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ABSTRACT
              This paper presents the results of three surveys
about live, two-way interactive video (compressed video) and
discusses some possible trends in its use, applications, and
technological development. Surveys are an Association for Educational
Communications and Technology (AECT) survey that has not been
completed; one from the "International Video Teleconferencing Source
Book," which lists over 900 users in the United States; and the
National Association of State Telecommunications Directors survey of
10 western states. There is a broad trend toward the use of lower
transmission rates among educational institutions. The current
edition of the "Source Book" states that 71% of educational
institutions use transmission rates of 384 Kbps or lower. There is a
general increase in the use of VideoTelecom equipment. Noneducational
users also tend to use lower transmission rates, confirming the
overall trend toward lower bandwidth technology. Nine figures
illustrate the survey findings. (Contains 3 references.) (SLD)

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Title:

1993 Survey of Compressed Video Applications:
Higher Education, K-12, and the Private Sector

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Introduction

Compressed video is not a new technology. As early as 1970 AT&T produced its Picturephone which was based on its experiments with reduced bandwidth and the use of digitized video. However its cost and complexity thwarted growth and demand for the product until the mid to late 1980s, and now, "compressed video is a hot technology and will get hotter throughout the 1990s. Increased microprocessor speeds, decreasing costs and the ever increasing availability of bandwidth are all driving the usefulness and economics of the technology. The underlying technology of compressed video is complex, but so is computer and telephone technology. At the practical level, implementation and operation of compressed video is not more complicated than many computer networks , and a lot less complex than some." (Burton, 1993). This paper presents the results of three surveys about live, two-way interactive video (CV) and discusses some possible trends in utilization, applications and the technology itself. The surveys are drawn from an AECT survey done by the authors, the *International Video Teleconferencing Source Book* (hereinafter referred to as *The Source Book*), and the National Association of State Telecommunications Directors (NASTD) 1993 survey of the western region of the United States.

In February of 1993, AECT published *Compressed Video: Operations and Applications* by Barbara Hakes, Steven Sachs, Cecelia Box and John Cochenour. The book contains user profiles from some twenty different institutions, businesses and agencies. During the time the book was being published, and since its publication, the use of live, two-way compressed video (CV) has been increasing dramatically. As a result, a commitment to produce a supplement to the book was made with a target publication for 1994. In order to develop the supplement it was necessary for the authors to conduct a survey of compressed video users from higher education, K-12 and the private sector. This paper presents the initial results of that survey which is still in progress.

The first edition of the *Source Book* was published by AT&T Global Video Services and the International Teleconferencing Association in 1992; and the second edition in 1993. *The Source Book* was the first early attempt to compile a data base of compressed video information. The 1992 edition lists 1,600 entries world wide for video conferencing facilities. The 1993 edition lists 2,381 entries. Additionally, it provides the following information: 1) whether the facility is a private or public room, 2) the model of codec being used, 3) transmission rates, 4) encryption type, 5) carrier provider, 6) video phone number, if appropriate, and 7) a contact person and the contact person's voice phone number.

The NASTD survey was conducted by Dennis Nincehelser, Director of the Bureau of Administration in the division of Information Services in the state of South Dakota. The survey examined the compressed video operations and/or plans of the 16 states in the Western Interstate Commission for Higher Education cooperative: North Dakota, South Dakota, Nebraska, Montana, Wyoming, Colorado, New Mexico, Idaho, Utah, Arizona, Nevada, Washington, Oregon, California, Alaska and Hawaii. The results of that survey are discussed in this paper as well.

Procedure

The findings of the aforementioned sources are reviewed and apparent trends in compressed video utilization, applications and the technology itself are noted. For the AECT survey, the authors used the 1992 edition of the Source *Book* published by AT&T Global Video Services and the International Teleconferencing Association as the population base.

In June 1993, surveys were mailed to the 938 entries listed in *The Source Book*. In July of 1993, follow up letters were mailed. This letter requested a reply by September 15, 1993. In November another survey was mailed to those not responding by the September deadline. During December, various smaller mailings were made to additional institutions as the authors became aware of their uses of CV through a variety of other sources. Surveys were also completed via telephone interview during December 1993. A total of 44 surveys were completed via these processes

Multiple sources to examine trends for this paper were used for the following reasons. The AECT survey is not yet complete and response rate has been low. Data for *The Source Book*, although voluminous, was collected in 1990 to 1991 for the 1992 edition and 1992 to 1993 for the latest edition. Compressed video technology has changed dramatically since the time of the first edition and new users and applications are emerging as this paper is being written. In fact, "the anticipated growth of video teleconferencing in the 1990s is similar to the FAX 'explosion' of the 1980s" (Burton, 1993). Also information on data collection for *The Source Book* is sketchy, and the authors admit that it may represent a biased picture in unknown ways. For example, while the 1993 edition lists the state of Wyoming as having two video conferencing facilities equipped with CLI it in fact supports twelve video conference facilities equipped with VTel codecs. The NASTD survey is restricted to the Western region and may also reflect some bias because of its geographic restrictions. Because of possible inaccuracies in each survey, we have triangulated the surveys reported here in order to identify possible trends.

