a candidate had been found. The operation took place on the morning of December 4th, 1986 at Allegheny General Hospital in Pittsburgh, Pennsylvania. The attending surgeons were Dr. Kennerdell, Dr. Maroon and Dr. Malton with Dr. Strong as the assisting surgeon. The preoperative diagnosis revealed a metastatic carcinoid tumor of the left orbit. A left medial micro-orbitotomy using the $C0_2$ laser was selected as the operative procedure for the excision of the tumor because of its location and extent of invasion in the left orbit.[11]

The recording process began with the set-up and calibration of the video equipment in the operating room (see Appendix B. Fig. 1). This occurred prior to the surgical staff and patient entered the operating room. The equipment consisted of a 3/4 inch tripod mounted camera located over the surgeon's right shoulder, a 3/4 inch remotely operated camera suspended over the surgical field, a mini camera mounted on the operating microscope and lastly a hand held 1/2inch VHS camcorder. The multi-camera set-up reduced the possibility of problems disrupting the shoot. The set-up was successful in capturing four visually interesting views of the surgical field. Cut-a-ways and support visuals were recorded by the camcorder. These images were used to create the environment in which the action took place. With the recording of the surgery complete, all the

master recorded videotapes were reviewed from beginning to end. Every action was entered into the log book (see Appendix B. Fig. 2). Each entry contained a description of the action, the camera which recorded it, and the duration and location on the videotape in hours, minutes, seconds and frames. From the log book, segments of video or audio could be selected without having to review the tapes to find the desired shoot.

The narration was recorded after the surgery was taped and the script finalized. As previously mentioned in the preproduction stage, a voice-over narration style was used in this production because it allowed for the greatest production flexibility. It permitted the recording of complex processes without interruptions and errors associated with describing the procedure during its execution.[12] The selection of a narrator was of great importance. His/her voice had to be capable of instilling a sense of respect and stimulating audience interest. At this point in the production, I was fortunate to have the assistance of Mr. Edward Casey, a very talented individual , whose abilities contributed greatly to the success of the thesis. The process of recording the narration was quite simple. The narrator reviewed the written script familiarizing himself with any difficult words or phrases. The script was read through several more times to establish pacing. Initially, the narration was to be recorded with a Sony industrial grade cassette recorder with an audio unit meter and lavaliere microphone. The equipment failed to function and a 1/2inch VHS consumer grade camcorder was used as the recording device. With the camcorder and lovelier microphone set-up, the recording process began. The recording of the narration was repeated three times as a safeguard for any mechanical problems or human mistakes. Because of equipment malfunction and the lack of a volume unit meter on the camcorder, the quality

of the final audio tape suffered. The extent of this problem became apparent after the review and logging of the footage. The only solution to this problem was to run the master audio tape through the audio mixer board in the video suite. This allowed me to manipulate the audio signal in the audio editing process. The procedure of generating and recording the computer graphics began after the narration had been recorded and logged.

COMPUTER GRAPHICS PRODUCTION:

This section describes the Artronics computer system, the production techniques and design considerations used in the creation of the electronic graphics incorporated in this project. As a production tool, the computer permits total flexibility in generating, editing and storing of electronic images efficiently and inexpensively. To better understand how this tool works, a description of its configuration is necessary.

The system can be divided into software and hardware components. The software or programing consisted of instructions which enabled the computer to perform specific tasks. The Artronics system is best described as a paint box system with a variety of painting, drawing and special effects functions. These capabilities enable the operator to electronically paint with two hundred and fifty six colors from a palette of 16.7 million. The only drawback was painting or drawing performed on top of any existing image which erases the underlying work. In this way, it was very similar to traditional painting except on an electronic canvas composed of pixels. Pixels are small rectangles with a defined height and weight. The Artronics system operates at what is defined as video resolution or 512 lines of pixels across the picture and 400 lines of pixels from the top to the bottom of the picture. The resolution was similar to that of a standard television which enabled me to view the graphics as they appeared to the intended audience during the development process. This system was not capable of generating true computer animation. As an eight bit system, each pixel was defined by eight bits of information, two bits for red, green, blue and two bits for the pixel's location within the image. Each pixel was controlled by a corresponding area on the color

palette. By utilizing the hardware feature in conjunction with the cycle paint capabilities, a pseudo-animation effect was achieved. The animation process will be discussed further in the section describing the atom sequence.

The hardware of the Artronics system can be divided into input devices, image processing and output devices (see Appendix B. Fig. 3). The input devices used in this production consisted of a videotape player/recorder and a video digitizing camera. The videotape player/recorder or VTR was used to frame grab images from the videotape. The digitizing camera was used to capture flat artwork such as the patterns incorporated into the background of the title graphics. These devices input graphic data into the computer. Once the data is in the computer, it can be manipulated in the image processing section. At the heart of this section, is the Leading Edge AT computer with a twenty megabyte hard drive, a 5 1/4inch floppy disk drive and, most importantly, the Number Nine graphics board. This board enabled the computer and software to display and manipulate the complex information and preview those changes on the RGB (red, green, blue) analog monitor. The keyboard and digitizing tablet with styles was used by the operator to control the manipulation process. Once the desired effect was achieved, the image was saved to floppy diskettes for storage. With the completion of all images for the program, the transfer to videotape began. This occurred in the section titled output devices. This section consisted of a Lyncom RGB (red, green blue) to NTSC (national television standards counsel) encoder, sync generator, 3/4inch video recorder/player and a standard consumer television. The transfer of images to tape began by loading one image at a time from the floppy disks onto the computer's hard disk. The file opened into the program. The pro-

gram and the graphics board defined how the file was to be portrayed. The graphics board turned the digital information in the file into an RGB analog signal. This signal appeared on the computer's RGB monitor. The same signal was also sent to a Lyncomn RGB to NTSC comosite encoder. The encoder, with the help of the sync generator, combined the RGB signals together into a composite video signal compatable with a consumer grade VCR or television. The composite signal was fed into a 3/4inch VTR and recorded to videotape. The process was repeated for each image or sequence. As a final check of image, color and signal integrity, the input to the VTR was viewed on a consumer grade television.

Before beginning the production process, an understanding of the preparation of graphics for video and television was necessary The first consideration was that all visuals would be created in a three-by-four aspect ratio. The ratio defined the proportions of a standard television screen.[13] In most cases, a portion of the picture was lost. The percentage varied with the make and model of the television. To compensate for these variations, a rectangular grid following the three-by-four ratio was created on the computer with the grid and rectangle functions. This was done because the computer system utilized an RGB (red, green, blue) monitor capable of displaying the entire picture. A standard Sony trinitron television was connected to the computer's composite video output with a BNC cable. The image with the three-by-four outline rectangle was scaled up and centered using the television as a guide. The grid or safe image area grid (see Appendix B. fig. 4) was used to determine the safe image area in which all pertinent information was to be placed. The image of the grid was saved on floppy disks to be used later in the production of graphics in the video. The remaining area outside the rectangle or scanning area

allowed for the variations in picture size and proportion in different televisions. It also adjusted for a ten percent image loss when transmitted over microwave or close-circuit television.[14] This cut-off principal was especially important in the transmission of written materials such as titles and credits.

The informational aspects of video graphic design were crucial to relay information to the audience accurately and efficiently. In a surgical videotape, the graphic information should illustrate the environment, the patient's orientation and condition. The graphics in this project were designed to convey concepts of both laser physics and biophysics. This design was based on the following question: How can this information be conveyed clearly and effectively to the viewer? The answer to this question was important because good design can have an emotional and psychological effect on the viewer. My desire was to develop a graphic style which would promote the feeling of continuity throughout the video. Therefore, the graphics should not only be capable of conveying information but also emphasize the importance of the information. In order to achieve this objective, an awareness of the fundamental elements of pictorial design were essential. These elements were: (1) balance and mass; (2) line and angle; and (3) tone and color.[15]

As artists, an understanding of these design elements should be of second nature. The only element requiring further discussion would be color. Color, as it relates to this project, can be characterized as having three components: hue, luminosity and saturation. Hue can be thought of as the actual color. Luminosity relates to a color's lightness or brightness on a scale from white to black. Saturation is the strength or intensity of a color as it compares to how far removed it is from neutral gray. These

three components can be referred to as the HLS color model. This model was important because video, as a media, is not particularly well suited to handle high contrast and intense color combinations. Contrast between adjacent colors produce a phenomena known as chroma crowl.[16] This is usually prominent between primary colors such as red and blue. Another phenomenon related to the luminance of a color, such as red, is referenced to as video bleed.[17] Both phenomenon were effectively controlled by mixing specific colors with the HLS color model. These colors were then tested by sending the composite video signal directly out of the computer through a wave form monitor. This devise measured the luminance of each color which made it possible to see any illegal color or combination of colors within an image. Another technique as effective as the wave form monitor, is to preview the image on a standard television. With the aspects involved in the preparation of the graphics covered, the process involved in generating the electronic images could be discussed.

The following images will be presented: (1) title graphics; (2) MRI enhancement and (3) atom sequence. These images have been selected because they exemplify the various techniques utilized in all of the computer graphics featured in the video.

The title graphics (see Appendix B. Fig. 5) were the first images to be created. They were designed to be used throughout the video as a unifying element. The marbled backgrounds of these images were captured from a sheet of Chinese marble paper. The pattern was initially captured in black and white with the Artronics 2000. The digitized image was then colorized by sorting and shifting ranges of blues into the controlling color palette. With the background pattern complete, the safe image area grid was modified to facilitate the placement of the titles, rule lines,

text and image inserts. The grid helped to maintain continuity and to ensure the accurate placement of all the elements listed above. The inserts, per-existing images such as the atom sequence, were scaled down 45% and merged with the textured background's palette. Drop shadows on the inserts were the last element to be added to the graphic.

The MRI enhancement (see Appendix B. fig. 6) was created from original footage recorded during the surgical procedure with a JVC 3/4 inch tripod mounted camera from an x-ray light box. To manipulate the image, it was necessary to digitize it into the computer. This was accomplished by replacing the grabbing camera on the Artronics 2000 with a 3/4 inch video player/recorder. The two machines were connected together using a standard BNC cable connected to the video out port on the computer and the video in port on the video player/recorder. The image grab was accomplished by: (1) pausing the video deck in play on the desired image, (2) clearing the screen of any scanning lines using the shuttle/ search control, and (3) capturing the image using the grab function. Image distortion caused by the paused video deck was corrected by scaling the image down 50% on the vertical axis with a percent scale function. The image was then scaled up 200% on the vertical axis to its original vertical height. The background of the scan was painted out with transparent black using a large round brush. Colorization of the image was used to highlight various structures of the MRI scan. This process was achieved by cutting and shifting desired portions of the image into other areas of the color palette. The desired color was copied to the location of the controlling palette shifting its color. The eye, optic nerve, lateral rectus muscle, and tumor were all generated with the paint functions. All of these structures were created as wire frame over the original MRI scan. This process

ensured that the finished structures would be accurate in size and orientation. They were recombined with the original MRI scan and saved to a floppy disk. The safe image area grid described earlier was loaded into the computer from a floppy diskette. The MRI scan was loaded from floppy disk, scaled and positioned inside the safe image area. The title, labels and insets were added and the grid was removed to complete the MRI enhancement.

The atom sequence (see Appendix B. Fig. 7) of images best illustrates the pseudo-animation capabilities of the Artronics computer. This sequence portrayed the process of electron transition, absorption and emission, naturally and spontaneously, of energy in the form of photons. To help describe the production of this sequence, the image was divided into its static and animated components.

The nucleus and background comprised the static portion of the atom sequence. The schematic nucleus with its 3/4 inch highlight, core shadow and reflected light was formed from four diagonally shaded squares. These four sequences were arranged into a larger square. Each smaller square was positioned so that the diagonal shading began at the outside corner of each square and ended at the common center of the larger square. To form the sphere with its 3/4inch highlight, a large round brush in the background color (black) was used in conjunction with the outline ellipse function. This procedure cut out the nucleus with the remaining corners of the square to be painted out using the background color. The sphere with highlight, core shadow and reflected light was achieved by manipulating the controlling spread of the four squares. The finished sphere was saved to the floppy disk as a window with a transparent black background. By creating and saving the image in this way, its

placement and scale were controlled.

The animated elements of the sequence consisted of electrons, energy levels and photons. The placement of the elements within the image were facilitated by retrieving the nucleus from the floppy diskette and positioning it centrally within the grid defining the safe image area. The background was filed with transparent black. The electrons were created using the color red with a large round paint brush. The placement of the electrons around the nucleus was achieved with an outline elliptical pattern. After all twenty five electrons were positioned, the ellipse color was shifted into the background color deleting it from the image. A similar procedure was utilized in generating the ground state and excited states of the electrons. Perspective was added to the electrons orbiting the nucleus by decreasing their size as they traveled from foreground to background around the ellipse.

The energy levels were created by copying the inner elliptical pattern used in the placement of the electrons and scaling them up 110% with a percent size function. This step was repeated eight times creating a multi shell effect around the nucleus. The incident and emitted beams of photons were created using the curve function and a flat 1/8 inch diagonal brush to generate the tapered "S" shape. This was copied and duplicated end-to-end diagonally from the upper left corner of the image to the nucleus and from the nucleus to the bottom right corner.

The animation process began after all the elements (electrons, photons and energy levels) had been arranged within the image. As mentioned above, all of these elements were created using a single palette area, red. It was necessary to shift each of these elements into specific locations on the color palette. The process of shifting colors was the key to

animating on this type of system. Each area on the color palette controls its corresponding color in the image. By incorporating this feature into the design of the atom sequence, a psuedo-animation effect was created. The completed sequence had a controlling palette consisting of 136 distinct areas or colors from a total of 256. The first 64 areas within the palette were used as the working area and as the controlling palette for the nucleus and background. The spread of colors beginning at palette area 65 and ending at area 201 controls each electron, photon and energy level within the image. Each group of elements, such as the electrons, were assigned to the palette sequentially in which they were stimulated in the process of electron stimulation and transition. The actual animation was achieved with the cycle paint function. This function cycles colors through a pre-selected range of the palette. The cycle colors in the atom sequence were composed primarily of a transparent black color. Eight palette areas within this selected range were ramped from the background black to red. This ramping permits the electrons, photons and energy levels highlighted by the above ramp as it cycles through the selected portion of the palette to become visible. Conversely, those elements not highlighted by the ramp disappear into the background. The control of the animation was determined by three variables: cycle color, cycle range and cycle ratio. The cycle color was the color or colors which were cycled through the palette. The cycle range was the number of palette areas out of a possible 256 available. The cycle ratio was the number of palette areas to be cycled through in a set amount of time. In the atom sequence, a cycle ratio of 3 to 1 was used. With the variables set, and the cycle function started, the image springs to life. A variety of effects were created by altering the above variables.

With the desired effects achieved, the atom sequences, MRI enhancement and title graphics were recorded onto videotape with a 3/4 inch Umatic video player/recorder. The computer was connected to the video recorder with an NTSC composite video cable attached to the video out port on the back of the encoder box. With the recording process of the computer graphics complete, the master recorded videotape containing the graphics was logged in the same manner as the surgical footage.

POST PRODUCTION STAGE:

The post production stage was the final sequence in the production process. In this stage, all audio and video elements from the original recorded master videotapes were electronically edited together into the final master videotape. This electronic transfer editing process was similar to the traditional methods of editing film by cutting and splicing segments together into desired sequences. This electronic process allowed for the selection of segments from the recorded master tapes with no physical cuts accruing. With the desired sections of videotape selected, it was possible to transfer copies to any location of the edited master tape. The advantages of this electronic process over traditional methods of editing were: no cutting of the original footage and it can be repeated until the desired effect was achieved.

