JPL PUBLICATION 82-108

(NASA-CR-170294) INTRODUCTICN TO THE CONCEPTS OF TELEDEMC AND TELEDIMS (Jet Propulsion Lab.) 24 p HC A02/MF A01 CSCL 17B

N83-23499

Unclas G3/32 03531

Introduction to the Concepts of TELEDEMO and TELEDIMS

Robert F. Rice and Alan P. Schlutsmeyer

December 15, 1982

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

JPL PUBLICATION 82-108

Introduction to the Concepts of TELEDEMO and TELEDIMS

Robert F. Rice and Alan P. Schlutsmeyer

December 15, 1982

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

ACKNOWLEDGMENT

The authors wish to thank Chris Pettus and Steve Philipson for their technical contributions to MAKEDEMO software development. They also wish to express gratitude to Al Ferrari and Tom Duxbury for their support of the concepts described herein.

The research described in this publication was carried out by members of the Information Processing Research group of the Jet Propulsion Laboratory, California Institute of Technology.

ABSTRACT

This paper provides an introduction to the system concepts: TELEDEMO and TELEDIMS. TELEDEMO is derived primarily from computer graphics and, via incorporation of sophisticated image data compression, enables effective low-cost teleconferencing at data rates as low as 1K bit/second using dial-up phone lines. Combining TELEDEMO's powerful capabilities for the development of presentation material with microprocessor-based Information Management Systems (IMS) of today yields a truly all electronic IMS called TELEDIMS.

TABLE OF CONTENTS

INTRODUCTION
TO THE CONCEPTS
OF
TELEDEMO AND TELEDIMS

The purpose of this paper is to introduce two system concepts which should have dramatic impact on the efficiency of governmental organizations as well as the private business world in general. TELEDEMO is a self-contained concept derived primarily from computer graphics which, as one of its key features, enables effective low cost teleconferencing using dial-up phone lines. Combining TELEDEMO's capabilities for the development of presentation material with microprocessor-based Information Management Systems (IMS) of today yields a truly all-electronic IMS referred to here as TELEDIMS. The significant modular increments to functional capability provided by TELEDIMS should eventually make it the information management system of the future.

TELEDEMO, while providing numerous other desirable features, was originally conceived as an alternative approach to teleconferencing. Hence to fully appreciate the consequences of both concepts we will precede their introduction with a thorough description of the technology and costs associated with today's video teleconferencing industry.†

BACKGROUND ON VIDEO TELECONFERENCING

There is currently a significant industry[1] in the United States and abroad devoted entirely to the concept of video teleconferencing. Millions of dollars have been spent on developing such systems, which are based on the *valid* premise that the majority of business travel could be avoided by substituting the transmission and display of necessary visual and audio information. Video teleconferencing then, generally refers to the transmission of *live* scenes taken at one or more conference sites. The scenes are of people, prepared presentation material, and chalkboards (real and electronic black and white). This is illustrated in Fig. 1 where the video camera is shown as the system focal point.

Full Motion Video

In the most expensive teleconferencing systems the functional requirements are driven by a presumed need to view other people face to face. The resolution requirements for this need can be met by NTSC standard color video, such as that used in home television. Although theoretically providing over 500 lines of resolu-

†Note that costs and capabilities quoted here for available equipment were primarily derived from industry sources in mid-year 1982.

ORIGINAL PAGE IS
OF POOR QUALITY

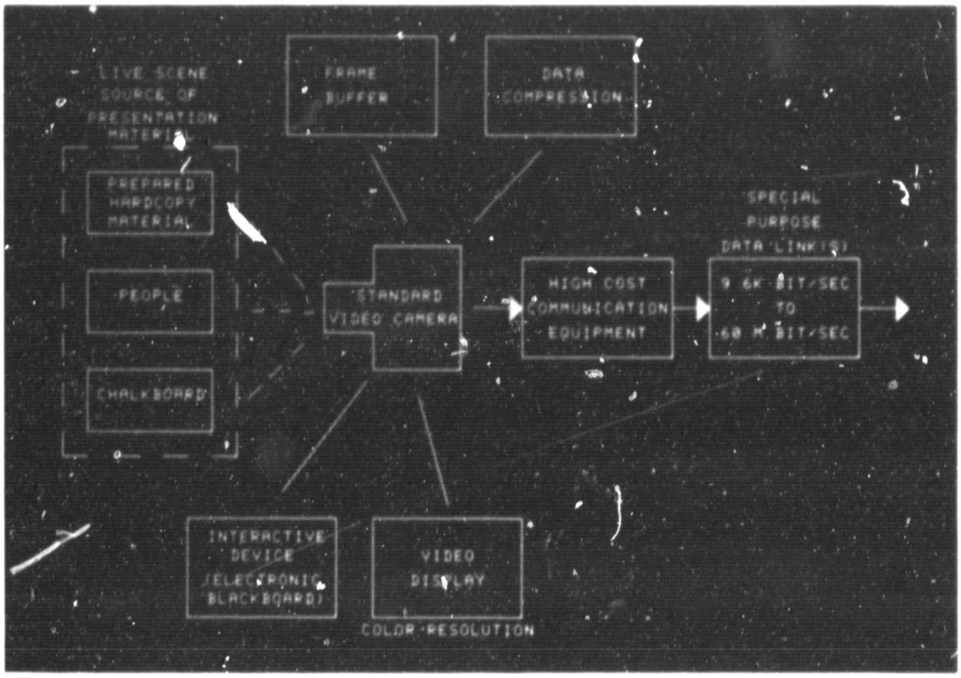

Fig. 1. Video Teleconferencing.

tion, an NTSC standard color video signal will yield a usable resolution of only about 300 lines. While adequate for faces, this resolution is generally insufficient for the display of detailed presentation material, such as charts and viewgraphs.

