

ROCHESTER INSTITUTE OF TECHNOLOGY

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**ALICE
A DIGITAL IMAGING SYSTEM**

By

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INTRODUCTION

"...After more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned."

*Marshall McLuhan
Understanding Media*

Our society is now undergoing a transformation unlike anything anyone has experienced before. For the first time in history, barriers of time and space between individuals can be completely eliminated. We can experience real or virtual events, as they happen, anywhere in the world.

It has become commonplace for television screens to display real time images of things taking place on the other side of the earth, inside an atom, or even on another planet. Equipment such as telephone answering machines, facsimile machines, automatic bank tellers, compact disk players, cellular telephones, and home video games, which were unheard of a few years ago, have become virtually indispensable today, and are quickly becoming outdated as easier and faster techniques for transmission of information become available.

This remarkable global change is being fueled largely by developments in communications, digital information, and imaging technology. Images are turned into numerical abstractions, bounced off satellites, beamed anywhere at the speed of light, reinterpreted and displayed on computer screens with no loss of quality or resolution.

While completing this thesis, I have studied the latest advances and explored the potential of communications, imaging, and digital technologies. The Alice digital imaging system is the culmination of my exploration. The features of the device itself, incorporate the most recent advances in this technology which will change the way we experience the world around us. The methods used during the process of its design and development point toward changes in the way industrial design will be done in the future.

What follows is a review and analysis of existing communications, imaging, and digital technologies including projections of where they will be in the future; a discussion of how the design of the Alice system incorporates these technologies; an explanation of the methods used to design and present Alice; and an evaluation of what these technologies mean for the future of industrial design.

EXISTING PRODUCTS

"Now, almost as prehistoric man communed and tried to control nature with paintings on cave walls, we control and invent and discover ourselves with machine-handled symbols communicating with pictures through our eyes."

*Richard L. Gregory
The Second Computer Revolution Visualization*

Before developing the Alice system, I studied, examined, and in some cases used, a number of products that utilize new technologies. I also completed research on what developments are expected for the near future. What follows are descriptions of some products and systems that are playing a role in the current information revolution.

Computers

Perhaps the most visible application of digital technology is the computer. Traditionally, computers have been thought of as highly complex number crunchers. People assume that computers are hard to understand and can only be communicated with by typing long strings of characters and learning a language that is nothing like English. Recently however, this perception has begun to change.

As hardware and software have become faster and more powerful, the interface between the computer and the user has evolved to become more

sophisticated and friendlier. This user friendly interface opens up unique possibilities for designers. By using menus [lists of commands and choices appearing on the computer screen at appropriate times], soft controls [controls that can have various functions based upon their programming at a given time], and hypermedia [a nonlinear associational system of information navigation], designers can give everyone access to the real strength of computers.

Eventually, the user/computer interface will become so adaptable and friendly that it will seem to disappear. The computer will be given more of the responsibility for understanding the intentions of the user. By looking, pointing and speaking, the user will be able to interact with the computer as naturally as with another person. Because of this, in the future, computers may be part of almost all products. Many of the objects in our environment will be fully interactive. There will be computers hidden inside potentially complex products making them easier to use. These computers will be invisible to the users of the products.

Invisible computers are already making their way into many products. When we look at our watch, use a microwave oven, or drive a car, we often do not consider that we are interacting with a computer. However, our interface with the product is enhanced through the application of digital technology.

In the future, computers will be fast and powerful enough to know what our intentions are without us explicitly stating what we want. For example, by keeping a record of the books, articles and programs we view on our monitors, our computer can get an idea of what we like to read and watch. It can then use its knowledge about us to prioritize our news and mail and to sort out what we need and want from the vast amount of information

potentially available in our media rich society. This is only one small example of how computer technology will change the way people relate to their environment and to their society. In the past few decades we have merely begun to explore a small fraction of the amazing possibilities which computer technology is bringing forth.

Still Video

A product that is closely related to the Alice digital imaging system is the still video camera. Through my association with Douglas Rea in the school of photographic arts and sciences here at RIT, I have had the opportunity to use and evaluate a number of still video cameras and accessories.

The still video camera uses a CCD [charge coupled device] to record still images on a magnetic disk. It exploits much of the same technology used in standard video recording. The information recorded by the still video camera is an analog magnetic signal. Therefore, as many as fifty photographs can fit on a single two inch diameter disk.

One of the greatest features of still video recording is the ability to play images back immediately after capturing them. When using standard chemical photography, there is an often lengthy processing time to contend with before photographs can be viewed. With still video, the disk can be popped out at any time and images can be played back on a television. For hard output, the image can also be sent to an ink jet, thermal or other type of printer.

The biggest drawback of still video is its limited resolution. Each image is made up of approximately 380,000 pixels [picture elements, single points of the picture] as opposed to the equivalent of 18 million pixels in a 35 mm film frame.¹

If the analog still video image is converted to digital information, it can then be processed and manipulated using a computer. Photographs can be cropped, flaws can be repaired, and colors can be corrected. These procedures have traditionally been done manually. There are processes however, which can be done to images only through the use of a computer. For example, there are deblurring algorithms that can correct the blur of an image that was shot out of focus or with a shaky camera. The computer can also be used to produce cyan, magenta, yellow, and black color separations for four color printing.

The amount of information contained in an image becomes much larger when it is converted from analog into digital. Instead of fifty analog pictures stored on a two inch disk, there can generally be, at most, two digital images on a 3.5 inch disk.

The potential of still video is probably most apparent in the field of photojournalism. The speed with which images of newsworthy events can be printed, using this technology, cannot be matched by chemical processing. Uses of still video technology are also being found in medicine, science, and art, where the ability to quickly process and recombine digital images can create some astounding results.

¹ Michael L. Morse, "How electronics will change the way we do business," *The Electronic Revolution in news photography a NPPA National Report*, (1987), 11-17.

Digital Video

Along with cameras which record analog video images, there is at least one camera that will record digital video images.

With Fuji's introduction of the Fujix DS-1P, some of the problems associated with analog still video will be eliminated. Instead of using the standard 2-inch magnetic floppy, the digital camera records digitally on a 16 megabit SRAM card that was developed jointly with Toshiba.² This solid state technology eliminates the need for a motor or mechanical drive used when spinning a disk. Because the picture is converted to digital information before it is recorded, there is also no need for down stream analog to digital conversion as with standard still video.

As previously mentioned, however, digital images often contain a very large amount of information. Depending upon the amount of colors an image contains, there can be up to 24 bits [binary digits, the basic on/off units of information] of information per pixel. This can mean well over a megabyte [2²⁰ bits] of information for one video image. This large amount of information is difficult to store, to move, and to work with.

There are, however, ways to compress the amount of information without greatly affecting the visible image quality. The SRAM card is reported to hold 40 compressed digital images. With software such as Kodak ColorSqueeze®, I have been able to achieve compression ratios of up to 40/1. Additionally there are fractal compression routines that claim astounding results of 500/1.³ Image compression is critical to the future of digital

² Paul Anderson, "Electronic Still Photography: Where it Stands Now," *Advanced Imaging* (1989).

³ Karen Wright, "The Road to the Global Village," *Scientific American*, 262, No. 3 (March 1990), 83-94.

imaging. As development of compression technology continues, the number, quality, and resolution of stored digital images will increase.

HDTV

When looking at images of a given size, be they analog or digital, it is always best to view them in the highest resolution possible. The resolution of most television monitors, still video cameras, and digital video cameras however, is based upon the NTSC [National Television Systems Committee] standard of 525 lines of vertical resolution. This was fine in 1953 when it was developed, but it falls far short of meeting today's and tomorrow's needs.

New systems of HDTV [high definition television] have been developed in Japan. Now, as various technical and political problems are being worked out, HDTV systems are beginning to appear in this country. HDTV gets its high definition by having 1125 vertical lines of resolution. Instead of the flickering, poor color, low resolution image of standard television, the picture is comparable to that of 35 mm film.

Another difference between NTSC television and HDTV is aspect ratio [the ratio of the width to the height of an image]. Instead of the standard aspect ratio of 4:3, HDTV uses a ratio of 16:9. This brings the image closer to the proportions of a movie screen.

HDTV is a good idea, but in my opinion it still falls short of what is needed. The next step in television development should be digital. Instead of the HDTV analog signal, a digital television signal should arrive in the home. This could make television truly interactive by giving viewers more control over what they watched. With the help of a friendly computer, they

could become their own directors. For example, while watching a sporting event, viewers could create their own slow motion replay. They could decide which camera angle to use, or they could split their screen and see a number of different views simultaneously. The basic concept of television watching as a passive activity would be changed to one in which viewers take an active role in what they see. With interactive digital television, a powerful new form of communication would emerge.

One of the only drawbacks to a digital television broadcast system is that sending motion, full color, digital signals into the home would require a huge amount of information per second. The broadcast and the cable systems we now have in place would not be able to handle it. There is, however, a system on the horizon that could carry this signal with room to spare.

ISDN

ISDN [integrated services digital network] is a digital telephone system that will be replacing our current analog system within the next decade. In combination with optical fiber [a high bandwidth medium for transmitting information with light], ISDN will be responsible for putting the individual in touch with the world. We will be able to talk over the phone with digital clarity, have our utilities metered, receive electronic mail, do library research, and watch digital HDTV, all through the same thin cable, with no noise or interference. ISDN will make many products obsolete including facsimile machines, modems, and cable TV.

Test sights for ISDN are already in place in this country. Over one hundred countries are involved in an enormous international effort to link

all the world's phone systems with an ISDN network capable of carrying every kind of signal, including television.⁴

ISDN in conjunction with other digital communications technologies will be one of the first steps in creating a new global society that is based upon access to information and communication. It will eliminate the boundaries between us and put us in touch with anyone anywhere.

⁴ Stewart Brand, *The Media Lab* (New York: Viking Penguin inc., 1987), 31.

ALICE

“‘Who are you?’ said the Caterpillar.

This was not an encouraging opening for a conversation. Alice replied, rather shyly, I-I hardly know, Sir, just at present-at least I know who I was when I got up this morning, but I think I must have changed several times since then.’”

*Lewis Carroll
Alice’s Adventures in Wonderland*

Perhaps the question I was asked most frequently while designing the Alice digital imaging system is "Who is Alice?"

The name is derived from the story *Through the Looking Glass*, written by Lewis Carroll in 1871. In it, a young girl named Alice discovers that her two dimensional image in a mirror contains a whole new world where anything she can imagine is possible. By using this girl's name, I am referring to the wondrous things that are now possible with two dimensional image processing. The name also serves to make the product friendlier and more approachable. High-tech sounding names with a lot of meaningless numbers and letters only serve to reinforce the impression that technology is difficult to understand and to use. In the information age, industrial design should serve to demystify technology and make it accessible to everyone.