Findings

AECT Survey

While the authors are not yet finished with data collection, the information that has been obtained reveals some interesting trends and possible patterns for the future direction of compressed video conferencing and networking. Among 22 questions responded to in the survey were the following.
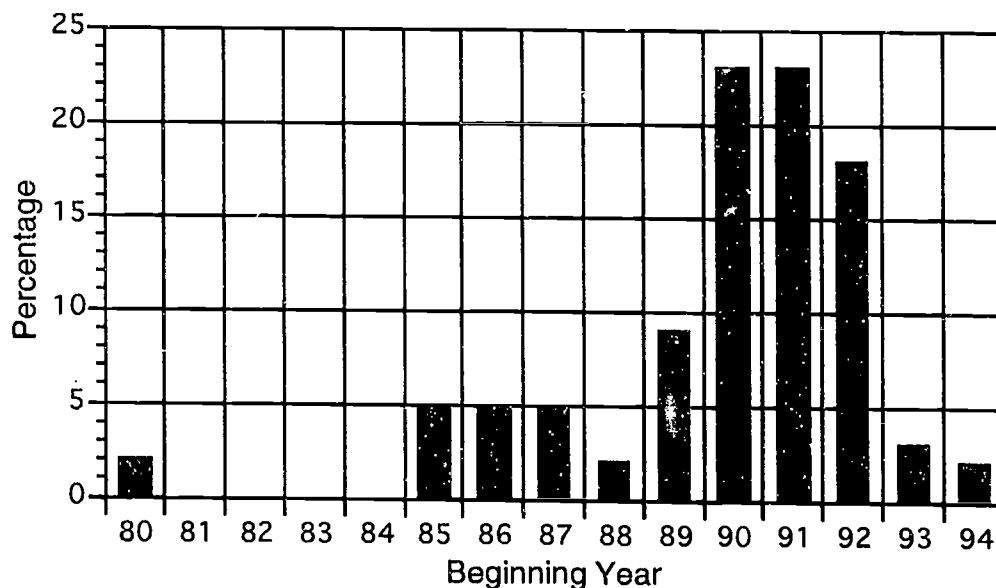

Figure 1: Year in which respondents began using compressed video.

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When did you start using compressed video? The earliest start date was 1980. Most of the respondents began in either 1990 or 1991. This probably reflects the use of the first edition *Source Book* as the population base for the basic survey. The first edition used data compiled in 1990-91 and the institutions listed therein would have begun prior to its publication. The institutions starting in 1992-94 as shown in our data come from a smaller database compiled by the authors own networking. (see figure 1)

How did you decide to use compressed video as opposed to other telecommunications systems? Eighteen percent of the respondents did not provide an answer to this question, but those that did had an interesting variety of reasons for choosing compressed video. Fifty percent of the group listed cost as the primary reason for selecting compressed video. The other two major categories were the higher quality of the compressed video (23%) and the existence of a system (18%) where the system was inherited and original reasons were unknown. (see figure 2) It should be noted that in some cases compressed video and other telecommunications systems are used in conjunction, and it is not necessarily a decision to use only one system.
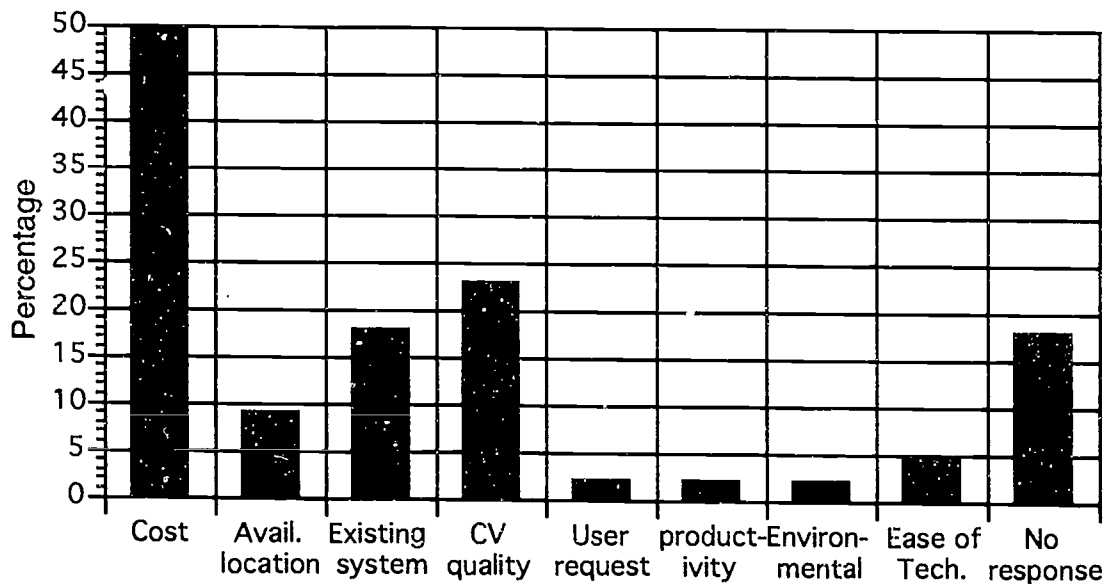