Real time video necessitates very high data rates and hence very expensive communication costs. To reduce these costs somewhat, sophisticated frame-to-frame image data compression has been developed by several suppliers (e.g., Compression Laboratories Inc., various Japanese companies) which allows the transmission of somewhat degraded real time imagery at 1.5M bits/second. These systems introduce some loss in resolution, and experience severe discontinuities whenever significant motion occurs in the scene. The 1.5M bits/second lines for a two-way hookup are available in a limited number of locations for \$35K/month, or 50 hours/month for \$19K. These costs do not include the communication gear or the teleconferencing equipment. Two site teleconferencing equipment is available from Compression Labs Inc. for about \$300K. Use of a two site fully equipped Bell System teleconferencing facility costs roughly \$2000/hr plus other lease costs, or about \$1 million/year.

Thus the real time video teleconferencing systems are extremely costly and provide only marginal resolution capabilities for the primary source of information in any good presentation — diagrams, pictures, and standard viewgraphs. Even with these substantial costs and resolution limitations, several corporations have included this form of teleconferencing in their business operations. Video Systems Network, Inc. reports that in addition to AT&T itself, some of the big users include Hewlett Packard, Atlantic Richfield, Allstate and Northrop.

Slow Scan

To avoid the extremely high costs of communicating full motion video, several companies have chosen instead to use slow scan television, sometimes referred to as "freeze frame." This technique is based on the same principles as the full motion systems noted above. It accepts a reduction in functional capability by giving up the ability to see people talking. Slow scan functionally means taking individual snapshots *with a TV camera* and holding each snapshot in memory while transmitting it slowly over an available digital data link. Simultaneously, speech is communicated over a standard dial-up phone line. The most advanced of these systems is made by Colorado Video, Inc.

It is no surprise that the advertisements for this system correctly identify the fact that most of the information dealt with in a teleconferencing situation is in the form of figures and occasional pictures. The viewing of people talking, although important in some situations, is generally a costly luxury. Unfortunately, the slow scan systems such as Colorado Video's are still based on a desire to conform to standard (i.e., low resolution) video formats.

There are severe ramifications in this constraint, as the introduction to TELEDEMO will show.

- The Colorado Video slow scan system can improve the resolution capabilities for detailed presentation material, but only by sacrificing the ability to display color.

- While no longer requiring data rates in excess of 1 M bit/second, the slow scan system still requires operation over 56K bits/second data lines (if available) to be effective. For example, a full detail 512 × 512 black and white image at 8 bits/pixel (the Colorado Video system uses no data compression) would require 40 seconds for communication at 56K bits/-second. A full color image able to drive a high resolution color RGB monitor would take three times as long. The black and white system can be bought for $18,000, with full time operation of 56K bits/second data lines costing an additional $4,000/month or $48K per year.

Electronic Blackboard

AT&T makes a device called the Electronic Blackboard, for use in some teleconferencing situations. The unit has a 4 ft. by 6 ft. blackboard covered with two mylar sheets on which the user draws with ordinary chalk and eraser. A grid implanted in the rear mylar sheet senses the chalk (or eraser) location whenever pressure is applied to the board. The system's electronics then "draws" a corresponding image in its buffer memory, which is used to display the electronic image locally on a standard black and white T.V. monitor. Simultaneously the coordinates are transmitted to one or more remote sites over a dial-up phone line. Again a second dial-up line carries the voice portion of the presentation. A standard 2-track audio cassette recorder can be used to record both the sound and video portions of the presentation for later replay.

The Electronic Blackboard is a low cost system. It leases for $500/month with an initial $500 installation fee, and the communication link is two standard dial-up phone links, with the data link being operated at 1280 bits/second. But the system also has very limited capability. The system resolution is only 240 lines, and the displays are limited to only that which can be drawn by hand on a blackboard. This means: 1) no detailed or professional looking charts and graphs; 2) no greyscale images; and 3) no color. These shortcomings preclude the use of the Electronic Blackboard in the vast majority of teleconferencing situations.

Other Systems

There are rather inadequate analog black and white slow scan systems which can be leased at $6000 annually. Slow scan type systems can be used in a limited form over 9.6K bits/second data lines. Leased lines cost about $1000/month and appropriate modems can be bought for about $10K. Of course, any limitations that existed with a slow scan system operating at 56K bits/second are further compounded by operating at only 1/6th that rate.

MOTIVATION FOR TELEDEMO

We fully support the slow scan philosophy that the primary visual information source in conferencing is detailed prepared material such as viewgraphs and slides. For most applications viewing people talking is a high cost luxury. In comparing the two system approaches, slow scan *subtracts* capability from full motion video (incorporating an Electronic Blackboard) in order to achieve a reduction in costs of both the data link and video equipment. Thus, one system cannot be considered an add-on for the other. A user would generally select one approach or the other. As we shall see, TELEDEMO would (in addition to providing substantial other benefits) add significant performance advantages to an existing slow scan or full motion video system. We feel that the TELEDEMO concept can satisfy the vast majority of teleconferencing situations at much lower cost. Thus full motion video systems can, in the future, be interpreted as high cost extras to TELEDEMO. Further, the slow scan function can be added to TELEDEMO at relatively low cost.

As stated below, the relative capabilities of TELEDEMO to perform the visual conferencing function constitute a major breakthrough. The TELEDEMO concept is derived from the rapidly evolving technology of computer graphics, not from the television industry. The motivation for TELEDEMO was itself a recognition of the current and future capabilities of the computer graphics industry.

Computer Graphics Versus Standard Video

To understand the TELEDEMO visual conferencing function one needs to recognize the distinction between an image resulting from computer graphics, and one derived from a camera such as the two video systems described above.

The standard color home video system is based on the display of an NTSC standard composite signal which drives one or more electron guns to display a new image once every 1/30th of a second. (Some new solid state displays may not require electron guns.) The electron guns direct modulated beams of electrons to excite red, green, and blue phosphors which additively create a desired color.

The NTSC standard is, in practice, actually a form of bandwidth compression. It was initially created to assure compatibility of color television with black and white. The bandwidth compression is required to fit the greater information content of the color signal on the standard 3.58 Mhz carrier. This results in some loss of effective resolution in color video displays, both monitor form and projection television. A potential 500 or so lines of resolution becomes 300 or so in practice. But this level of quality is adequate for its intended purpose — home television.