The Alice system consists of a digital picture card, a camera, and a transceiver. The camera serves to grab images and record them digitally on the card. The transceiver is used for viewing and storing images and communicating with other digital media.

Card

The digital picture card is the focus of the entire Alice digital imaging system. Between 100 and 500 highly compressed, digital, high definition images can fit on a single card, depending upon the chosen resolution for each picture. Like the SRAM card, no motor drive is required. It is 3 inches long and 1.6875 inches wide. This gives it the proportions of 16:9 which relates it visually to the digital HDTV images it holds. Like a floppy disk, or a cassette tape, it can be mechanically locked by sliding a plastic tab into position. There is a generous finger grip so that the proper orientation is maintained when inserting it into the system. The finger grip also helps the cards to stack neatly.

Camera

The Alice camera has everything a professional photographer would need to capture images, but it is accessible to amateur photographers as well. If the round metal switch at the back of the camera is turned one notch counterclockwise, then the camera is turned on and all of the adjustments are set to automatic. One just has to pop in a card, point, and press the shutter located next to the "on" switch. One more notch turns off the auto focus mechanism, and the final position makes all of the settings manual so the photographer can have complete control over the images.

The camera is made of molded thermoplastic rubber over a cast metal sub-structure. These materials make it soft, durable, slip resistant and water

resistant. A strap, which runs from the metal clip by the eye piece to the clip near the lens, helps to keep the camera comfortable and secure in the hand.

The eye piece can be rotated so that either the left eye or the right eye can be used. The camera is designed to be held in the right hand and focused with the left by rotating the lens. However, when auto focus is activated, the sonar in the front measures the distance to the subject, and only one hand is needed.

Also located on the front of the camera, are the light meter and the flash. The flash can be turned on or off, or set to automatic, with the switch above it. With digital imaging, it is possible to automatically adjust the equivalent ISO of an image based upon the available light. Therefore only a fill flash is needed.

There are multiple lenses available for the camera, which can be attached by twisting them onto the camera body. Because the CCD is 75% smaller than 35 mm film, the lenses have a much shorter focal length than on a conventional camera. The lens shown in the images of the camera, can zoom from 10 to 50 mm by pushing or pulling the focusing ring. This is the equivalent of a 40 to 200 mm zoom on a conventional camera. Also located on the lens is the ring which adjusts the aperture. The shutter speed is controlled with the metal dial on the top front.

The battery compartment is located on the bottom of the camera. Alice uses lead acid batteries because they provide long operating life and can be recharged more fully and more often than nickel cadmium batteries. Furthermore, since the battery voltage of a lead acid battery diminishes gradually, the power level can be closely monitored and low power warnings can be posted well before the battery's energy is used up.

Also located on the bottom of the camera is the HDTV output. By attaching an external recorder to this port and holding down the shutter release, Alice can be used as a standard HDTV video recorder.

In order to keep Alice simple and easy to understand, and not fill up every available surface with buttons and switches, a number of the lesser-used controls were placed in the software included with the camera.

Adjustments are made through the LCD [liquid crystal display] screen on the top of the camera, and controlled with soft controls accessed with the three buttons next to the screen. The middle button toggles through the command menu, and the two triangular buttons control adjustments. The following features are included in the software:

Help -- Alice can demonstrate, with instructions and diagrams, how it is used.

Clock/Calendar -- A clock and a calendar can be displayed on the screen, and information about when each image was taken can be included on the card.

Resolution -- The resolution of the images can be adjusted to trade off between the quality and the quantity of images that can fit on a card.

Automatic preference -- This selects whether the automatic settings are speed or aperture preferred. It can also be set to automatically adjust both.

Timer -- As on a standard camera, the shutter can be set to open after a specified interval.

Display/Erase -- This allows the photographer to see a low resolution picture of what an image looks like and gives the option to remove it to make room for another one.

Broadcast -- An FM broadcast of what appears in the lens can be sent to the transceiver to help set up a shot.

Transceiver

After a card has an image recorded on it, it can be placed into one of the card drives in the transceiver for viewing. Except for the on button located in between the two card drives, all functions of the transceiver are controlled by software accessed through the color, high definition, LCD touch screen. With easily navigated menus the process of information manipulation is kept simple. Images can be copied from one card to another or stored on the transceiver's one gigabyte [1000 megabytes] internal hard drive.

Some basic image processing can be done with the software included. For major digital darkroom work however, users will want to connect to a more powerful computer. This is where the real strength of the Alice digital imaging system lies. On the back of the transceiver are located a number of ports that can send and receive information in various ways.

The simplest and most common way for computers to communicate with other digital devices is through a serial port, so called because information is sent and received in serial fashion, one bit at a time. Alice has two serial ports that are based upon the RS-232 standard and can transfer data at 5,000 bytes per second.

The computer industry has been moving toward a series of hardware standards to make it easier for computers to communicate with each other. One such standard is SCSI [small computer system interface] (pronounced "scuzzy"). This defines a set of signals and protocols to allow computers to

communicate with devices such as hard disks, digitizers, and scanners. The Alice transceiver has two SCSI ports which allow it to be daisy chained [linked in series] to any compatible device.

The Alice system records images in digital HDTV format. Therefore, HDTV output and input ports have been included on the transceiver. This will allow images to be recorded onto tape, as well as allowing the transceiver to be used as an HDTV monitor.

Perhaps the most important link included on the transceiver is the ISDN port. This allows the system to be hooked up to the worldwide digital information network. Images can be sent around the world to appear on televisions or to be printed and published moments after they are taken.

The more ways there are for Alice to communicate with other devices; the more languages it can speak; the more useful and adaptable it is.

Form

All the technological innovations discussed above are happening so quickly that it is easy to lose sight of the basic reason for their development: to improve and enhance people's productivity and access to information. This is where industrial designers play a crucial role.

The tasks of industrial design in contemporary society are to translate technologies into understandable, usable tools and products, and to ease the integration of these technologies into our existing culture.

These tasks can be achieved by developing product forms which are related to function; are based, in part, upon familiar cultural icons; and are comfortable, inviting, and friendly to the hand and to the eye.

The physical form of the Alice digital imaging system has been derived from a number of sources. Ergonomic considerations dictated the soft gentle curves of the main camera body and of the bottom of the transceiver, which fit the hand and the body and give Alice a friendly, unimposing quality. Human factors also played a major role in determining the layout of the controls and components. Buttons and switches were placed within reach of the fingers. However, they were not put in positions where they could accidentally be activated. The position, shape, size, and material of the controls and components are intended to give cues about their function and operation. The layering of the card areas is derived from a representation of the compression of multiple images onto one card, and is reminiscent of the bellows of early cameras. The eye piece is designed to softly cradle the eye, while shielding it from ambient light.

In general, the form is intended to present a high technology tool as something that is friendly, fun, and easy to use and to understand.

COMPUTER AIDED INDUSTRIAL DESIGN

"To know the world, one must construct it."

Giovanni Battista Vico

Perhaps the greatest influence upon the form of the Alice system was the method used to design it. The computer is now beginning to be accepted as a useful and powerful tool for the design of products. As with chisels and paint brushes, the marks of tools are often apparent on the objects they help to create. The tools often add their own unique qualities to the finished product. As computers are being used more often by designers, forms are emerging which show new influences.

In designing the Alice system I used a number of computer technologies that may change the field of industrial design.

Intergraph Mechanical Engineering Design System

As with most products, the design process used for the Alice system began with research, idea generation, and sketching. When a preliminary design was arrived at, I began to enter three dimensional geometric information into an Intergraph MEDS [Mechanical Engineering Design System] design file. This enabled me to create a virtual model [a three dimensional model digitally stored in the memory of a computer] of my proposed design.

As with a real model, I was able to move this virtual model into any position and see it on the computer screen from any point of view. I could also zoom in to get a close-up view of the details and work at a smaller scale than is possible with a real model.

The information I entered was accurate to six decimal places, so the computer sketches I made were exact geometric representations of my design concepts. As the design developed, it was easy to implement changes in the position, scale, and form of components. Instead of having to make a completely new model, as I might have had to do if I was using traditional design methods, I could simply make a copy of the original design file and change whatever information was necessary. Using this method I could easily compare and evaluate a large number of alternative design solutions.

When I arrived at my final solution, I was ready to produce scaled orthographic drawings. Because I already had the three dimensional geometric information in the computer's memory, I simply had to lay out the views I wanted and instruct the computer to remove all the hidden lines. After the computer produced this two dimensional file using my three dimensional information, I was ready to add text and graphics and plot out full scale orthographic drawings.

Raytracing

Using MEDS I was able to create perspective renderings of the Alice system. These renderings could be in any colors, from any point of view, with a light source from any direction. It was impossible, however, to show

surface texture, specular highlights, or differences in materials. To do this I needed software called ModelView.

Through an arrangement with Gail Levy at Xerox Corporation, I was given some access to a computer system which had this powerful software. I saved the MEDS file I had created on a floppy disk and loaded it into this computer system.

ModelView is software, made by Intergraph Corporation, which can be used to create photorealistic images of virtual three dimensional models. The most effective process used to create these images is Raytracing.

The first thing to do when Raytracing an image is to create a material table which assigns specific qualities to each surface of the model. These qualities are transparency, specular reflectivity, diffuse reflectivity, surface finish, and color. By varying these qualities, surfaces can be made to look like any material including glass, plastic, metal, and rubber. It is also possible to take an existing image (either created in the computer, or scanned in from some other source) and map it onto a surface. Once this material table is created, the model is moved into the desired orientation and the computer is instructed to begin creating the image.

To accomplish Raytracing, the computer calculates the path of each light ray that would enter the eye in a real three dimensional environment. Based upon the material table, the computer decides how much of the light hitting a surface is absorbed and how much is reflected. This requires an enormous amount of computation, and therefore often takes a very long time. In some tests I ran at Xerox, the creation of one image took as long as thirty hours. It was therefore not practical to use Raytracing for all the images I wished to create.

An alternative method of rendering included in the ModelView software is Quicktrace. Quicktracing takes a fraction of the time of Raytracing (approximately ten minutes for one image) and gives acceptable image quality. I therefore used Quicktrace for the majority of the images I generated.

Scatt Printer

When the renderings were created I was able to view them on the computer screen. However, I wanted some way of printing them. The machine which would give me the best possible results was the Scatt thermal printer which has recently been developed by Xerox

The Scatt printer was still being developed when I was using it, and a friendly interface was not yet in place. Because of this, a number of things had to be done to the images before I could print them. First, they were stretched so they would be eight by ten instead of four by five format. After this, each image was divided into three files; one for each of the cyan, yellow, and magenta planes of color. When this was done, the three files were sent to the printer and a thermal copy was made.