Figure 2: Reasons for choosing compressed video over other telecommunication systems

What delivery system(s) do you use (i.e. satellite, land line (fiber, T1 etc.)? Many of the systems described by our respondents used more than one delivery system, so the percentages listed here exceed 100 percent. Eighty four percent of the respondents stated they were using T1 as a delivery system. Twenty three percent were using satellite delivery; eleven percent were on land line, and five percent were using switched 56. This five percent are primarily represented by institutions that began using compressed video during 1993.

How many sites are included in the network? Two of the responses listed only one site, or essentially not part of a yet established network. One response listed 1400 sites in the network. However, the majority of the respondents listed sites that numbered between six and twenty. (see figure 3)
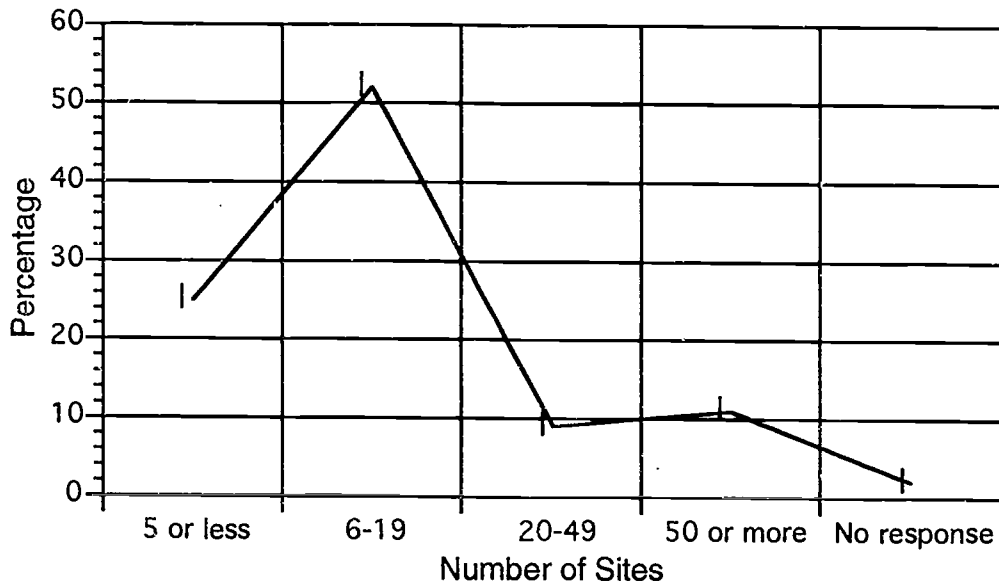
Figure 3: Number of compressed video sites in the network

Please describe each application that is presently using the compressed video network. Several different applications were listed. Most of the respondents had more than one application. The applications have been categorized and the percentage of respondents using the application are shown in figure 4.

Who operates the facilities? Again, this was not an either/or question and many of our respondents had more than one means of operating the system. Sixty eight percent stated they used a technician at least part of the time to handle the operation of the system. Fifty seven percent stated the primary user or a participant operated the system at least part of the time. Seventy percent of the respondents indicated that the system operator had received some training regarding the operation of the system. The most common training was simply an audio/visual orientation, but two percent of the operators had electronics training and nine percent had video production training.