The allocation of video bandwidths in the UHF bands is complete. In essence the industry has roped itself off from further fidelity improvements. It is only the long term possibility of totally different, albeit incompatible channels such as satellite and cable, that may eventually lead to high fidelity amusement television. But the video teleconferencing systems discussed above are based on a compatibility with this existing home television technology.

The motivation of the computer graphics industry comes from a different direction. Although the final product, a color or black and white image, is displayed in much the same manner (in fact, home computer graphics systems usually make use of home televisions for display purposes) the method of derivation and representation of such images is quite different. The image derived from computer graphics is a *drawn image*, not one derived from a snapshot of a scene. Resolution requirements and motivation are not driven by the need to display a person's face adequately but by the need to resolve the smallest basic elements of a drawn image making up a graphics display: lines, arcs, lettering, etc. Needless to say, a drawn image is generally the predominant constituent of most presentations.

Computer graphics' need for greater full color resolution has fostered the development of high resolution monitors and projection display devices not constrained to the NTSC standard.† One thousand line color monitors, albeit expensive now, are available. The computer graphics industry is rapidly evolving systems to

†For example, the authors have purchased a V STAR 4 projection display device capable of true full color 800 line resolution (versus about 300 for the video teleconferencing systems).

drive such high resolution displays. For example, RAMTEK, GENISCO and CHROMATICS offer such high resolution graphics systems for \$40-50K today. This is a young industry, and such costs will come down dramatically in the future.

Key Capabilities for Graphics Based Visual Conferencing

There are two keys to utilizing this evolving graphics capability within a conferencing environment:

Efficient communication. The first is to recognize the basic consequence of a computer graphics drawn image. Each line, curve, arc, box, letter, etc. is a sequence of one or more computer commands which can be interpreted by the computer to rapidly *draw* that element within a frame buffer. The actual display is derived by periodically scanning and interpreting the contents of the frame buffer. Simple modifications to the computer commands can result in animation of drawn images.

The computer commands are, in essence, one of the most compressed forms possible for representing such an image. For example, an optimum data compressor for graphics type images (i.e., viewgraph artwork scanned and placed into standard line/pixel format) would consist of algorithms to break the image up into basic elements such as lines, boxes, colors, etc. This is the initial form of a computer graphics drawn image. (We will later discuss the effect of facsimile data compression.)

By our own estimates a typical *sophisticated* multicolor viewgraph with animation and true 512 X 512 resolution could be represented as computer commands with roughly 30,000 bits, and only 10,000 bits by applying statistical noiseless coding to the commands. This means such a viewgraph could be communicated at only 1000 bits/second in 30 or 10 seconds, respectively. Less detailed word viewgraphs could be communicated in less than a second. Here is a case where far better fidelity images might be communicated, *in an adequate time period for presentations*, with 1/1000th the data rate required by full motion video and 1/50th that required by today's slow scan techniques. More important, such data rates are obtainable over standard dial-up phone lines (hence universal applicability) using off-the-shelf low cost modems (<\$1000).†

Audience interaction can be easily provided in a graphics based system, without unduly impacting the communication channel. For example, by using a standard interactive graphics device such as a joystick or graphic tablet, any audience member could position a pointer on the video image, or possibly draw on the image. The pointer could then be simultaneously displayed at all remote locations at a communications cost of only about 100 bits/second.

---

†As with slow scan systems, a graphics based system would use a separate dial-up line or network for voice.

User friendly tool. The second key observation to achieving practical teleconferencing via such computer graphics is that the creation of graphics materials (the viewgraphs) must be a user friendly process to the extent that non-programmers can quickly and easily accomplish the task. To this end we have developed a first generation interactive viewgraph development tool called MAKEDEMO, which has the additional benefit of being machine independent, thus assuring the broadest applicability to the computer graphics systems available today as well as those appearing in the next few years.

There exists today a broad selection of computer graphics systems available with a corresponding broad range of prices. Most of these systems can perform the basic functions needed for presentation material (see later sections for specific requirements). However, the entry and development of such material on all these machines is at this time cumbersome. There appears to be only a limited development of necessary user friendly tools such as those inherent in the first generation MAKEDEMO. The MAKEDEMO software could with high confidence be implemented on the vast majority of these graphics systems (e.g., RAMTEK, CHROMATICS, GENISCO).†

Graphics files are frequently communicated between similar machines in industry. Why, then, has the graphics industry not already recognized the teleconferencing problem and produced solutions? Much of the remote graphics work involves CAD/CAM, where the remote interactive development of highly detailed designs necessitates higher data rates. The unique aspects of teleconferencing, such as the acceptability of a 1000 bits/second data link, have never been fully recognized. And without a simple but adequately powerful mechanism for presentation development, such as MAKEDEMO, the applicability of computer graphics to teleconferencing is not obvious.

We are now ready to define and elaborate on the system concept, TELEDEMO.

---

†Our demonstration vehicle at this time is a GENISCO Graphics/SEL host computer system.

TELEDEMO

Figure 2† shows the functional block diagram of TELEDEMO. Note that while teleconferencing at very low data rates is an enabling function of TELEDEMO, the full utility of the presentation development tools is far broader. In concise form, TELEDEMO is a system concept, embracing computer graphics, which

- provides a low cost, user friendly means of generating effective visual presentation material (MAKEDEMO) which, in combination with images from a data base or local video camera, can be used to: (1)
    - generate standard slide and viewgraph materials using various commercially available hardcopy devices; (1a)
    - provide local, all electronic animated presentations; (1b)
- In conjunction with the parallel communication of voice and the use of data compression, enables effective interactive presentations of such material to one or more audiences at data rates as low as 1000 bits/second. (Such rates are generally available using low cost off-the-shelf modems and dial-up phone lines or tactical military communication lines.) (2)

---

†All diagrams in this report were generated using MAKEDEMO with a display resolution of 640 × 512. Figure 2 took approximately 20 minutes to complete.