A thermal copy works by heating spots of color film and thereby transferring that color to a sheet of paper. In this case, each copy required three different passes through the heater, one for each of the three color planes. Thermal copying is a continuous tone process, which means that there are no individual dots of color visible on the print. The prints that I ended up with had the quality of photographs of the virtual model stored in the computer's memory. (The prints that are included in this thesis are color

laser copies and die sublimation prints. These prints do not represent the quality of the original Scatt thermal prints.)

Stereo Lithography

As previously mentioned, there are many advantages to using a virtual model while creating and visualizing a design. When interacting physically with an object however, a real model is still necessary. There are many nuances and subtleties of form that a designer or user can only experience by holding a product. As of today, virtual models cannot be effectively touched. There are however, a few methods of creating a real model from a virtual model. One of these methods is called stereo lithography.

Stereo lithography is like three dimensional plotting. First the virtual model is divided into many sections each .005 to .01 of an inch thick. The first section is then drawn, with a laser, onto the surface of a vat of photocurable polymer. The laser solidifies the polymer, creating a solid plastic cross-section of the model. The elevator platform holding this section moves down the programmed amount and the second layer is created on top of the first. This process continues until all the sections have been made solid, and the platform is raised revealing a real three dimensional model. The model is stripped from the table and is taken to a special apparatus for final curing.

During my thesis work I had the opportunity to visit J.H. Young Company where I saw the creation of stereo lithographic models. I was able to run some tests of the stereo lithography process using my own design files.

As of today, this process is being used only for prototypes and models. In the future, however, stereo lithography may become a true production process. This would eliminate time consuming mold fabrication and costly retooling for design changes. If a change was needed, it would merely have to be entered into the computer.

Stereo Lithography, as a production process, would open up new possibilities for designers to gear products toward specific user populations. For example, a handle would no longer be designed to fit the hand of the average person. Using stereo lithography, the size of a handle could be varied and produced in sizes that would exactly fit the population.

New materials are now being developed which will help to expand the potential of this unique process. In the near future, virtual models created on the computer may be able to be turned into materials like metal, glass, and even rubber.

The Future of Computer Aided Industrial Design

The processes of computer aided industrial design, such as those used during the creation of the Alice system, are just beginning to have an impact on the field of product design. In most design firms today, if a computer is used for anything other than word processing, it is only to produce two dimensional line drawings. As more industrial designers begin to take advantage of the real potential of computer aided design, the design process will be drastically altered.

In the future the entire creation of a product will be accomplished with a computer. For initial research there will be access from the console on the

designer's desk to the libraries of the world. Sketches done on a sensitive screen will be read, interpreted, and understood by the computer.

The computer will be able to generate alternative forms based upon the criteria setup and ranked by the designer. By referring to an ergonomic database the computer will flag potential human factors problems.

A virtual three dimensional design model will be displayed holographically [a method of displaying a three dimensional image using the information contained in the interference pattern on a photographic emulsion]. This virtual model will be able to be touched and manipulated by using a special glove on the designer's hand. The same model will be able to be displayed anywhere in the world, over digital phone lines. Designers will be able to meet with people on the other side of the world as though they were sitting in the same room. Design decisions will be made more quickly. Changes in product forms will be able to be implemented in front of the client's eyes.

New manufacturing processes will be digitally controlled by the same computer used for design, structural analysis, packaging and graphics.

Computer aided industrial design will simplify, speed up and enhance the process of product creation. This will result in greater control, as well as greater responsibility, for designers over the products we create. The designer's concepts and ideas will have a greater impact and a better chance of success.

CONCLUSION

Overall, the process of researching and designing the Alice digital imaging system was a success, both professionally and personally. I gained knowledge and expertise in many areas. I met people and was exposed to equipment and environments that were interesting and exciting.

Through my research of new technologies I gained insight which is changing the way I view the world. I have continued to read and explore these topics and they have sparked many new design ideas that I intend to develop in the future.

I feel that the final design solution for the Alice system is well thought out and effective. There are however, a number of areas that could have benefited from more attention. For example, the form of the transceiver lacks detail. The screen is flat and unexciting. It is obvious that less time was spent in designing this component than in designing the camera. Perhaps a curved screen could add visual interest as well as make the unit more inviting and easier to carry. The straps on both the transceiver and the camera also need to be further developed.

The form does show however, a successful use of the computer for industrial design. It succeeds in countering the idea that geometry created on a computer is always rectilinear. It proves that sculptural organic forms can be created digitally. The use of a virtual model for the rapid visualization and manipulation of design ideas is a process which will revolutionize the field of industrial design.

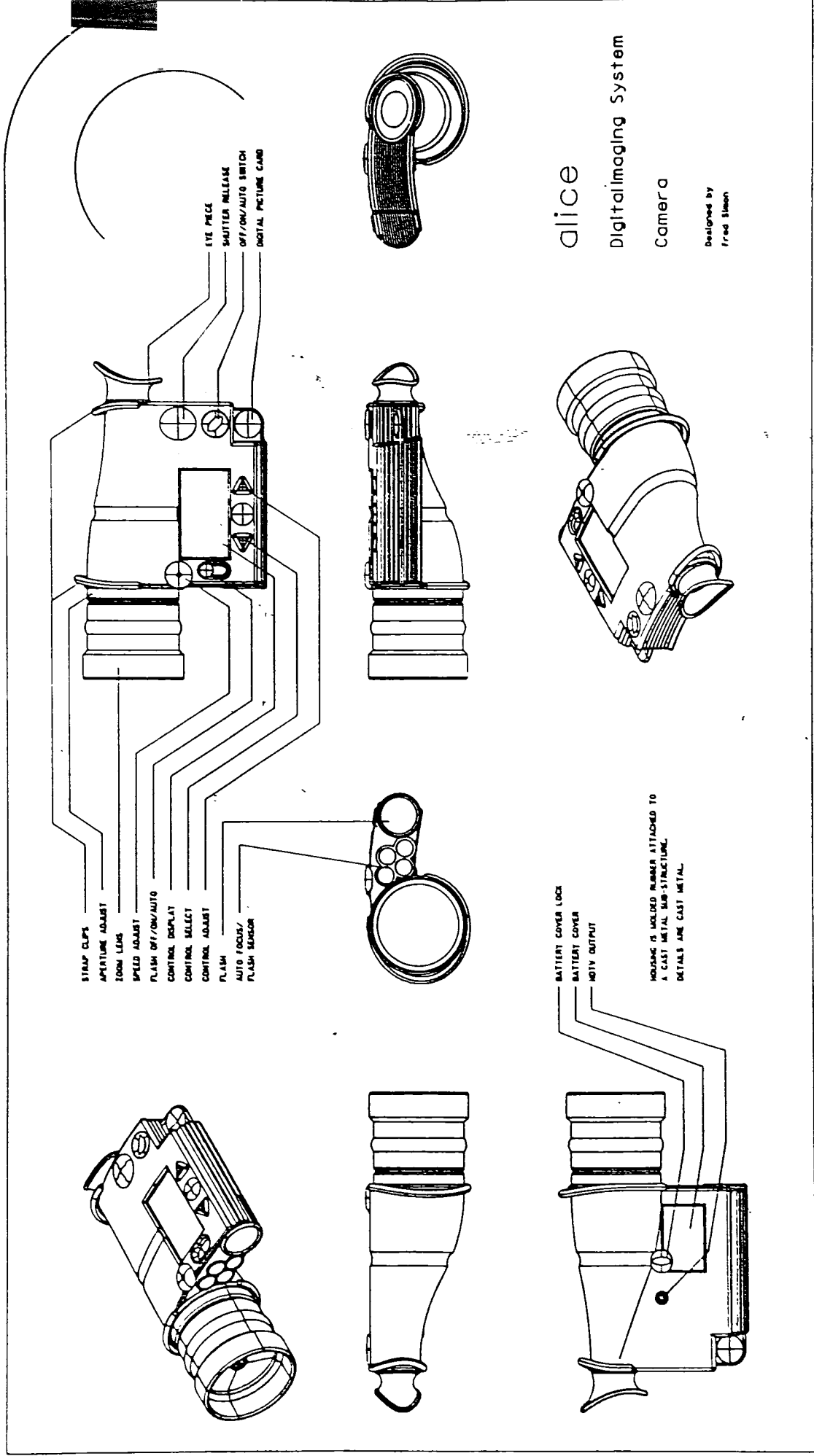
With this design I became completely comfortable and familiar with Intergraph MEDS. I was also exposed to some other hardware and software systems as well.

Through my association with the people at RIT, Xerox, and J.H. Young, I got a glimpse, not only of the future of society, but of my personal future as well. I plan to continue my research and design of digital imaging and computer technologies. I hope to be on the front edge of the information revolution. Only designers who understand emerging imaging and communication technologies can participate in the creation of the future.

GLOSSARY

aspect ratio	the ratio of the width to the height of an image
bit	binary digit, the basic on/off unit of information
CCD	charge coupled device
daisy chained	linked in series
gigabyte	1000 megabytes
HDTV	high definition television
hologram	a method of displaying a three dimensional image using the information contained in the interference pattern on a photographic emulsion
hypermedia	a nonlinear associational system of information navigation
ISDN	integrated services digital network
LCD	liquid crystal display
MEDS	Mechanical Engineering Design System
megabyte	2^{20} bits
menus	lists of commands and choices appearing on the computer screen at appropriate times
NTSC	National Television Systems Committee
optical fiber	a high bandwidth medium for transmitting information with light
pixels	picture elements - single points of the picture
SCSI	pronounced "scuzzy" - small computer system interface
soft controls	controls that can have various functions based upon their programming at a given time
virtual model	a three dimensional model digitally stored in the memory of a computer