There were two editing techniques utilized, assemble and insert. Assemble editing transfers entire segments of videotape from the master recorded tapes to the edited master. These portions of the videotape consist of four tracks. The first was the control track which controls the scanning rate of the video player. Track two, the video track, contains all the image information. Track three and four makeup the two audio tracks, referred to as audio track one and two. The narration and other information was placed on these tracks. This technique required the editing process to follow a sequential pattern from beginning to end.[18] The assembly

process was used to create the narration on the edited master tape.

Insert editing was used extensively in this project to create the computer animations. This method was capable of editing entire segments just as the assembly process or just the audio or video portions of the tape. This control track is not transferred in the type of editing. As the name implies, it is capable of inserting video or audio into existing sequences. This ability made for greater flexibility and was the reason for its extensive use in this project.[19]

The equipment utilized in the editing process was representative of a small to medium sized biomedical department (see Appendix B. Fig. 8). The components should be thought of as a chain with the first link as the sync generator. The sync generator produced a synchronizing pulse. This signal was sent by cable to all the components that makeup the editing station locking them and their pictures together. The second component, a 3/4 inch videotape player, acted as the source deck. This deck was where all the recorded master videotapes were played. The third component, an NTSC video monitor, served as a preview device for the video signal being produced by the source deck. The fourth component was the remote edit controller. This device controlled the entire editing process from the source deck to the record deck. The fith component, a 3/4 inch videotape recorder acted as the record deck. The edited master tape was placed and recorded to this deck. The last component in this chain was a NTSC monitor which served as the program monitor, which allowed for the previewing of the completed edits.

The various principles of pictorial continuity incorporated into this project were originally developed by the early film makers. They realized that when one image was immediately replaced by another, an interaction

occurred in the viewer's mind. They believed that each image was part of a flow of images. By altering the relationship of these images to each other, a variety of interactions occurred. They also believed that these principles should not be thought of as exclusive to the post production or editing stages, but should be applied in all stages of the production process.[20] The following principles were applied in this project: composition, axis of action, flow of action, transition, shot relationship and cutting ratio.

Composition was the visual arrangement of audio or video elements within an image for the purpose of conveying information.[21] Traditionally, good composition utilized: line, form, tone, texture and color to create the feeling of unity, variety, harmony and balance. These elements were used extensively in the generation of the computer graphics. They were not as easily applied in the operating room due to the stringent controls placed on both the non-surgical staff and the unsterile video equipment. This lack of control was true of most documentary style productions. It was possible, however, to develop as strong a sense of continuity through the proper application of the remaining principles in the editing of the surgical footage. The axis of action (see Appendix B. Fig. 1) was an imaginary line along which all characters and action moved.[22] This line proved most useful in determining camera placement in the operating room. By recording from one side of this axis, the action stays consistent from camera to camera. A similar principle to the axis of action was the flow of action. This principle was concerned with the direction in which the action takes place in the frame. For example, right to left or foreground to background.[23] In this type of project, the action was confined to the immediate area around the surgical field. This reduced field limited the extent of action that could occur. This was beneficial in maintaining con-

sistency from shot to shot. However, this type of consistency makes for a visually static program. To counter this effect, transitions from one image to another were utilized as a means of adding variety. There are several types of transitions, each having its own psychological and grammatical impact on the viewer. In this project, two types of transition were utilized: fade and cut. A fade consists of a gradual transition from black to an image, from an image to black or from one image to another. This type of transition was used to imply a strong separation between the segments on laser physics, biophysics and the surgical portion of the project.[24] A cut was the straight replacement of one image with another. In this type of transition, it was implied that there were no change in time or location. The only change that occurred was that of perspective.[25] This form of transition was used extensively throughout the video as a method of adding variety. In the process of editing images together, cuts made between identical images produced a phenomena referred to as a jump cut. The slight movement between successive shots was disturbing to the eye. A common problem which can be avoided by editing between shots no more than three times larger or smaller than the preceding shot. The ratio of three to one was referred to as the cutting ratio, size relationships of successive shots.[26] This method of altering between extreme close-ups, intermediate and wide shots was successful in developing visual variety in the program. Shot relationships referred to how images related to each other in both an informational and aesthetic manner. This juxtaposition of over-all-collective shots establishing the environment, intermediate shots defining general information and close-up-shots revealing specifics.

EDITING PROCESS:

The initial step in the editing process was a review of the script, storyboard and production log. This final review was necessary because it familiarized the production crew with the available footage from which to choose. The script and production log were invaluable tools in the process of selecting and locating audio or video segments. This review also served as a means of identifying potential editing problems. The most important was the number of times the video would be duplicated in the process of assembling the edited master videotape. Each of these duplicates was referred to as a generation. With each generation, the image quality defined by color and sharpness diminished. To account for this inherent problem, an editing plan was devised to limit the number of generations. This plan, originally developed in the preproduction stage, calls for the narration to be edited first, creating an audio only track on the edited master. The video, including the computer animations, were then edited to match the previously laid-down audio track. By following this plan, the edited master would be of a second generation from the original recorded footage. Distribution of the final videotape would be accomplished by duplicating the master 3/4 inch tape to 1/2 inch VHS tapes. These copies were of a third generation from the original footage with minimal lose of image quality.

Step two of the post production process involved the laying down of the narration. This was accomplished by assemble editing the narration onto the edited master. The videotape had two audio channels. The narration was edited onto the second audio channel. The first channel was reserved for the sound track (musical score), time code or any other

information not essential to the program. The location of the channel on the edge of the videotape made it susceptible to physical damage from oxidation over time. As indicated in the production stage, the narration was recorded sequentially on a consumer grade VHS camcorder. This back-up equipment proved less than acceptable. The recorded narration had a noticeable hum from the camcorder's motor and from a background source. To correct this problem, the narration was patched from the source deck through the sound mixing board to the record deck via the patch panel. This setup enabled me to filter out most of the background noise while the editing was taking place. During the editing process, alterations were made to correct the timing between sentences, paragraphs and the sections on laser physics, biophysics and the surgical application in the narration. Mispronunciations, brakes and pauses were corrected by replacing them with segments from the other two recorded narrations. The completed audio track became a reference which determined the timing of the animation sequences and the locations of each video edit.

Step three involved the laying down of the video and animation sequences onto the edited master. An insert editing technique was used due to the complexity of these sequences. To simplify this discussion, a portion of the process involved in creating one animation, the atom sequence, will be illustrated. It should be noted that the completed animation consisted of six segments: electrons orbiting the nucleus in a steady state, electrons orbiting the nucleus in an elevated state, incident photons on an atom, emitted photons from an atom, elevation of electrons to an excited state and electrons crashing back to the ground state. Each of the above segments must be inserted into its proper location. Its location and duration was determined by the narration reducing the overall production

time. With the desired segments located, an illustration of the first edit is shown. The process begins by inserting the recorded master videotape

with the desired animation segments into the source deck. The first segment, electrons in their ground state, was queued up. The process begins with the production log which indicated where on the tape the segment was located. This information expressed in hours, minutes, seconds and frames was entered into the remote edit controller. The controller then searched the entire tape for the exact point. The segment can also be located with the shuddle\search knob on the edit controller. This knob allowed for a frame-by-frame or high speed search of the tape. Once the beginning of the desired shot was located, that point on the tape was electronically recorded into the controller's memory as the insert edit point. The end of the segment was stored as the edit out point in memory. In a majority of the video only edits, no edit out point was used. The edit was performed on the spot by stopping the transfer process after the edit out point by using the stop edit button. This technique was used when editing sequentially were the excess footage was recorded over by the next edit. The edited master with the audio track was inserted into the record deck. The audio track determined where the first segment of the atom sequence was layered down and stored in memory. Again, no edit-out-point was programmed on the record deck. With the in points programmed on both the source and the record decks, the edit was performed by pressing the perform edit button on the controller. The edit was executed by the controller within 1 to 4 frames of the points originally programmed into memory. The transfer process was stopped manually after the edit out point. This procedure was repeated for the rest of the animation sequence. Corrections to the animation were made by insert

editing small sections of video into the sequence as needed. This occured by programing in both an in and out point on the source and record decks. The final step involved the editing of the sound track.

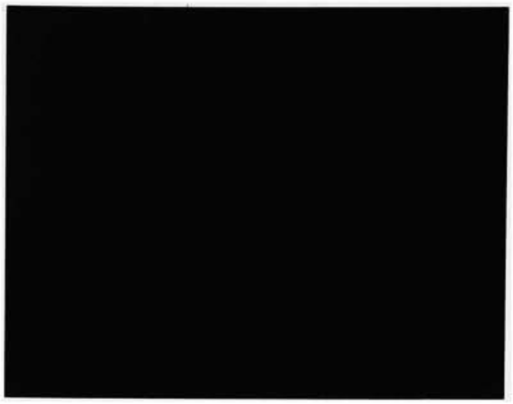
The sound track or musical score was insert edited onto audio channel one. This editing process was referred to as an audio only edit. It was accomplished by selecting the audio only edit mode on the edit controller. As indicated earlier, there were two audio tracks on a 3/4 inch videotape. In order to record the audio onto track one, a second switch on both the play and record VTRs was selected. Once this was complete, it was possible to lay the musical score over the entire program. While this transfer occurred, the level or volume of the music was adjusted up or down depending on the program. Initially, the music was faded up from black as the opening credits fade up and down again when the narration began. The music was faded up at the end of the program when the closing credits began and out to black as the credits fade to black.

With the editing process complete, the edited master tape was given to the client, Dr. Kennerdell for review. This review process gave Dr. Kennerdell a chance to review the animations and surgical footage for the first time. In larger productions, the client would be given an off-line-edit which was equivalent to a rough edit. This process requires very sophisticated editing equipment which was prohibitive in this project. The final review yielded several minor changes which included the dropping out of the last few lines of narration and lowering the volume of the music across the entire videotape. The changes were corrected by insert editing audio or video depending on the change of the unwanted segments. With the final corrections completed, the tape was reviewed again by the client and accepted bringing the project to completion.

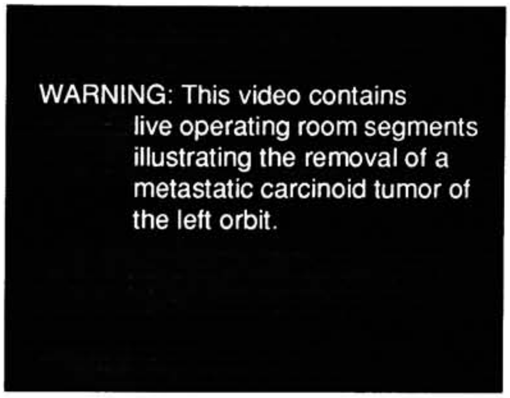
CONCLUSION:

The thesis was a record of the processes involved in production of a medical videotape. The primary objective of this project was to illustrate the physics, the biophysics and the surgical application of the CO_2 laser in a micro-medial orbitotomy. I believe, as bio-communicator, it is our responsibility to develop a working knowledge of new technologies. With this in mind, a second objective was created which focused on the exploration of desktop video as a production tool. Like many of the tools the medical artist uses, the quality of work produced was dependent on its application. Although these technologies open new areas as well as expanding existing ones, they will only be exploited by those who have a desire to adapt to change.

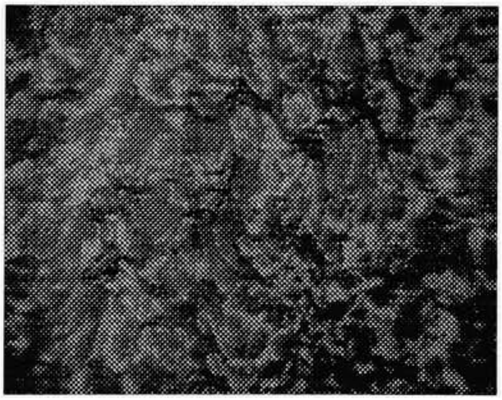
FADE UP FROM VIDEO BLACK:



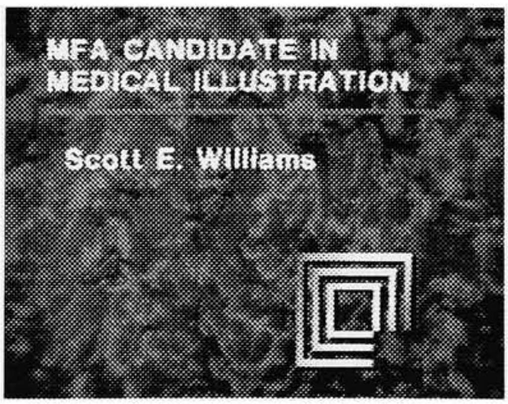
WARNING OF CONTENT:



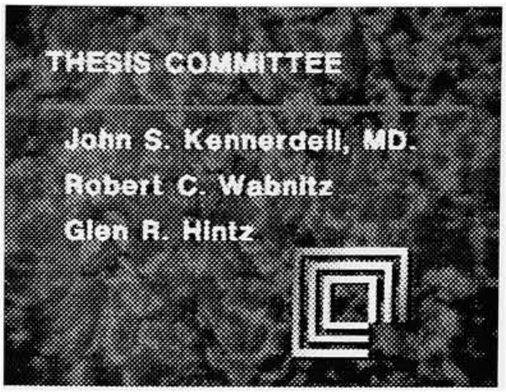
FADE TO MARBLE BACK-GROUND:



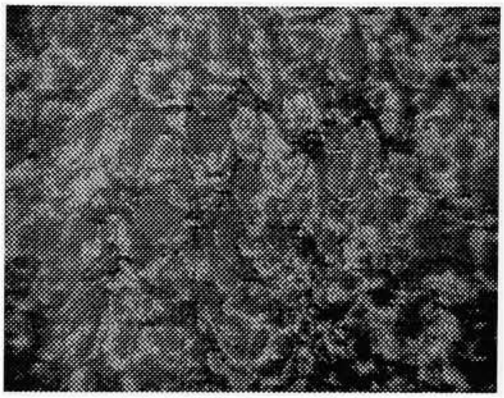
MFA CANDIDATE:



THESIS COMMITTEE:

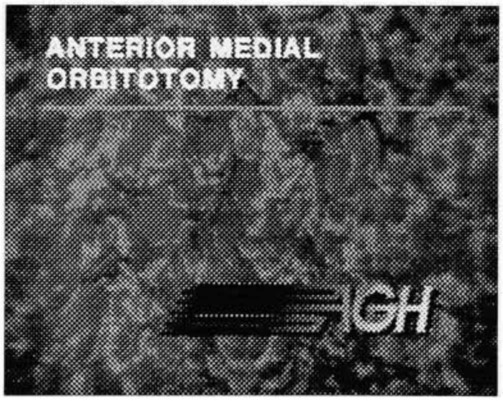


MARBLE BACKGROUND:

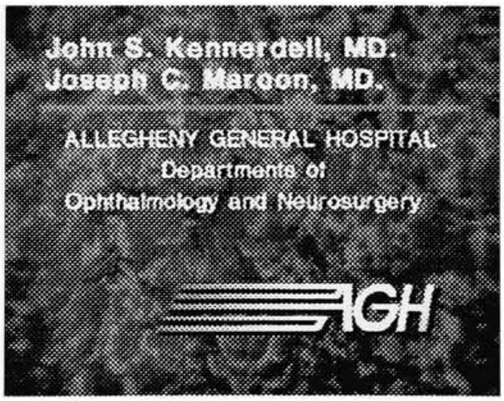


INTRODUCTION:

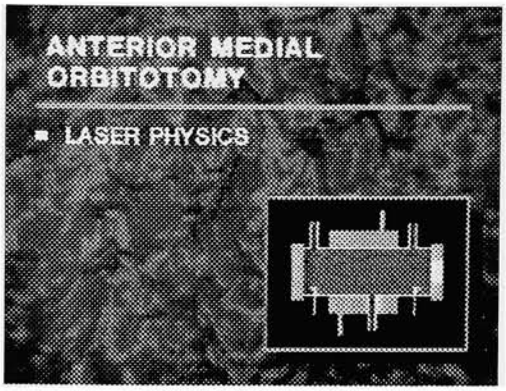
The purpose of this thesis is to develop a videotape for physician and resident education that illustrates basic laser physics and biophysics pertaining to a single case history of a medial orbitotomy.