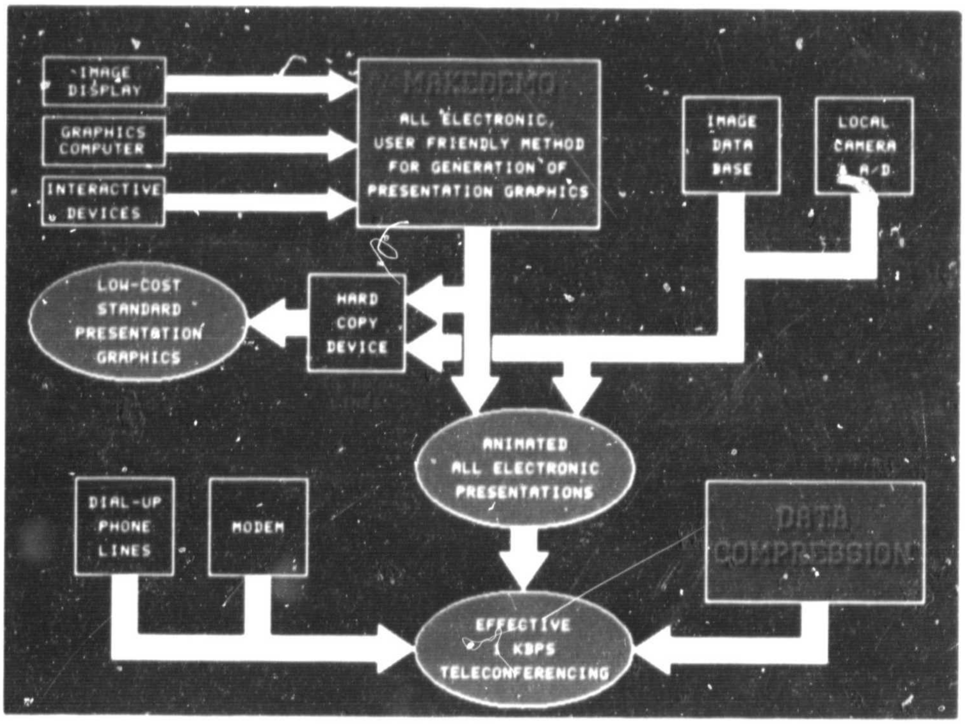

Fig. 2. TELEDEMO Functional Block Diagram.

Hardcopy Graphics

Note that paragraph (1e) implies that TELEDEMO could eventually replace standard graphics arts procedures for the generation of "hardcopy" viewgraph and slide displays. We demonstrated our current capabilities to a particularly competent JPL graphics arts vendor.[2] This vendor had developed a multi-color, multi-overlay set of viewgraphs for us a year earlier. The artwork had been lost so we duplicated that set at a resolution of 512 X 512 using MAKEDEMO, making 35mm slides. Those slides were later used by JPL Assistant Lab Director Don Rea in an outside presentation. MAKEDEMO came out ahead in a comparison of the relative costs in labor to produce an equivalent product. Further developments in MAKEDEMO should reduce the time, and hence costs, necessary to generate a given product by at least a factor of two.

It should be noted that whereas a high resolution color monitor display may currently be limited to 512 or 1024 lines, hardcopy output of graphics products can be performed at resolutions restricted only by the output device. Our present device, for example (a Dicomed film recorder) has full color 2048 X 2048 resolution capability. While this is a rather expensive device, there are considerably cheaper plotter type devices which can provide acceptable products at lower cost. At the other end of the cost scale, Optronics has a system capable of full color with resolution of 10,000 pixels by 8000 lines.

It would appear that the financial advantages of TELEDEMO generated color hardcopy artwork today is already quite noticeable at resolutions of 512 X 512, and increases exponentially at the higher resolutions. Since the user friendly nature of MAKEDEMO should eventually allow relatively low cost personnel (without any special artistic or computer training) to perform these tasks, the advantages may eventually be much more substantial.

Images

Clearly, the principal TELEDEMO presentation material is drawn graphics. However, the emphasis on graphics does not preclude the optional display of digitized images, as was indicated in Fig. 2. Images could be derived from any digital image data base or directly from a local camera or other video sensor. The MAKEDEMO interactive software would then be used to annotate and integrate such material into an electronic presentation (or prepare it for hardcopy output).

Teleconferencing

The use of data compression[3]-[8] and the interconnection of one or more TELEDEMO sites by digital data lines (and a parallel voice channel) makes possible teleconferencing using MAKEDEMO developed presentation material. However, it is the TELEDEMO graphics that makes practical the slow scan (local camera, image data base) function at only 1K bit/second, thus allowing the use of dial-up phone lines.

Basic transmission requirements. To understand this, first consider the image displays in Fig. 3. In the upper left is a 512 × 512 × 8 bit uncompressed grey scale image which would require roughly 30 minutes for transmission at 1K bit/second. By comparison, the upper right image is the result of compression by the RM2 algorithm[3]-[7] to 1 bit/pixel and requires roughly 4 minutes for transmission. In the lower left is a compressed 256 × 256 version of the same image (derived by first sub-sampling) which has been inserted in a viewgraph including descriptive MAKEDEMO text. This viewgraph, including text would take less than a minute for transmission.