APPENDIX I
ORTHOGRAPHIC DRAWINGS

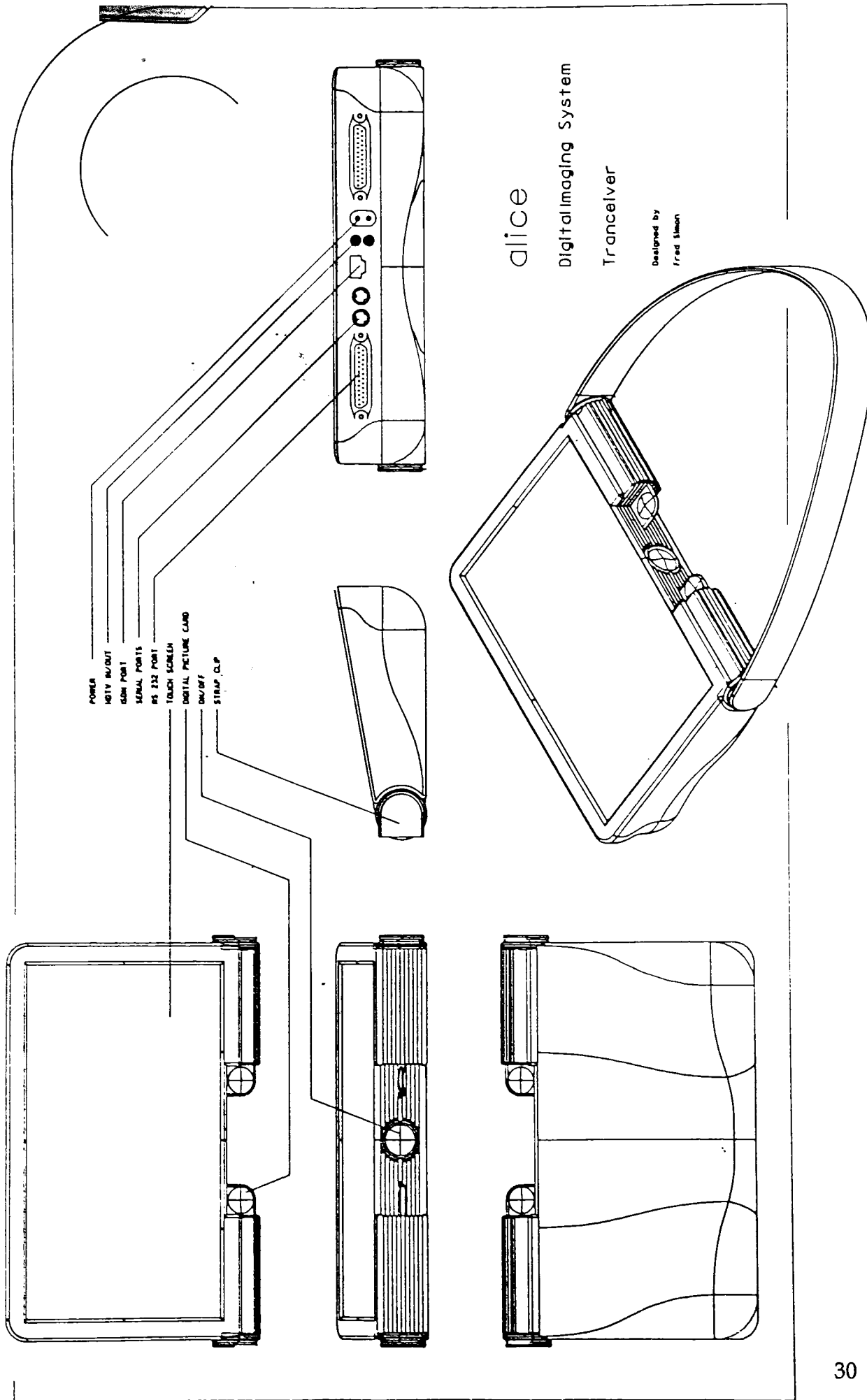


alice

Digital Imaging System

Camera

Designed by
Fred Simon



alice

Digital Imaging System

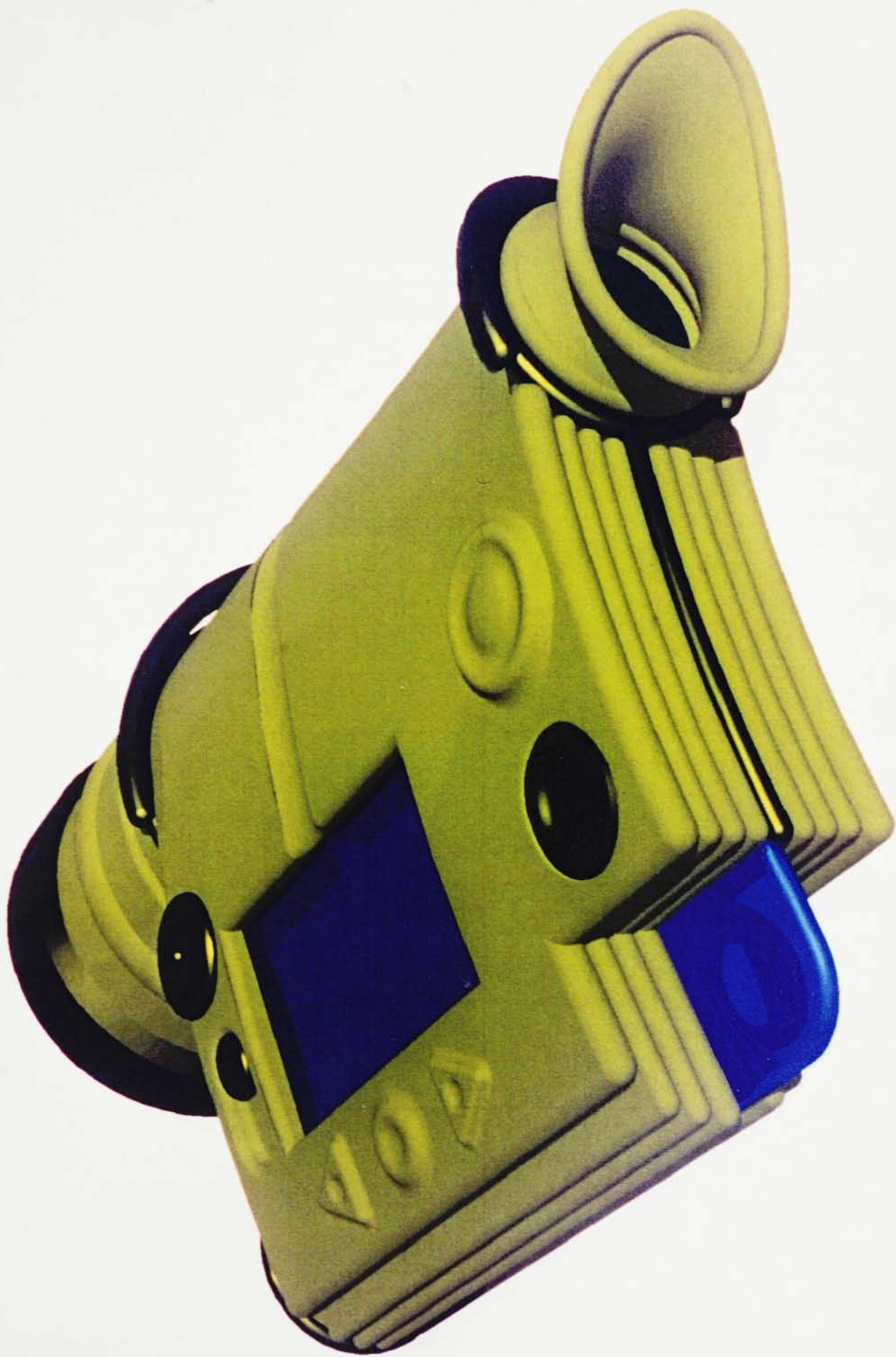
Tranceiver

Designed by
Fred Simon

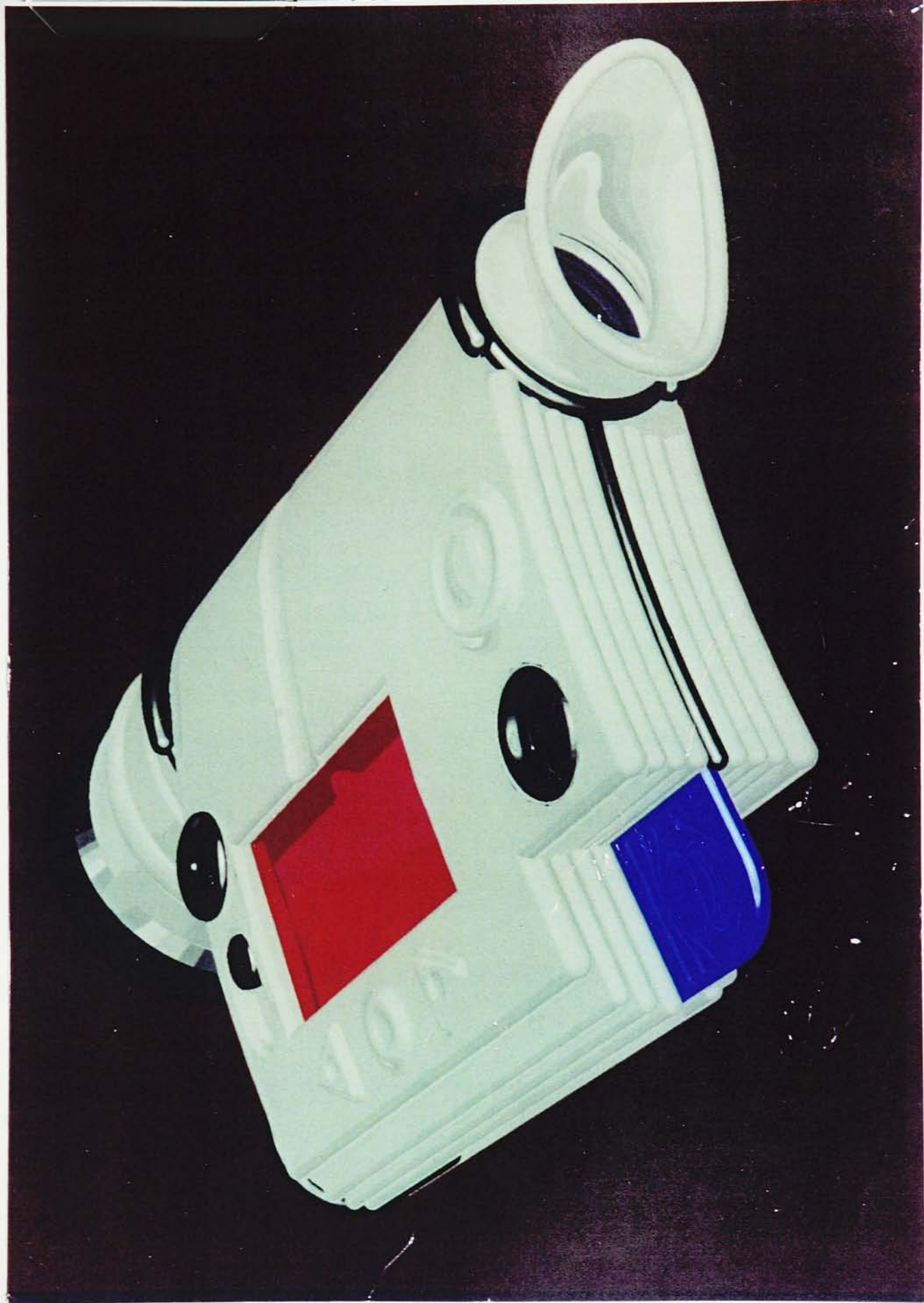
APPENDIX II

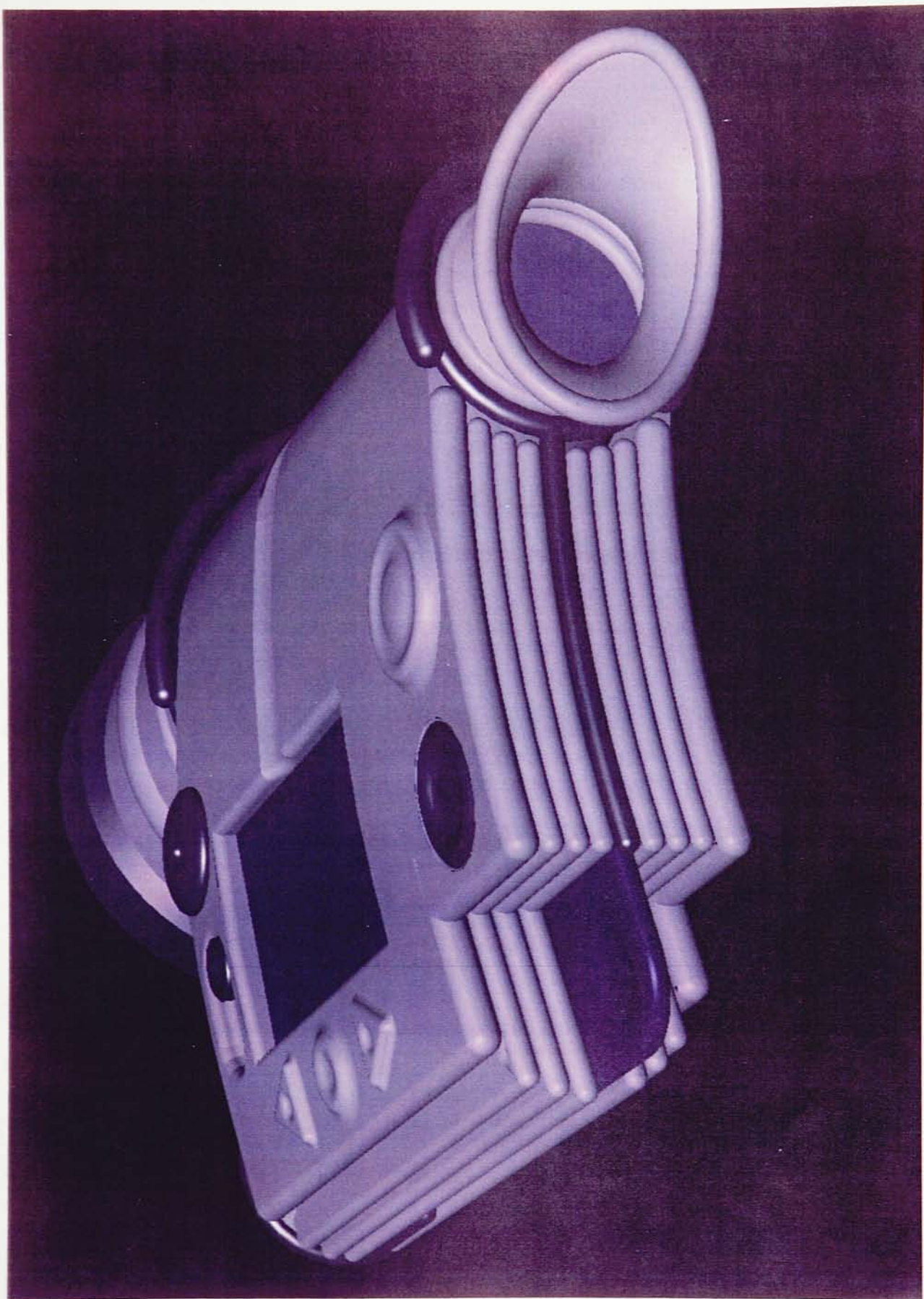
MODELVIEW IMAGES

Note: The color prints contained in this document are color copies. They do not represent the quality of the Xerox Scatt thermal prints.