A modified version of the Galbraith and Sullivan Technique, developed by John S. Kennerdell, M.D. and Joseph C. Maroon, M.D. of Allegheny General Hospital, Departments of Ophthalmology and Neurosurgery, will be presented.

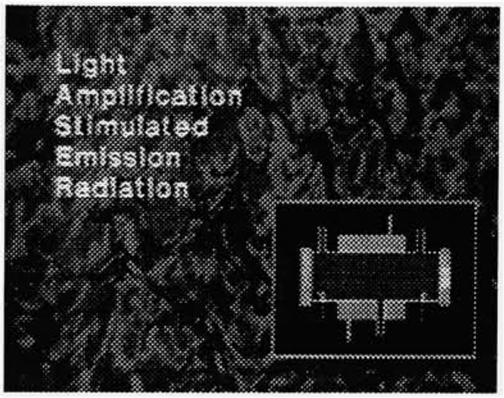


After viewing the videotape, the audience will also understand basic **laser physics** and **biophysics**. They will also understand how the carbon dioxide laser is utilized in the **subtotal excision of a metastatic carcinoid tumor of the left orbit**.

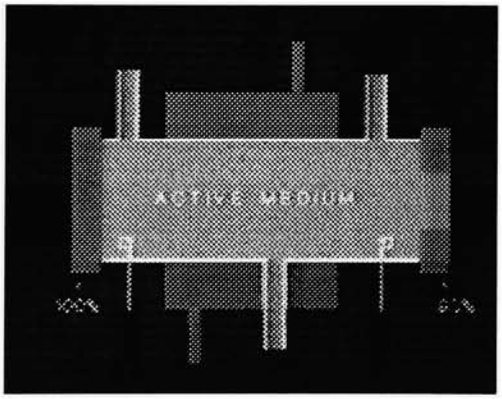


LASER PHYSICS:

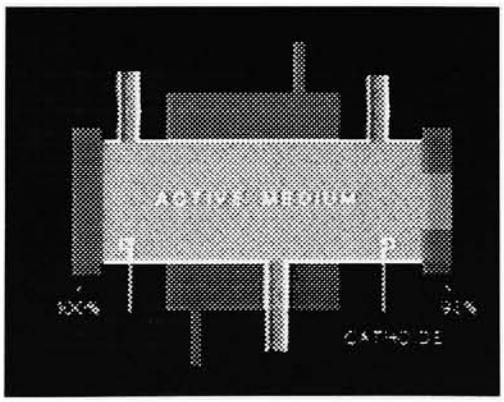
The term laser is an acronym for **Light Amplification by the Stimulated Emission of Radiation**.



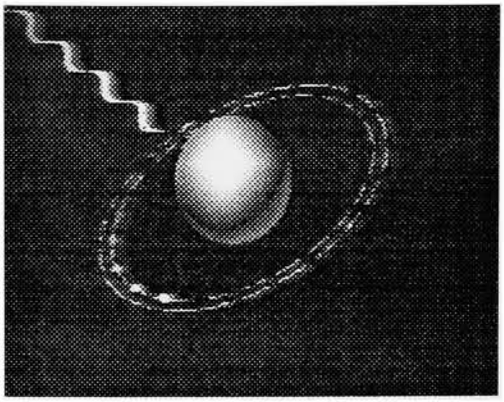
The CO_2 laser utilizes an **active medium** of carbon dioxide gas contained within an optical resinator chamber.[29]

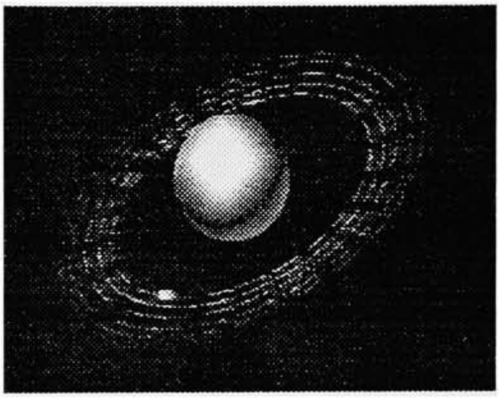


Energy pumped across the active medium by **cathoids** is absorbed by the atoms of the medium in the process of **electron transition**.

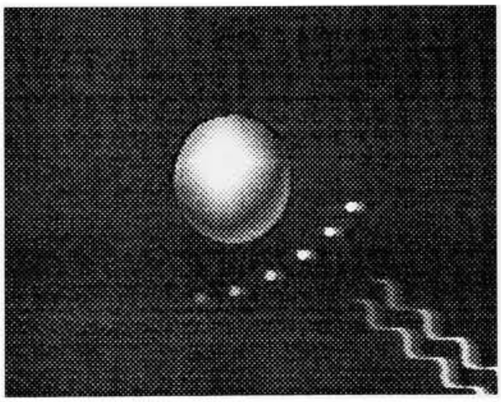


When a majority of the atoms in the active medium have electrons in higher energy states, **population inversion** has occurred. [30]

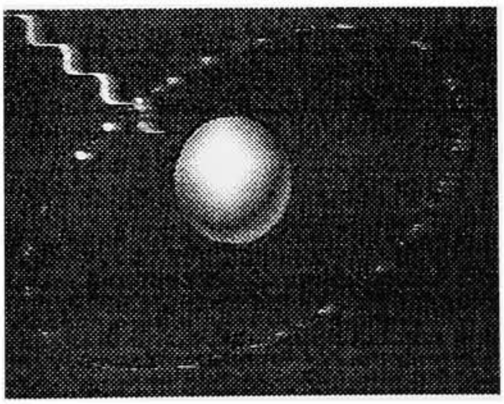


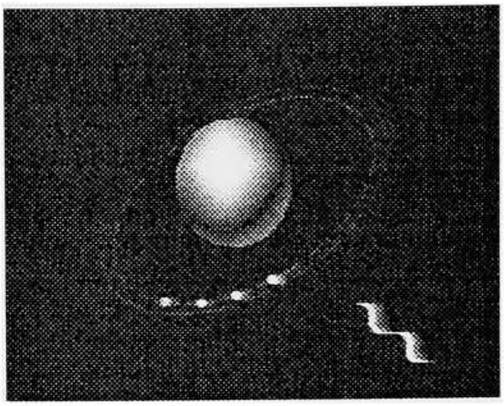


Two events occur during population inversion; **spontaneous emission**, the natural decay of electrons emitting a photon in a wavelength equal to the distance traveled during its decay and

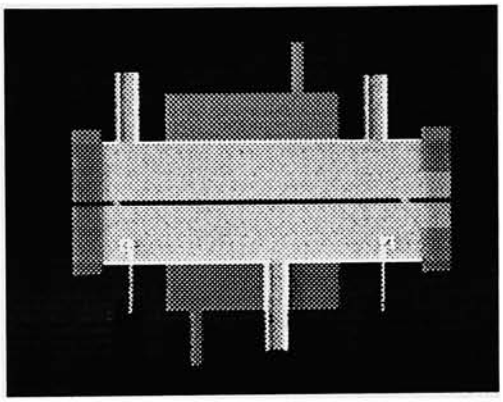


stimulated emission, a rapid decay of an energized atom due to the collision of an incident photon causing the liberation of two photons. [31]

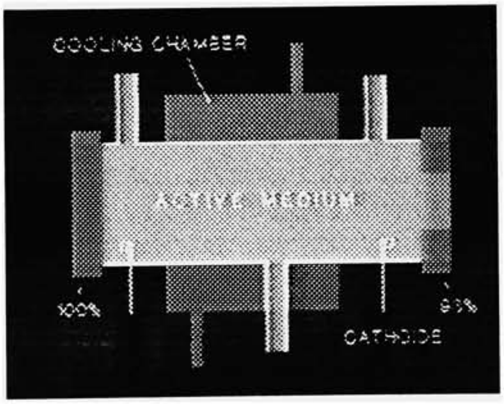




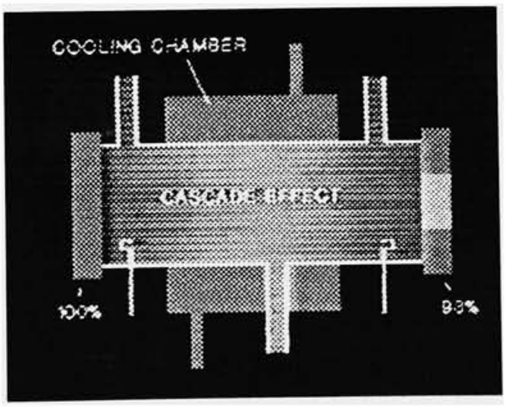
Photons emitted along the **central axis** of the resinator chamber are reflected by highly polished mirrors amplifying the number of photons produced along the axis by stimulated emission.



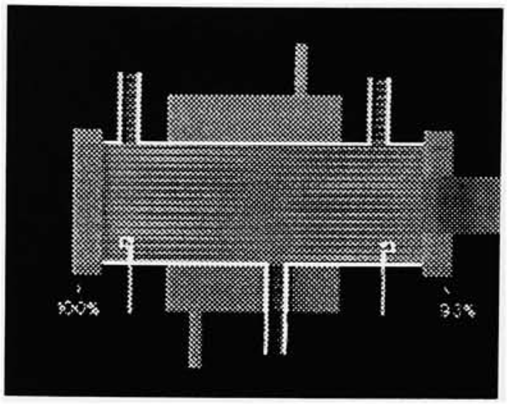
Any stray photons are absorbed as heat energy by the **cooling chamber**.



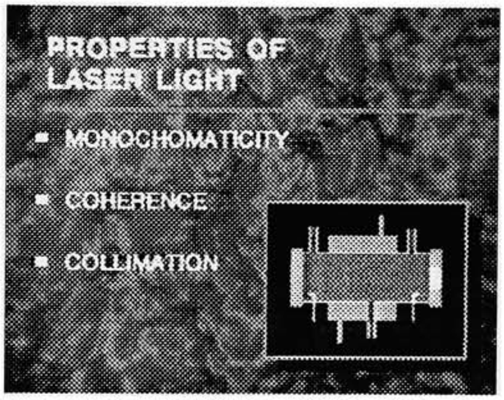
A **cascade effect** occurs throughout the active medium until the concentrated photons are emitted through the partially reflective mirror.



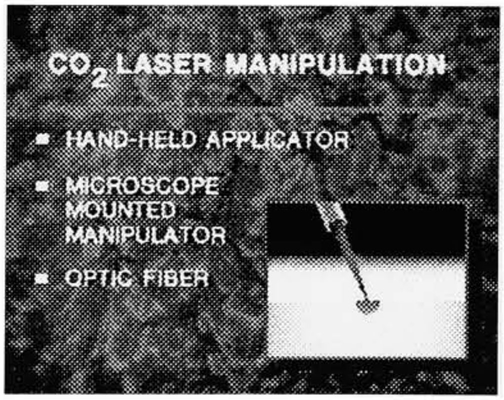
LASER EMITTED FROM RESINATOR CHAMBER:



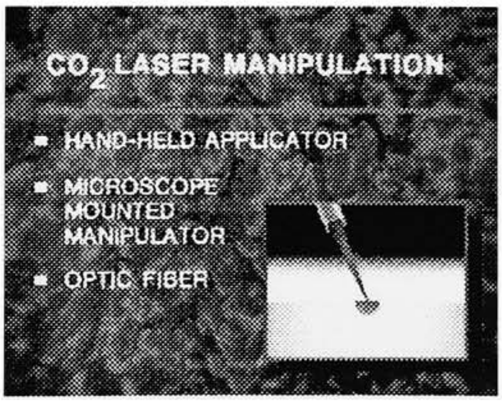
Laser light emitted by the CO_2 laser is characterized by three properties: **monochromaticity**, consisting of a single wavelength at 10.6 microns, **coherence**, consisting in phase spatially and temporally, and **collimation**, consisting of a non-divergent parallel beam.[33]



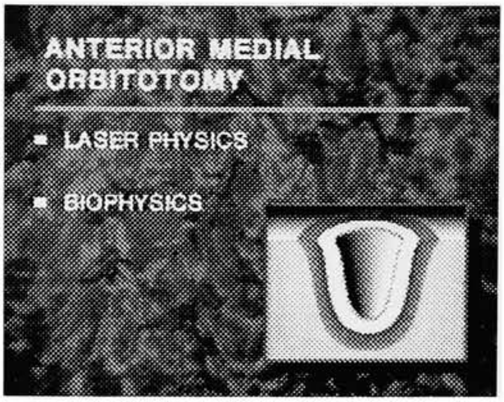
The emitted beam is transported to the surgical field by a delivery system composed of a series of hollow mirrored tubes with articulating mirrored joints. Because the CO_2 laser generates light far into the infrared spectrum, it is invisible, requiring a coaxial helium-neon pilot beam as a means of guidance.



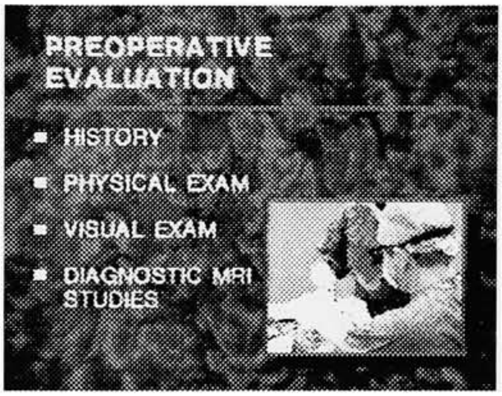
The laser beam is manipulated by a **hand-held applicator**, or a **microscope mounted, micro-manipulator** device permitting the manipulation of the laser under magnification. A third system consisting of an **optic fiber** is still under testing.[34]



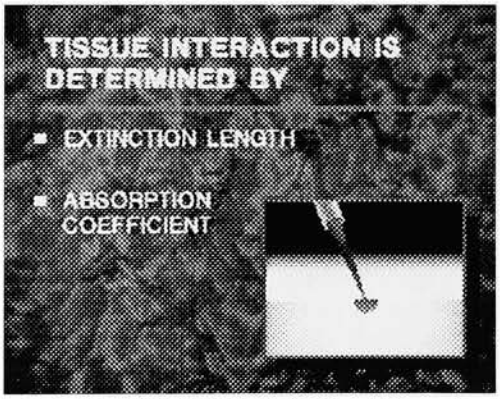
BIOPHYSICS:



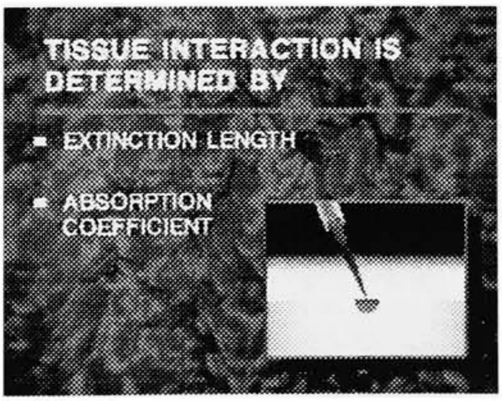
Laser energy incident on tissue elicits four specific responses: **reflection**, **transmission**, **scatte**r, and **absorption**.