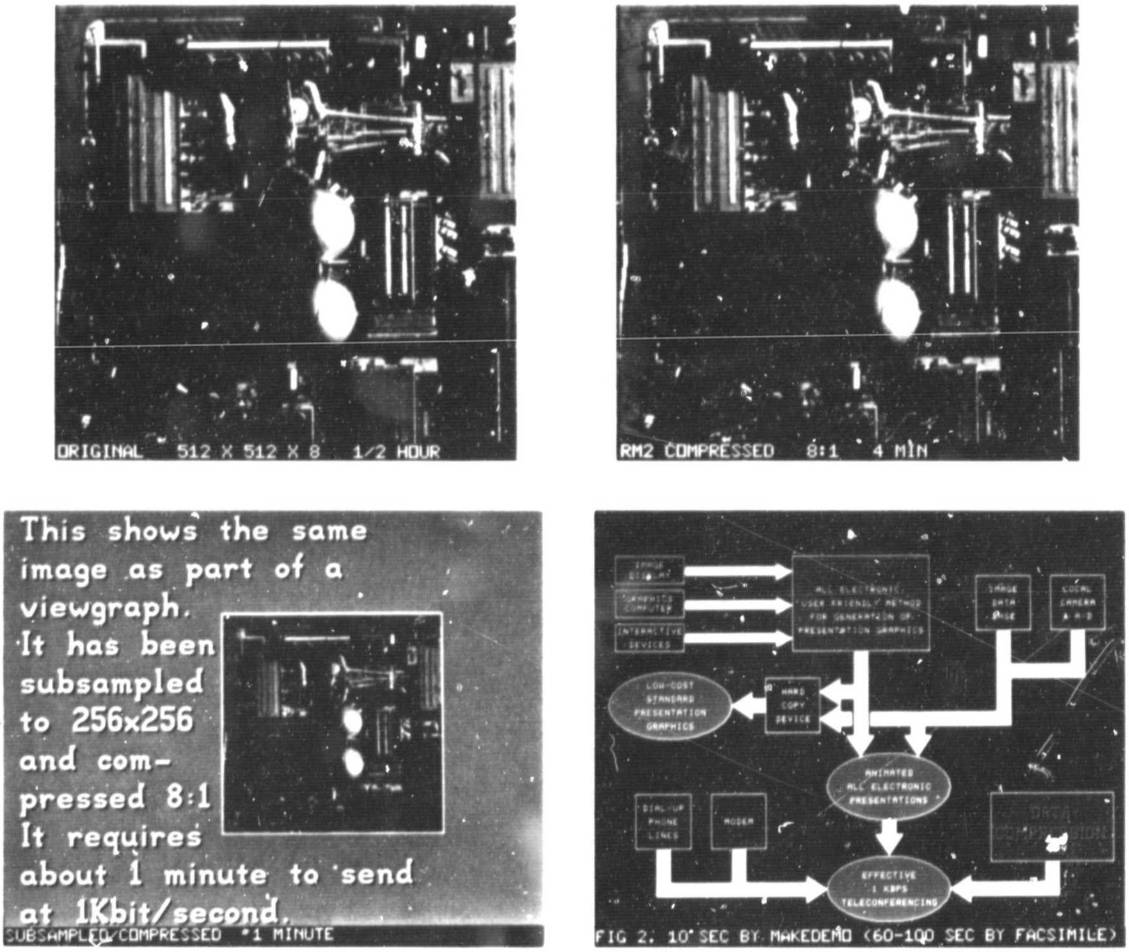

Fig. 3. Effect of Compression and Graphics on Communication at 1K bit/second.

Finally, the lower right image is a repeat of the MAKEDEMO generated Fig. 2 (640 X 512 resolution). If a graphical viewgraph is treated as a digital image in slow scan fashion, two-dimensional facsimile data compression techniques can be used to reduce transmission requirements. For example, application of IBM's two dimensional dual-mode run length coding[8] to a black and white version of Fig. 2 would yield an error free representation at a compression factor of 64:1 (compared to 8 bits/pixel). At 1K bit/second, such an "image" could be communicated in about 33 seconds. An 8-color version would require three times as long, or 100 seconds. Additional and not insignificant processing might reduce this to approximately 50 to 80 seconds. Then, via appropriate use of data compression (and by taking Fig. 2 as representative of the detail in a typical viewgraph), we see that the transmission requirements for digitized graphics (at 640 X 512 resolution) can be made roughly equivalent to that of a 256 X 256 image with 8 bits of grey scale.

By comparison, it would require only 10 seconds to communicate the "typical" MAKEDEMO generated full color Fig. 2 directly at 1K bit/second (with some internal noiseless coding assumed). Further, Fig. 2 as an electronic viewgraph would appear in four stages to allow a presenter to focus the audience's attention on individual elements of the whole. Thus Fig. 2 can be thought of as four viewgraphs requiring about 2.5 seconds for each segment.

Adding the effect of presentation time. Now recall that the primary content of the majority of presentations is graphic material (figures, diagrams, flow charts, word viewgraphs, etc.). TELEDEMO can communicate these typically in 10 seconds or less at 1K bit/second. By comparison the communication of grey scale material or graphics as images in the "slow scan" manner takes substantially longer. The lengthy transmission of such images could cause delays which would make a presentation awkward. However, the proper mix of graphic viewgraphs and image viewgraphs could effectively hide the excessive image transmission time.

For example, assume that each viewgraph in a presentation is discussed for one minute. Then five detailed graphics viewgraphs (e.g., Fig. 2) would take 50 seconds to transmit and 300 seconds to discuss. As soon as the first viewgraph is received, the presentation may begin. Forty seconds later, the last four viewgraphs have been transmitted and there are 260 seconds of discussion left. During this remaining time a full compressed 512 X 512 reconnaissance image could be transmitted.

Table 1 investigates the average communication times for individual display material as the relative mix of MAKEDEMO graphics to images is varied. The MAKEDEMO graphics (640 X 512) average communication time assumed is 10 seconds. Grey scale images are compressed to 1 bit/pixel and the MAKEDEMO graphics-to-image representation ratio is varied from 0 to ∞.

Table 1. Comparative TELEDEMO Average Transmission Times.

		MAKEDEMO Graphics to Image Ratio					
Average Transmission Time (sec. per frame)	Grey Scale Image Resolution	Images Only	4:1	6:1	8:1	10:1	MAKEDEMO Graphics Only
	512 X 512	262	60.4	46.0	38.0	32.9	10
	256 X 256†	66	21.2	18.0	16.2	15.1	10

As shown, even with only a 4:1 ratio of (MAKEDEMO) graphics material to 512 X 512 images the average communication time is one minute per frame. With 256 X 256 resolution images (MAKEDEMO graphics still at 640 X 512) this average drops to only 21 seconds. Increasing percentages of MAKEDEMO graphics to images, probably a more likely situation, rapidly decreases this average communication time. Further, intelligent placement of the images within a presentation (such as at the end) or pretransmission for later call up can further reduce the communication impact of a few selected images within a presentation.