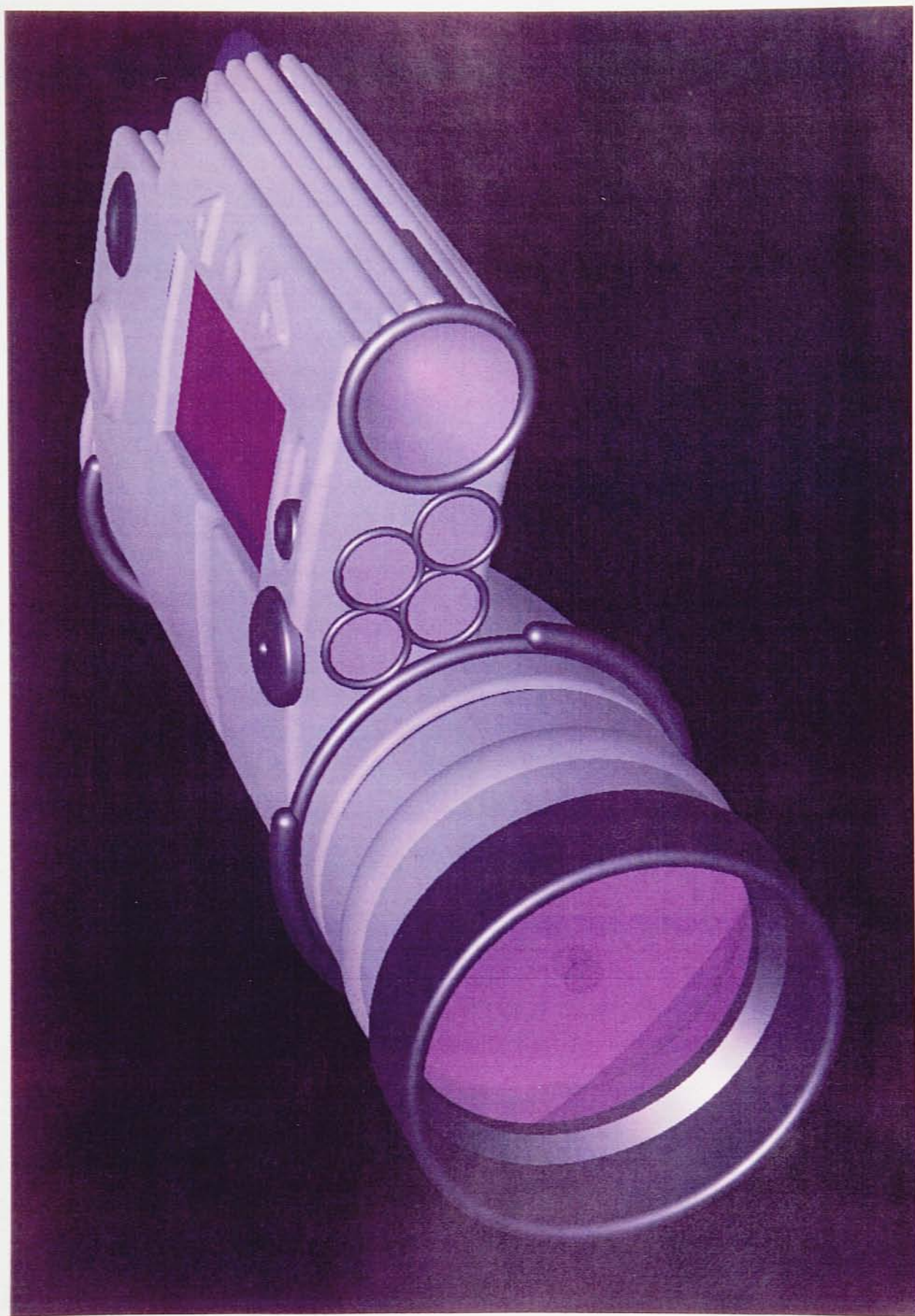


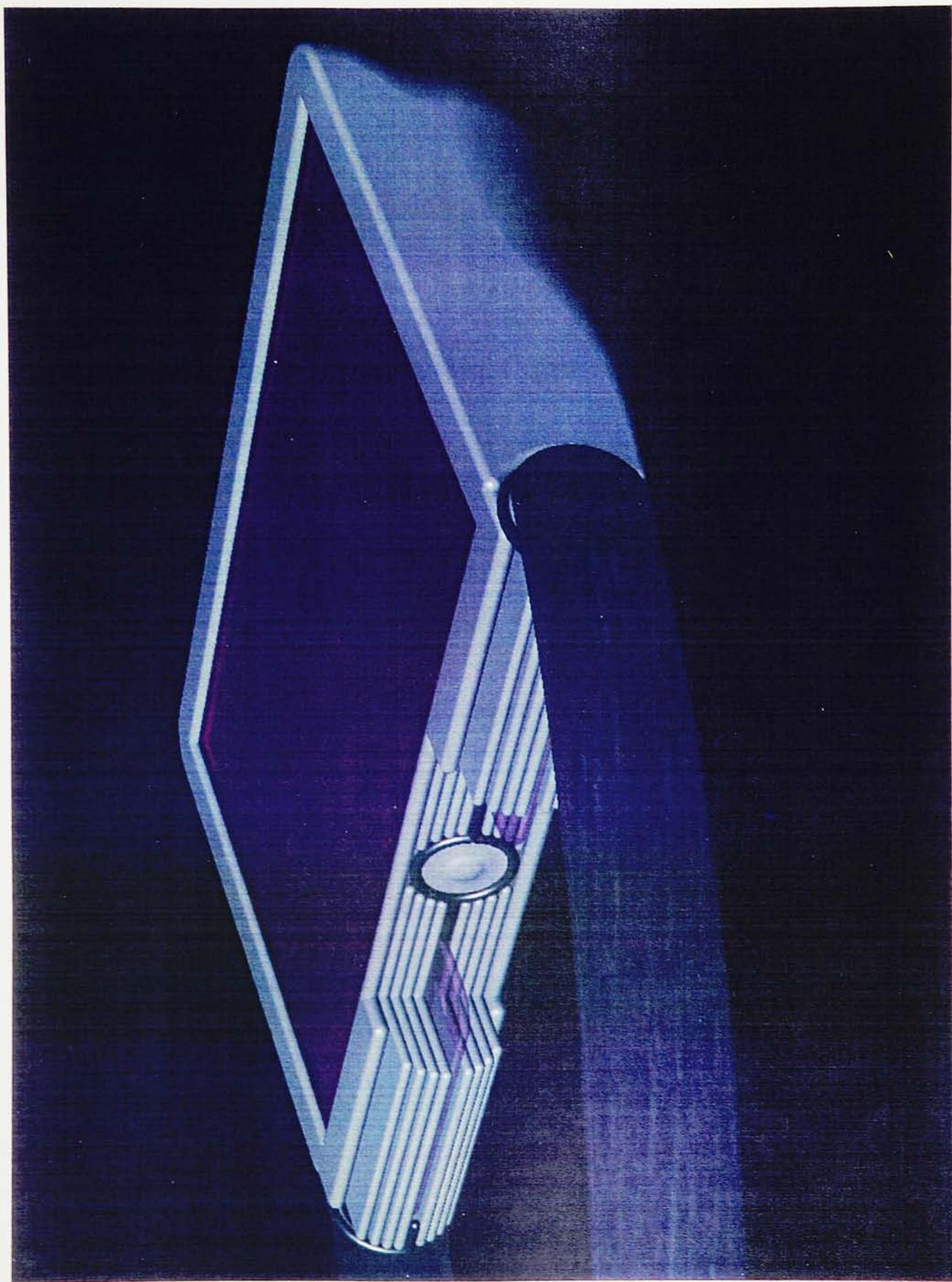




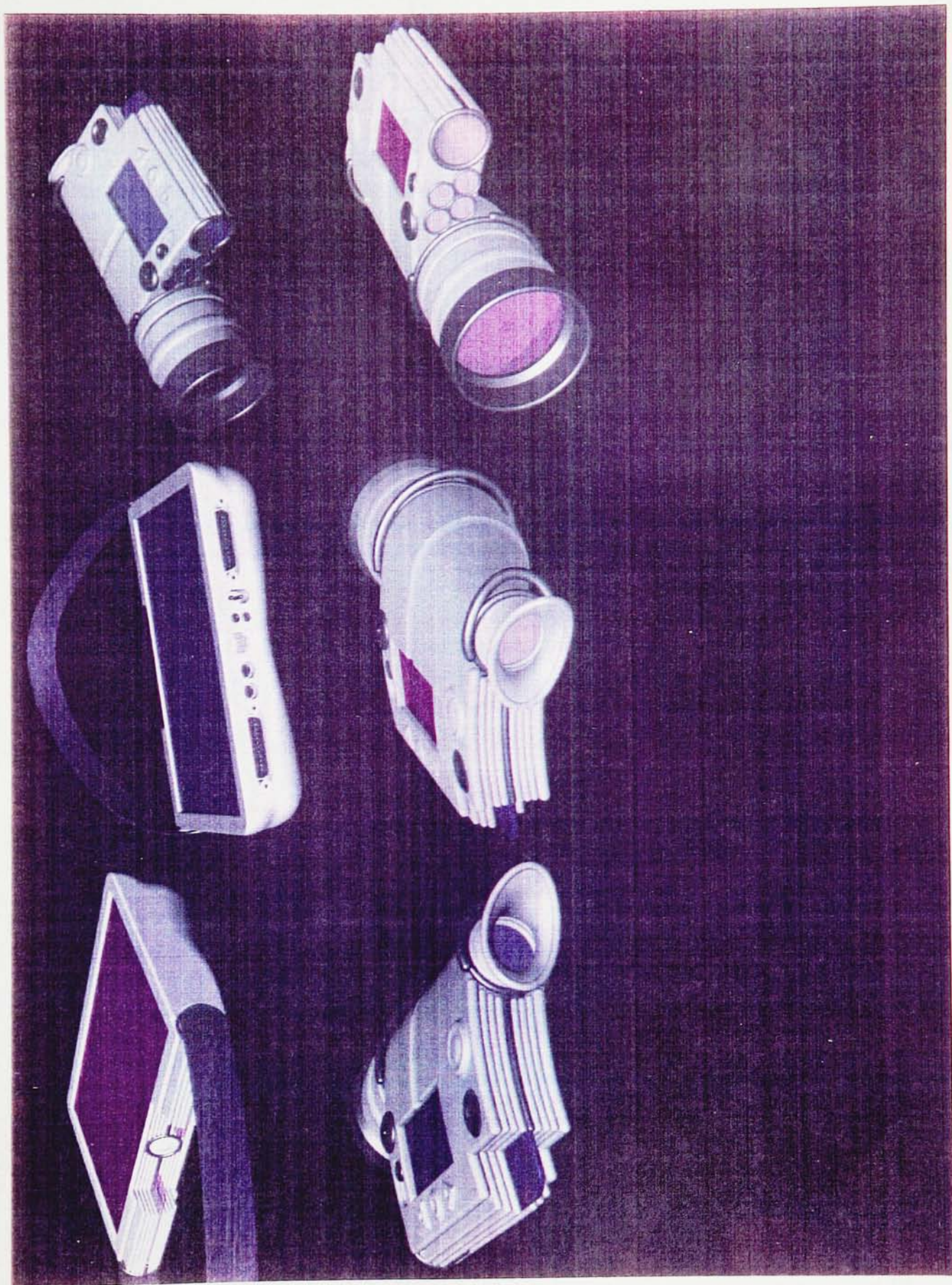