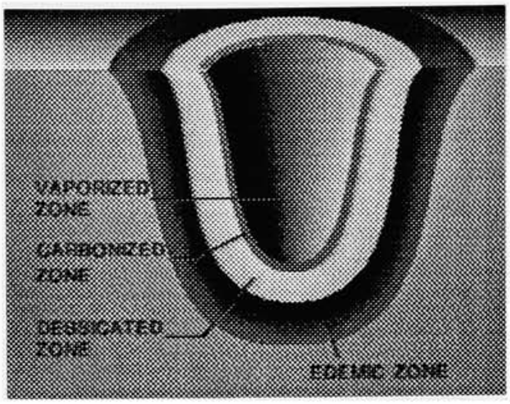
Tissue interaction is determined by the **extinction length** of the incident beam and the **absorption coefficient** of the tissue. The extinction length is the distance at which 90% of the laser energy is absorbed. The adsorption coefficient is the ability of a tissue to absorb electromagnetic radiation. [35]



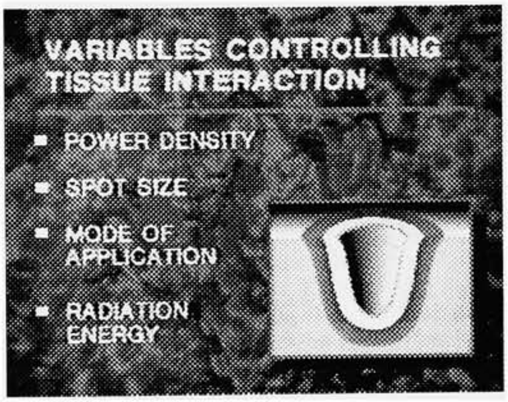
The carbon dioxide laser beam has a **short extinction length** of 0.03 mm in water. The beam is also **pigment independent**, enhancing the vaporization of surface tissue by flash boiling intercellular water. [36]



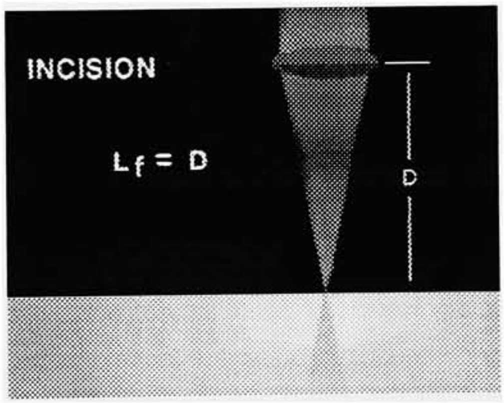
The morphology of the controlled carbon dioxide laser lesion can be characterized by a crater of total tissue **vaporization**, an inner zone of char or **carbonized debris**, a middle zone of **dessicated tissue**, and an outer zone of **edematous tissue**. The shape of the lesion in cross-section reflects the Gaussian or bell-shaped distribution of energy within the beam.



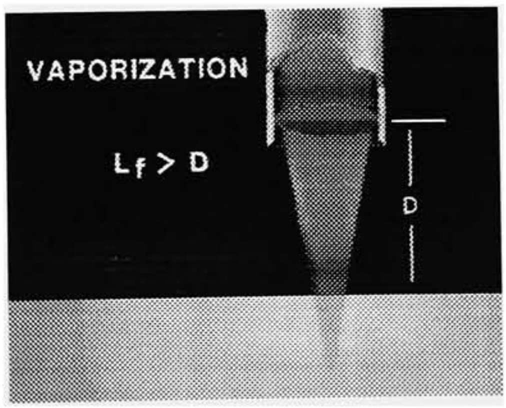
The extent of tissue interaction can be controlled by altering the **power density** (expressed as watts divided by square centimeters), **spot size** (determined by the focal length, distance from the lens to the tissue plane), **mode of application** (expressed as duration of exposure in either continuous or pulsed modes of application), and **radiation energy**.



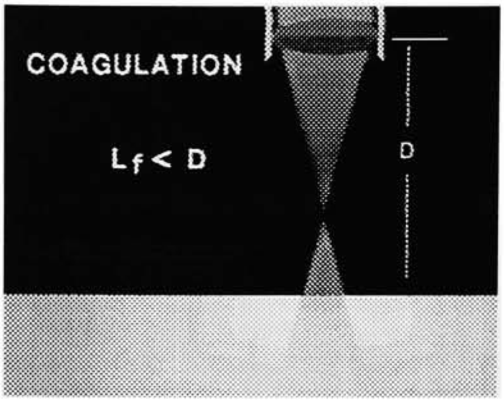
As a result of the manipulation of the four variables, three reactions occur at the tissue plane. **Incision** is achieved with a high-powered beam of focused light where the focal length is equal to the working distance.



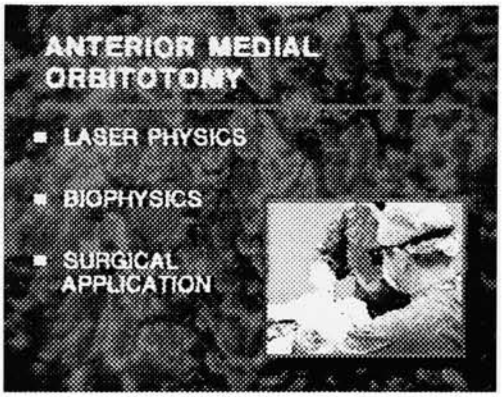
Vaporization of tissue is achieved with a high-powered prefocused beam, where the focal length of the lens is greater than the working distance.



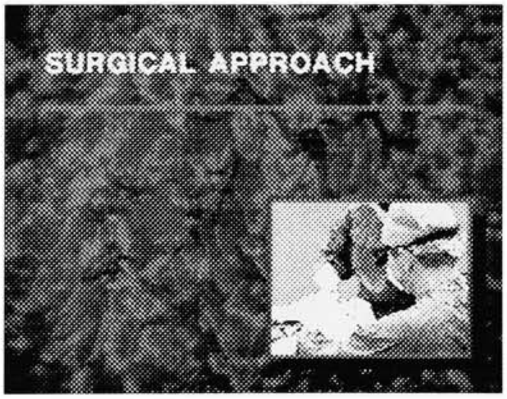
Coagulation of tissue is achieved with a low-powered defocused beam. The focal length being less than the working distance.[37]



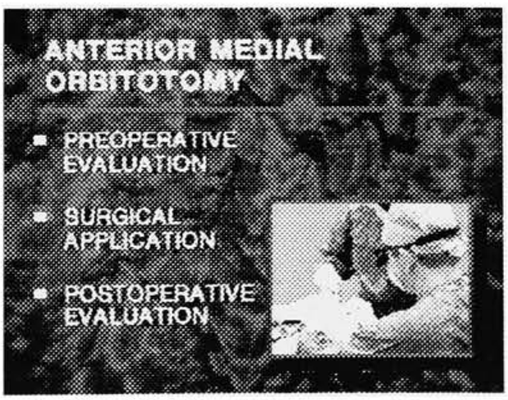
SURGICAL APPLICATION:



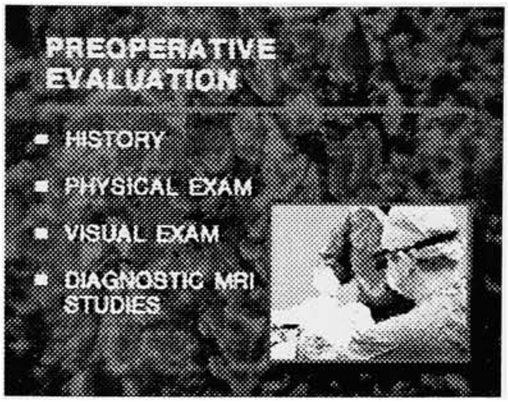
Since 1976, Dr. Kennerdell and Dr. Maroon have utilized a combined neurosurgical/neuro-ophthalmological diagnostic and therapeutic approach.



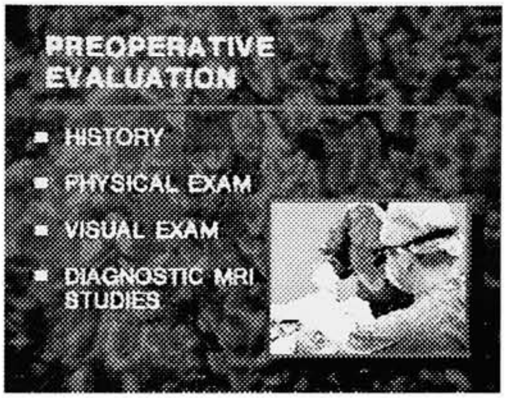
In this section, CO_2 laser application in a single case history of a micro-medial orbitotomy will be presented as follows: **preoperative evaluation**, **surgical application**, and **postoperative evaluation**.



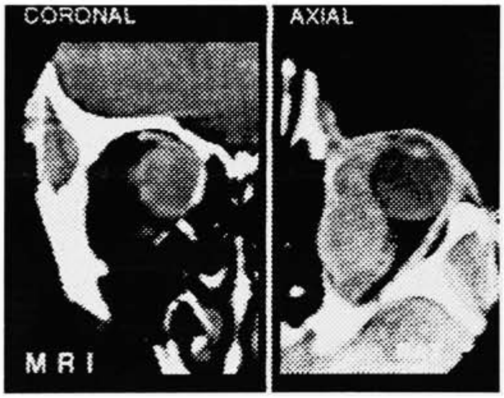
PREOPERATIVE EVALUATION:
A 46-year-old female with a slight proptosis of six months duration was examined. Her history revealed a status postcholedocystojejunostumy for the removal of a carcinoid tumor of the pancreas in 1982.



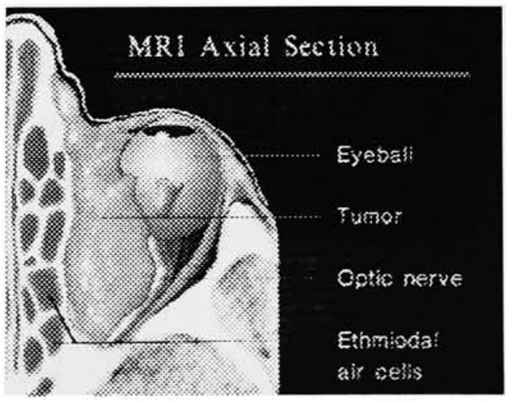
A metastatic carcinoid tumor was subsequently found in the left breast and left orbit. The physical examination revealed a remarked Grade II/VI systolic murmur without radiation and a mid line abdominal scar with no palatable masses.[38] The visual exam revealed visual acuities of 20/20 ou and marked deficient abduction of the left globe.



Diagnostic MRI axial and coronal studies revealed an infiltrative mass of the medial aspect of the left orbit obscuring the medial rectus muscle and displacing the globe and optic nerve laterally.



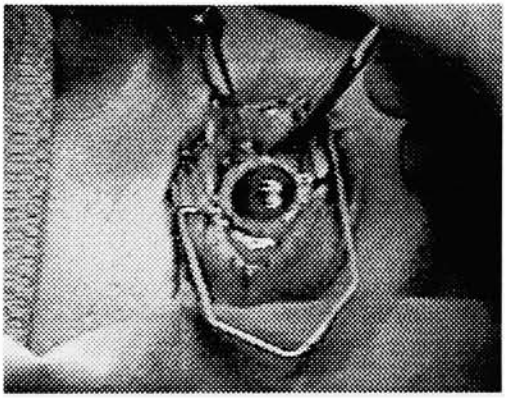
With the location and extent of the mass determined in the preoperative evaluation, a medial orbitotomy is selected because it provides the most direct approach and least morbidity.[39]



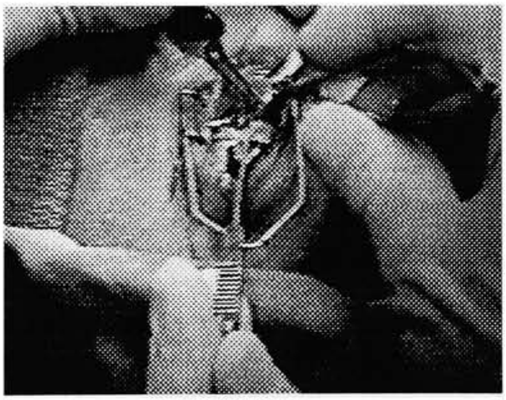
OPERATIVE PROCEDURE:

The micro-medial orbitotomy is performed with a 360 degree conjunctival peritotomy and superior nasal and inferior nasal relaxing incisions.

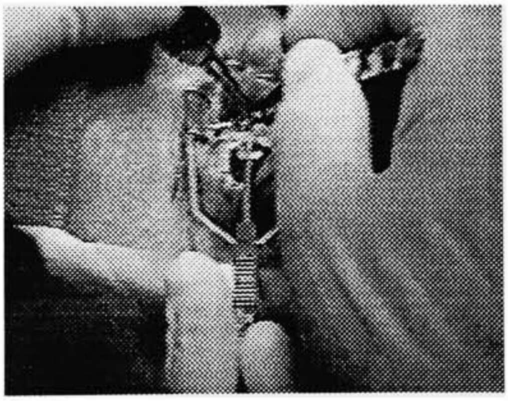
The medial rectus muscle is isolated anteriorly at its insertion on the globe and from its checking ligaments.



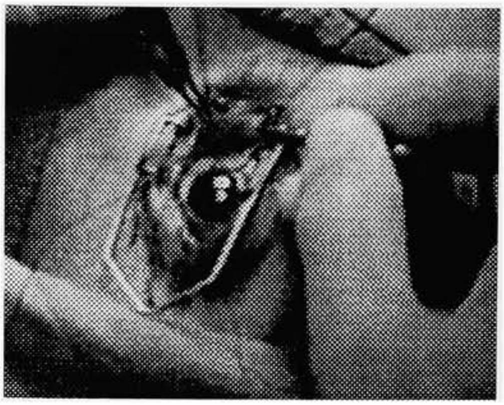
The anterior portion of the tumor is visualized and appears to involve a portion of the muscle.



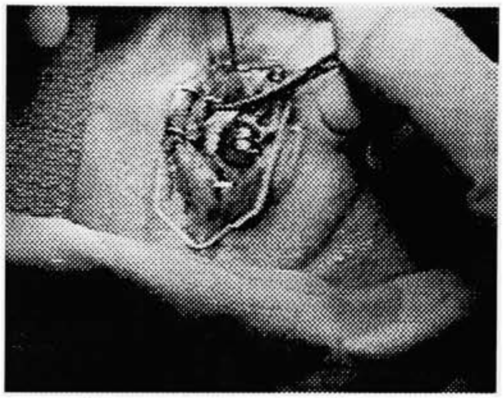
A plane is obtained and the anterior portion of the tumor dissected off the medial rectus muscle.