Figure 4 further illustrates the effect of communication times on a TELEDEMO visual conferencing situation. The figure is a time sequence of six snapshots representing the changing state of two interconnected TELEDEMO sites during a sample conference. The corresponding time for each snapshot from the conference start is shown in seconds directly below each sub-figure. The initial state A appears at the upper left.

This diagram shows (for this example):

- A presenter's system made up of
  - an image buffer, containing a single 256 X 256 X 8 bit image;
  - a graphics command buffer containing six (6) MAKEDEMO generated viewgraphs (shown in separate colors);
  - an image display device showing the first viewgraph;
  - a data compressor for efficient transmission of images (at 8:1) and MAKEDEMO viewgraphs (at 3:1);

---

†Roughly equivalent in transmission requirements to a 640 X 512 "image" of a typical graphical viewgraph compressed using two-dimensional facsimile compression techniques.

ORIGINAL PAGE IS
OF POOR QUALITY

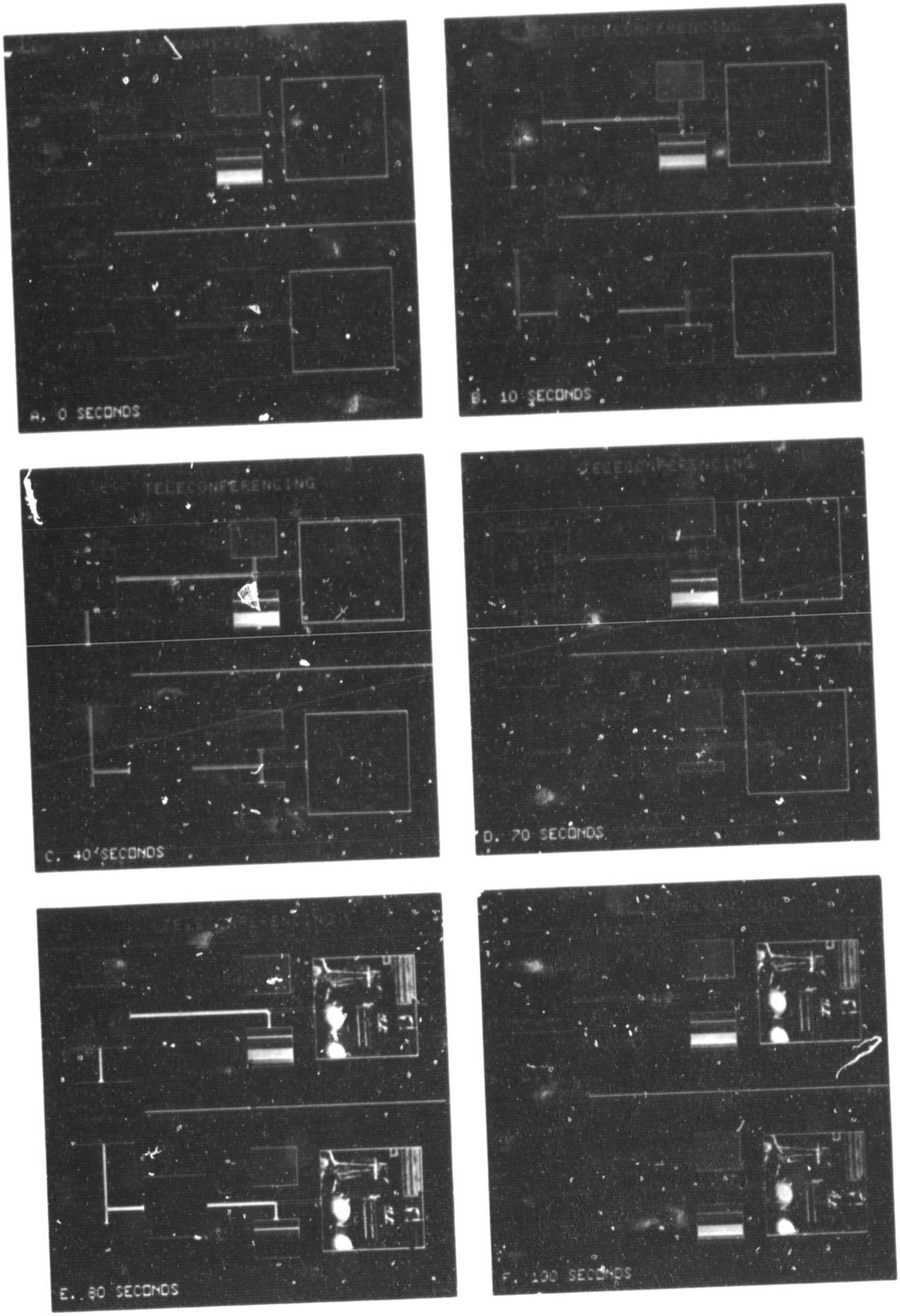

Fig. 4. A TELEDEMO Example Presentation.

- A 1200 bit/second communication link (i.e., a dial-up phone line);
- one audience site configured similarly to the presenter's site, except for
  - a data decompressor;
  - empty buffers and blank display;
- optional links to other audience sites.

At time zero (A), transmission of the first viewgraph begins. Assuming that its detail is typical (i.e., corresponding to Fig. 2 in this paper) the first viewgraph will be available for viewing on the audience display in about 10 seconds (B) at which time actual conferencing can begin. Transmission of the second electronic viewgraph, assumed to be a 256 X 256 grey scale image, commences at an 8:1 compression factor while the first viewgraph is being discussed using a parallel voice grade line. A presenter or his distant audience may make use of an interactive pointer, shown red in both displays (C), to visually supplement the discussion. This has negligible impact on transmission times. The transmission of the image viewgraph is shown half complete at 40 seconds (C) and available for display at 70 seconds (D). At 80 seconds (E) two more, simpler viewgraphs are available for display when desired. At 100 seconds (F) the complete set of six are available. At this point the presenter might still be discussing the first or second viewgraph.