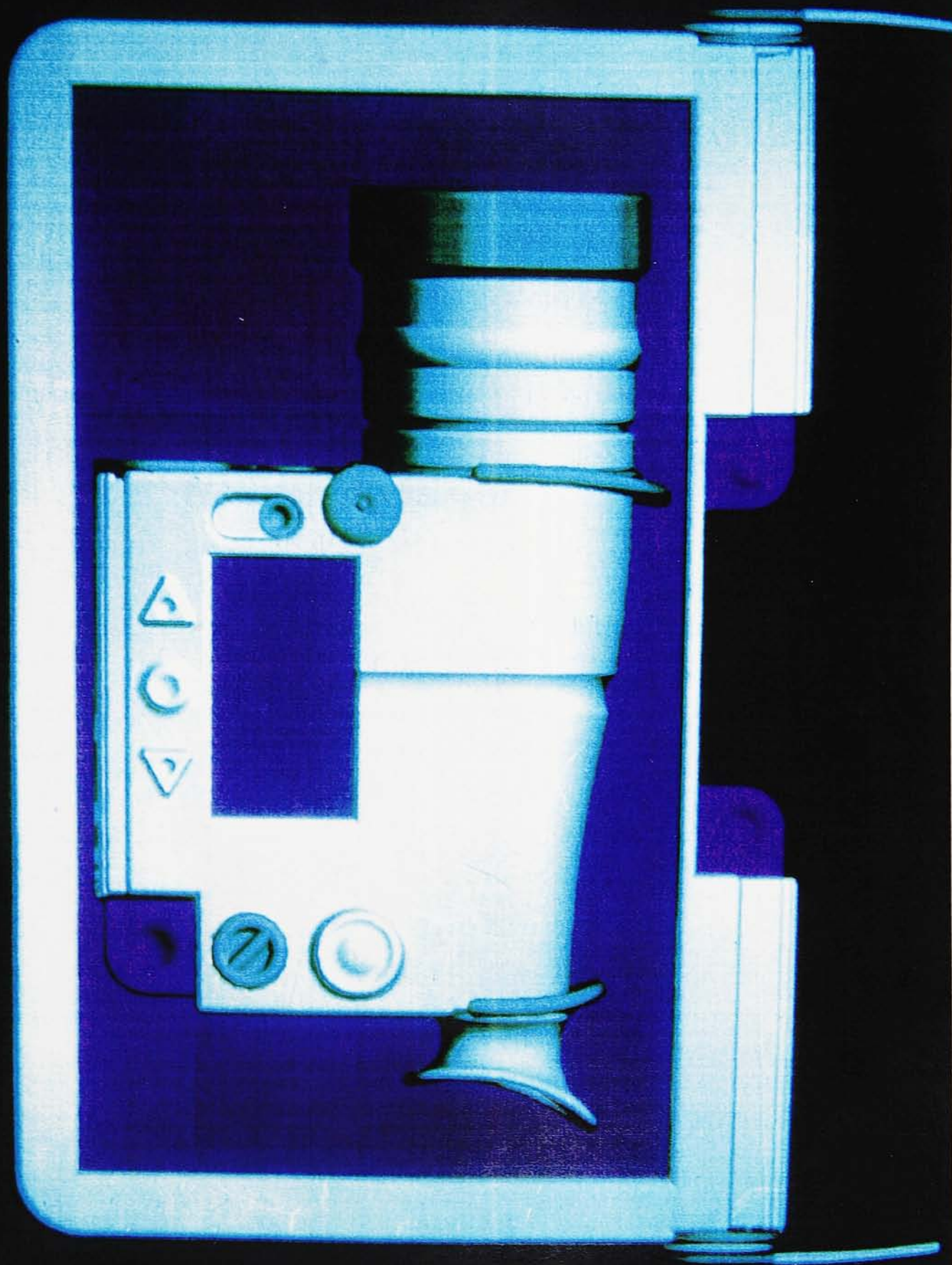


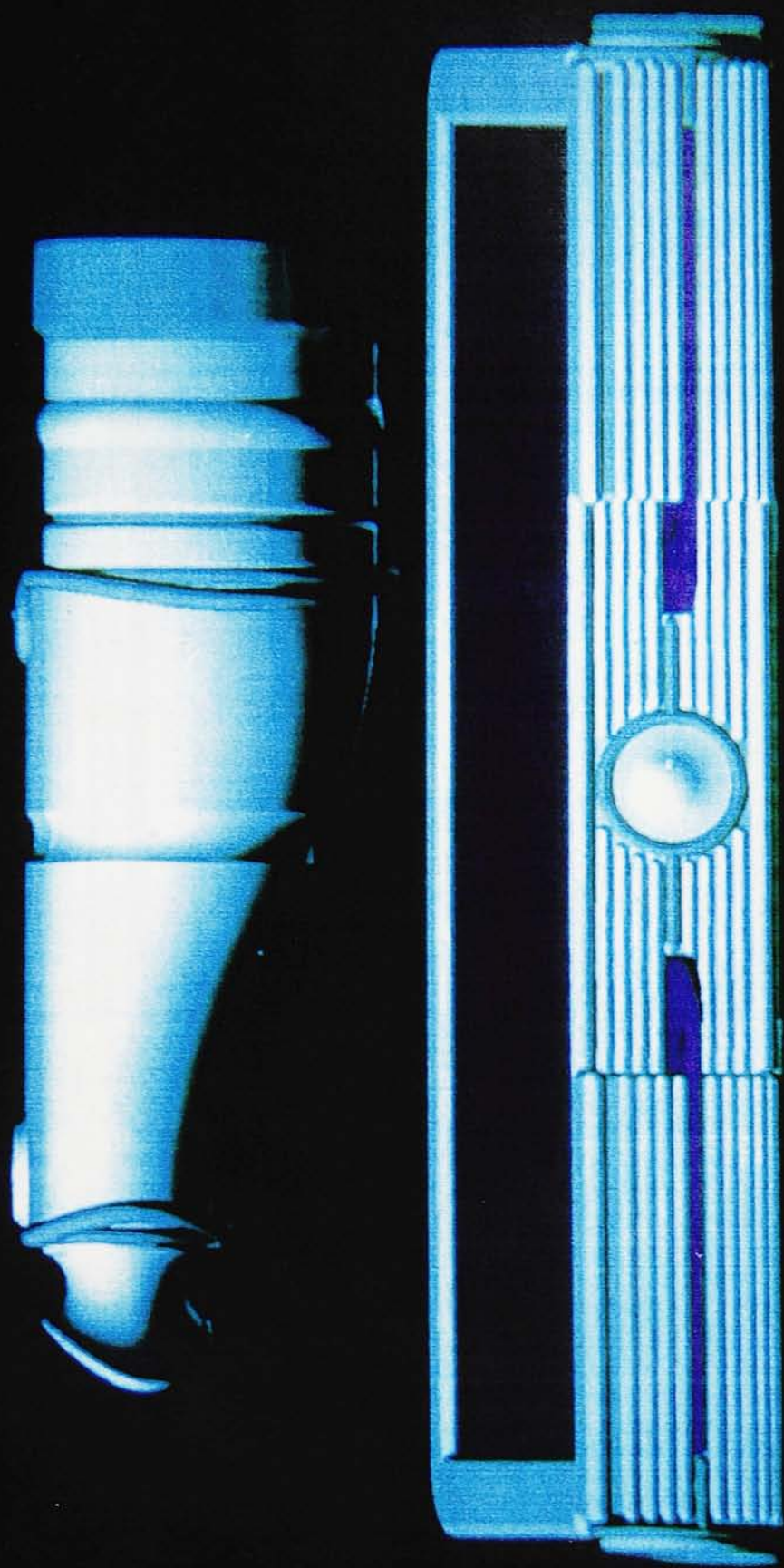
APPENDIX III

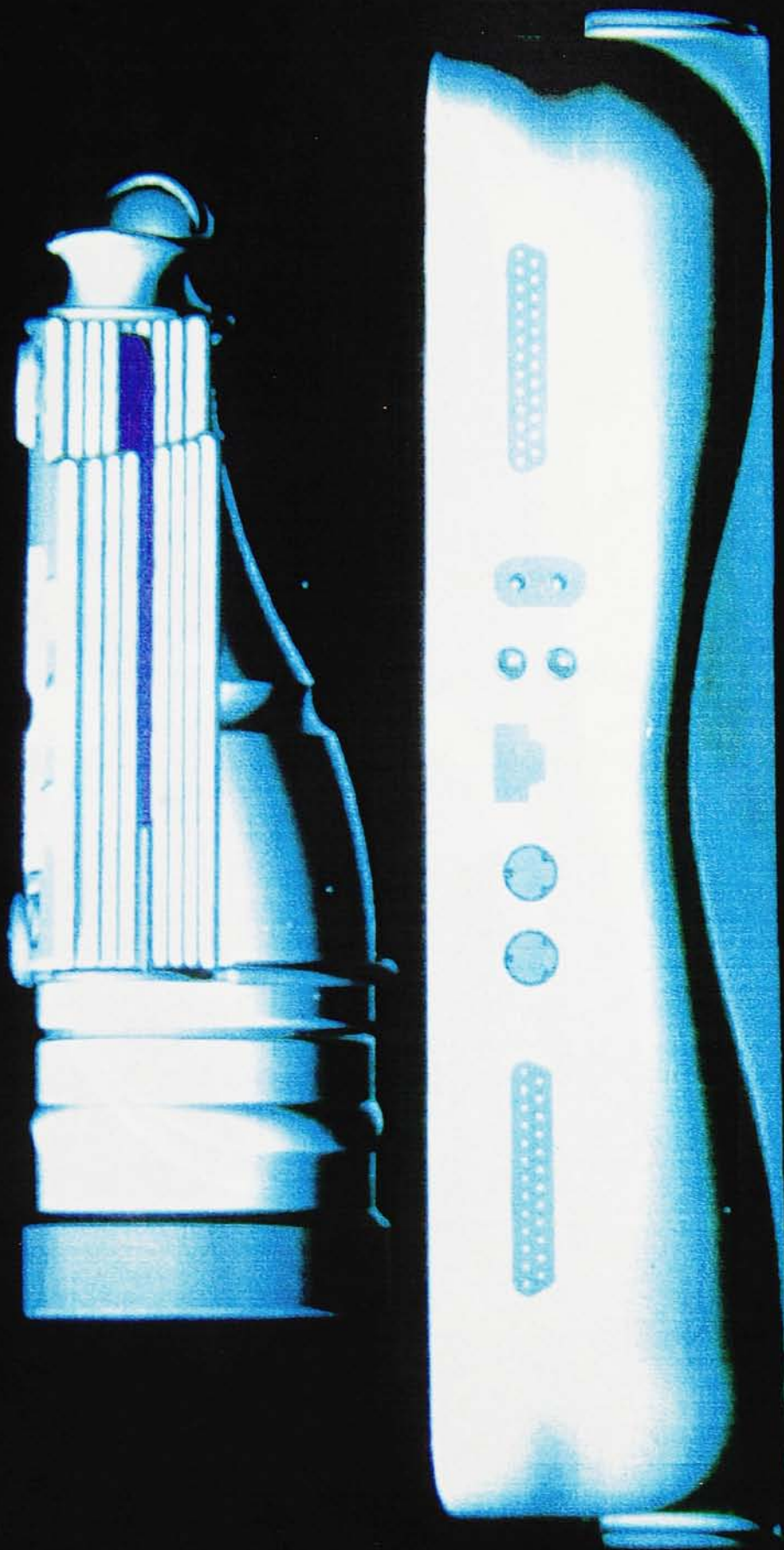
MEDS IMAGES

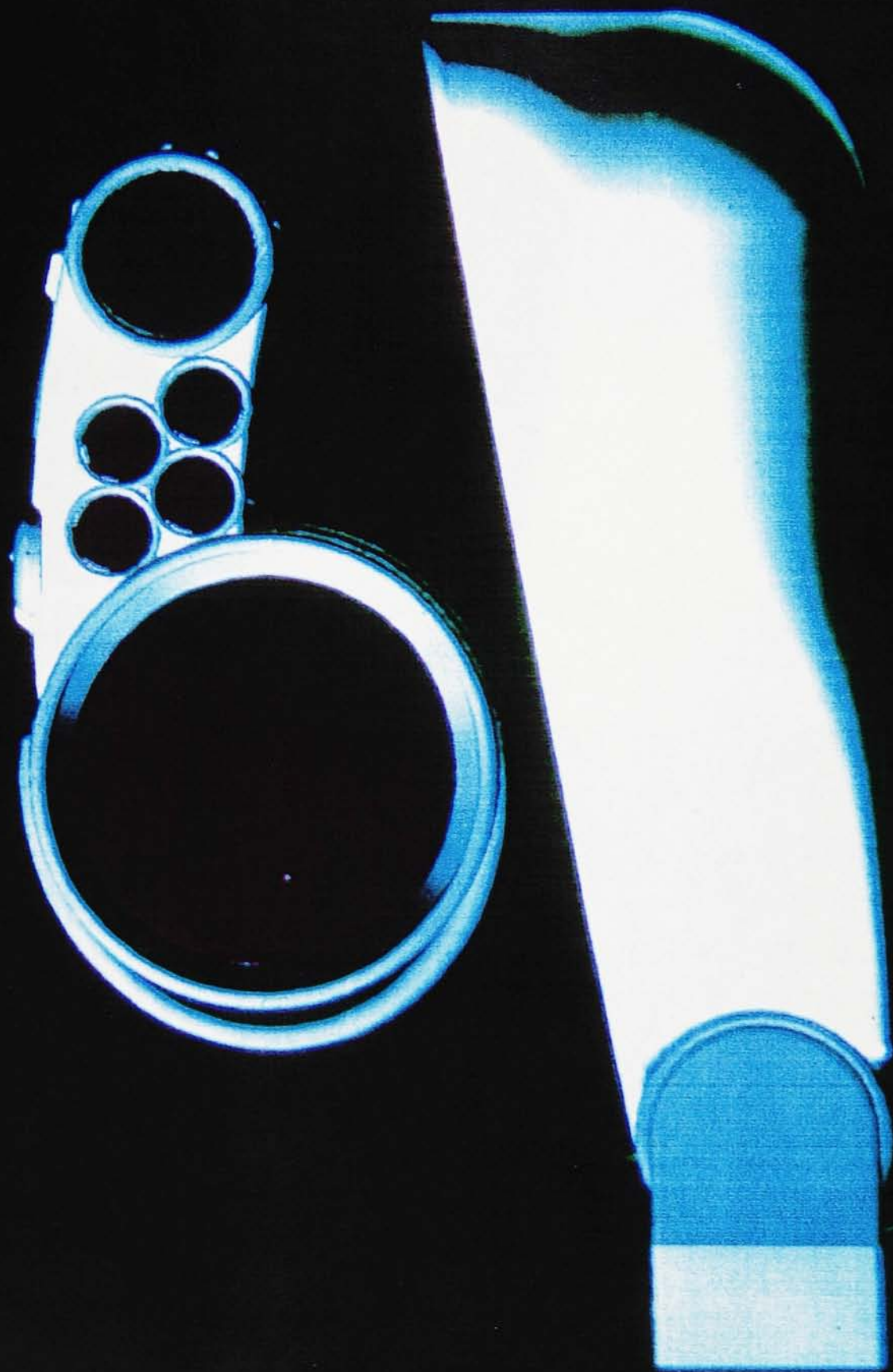
Note: The color prints contained in this document are color copies. They do not represent the quality of the Xerox Scatt thermal prints.