What rate(s) do you use for transmission? The most common transmission rate reported was 384 kbps. Several of the sites reported more than one rate was available for use depending upon the connecting network and the application need. (see figure 5)

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Higher education	45
Sharing instructors	14
Training and delivery	34
Videioconferencing	59
Think tank	23
Planning	41
Advising	20
Administration	43
Depositions	18
Consultation	25
Student project	18
Research	14
Government	20
Private business	16
Grade school educatio	5
Jr./Sr. high education	5
Court hearing/arraignment	5
CPA reviews	2
No response	2

Figure 4: Applications for compressed video and the percentage of
respondents using such applications

Are you presently using (or plan to use) the public switched 56 network for interstate
or international communications? Thirteen of the respondents failed to answer this question
and fifty seven percent responded negatively. However, thirty percent of the survey
respondents indicated they were, or had plans to, use public switched 56 network for
interstate or international communications.

What hardware model and brand are you using? Our findings were similar to those
in The Source Book. (see discussion below) The more popular codec brands were:

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VideoTelecom - 48%, CLI - 34%, and PictureTel - 11%. Sixteen percent of the respondents were scattered among other systems. The respondents were fairly evenly divided between stationary and rollabout systems.
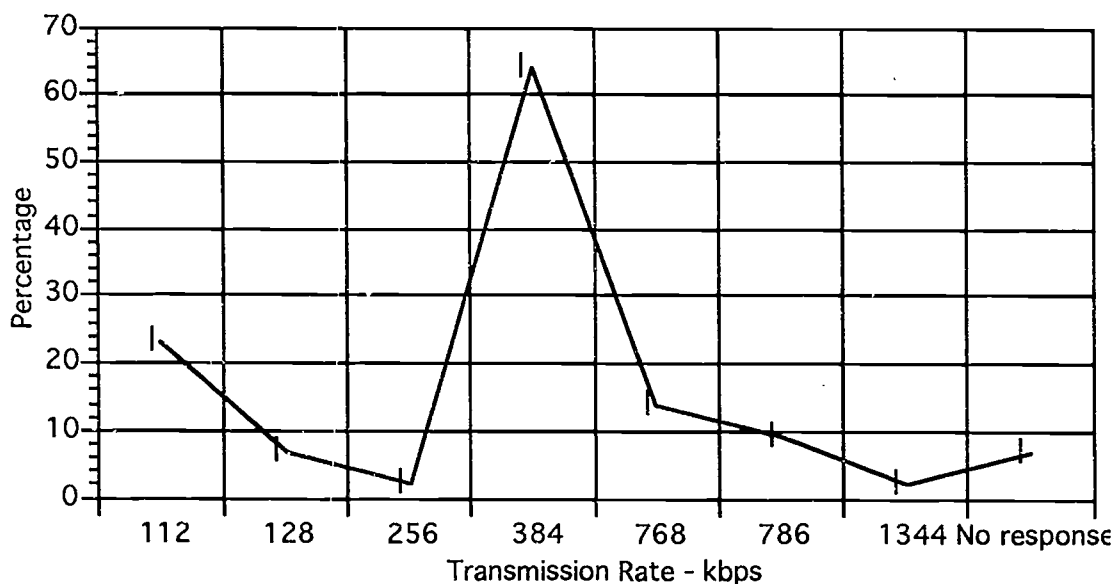

Figure 5: Percentage of respondents reporting use of a specific transmission rate.

What peripherals are attached to the system? Two popular peripherals were a VCR and the Elmo presenter, both were part of fifty seven percent of the systems. The most common peripheral, however, was a computer. Sixty four percent of the systems had a computer as part of the system, and the MS-DOS compatible computer was used seventy five percent of the time. Additional peripherals that were frequently listed included external cameras, fax machines, and the pen pal. Other peripherals that were less commonly mentioned included: slide projectors, overhead, CD-Rom, speakers, zoom box, black box converter, special effects switcher, and videowriter.

Source Book

Educational institutions- 1992/3. The *1992/3 Source Book* contains 1,600 listings for international facilities for compressed video. Facilities in the United States comprised about 938 listings for approximately 60% of the sites available world wide. 121 sites were not included in the authors' analysis due to incomplete information contained in the directory. Of the 938 sites listed in the United states 678 were listed as private facilities and only 260 locations were listed as public. (see figure 6) Educational institutions supported only 28 of the facilities listed in the directory for a little less than 30% of the total number of compressed video locations. The twenty eight educational institutions listed in the source book utilized 22 sites with Compression Labs Inc.(CLI) codecs, four with PictureTel (PCTL) Codecs and six with VideoTelecom (VTEL) codecs. (see figure 7) One site utilized a GPT codec and the 28th site utilized a VisuaLink codec. Six sites supported two different vendors' codecs operating at different transmission speeds. Transmission rates (see figure 8) at these sites ranged from nine locations which used a full T1 carrier (1.544