Note that, although posing no problem to a presenter, this example represents an unnecessarily difficult scenario for a presentation. More realistically, the impact of images could be significantly reduced by a) utilizing a few minutes of pre-conference transmission time and, b) placing images later in a presentation.

Other configurations. If images are not required then image data compression is unnecessary and, in fact, TELEDEMO could probably operate effectively at only 300 bits/second. On the other hand, an improvement in data rate above 1 K bit/second, such as from dedicated lines, would improve the ability to include images within a teleconferenced presentation. The improved data rate could be used to improve image quality or reduce image transmission time.

Requirement for full motion video. A TELEDEMO user may obtain the additional capability of viewing people moving and talking by "adding on" one of the existing video teleconferencing systems for more than an order of magnitude increase in cost. We offer no alternative if this is a strict requirement.

Preparing an Electronic Presentation

A MAKEDEMO edited presentation can be comprised of elements from many sources, as illustrated in Fig. 5. MAKEDEMO enables a user to rapidly develop electronic viewgraph art by copying existing hardcopy artwork, by using a rough

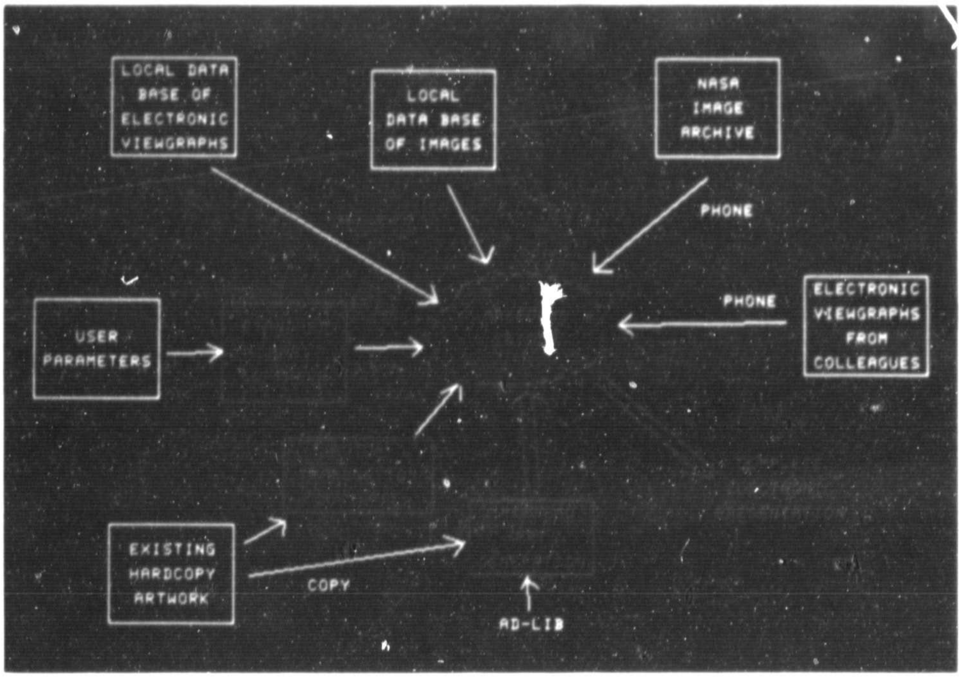

Fig. 5. Preparing an Electronic Presentation.

sketch, or by "ad-libbing" on the spot. The user may also include and/or modify existing viewgraphs either from his local data base or (assuming widespread use of TELEDEMO) from his colleagues at remote sites. Two or more remote users could even work interactively on the same viewgraph simultaneously. Images from local or remote computer image archives may be incorporated as well. Future development could provide the capability to automatically convert digitized images of existing hardcopy viewgraphs into MAKEDEMO graphic command form.

When presentation formats can be standardized and **still remain effective**, software tools can be provided to dramatically speed the development of those electronic displays which can be specified by several parameters and/or stored data. These displays include pie charts, bar graphs, etc., as examples. Current efforts of the graphics industry in the area of presentation development appears to be focussed on developing such "chart" presentation software. This capability is an important subset of the TELEDEMO presentation development tools as indicated in Fig. 5.

Once in electronic form, the viewgraphs can be segmented into overlays (such as in Fig. 2 above), and can include animation such as blinking or moving objects, indications of flow and rapidly changing colors. The individual viewgraphs can then be packaged by the MAKEDEMO presentation editor into a presentation sequence. The sequencing can be flexible enough to allow viewgraphs to be shown out of sequence if needed, and to enable back-up viewgraphs to be retrieved to answer in-depth questions.

Implementation Requirements Summary

Table 2 summarizes key hardware and software elements needed to implement an individual TELEDEMO site. Note that several major items have been identified as optional add-ons. This is a consequence of broad TELEDEMO utility derived from the MAKEDEMO presentation development software. For example, data compression and phone-line communication is not absolutely necessary if TELEDEMO is only used to locally generate standard slides and viewgraphs. Similarly, the hardcopy device could be omitted if displays are only to be viewed electronically, either locally or in a teleconferencing mode.

Table 2. Basic TELEDEMO Requirements.

Unique to TELEDEMO	I. A graphics subsystem, with • A raster graphics processor • A display device (T.V. monitor or projection T.V.) • One or more interactive devices (joystick, graphic tablet)
Required, but may utilize existing hardware	II. A host subsystem, with • A host processor • Mass Storage (i.e., a hard disk or floppies) • DEMO/MAKEDEMO software
Optional add-ons	III. • Phone line communication port and modem • Data compression • Hardcopy device (film or paper) • Video digitizer • Video recorder • Etc.

In a "stand-alone" TELEDEMO system, all of these devices would be dedicated to the tasks of preparation, storage and presentation of graphic material. However, the same capabilities could be obtained by attaching the graphics subsystem to an existing host. This relieves the requirement for a dedicated host processor, and reduces the cost of TELEDEMO capability for those potential users who already have an appropriate host computer system.