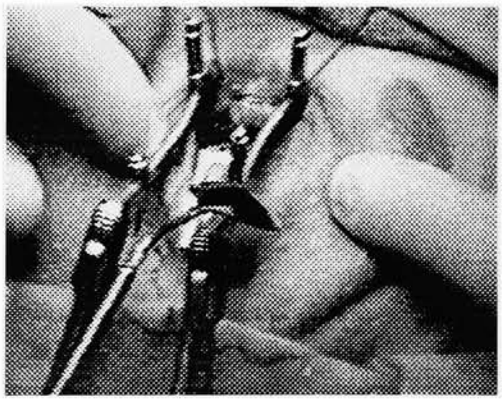
The muscle is imbricated near its insertion with 6-0 vicryl suture and double locked at each border.



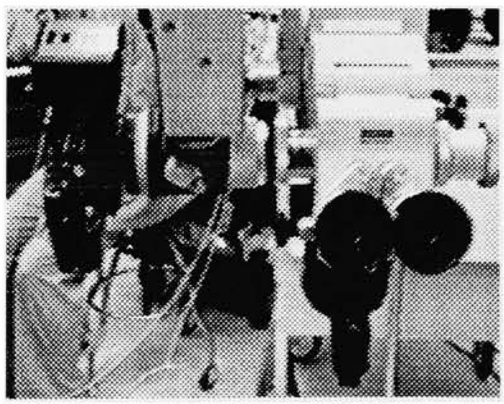
The medial rectus muscle is severed from the globe at its insertion.



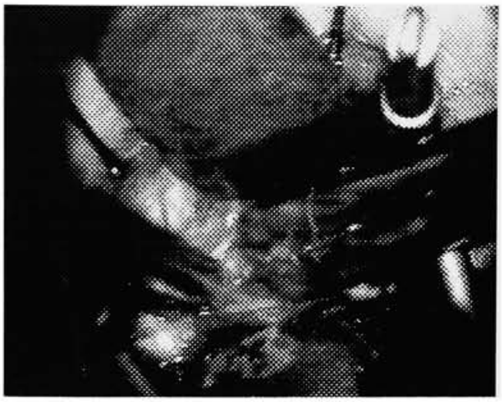
A self-retaining medial orbital retractor with enucleation spoon and dissecting blades is inserted.



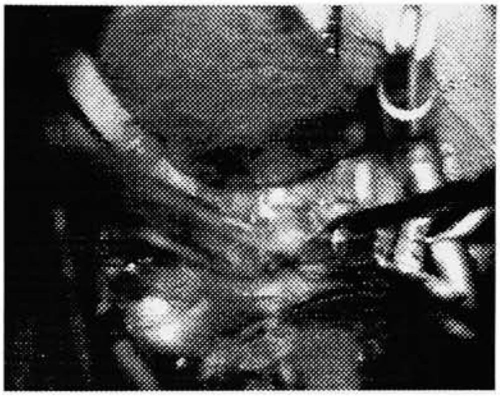
With direct access to the tumor achieved, the operating microscope with its 300 mm objective lens and laser micro manipulator is brought into position.



Under magnification the anterior portion of the tumor including the scleral and episcleral adhesions and connections with the medial rectus muscle are carefully dissected.



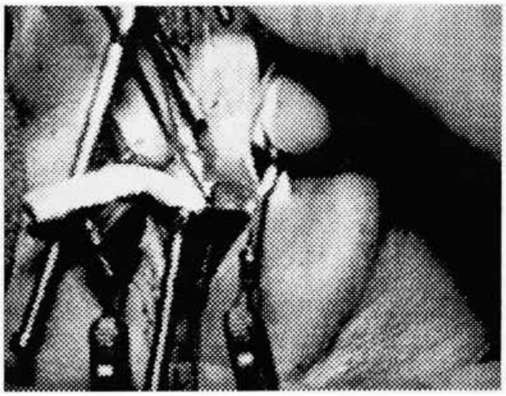
As the approach into the orbit deepens, the CO_2 laser is utilized at 3-5 watts in a continuous wave mode. The laser is applied over the tumor in a painting fashion debulking the mass and reducing lateral tissue heating by carbon deposits.



The medial rectus muscle and surrounding structures are protected with wet cottonoids.

Mild retraction and smoke evacuation is achieved with a suction catheter.

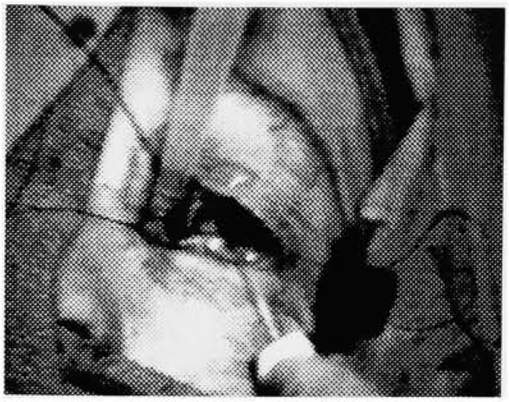
As we proceed posteriorly into the orbit, the optic nerve is isolated and the tumor debulked medially and superorly.

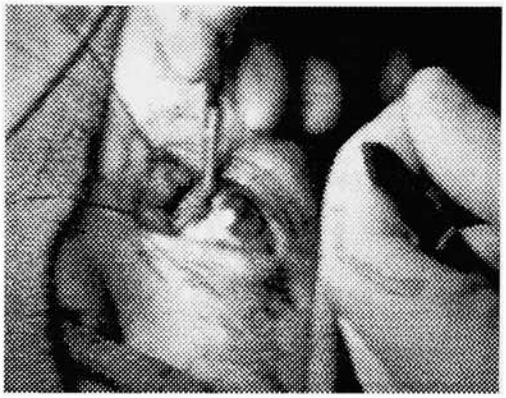


A small portion of the tumor was felt in the superiomedial area of the orbit. It was shrunk with the bipolar cautery.

With 80% of the tumor remover, hemostasis is obtained with the bipolar cautery and the orbit is irrigated with antibiotic solution.

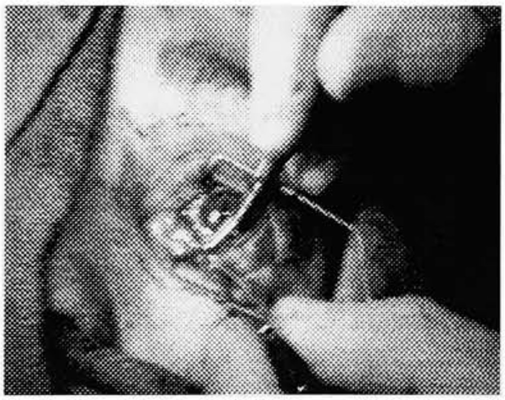
The medial rectus muscle is reapproximated back onto its insertion and the conjucnctiva is applied and a Lancaster-type opthalmic dressing is placed over the eye. [40,41,42]





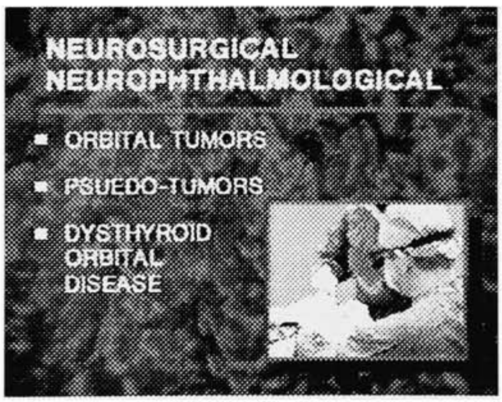
POSTOPERATIVE EVALUATION:

The patient did well postoperatively with good visual acuity and moderate edema of the left eye. The remaining portion of the tumor will be treated with radiation therapy. [43]

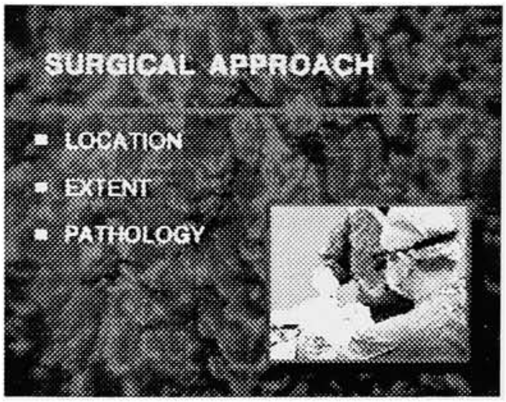


CONCLUSION:

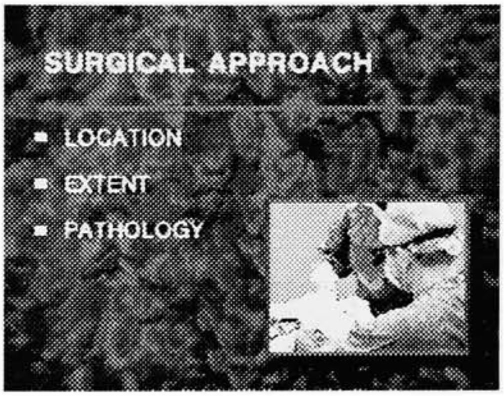
Since 1976, Dr. Kennerdell and Dr. Maroon have utilized a combined neurosurgical / neurophthalmological diagnostic and therapeutic approach on patients with orbital tumors, pseudo tumors, and dysthyroid-orbital disease.



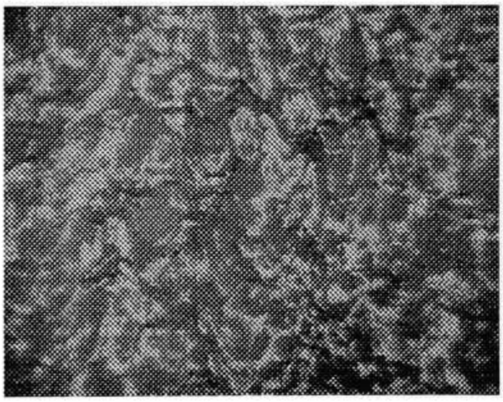
After establishing a diagnosis through computer tomography, diagnostic ultra sound, and fine-needle aspiration biopsy, a surgical approach is selected on the basis of tumor location, extent, and pathology.



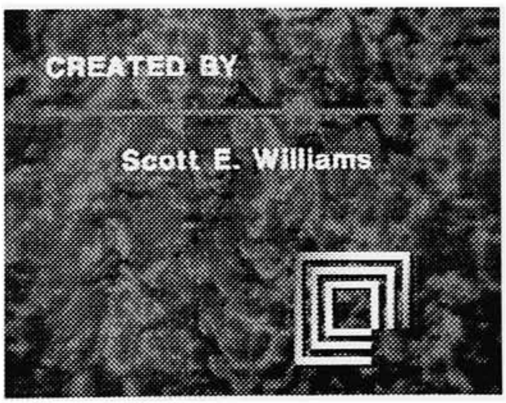
Our surgical goal is the total excision of the tumor. We utilize the CO_2 laser's hemostatic action in a continuous-wave mode to debulk the tumor.[44, 45, 46]



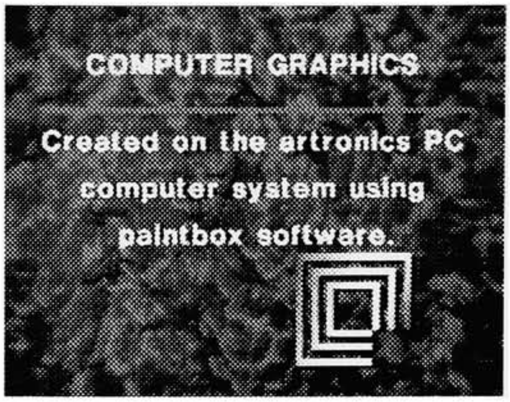
BACKGROUND GRAPHIC:



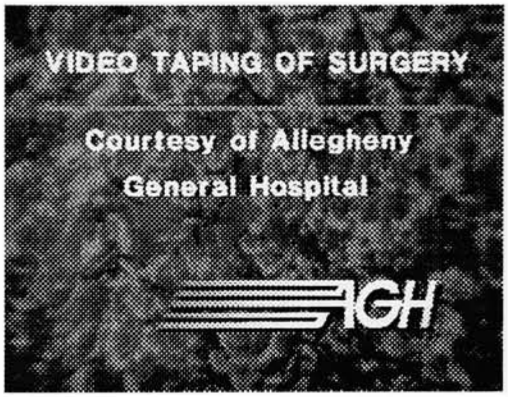
CREDIT:
CREATED BY



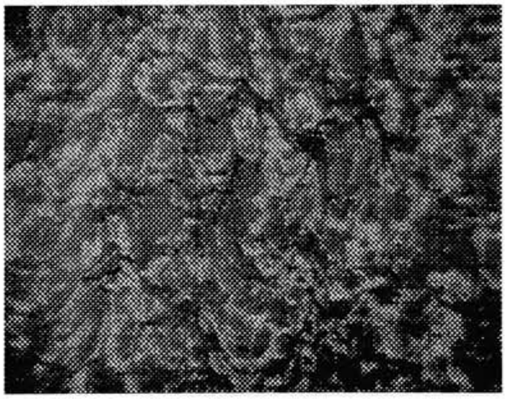
CREDITS:
COMPUTER GRAPHICS



CREDITS:
VIDEO TAPING OF SURGERY



BACKGROUND GRAPHIC:



FADE TO VIDEO BLACK:

Operating Room Setup:

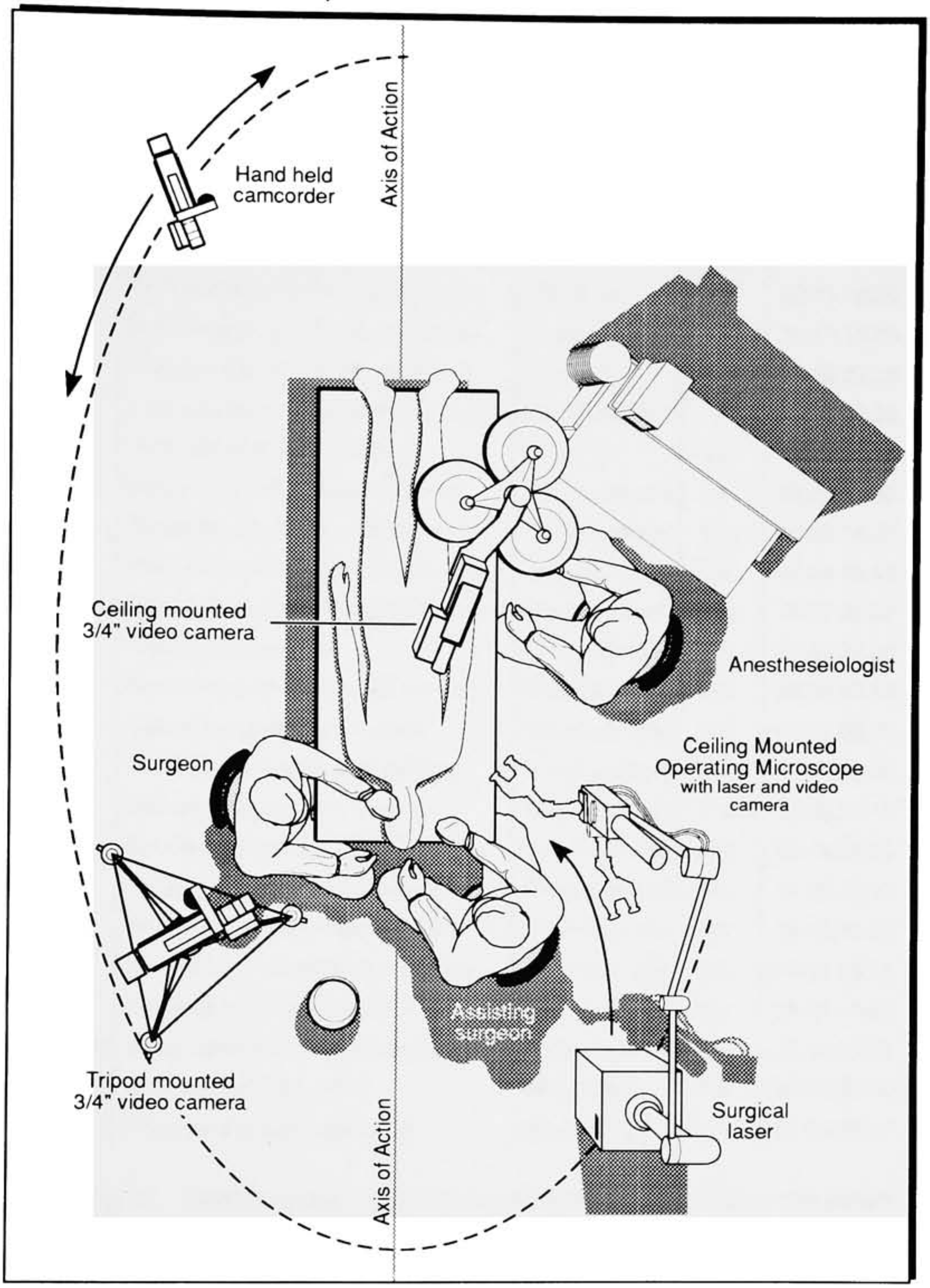


Fig. 1. Diagram of operating room showing placement of patient, surgical staff and video equipment. Also depicted in this diagram is the axis of action (doted line) which was used to plan camera placement and movement around the suite.