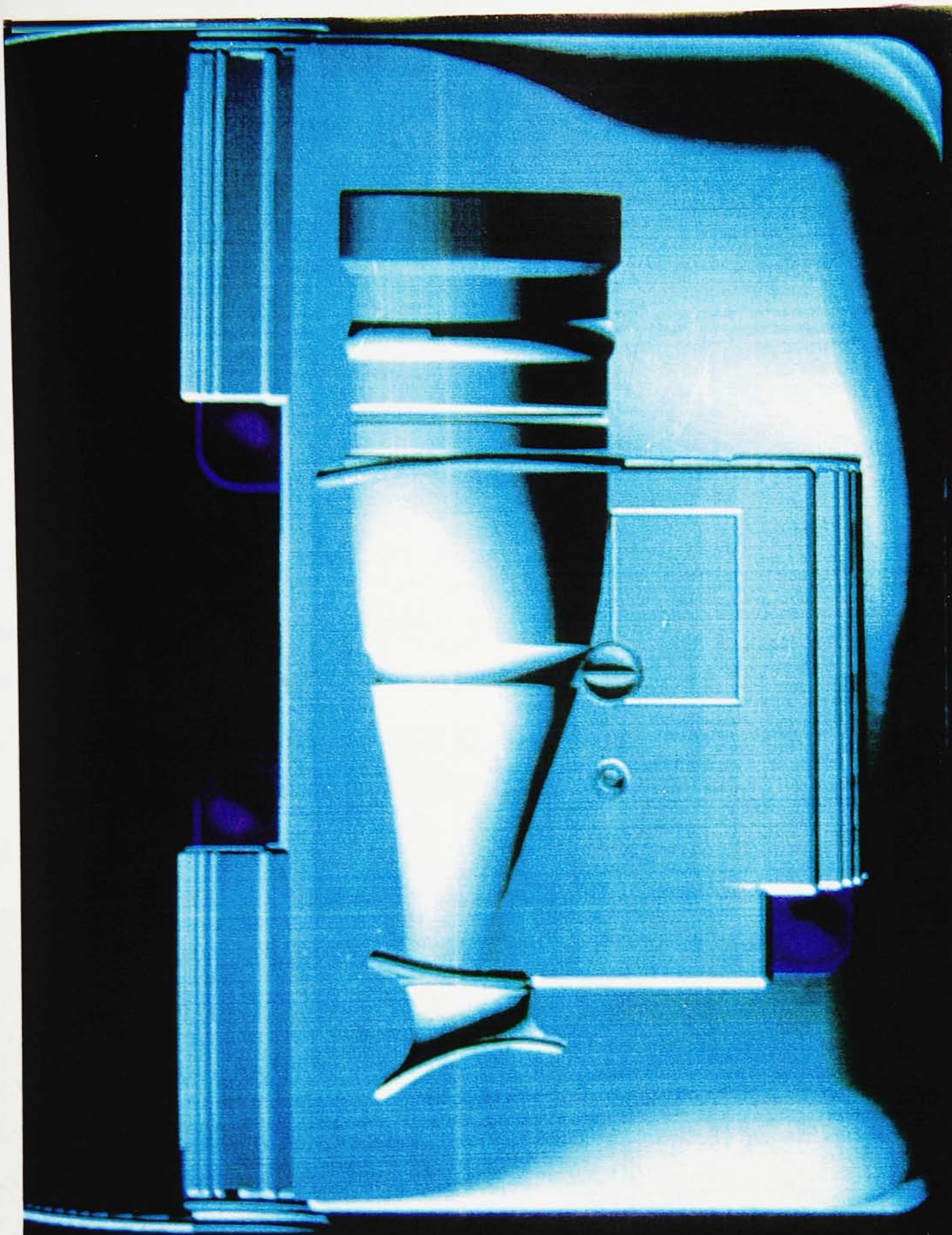












APPENDIX IV
MATERIAL TABLES

@defcol.tbl

```
for  
color 1  
{  
  Blue_dark_slate;  
  flat;  
}
```

```
for  
color 2  
{  
  Blue_dark_slate;  
  flat;  
}
```

```
for  
color 3  
{  
  Blue_dark_slate;  
  metal;  
}
```

```
for  
color 4  
{  
  Maroon;  
  glass;  
}
```

```
for  
color 7  
{  
  Grey_light;  
  plastic;  
}
```

```
for  
color 5  
{  
  Plum;  
  glass;  
}
```

```
for  
color 6  
{  
  Wheat;  
  flat;  
}
```

3
4 This is an include file

```
5 { reflect = 0.4; finish = 0.9; transmit = 0.0; }  
6 { reflect = 0.1; finish = 0.9; transmit = 0.0; }  
7 { reflect = 0.8; finish = 0.5; transmit = 0.0; }  
8 { reflect = 0.9; finish = 0.0; transmit = 0.9; }  
9 { reflect = 0.95; finish = 0.5; transmit = 0.0; }  
10 #  
11 # This file contains a list of predefined colors  
12 #  
13 Aquamarine { color = (0.500000,0.800000,0.600000); }  
14 Aquamarine_med { color = (0.285714,0.714286,0.571429); }  
15 Black { color = (0.000000,0.000000,0.000000); }  
16 Blue { color = (0.000000,0.000000,1.000000); }  
17 Blue_cadet { color = (0.428571,0.571429,0.571429); }  
18 Blue_cornflower { color = (0.257143,0.257143,0.442857); }  
19 Blue_dark_slate { color = (0.442857,0.071429,0.628571); }  
20 Blue_light { color = (0.771429,0.828571,0.828571); }  
21 Blue_light_steel { color = (0.600000,0.600000,0.700000); }  
22 Blue_medium { color = (0.285714,0.285714,0.714286); }  
23 Blue_midnight { color = (0.142857,0.142857,0.357143); }  
24 Blue_navy { color = (0.071429,0.071429,0.628571); }  
25 Blue_sky { color = (0.285714,0.571429,0.714286); }  
26 Blue_slate { color = (0.000000,0.500000,1.000000); }  
27 Blue_steel { color = (0.071429,0.442857,0.628571); }  
28 Coral { color = (1.000000,0.500000,0.000000); }  
29 Cyan { color = (0.000000,1.000000,1.000000); }  
30 Firebrick { color = (0.628571,0.071429,0.071429); }  
31 Gold { color = (0.714286,0.500000,0.285714); }  
32 Goldenrod { color = (0.800000,0.800000,0.500000); }  
33 Goldenrod_medium { color = (0.885714,0.885714,0.714286); }  
34 Green { color = (0.000000,1.000000,0.000000); }  
35 Green_dark { color = (0.142857,0.357143,0.142857); }  
36 Green_dark_olive { color = (0.357143,0.357143,0.142857); }  
37 Green_forest { color = (0.071429,0.628571,0.071429); }  
38 Green_lime { color = (0.285714,0.714286,0.285714); }  
39 Green_medium_forest { color = (0.442857,0.628571,0.071429); }  
40 Green_medium_sea { color = (0.257143,0.442857,0.257143); }  
41 Green_medium_spring { color = (0.500000,1.000000,0.000000); }  
42 Green_pale { color = (0.600000,0.700000,0.666667); }  
43 Green_sea { color = (0.071429,0.628571,0.442857); }  
44 Green_spring { color = (0.000000,1.000000,0.500000); }  
45 Green_yellow { color = (0.571429,0.714286,0.285714); }  
46 Grey_dark_slate { color = (0.142857,0.357143,0.357143); }  
47 Grey_dim { color = (0.330000,0.330000,0.330000); }  
48 Grey_light { color = (0.660000,0.660000,0.660000); }  
49 Khaki { color = (0.571429,0.571429,0.428571); }  
50 Magenta { color = (1.000000,0.000000,1.000000); }  
51 Maroon { color = (0.628571,0.071429,0.442857); }  
52 Orange { color = (0.714286,0.285714,0.285714); }  
53 Orchid { color = (0.800000,0.500000,0.800000); }  
54 Orchid_dark { color = (0.571429,0.285714,0.714286); }  
55 Orchid_medium { color = (0.600000,0.500000,0.800000); }  
56 Pink { color = (0.700000,0.600000,0.600000); }  
57 Plum { color = (0.885714,0.714286,0.885714); }  
58 Red { color = (1.000000,0.000000,0.000000); }  
59 Red_indian { color = (0.357143,0.142857,0.142857); }  
60 Red_medium_violet { color = (0.800000,0.500000,0.600000); }  
61 Red_orange { color = (1.000000,0.000000,0.500000); }  
62 Red_violet { color = (0.714286,0.285714,0.571429); }  
63 Salmon { color = (0.442857,0.257143,0.257143); }  
64 Sienna { color = (0.628571,0.442857,0.071429); }  
65 Tan { color = (0.800000,0.600000,0.500000); }  
66 Thistle { color = (0.828571,0.771429,0.828571); }  
67 Turquoise { color = (0.714286,0.885714,0.885714); }  
68 Turquoise_dark { color = (0.500000,0.600000,0.800000); }  
69 Turquoise_medium { color = (0.500000,0.800000,0.800000); }  
70 Violet { color = (0.357143,0.142857,0.357143); }  
71 Violet_blue { color = (0.571429,0.428571,0.571429); }  
72 Wheat { color = (0.828571,0.828571,0.771429); }  
73 White { color = (1.000000,1.000000,1.000000); }  
74 Yellow { color = (1.000000,1.000000,0.000000); }  
75 Yellow_green { color = (0.600000,0.800000,0.500000); }
```


APPENDIX V
HOW TO PLOT USING THE SCATT PRINTER

HOW TO PLOT A RGB FILE USING THE SCATT PRINTER

#1. Increase the file size to the max sheet size using "stretch".

```
$ /usr/lp32/ModelView/stretch -x 2368 -y 1768 c1.rgb C1
stretch 1.3
1247/1247
```

#2. Convert C1.rgb to C1-*.ais files for transfer to onyx.

```
$ aiscat C1 C1
C1: 508; 510; 27; 9
x=2368; y=1768; R=0; G=0; B=0;
508; 510; 27; 9
x=2368; y=1768; R=0; G=0; B=0;
508; 510; 27; 9
x=2368; y=1768; R=0; G=0; B=0;
508; 510; 27; 9
x=2368; y=1768; R=0; G=0; B=0;
$
```

#3. Transfer converted files to onyx.

```
$ $ ftp
Please set file transfer type before transferring files.
ftp> open onyx
Connected to onyx.
220 onyx FTP server (Version 4.15 Sat Nov 7 15:24:41 PST 1987) ready.
Name (onyx:levy):
331 Password required for levy.
Password:
230 User levy logged in.
ftp> cd /usr/scat
200 CWD command okay.
ftp> lcd /usr/levy/fired
Local directory is now /usr/levy/fired
ftp> binary
200 Type set to I.
ftp> put C1-c.ais
Using binary mode to transfer data.
200 PORT command okay.
150 Opening data connection for C1-c.ais (13.0.33.12,1055).
226 Transfer complete.
local: C1-c.ais remote: C1-c.ais
4188672 bytes sent in 35.04 seconds (116.74 Kbytes/s)
ftp> put C1-m.ais
Using binary mode to transfer data.
200 PORT command okay.
150 Opening data connection for C1-m.ais (13.0.33.12,1058).
226 Transfer complete.
local: C1-m.ais remote: C1-m.ais
4188672 bytes sent in 34.14 seconds (119.82 Kbytes/s)
ftp> put C1-y.ais
Using binary mode to transfer data.
200 PORT command okay.
150 Opening data connection for C1-y.ais (13.0.33.12,1061).
226 Transfer complete.
local: C1-y.ais remote: C1-y.ais
4188672 bytes sent in 35.80 seconds (114.26 Kbytes/s)
ftp> close
221 Goodbye.
ftp> bye
```

#4. SCATT printing of *.ais files.

```
onyx% scprint -xk C1
onyx% rm *.ais
onyx% close
onyx% goodbye
onyx% bye
- ftp
```

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