Impact on Teleconferencing

The teleconferencing user has up to now been faced with an unpleasant choice: "What do I give up?" He could get full motion video, but only at high dollar cost. Or he could get good video resolution, but he must give up color and motion.

Now TELEDEMO can provide the great majority of teleconferencing users with a better alternative. TELEDEMO combines high video resolution, color, simulated motion (animation) and user interaction into a single system, at a lifetime cost comparable to the cheapest system available today (Table 3).

Table 3. Teleconferencing System Cost Comparisons.

System	Initial Cost/Site $	Operating Costs/Year $	Five (5) Year Total Cost $
Full Video	300,000	1,000,000	5,300,000
Slow Scan	18,000	48,000	258,000
Electronic Blackboard	500†	8,000†	40,500
TELEDEMO	30,000	2,000	40,000
†The Electronic Blackboard is currently available on a lease basis only.			

TELEDIMS

Today's microprocessor driven smaller office information management systems (IMS) are primarily based on the functional capabilities to perform word processing and data base management. These capabilities generally provide a user friendly means for the speedy generation and retrieval of textual information. The ability to generate and insert graphics artwork or images for figures is generally crude and cumbersome. Sophisticated drawings or pictures must generally be developed and inserted in hardcopy form as a totally separate step. This shortcoming precludes full monitor display of a finished product either at the originating site or after digital communication to other sites within an IMS network. It is clearly a major bottleneck in any efforts to fully automate office management systems.

TELEDEMO has the functional capabilities to provide a fully electronic IMS. The addition of TELEDEMO capabilities to standard information management systems we call TELEDEMO Information Management System (TELEDIMS; see Fig. 6).

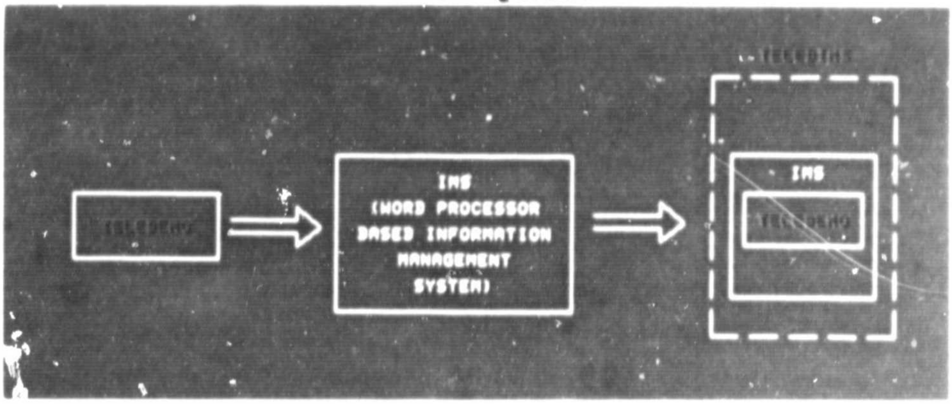

Fig. 6. Creation of TELEDIMS.

In TELEDIMS, word processing operations would be performed as in a standard IMS. However, with TELEDEMO graphics, elaborate full color figures or images could be developed by the same individuals performing the word processing function. These might be the same figures developed for conference viewgraphs. They would be stored in a data base for retrieval at later times in the same manner that pure text is stored today. Communication of such electronic artwork is no different than for TELEDEMO. The same low rate media used for existing word processor interconnection or for TELEDEMO alone would suffice.

The generation of hardcopy quality products containing detailed graphics art and/or images would currently require a high resolution film output device (as described for TELEDEMO). Pure text output would utilize standard printing equipment now used. Somewhat lower quality color graphics is now becoming available using dot matrix printers (e.g., RAMTEK).

Note that a hardcopy page containing electronic artwork must contain an "inserted" static form of a figure. That is, the selected figure must fit within the text. There is no such limitation if the "electronic" document is to be read directly from TELEDIMS. The text might be displayed on one screen as is normally done today and detailed, full color, animated figures might fill a second monitor or big screen display as they would in teleconferencing situations using TELEDEMO alone.

Thus TELEDEMO could provide a substantial increment to the capabilities of today's IMS. Observe that with a fully developed TELEDEMO this significant improvement could eventually be bought without a full cost investment in TELEDEMO. Just as with slow scan many of the modular components of TELEDEMO are already elements of a word processor based IMS. These include phone line communication, mass storage, memory, and possibly a host processor to drive the TELEDEMO graphics.

REFERENCES

(1) Patrick S. Portway, "Video Teleconferencing," IEEE sponsored presentation, Jet Propulsion Laboratory, Pasadena, CA., May 14, 1982. (Mr. Portway is vice-president of Marketing for Video Systems Network, Inc. and president of VSN Satellite Communication Services).

(2) Conversations with Virgil Austin, Gamo Publications, Feb. 1982.

(3) R. F. Rice, "An Advanced Imaging Communication System for Planetary Exploration," Vol. 66 SPIE Seminar Proceedings, Aug. 21-22, 1975, pp. 70-89.

(4) R. F. Rice, "Some Practical Universal Noiseless Coding Techniques," JPL Publication 79-22. Jet Propulsion Laboratory, Pasadena, CA., March 15, 1979.

(5) R. F. Rice et al., "Block Adaptive Rate Controlled Image Data Compression," Proceedings of the 1979 National Telecommunications Conference, Washington, D.C., Nov. 1979.

(6) R. F. Rice, Alan Schlutsmeyer, "Data Compression for NOAA Weather Satellite Systems," Vol. 249 SPIE Symposium Proceedings, "Advances in Image Transmission II," San Diego, CA., July 1980.

(7) R. F. Rice, "End-to-End Imaging Information Rate Advantages of Various Alternative Communication Systems," JPL Publication 82-61. Jet Propulsion Laboratory, Pasadena, CA., Sept. 1, 1982.

(8) J. Mitchell et al., "Yorktown Dual Mode Data Compression and Decompression System," IBM Research Report RC 7490-32362. IBM Research Center, Yorktown Heights, NY, Jan. 25, 1979.