Production Log:

TAPE	DESCRIPTION OF ACTION	NOTES	USE	LOCATION
OR#1 3/4"	Video camera mounted over OR table	Set-up / Bars	No	00:05.00.00
	Incision around cornea	Close-up	Yes	00:09.00.24
	Two relaxing incisions medially	Close-up/hand	Yes	00:10.15.15
	Free conjuctiva from near by tissue	Close-up	Yes	00:15.00.25
	Retracting suture in sup. conjuctiva	Close-up/focus	?	00:15.10.05
	Retracting suture in inf. conjuctiva	Close-up	Yes	00:15.22.29
	Free conjuctiva from M. rectus muscle	Close-up/focus	?	00:16.00.00
	Introduction of electrocautery	Close-up	Yes	00:25.35.14
	Removal of small portion of tumor	Close-up/hand	?	00:31.11.00
	Dissection of medial rectus muscle	Close-up/hand	Yes	00:33.18.05
	Placement of hook, medial rectus m.	Close-up	Yes	00:36.15.18
	Rectus m. sutured at insertion on eye	Close-up/hand	Yes	00:37.05.22
	Rectus muscle is cut	Close-up/hand	Yes	00:37.27.00
	Rectus muscle is retracted medially	Close-up/hand	Yes	00:38.08.19
	Two relaxing incisions medialy	Close-up/hand	Yes	00:41.03.29
	Placement of spong over cornea	Close-up/hand	Yes	00:42.13.04
	Self-retaining retractor inserted	Close-up/hand	Yes	00:43.24.15
	Enucleation spoon inserted in conj.	Close-up/hand	Yes	00:44.05.00
	Finger inserted to feel for tumor	Close-up/hand	Yes	00:46.15.07
	Dissection of intraorbital fat and tumor	Close-up/hand	Yes	00:46.28.25
	Dissection of medial rectus muscle	Close-up/hand	Yes	00:48.08.29
	Close-up of retractor in place	Close-up/hand	Yes	00:49.15.02
OR#2 3/4"	Video camera on OR microscope	Microscope	No	00:50.30.19
	Dissection of orbit - RGS	Microscope	Yes	00:54.20.00
	Placement of wet cotoniodes	Microscope	Yes	01:04.00.17

Fig. 2. Sample page from the production log describing the videotape recorded by the video camera mounted on the operating room's ceiling just over the patient as illustrated in Fig. 1. The log describes the action which took place in the segment, notes the type of shot, indicates whether it should be used and locates its position on the videotape.

Artronics Computer System:

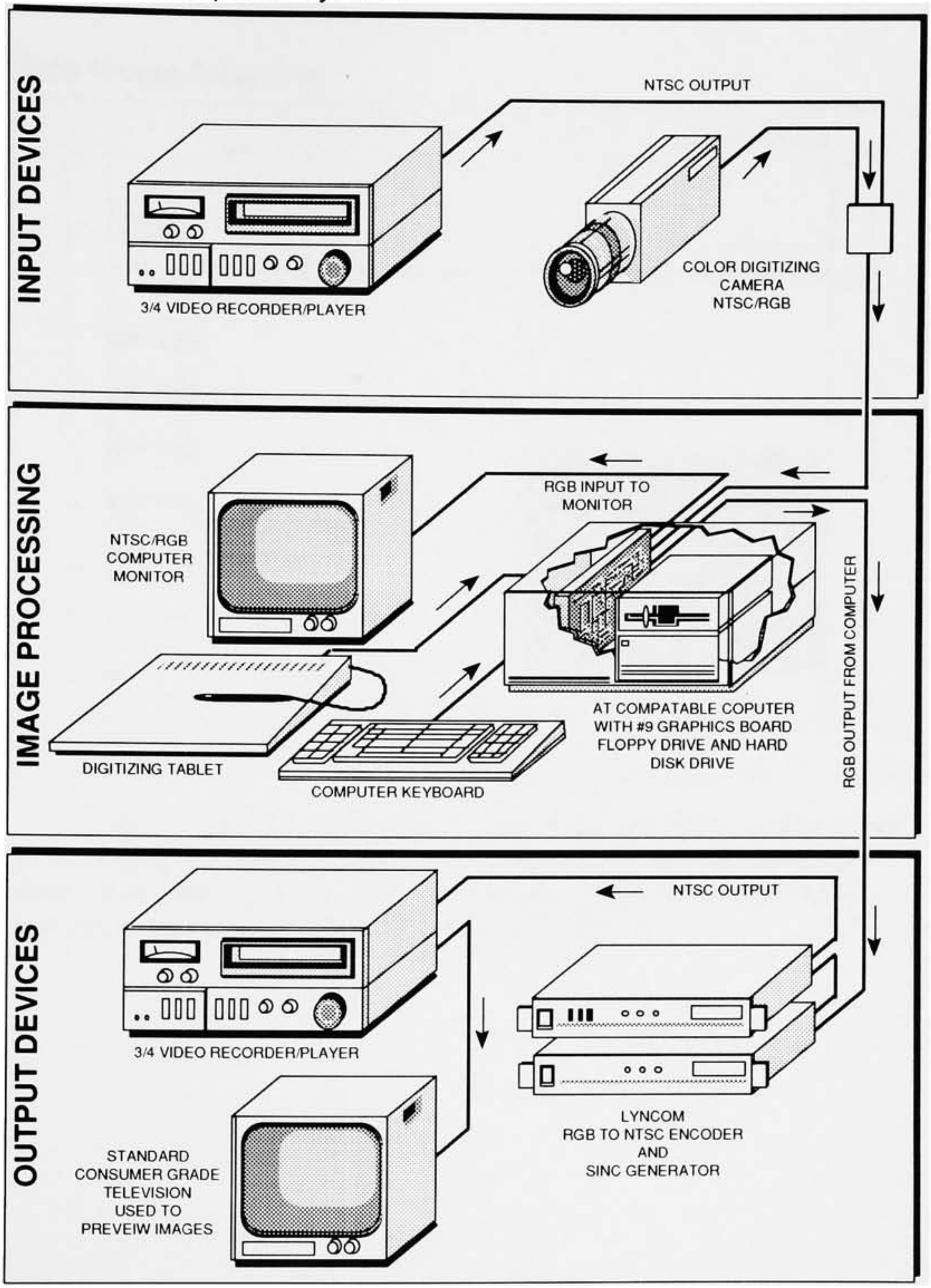


Fig. 3. Schematic representation of the Artronics computer system used in the production of the electronic graphics featured in the video. The schematic has been broken up into three areas according to function.

Safe Image Area Grid:

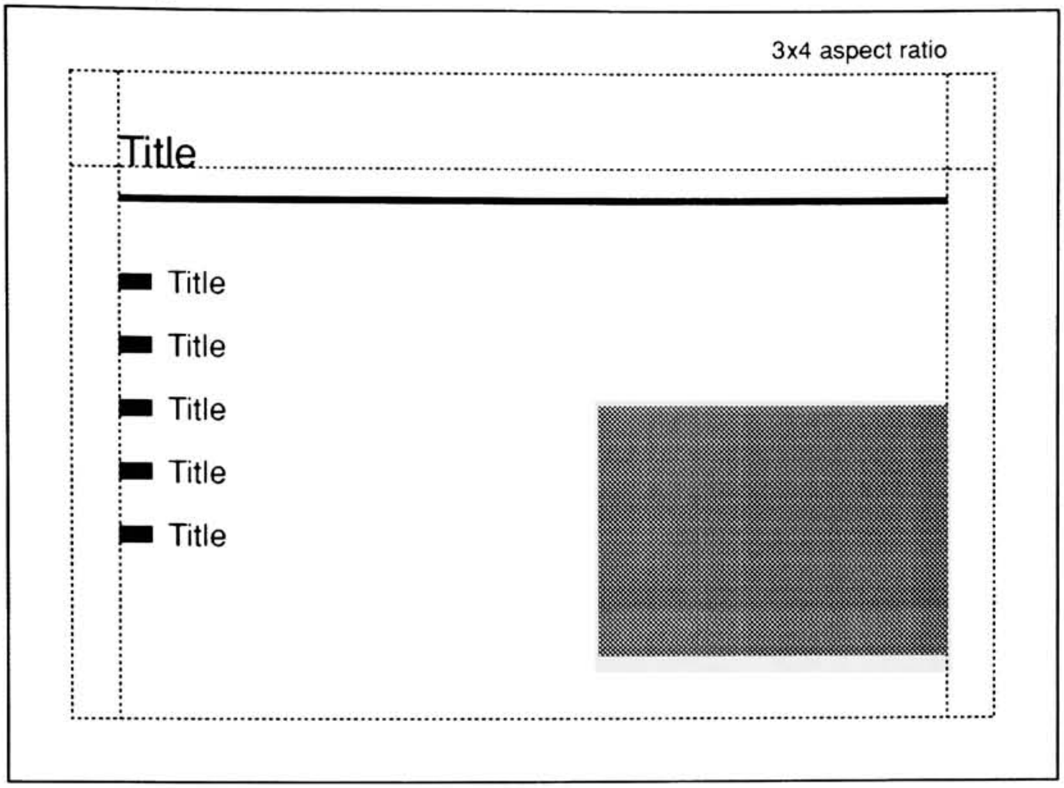


Fig. 4. Representation of the safe image area grid used to layout all the electronic graphics featured in the video. This grid depicted by dotted lines identifies the location of the safe image area, titles, bullets, text items, rule lines and insets as depicted in Fig. 5.

Title Graphics:

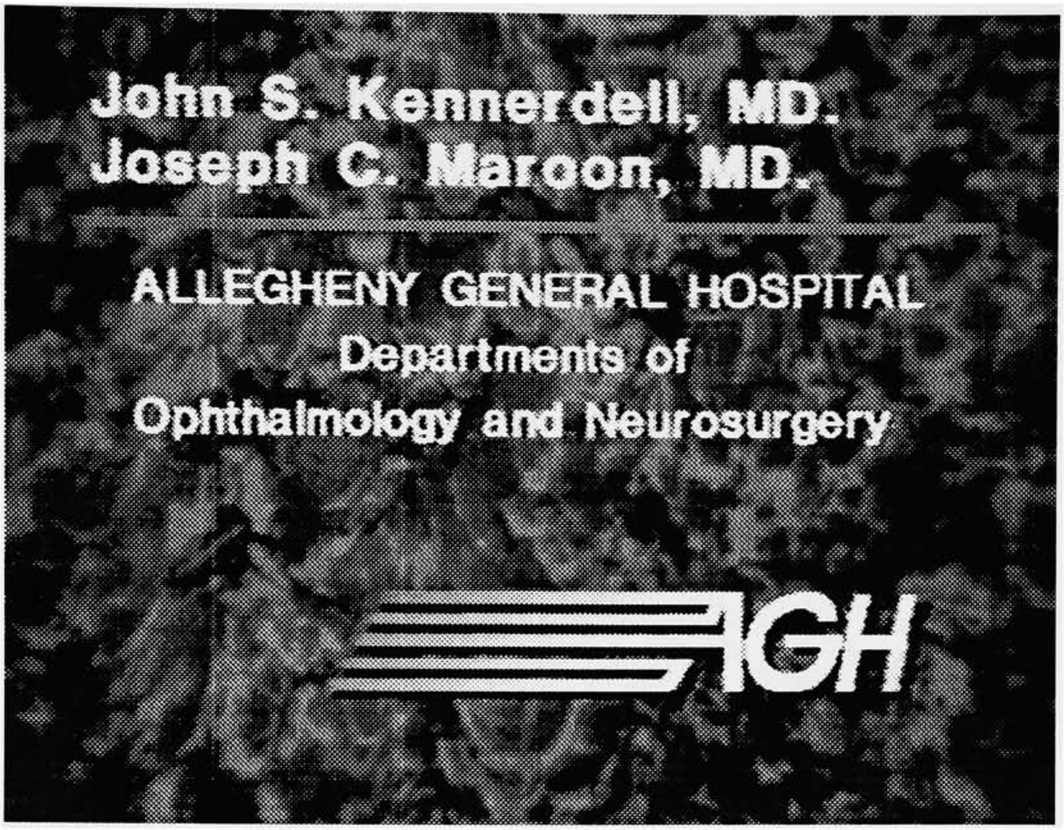


Fig. 5. Digitized image from a 3/4 inch videotape player of one text graphics utilized in the video. This graphic with its yellow title, white text, inset and marbled blue background served as a unifying element throughout the videotape. This image represents the advanced character generation capabilities of the Artronics computer system.

MRI Axial Section:

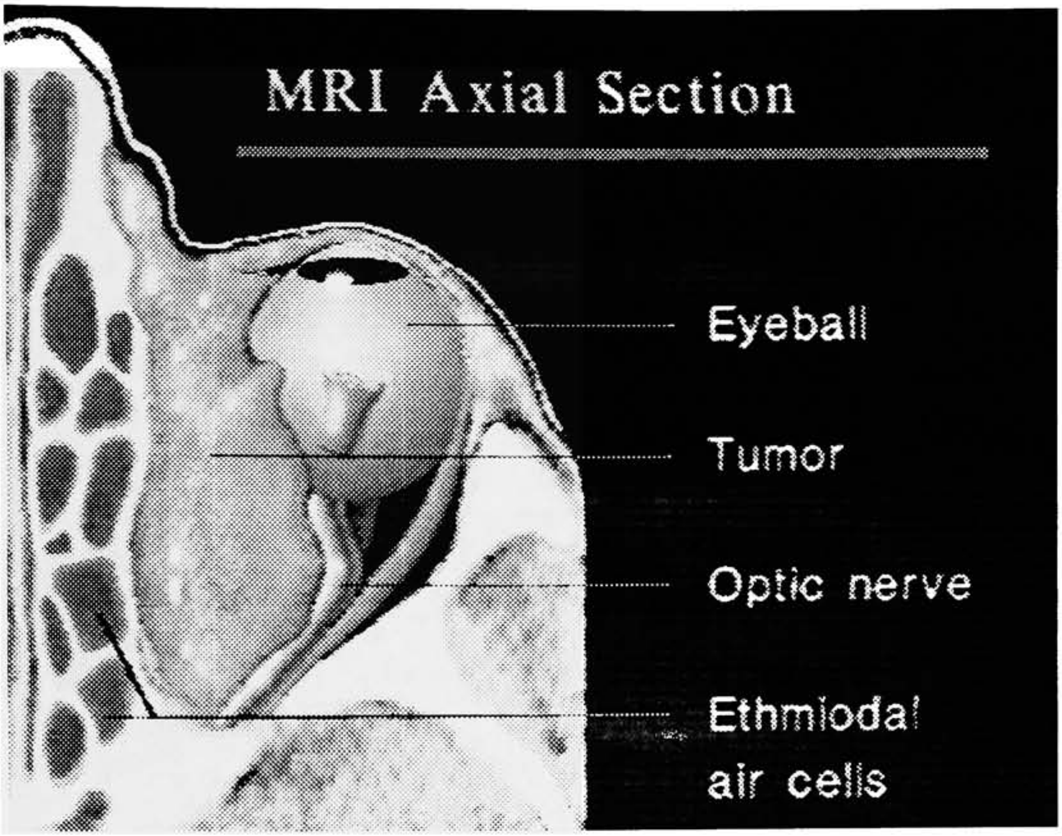


Fig. 6. Digitized image from a 3/4 inch videotape player of an MRI (magnetic resonance imaging) scan with eyeball, optic nerve, rectus muscles, ethmiodal air cells and tumor added. This image represents the image processing and rendering capabilities of the Artronics computer system.

Atom Sequence:

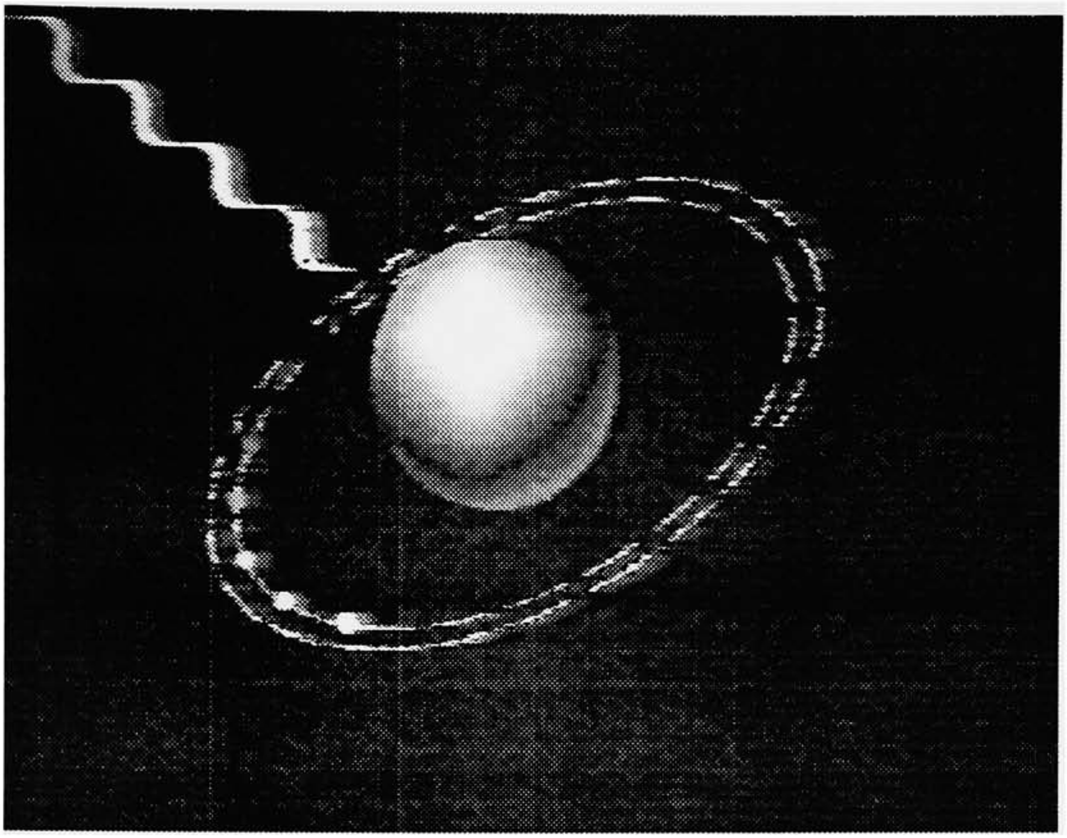


Fig. 7. Digitized image from a 3/4 inch videotape player of a schematic representation of an atom with electrons in an excited state and an incident photon about to strick them. This process of stimulated emission is accruing within the active medium of a carbon dioxide laser. The image represents the animation (cycle paint) capabilities of the Artronics computer system.

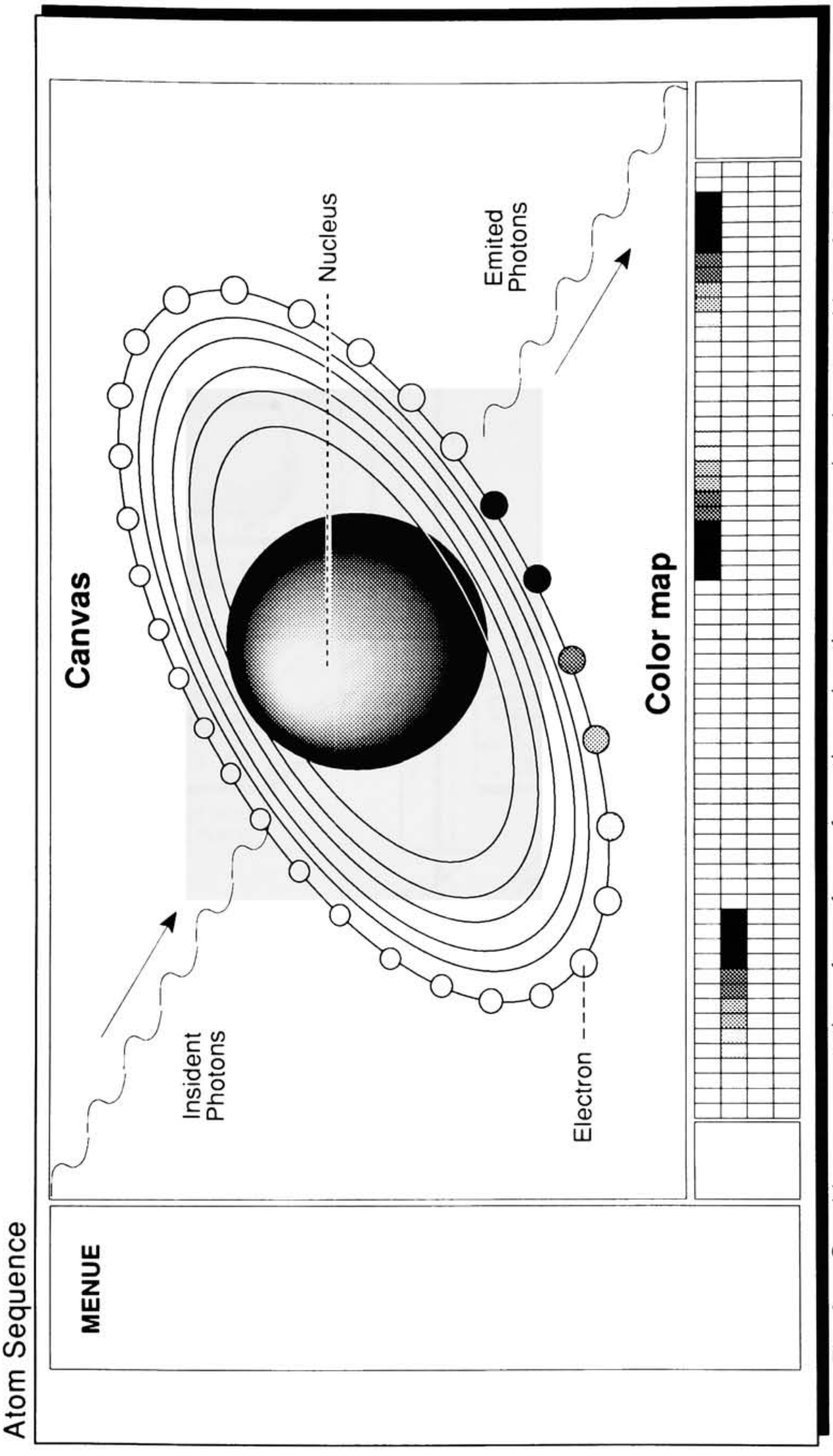


Fig. 8. Graphic representation of one frame from the animation sequence showing transition of electrons from a lower energy level to an elevated level. Also represented in this frame is the menue and color map of the Artronics system.

Videographic editing station:

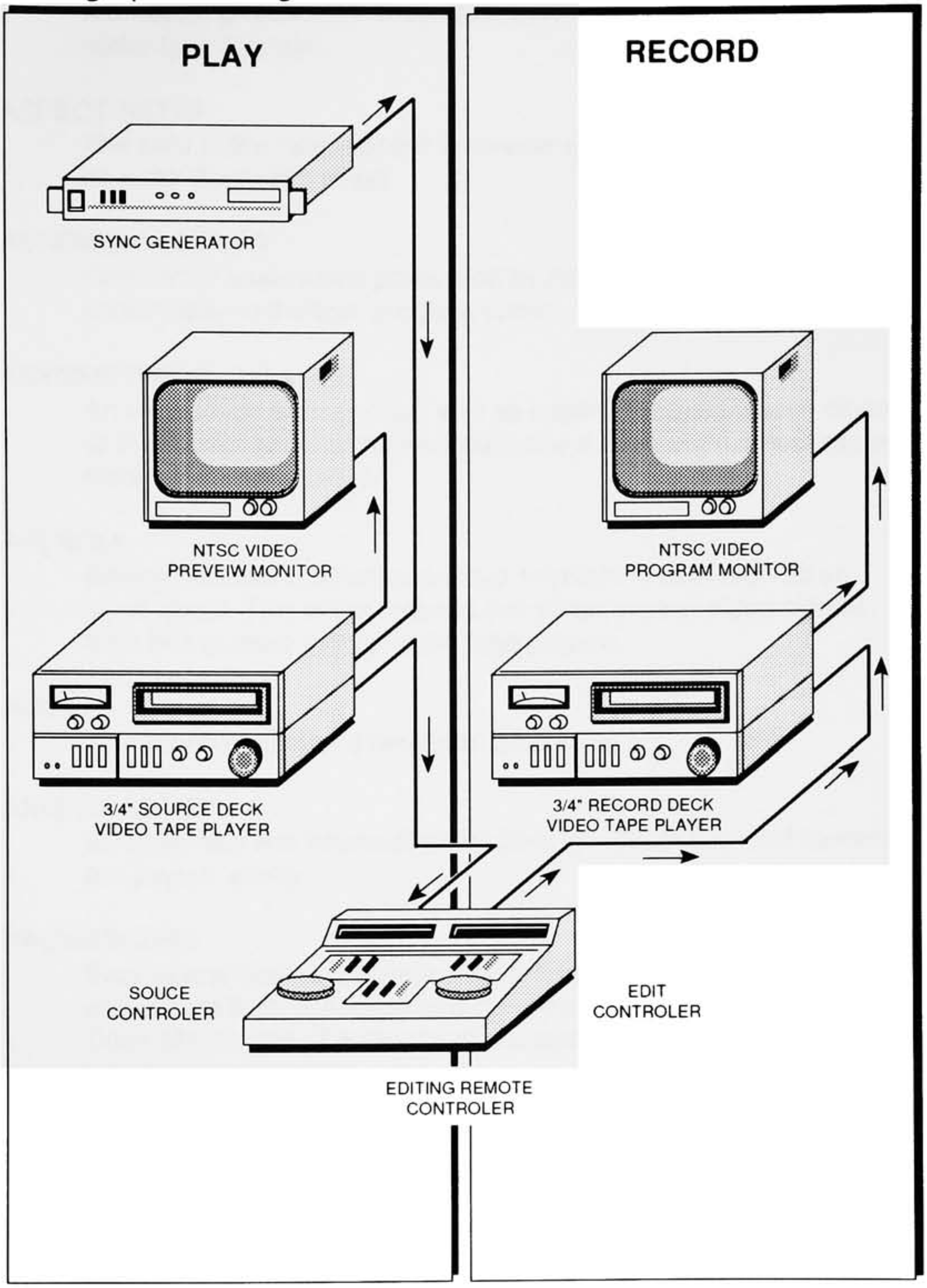


Fig. 9. Schematic representation of the 3/4" editing station used in the production process. The equipment is representative of a small to medium sized biomedical department. The sound mixing board is not illustrated because it was used to correct an unusual technical problem which is not encountered often.

ANTI-ALIAS
A smoothing technique to correct jagged edges or star stepping of raster type displays.

ASPECT RATIO
The ratio of the height of the television screen (three units high) to its width (four units wide).

ASSEMBLE EDITING
Creation of a television production by adding various segments sequentially in the final program order.

ASYMMETRICAL BALANCE
An information arrangement with an important object placed close to the center of the picture balanced by a lightweight object some distance from the center.

A-B ROLE
Editing process in which one video segment is disolved into an other signal. This effect requires two simultaneous video signals from two or more source video tape players.

AUDIO
The sound portion of a television production.

AXIS OF ACTION
An imaginary line where all characters move along and all cameras are placed along.

BACKGROUND
Each scene has a background (backdrop or canvas) upon which all objects are built. A background can be created from colors in the Color Map in one of a several ways, such as Flat or Color-Gradient, or it can be an image.

BALANCE
Visually, the relative composition and stability among elements in a picture.

BIT
A binary digital, the smallest unit of digital information. A bit can represent only one of two values: 1 for on or true and 0 for off or false.

BIT MAP
A digital representation of a display image as a pattern of bits, where each bit corresponds or maps to one or more picture elements (pixels).

BLACK
Technically, a synchronized video signal that contains no picture information - a blank screen.

BRUSH
Any simple shape which can be copied rapidly as it is moved across any path on the screen with the effect of pulling a brush filled with paint across a canvas.

BUFFER
A storage area which receives and subsequently releases transient data. It is used in computer system for the transfer of information at different speeds.

BYTE
Commonly for microcomputers, a byte is 8 bits. The basic unit of data processed by the computer's CPU, a byte is usually used to represent an alphanumeric character or a number in the range 0 to 255.

CANVAS
The Canvas is your drawing or painting area on a monitor, The Artronics' Canvas contains from 400 to 482 rows containing 512 pixels each.

CAPTURE
Digitization of images from a video camera or any other video or RGB device such as a VTR.

COLLECTIVE SHOT
A wide shot showing the collective effect or relationship of various elements-an establishing shot.

COLLIMATION
Quality of laser light not to diverge in space while traveling great distances in a none parallel beam.

COHERENCE
Property of laser light which is in phase spacialy and temporally.

COLOR CHIP
A square icon which visually represents the current selected color.

COLOR MAP
Synonymous with Map. A display of 256 colors that is found at the bottom of the Artronics menu. The Active Color Map represents a selection of 256 colors from a possible 16 million.

COMPOSITE SIGNAL
Electronic signal that contains both picture information and the sync pulse.

COMPUTER
Any device that can receive and then follow instructions to manipulating information. In any computer, both the set of instructions and the information on which the instructions operate may be varied from one moment to the next. A device whose instructions may not be changed is not a computer.

COMPUTER ANIMATION
The use of computer graphics to generate motion pictures, either traditionally in the form of cells or in real-time.

CONTROL TRACK
Portion of a videotape that is used to record the synchronizing pulse.

COVER SHOT (ESTABLISHING SHOT)
An all-inclusive long shot that, by its collective nature, establishes the relationship of performers and other elements in a given scene.

CPU
Central Processing Unit is the "brain" of any computer. A chip in the computer used in every computer operation that processes data and executes instructions.

CRITICAL AREA
The central portion of the scanning area of a graphic card that contains all of the essential information that probably be seen on the receiving set.

CRT
Cathode Ray Tube describes any television-screen type of display used on most computers.

CUT

To eliminate or leave out part of a programs material through the process of editing.

CURSOR

A figure expressed as cross hairs that shows your location on the canvas (computer's screen).

CMY

Cyan, Magenta, and Yellow. The Artronics uses these three colors as primaries, like paints or pigments.

DELETE

Completely remove or erase a selected object on the screen. Any objects currently selected when DELETE is chosen will be erased.

DENSITY VALUE

An attribute or property of object drop shadows which controls the ability to "see through" the drop shadow to reveal what stands behind the drop shadow (100% is opaque; 0% is transparent).

DIGITAL

A electronic equipment such as a computer that manipulates and stores information in a binary state (1 for on and 0 for off).

DISK

A magneticly coated disk similar to an audio tape tape. Information is stored on the disk digitally.

DISKETTE

A small flexible disk enclosed in a plastic envelope or hard plastic case.

DISK DRIVE

A peripheral device capable of storing and retrieving digital in formation. Simular to a diskette but with a mutch greater storage capacity.

DROP SHADOW

The simulated shadow cast by an object's extent on the back ground or over other objects.

EDITED MASTER

Final program

ELECTRONIC EDITING

Joining together program elements on videotape by sequential signal transfer from an original (playback) tape to a second (record) tape.

ENCODER

An electronic device used to transform an NTSC composit video signal into another format such as RGB (red, green ,blue), S-Video or BETA.

FADE

The gradual transition from black to a picture (fade in) or from a picture to black (fade out).

FIELD

One-half of a television picture, consisting of alternate scanning lines, lasting one-sixtieth of a second.

FIELD AVERAGING

A command that removes the distortion normally associated with capturing a single frame of a moving object.

FILE

Information from the program is stored on disk in units, called files, which have names.

FILM RECORDER

A device which can expose a computer-generated graphic image on a film medium to produce a 35 mm slide, 4" x 5", or 8" x 10" print or transparency.

FONT

A set of characters in a particular type face.

FRAME

One complete television picture, consisting of two fields. To compose a picture artistically within the frame of the television screen.

GEN LOCK

An ability to synchronize a video input and output device sync signals to the sync signal of the Number 9 graphics board so that the screen image does not "roll."

GRADIENT

A smooth spread from one color (blue) to another color (red).

GRAPHICS

Two-dimensional visuals specifically prepared for television presen tation-chart, drawing photographs, maps, slides, and the like.

GRAPHICS TABLET

A device connected to the computer through which you communicate locations to the program. The stylus attached to the graphics tablet indicates the position of the cursor on the graphics screen.

GRID

A uniformly spaced set of intersecting lines within which an object can be defined.

HARDWARE

The physical portion of a computer such as the monitor, CPU and keyboard.

HLS

Hue, Luminance, and Saturation color model used to mix and create new colors for a color map.

HSV

Hue, Saturation, and Value color model that is used to mix and create new colors. This allows one to set tint, shading, and toning.

HUE

The actual color base, such as red, green, orange, and so forth.

ICON

A visual, pictorial figure, used to represent a concept, command, or action.

IMAGE

A collection of pixels in which the color is specified for each pixel. The picture portrayed in an image can be used as a background, an image object in a scene, or a texture for a text or geometric object. Images are stored to and retrieved from files which are always in raster form, as opposed to object-oriented Scenes files.

INPUT DEVICE

Hardware which makes it possible to store, record or view information leaving the computer. These devices include: CRTs, monitors, and videotape recorders.A hardware device which makes it possible to enter information or data into a computer. Input devices can include: Key boards, video cameras, flatbed scanners and graphic tablets.

INSERT EDITING

Electronically inserting a new program segment into the middle of a previously recorded production; the new material (video and/or audio) to be inserted is locked into the existing control track.

JUMP CUT

A take between two shots or a badly planned edit that results in connecting two shots that have almost identical views of the same object; as a result the object appears to jump slightly for no apparent reason.

LASER

Acronym for light amplification by stimulated emission of radiation.

LAVALIERE

A small microphone that can be worn around the neck on a cord or clipped to an article of clothing.

LINE MONITOR

The master program monitor that displays the final program picture that is to be recorded or transmitted.

LONG SHOT (LS)

View of a subject from a relatively great distance.

LOAD

Bring a file from the disk into the artronics software.

LUMANACE (LUM)

Sets the model by which images with color are translated into gray levels. The model named Average takes the average of the Red, Green, and Blue components of each pixel. Max will take the largest of the three components, and Min will take the minimum. The fourth model, Perceive, weighs each of thecomponents to give a perceptually accurate gray-level translation.

MEDIUM SHOT (MS)

View of a subject from a comfortable medium distance, between a long shot and a close-up.

MENU

A list functions appearing on the display screen from which an operator can choose one or more through the use of an input device. Menu represents a list of functions or attributes from which you can choose.

MIRROR

Flips an image to look like its mirror reflection. The mirror reflection will print to the output device.

MIXER

An electronic control unit for selecting, combining, and balancing audio signals from one source to another.

MOIRE EFFECT

Distracting visual vibration caused by the interaction of a narrow striped pattern and the television scanning lines.

MONITOR

A video display device that features a high-quality television picture that has not been modulated to an RF signal; it is ordinarily used in studio and control room applications.

MONOCHROMATICITY

A square icon which visually represents the current selected color.

MRI

Acronym for magnetic resonance imaging.

NOISE

Any interference that distracts from the communicative act.

ON-LINE EDITING

Electronic editing technique involving the direct transfer of materials from an original tape to a final program master.

OUTPUT DEVICE

Hardware which makes it possible to store, record or view information leaving the computer. These devices include: CRTs, monitors, and videotape recorders.

PAUSE MODE

Repeated scanning of a single video frame-while holding the videotape stationary-resulting in a still frame during playback.

PICTURE CONTINUITY

The relationship of visual images from one shot to the next, involving flow of action, screen direction, composition, cutting ratio, type of transitions, motivation, and similar consideration.

PLAYBACK

The process whereby the recorded magnetic information stored on the recording tape is picked up by the playback head to recreate the original video and/or audio electronic signals.

PIXEL

Short for Picture Element, a pixel represents the smallest element of a raster type display. Represented as a rectangle with a defined height, width and color. The smaller the pixel the greater the display resolution.

PREPRODUCTION PLANNING

All of the preparation and careful planning that a director must complete before starting studio or location production.

PREVIEW MONITOR

A large monitor that can be used to look at any camera picture or video effect before putting it on the program line.

PROGRAM

Sequence of instructions or code that a computer uses to perform a process.

RASTER

A rectangular array of pixels.

RECORDING

The process whereby the audio and /or video electronic signal is used to arrange iron oxide particles on the magnetic recording tape to store a record of the electronic signal for later retrieval.

RESOLUTION

The precision of a monitor or CRT, measured in pixels along the screens horizontal and vertical dimensions.

RGB

Red, Green, and Blue color model that is based on a scheme of mixing additive primary colors to achieve different colors for the color maps.

SATURATION (CHROMA)

The strength or intensity of a color-how far removed it is from a neutral or gray shade.

SAVE

Storing a file on the disk for future use.

SCANNING AREA

The portion of a graphic card that actually can be seen by the camera pickup tube.

SCREEN

The visible area of the display monitor, also known as the Canvas.

SPREAD

Allows you to set up a color spread between any two colors on the active color map. Spread creates possible color shades between two end point colors.

STYLUS

The pen attached to a graphics tablet. The stylus functions as a pointing device and controls the cursor on the graphics screen.

SYMMETRICAL BALANCE

Formal arrangement with the most important element centered in the picture and other equal objects placed equidistant from the center.

SYNC GENERATOR

The part of the video system that produces a synchronizing signal (sync pulse), which keeps all video pictures locked together.

SYNC PULSE

A complex signal (added to the picture information) consisting of electronic control information that keeps all video components synchronized.

TABLET

The tablet is a graphics device to which the Stylus is attached. The position of the Stylus on the surface of the tablet corresponds to the position of the Cursor on the RIO Canvas.

TRANSFER EDIT

The electronic re-recording (or dubbing) of video and audio information from an original videotape to a second tape for assembly in program sequence.

TRIPOD

Three-legged camera mount, usually with casters to facilitate camera movement.

TYPEFACE

A style of text, such as medium, sans serif.

VIDEO

The visual portion of a television production.

VIDEOTAPE

A plastic tape, coated with iron oxide, that can magnetically record various audio, video and control track information.

VIDEOTAPE RECORDER (VTR)

A magnetic-electronic recording machine that records audio, video, and control signals on videotape.

VOLUME UNIT METER (VUM)

A display meter that shows the relative volume of program audio.

WIPE

A camera transition whereby one image is gradually pushed off the screen-horizontally, vertically, diagonally-as another picture replaces it.

[1] Thomas D. Burrows and Donald N. Wood, Television Production: Disciplines and Techniques , (Duduque, Iowa: Wm. C. Brown Company Publishers, 1983), p. 171-176.

[2] Marsha E. Jessup, M.S., " Computers: A Scientific Tool and an Aid to the Medical Illustrator," Journal of Biocommunications, (AMI, HeSCA and ABCD, May 1984), Vol. 11, No. 2, p. 23-27.

[3] Herbert R. Smith, Jr., M.A., " Computer graphics and Biocommunication: A Report on the Impact," Journal of Biocommunications, (AMI, HeSCA and ABCD, May 1984), Vol. 11, No. 2, p. 40-48.

[4] Francis M. Dwyer. , "Motion as an instructional cue, " A Guide for Improving Visualized Instruction , (Learning Services, State College, Pa. , 1972), p. 40-42.

[5] Francis M. Dwyer. , "Effect of Methods in Cueing Televised Instruction, " A Guide for Improving Visualized Instruction , (Learning Services, State College, Pa. , 1972), p. 44-48.

[6] Francis M. Dwyer. , "Effects of Questions on Visual Learning, Perceptual and Motion Skills, " A Guide for Improving Visualized Instruction , (Learning Services, State College, Pa. , 1972), p. 42-44.

[7] Dwyer, "Effect of Methods in Cueing Televised Instruction, " p. 48.

[8] Graphic Artists Guild, Inc., Pricing and Ethical Guidlines handbook (Graphic Artists Guild, Inc., 1987), p. 135.

[9] Allan Waller. , "Graphics and Animation for Medical Television, " Journal of Audiovisual Media in Medicine , (May 1982), p. 63-68.

[10] Handbook of Effective Audiovisuals , (Medical Illustration and Audiovisual Education, Baylor Collage of Medicine, Houston Tx. , 1975), p. 12.

[11] Mark McGahan, Preproduction Techniques with Storyboards AV Video , Oct. 1988 Vol. 10 No. 10 p. 45-47

[12] Record of Operation, John S. Kennerdell, M.D. Joseph C. Maroon, M.D. , Mark Malton, M.D. , Department of Ophthalmology and Neurosurgery, Allegheny General Hospital, Pittsburgh, Pa. , 4 Dec. 1986.

[13] Burrows and Wood, Television Production: Disciplines and Techniques , p. 185-189

[14] Ibid. , p. 207-211

[15] Ibid. , p. 214

[16] Ibid. , p. 194

[17] Ibid. , p. 214

[18] Ibid. , p. 214

[19] Ibid. , p. 171-176

[20] Ibid. , p. 177

[21] Ibid. , p. 255-256

[22] Ibid. , p. 117-121

[23] Ibid. , p. 257

[24] Ibid. , p. 259

[25] Ibid. , p. 260

[26] Ibid. , p. 261

[27] Ibid. , p. 257

[28] Ibid. , p. 214

[29] John M. Tew, M.D. and William D. Tobler, M.D. "The Laser: History, Biophysics, and Neurosurgical Applications," Clinical Neurosurgery , 1984, Volume 31, p. 506.

[30] Ibid. , p. 506

[31] Michael S. B. Edwards, M.D., James E. Boggan, M.D. and Terry A. Fuller, PH.D. "The Laser In Neurological Surgery," Journal of Neurosurgery , (Oct. 1983), Volume 59, p. 555.

[32] Tew and Tobler "The Laser: History, Biophysics, and Neurosurgical Applications," Clinical Neurosurgery , Volume 31, p. 509-510.

[33] Ibid. , p. 520

[34] Ibid. , p. 515

[35] Ibid. , p. 515-216

[36] Ibid. , p. 517-518

[37] Edwards, Boggan and Fuller "The Laser In Neurological Surgery," Journal of Neurosurgery , Volume 59, p. 557-560

[38] Ibid. , p. 512-516

[39] Preoperative Diagnosis, John S. Kennerdell, M.D. , Surgeon, Department of Ophthalmology, Allegheny General Hospital, Pittsburgh, Pa. , Dec. 1986.

[40] Radiologist Report, William E. Rothfus, M.D. , Radiologist, Department of Radiology, Allegheny General Hospital, Pittsburgh, Pa. , 3 Dec. 1986.

[41] Record of Operation, Kennerdell, Maroon, Malton, Department of Ophthalmology and Neurosurgery, Allegheny General Hospital, Pittsburgh, Pa. , 4 Dec. 1986.

[42] Surgical Pathology Report, Karl R. Fox, M.D. , Surgical Pathologist, Department of Laboritor Medicine, Allegheny General Hospital, Pittsburgh, Pa. , 4 Dec. 1986.

[43] Discharge Summary Report, Mark Malton, M.D. and J. Kennerdell, M.D., Ophthalmologist, Department of Ophthalmology, Allegheny General Hospital, Pittsburgh, Pa. , 7 Dec. 1986.

[44] John S. Kennerdell, M.D. and Joseph C. Maroon, M.D., "Microsurgical Approach to Intraorbital Tumors, " Archives of Ophthalmology , (Aug. 1976), 94: p. 1333-1336.

[45] John S. Kennerdell, M.D. Joseph C. Maroon, M.D. James A. Garritty, M.D. and Adnan A. Abla, M.D. , "Surgical Management of Orbital Lymphangioma with The Carbon Dioxide Laser, " American Journal of Ophthalmology , (Sept. 1986), p. 308-314.

[46] Joseph C. Maroon, M.D. John S. Kennerdell, M.D., "Surgical Approaches To The Orbit, Indications And Techniques," Journal of Neurosurgery , (June. 1984), 60: p.
1226-1235.

Kaplan, Isaac M.D. "Plastic And Reconstructive Surgery," Current CO_2 Laser Surgery , Raven Press, N.Y., March 1982, Vol. 69, No. 3.

Klausmeyer, John M.S. " Computers: An Introduction to the Technology," Journal of Biocommunications, (Association of Medical Illustrators, Health Science Communications Association and Association of Biomedical Communications Directors, May 1984), Vol. 11, No. 2, p. 3-12.