megabytes per second), three locations which used variable rates from 384 Kbps to 1.544 Mbps, one site using 112 Kbps to 1.544 Mbps, two which used 768 Kbps, eight which used 384 Kbps, five which used 112 Kbps. Since lower transmission rates require less space on the carrier, whether it be land line, satellite or microwave, conferencing costs are reduced at the lower rates. Yet at the lower rates some quality in transmission is sacrificed. Transmission at 384 Kbps utilizes only about 1/3 of the capacity of a T1 carrier. In the sample of educational institutions contained in *The Source Book,* 40% utilized transmission rates at 768 Kbps or a full T1, 14% at variable rates ranging from 112 Kbps to a full T1, and 46 % used transmission rates at 384 Kbps or lower.
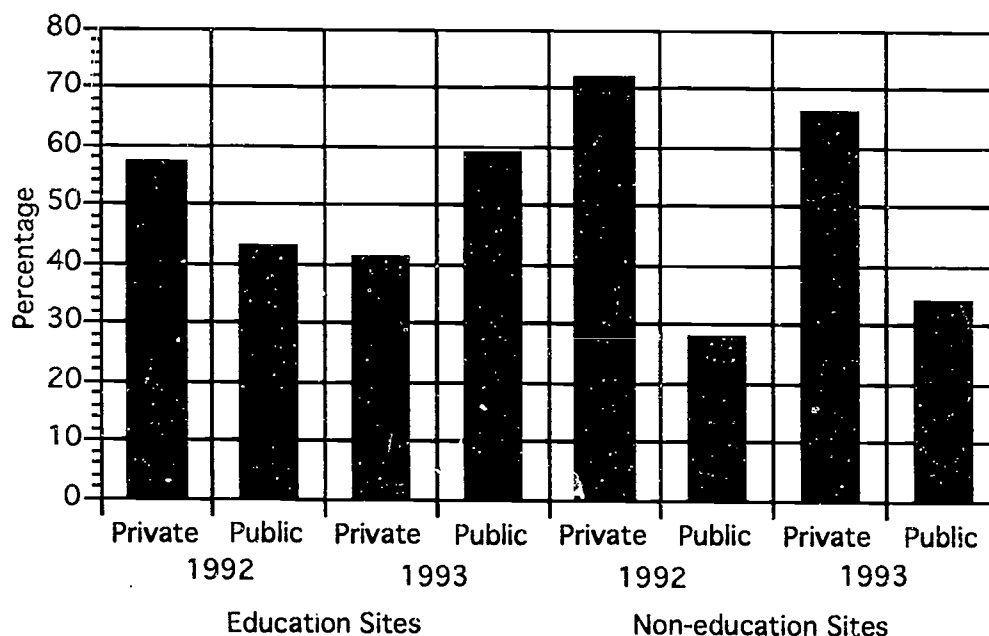

Figure 6: Percentage of private and public facilities for educational and non-educational compressed video sites, 1992 and 1993.

Educational Institutions-1993/4. *The 1993/4 Source Book* contains 2,381 listings for international facilities for compressed video. This represents an increase in listing of 38% over the previous edition. Facilities in the United States comprised 1,526 listings for approximately 64% of the sites available world wide. 64 sites were not included in the authors' analysis due to incomplete information contained in the directory. Of the 1,562 sites listed in the United states 1,004 were listed as private facilities and 521 locations were listed as public. (see figure 6) This increase in the number of public compressed video facilities is double the number listed in the previous year's directory. Educational institutions supported 49 of the facilities listed in the directory for a little less than 32% of the total number of compressed video locations. The forty- nine educational institutions listed in the source book utilized eighteen sites with Compression Labs Inc.(CLI) codecs, eight with PictureTel (PCTL) Codecs and thirty-seven with VideoTelecom (VTEL) codecs. Three sites utilized GPT codecs. (see figure 7) Seventeen sites supported two different vendors' codecs operating at different transmission speeds. Transmission rates (see figure

8) at these sites ranged from six locations which used a full T1 carrier (1.544 megabytes per second), two sites using 112 Kbps to 1.544 Mbps, four which used 768 Kbps, twenty-two which used 384 Kbps, thirteen of which used 112 Kbps. In the sample of educational institutions contained in *The 1993/4 Source Book*, 20% utilized transmission rates at 768 Kbps or a full T1, 8% at variable rates ranging from 112 Kbps to a full T1, and 71 % used transmission rates at 384 Kbps or lower.
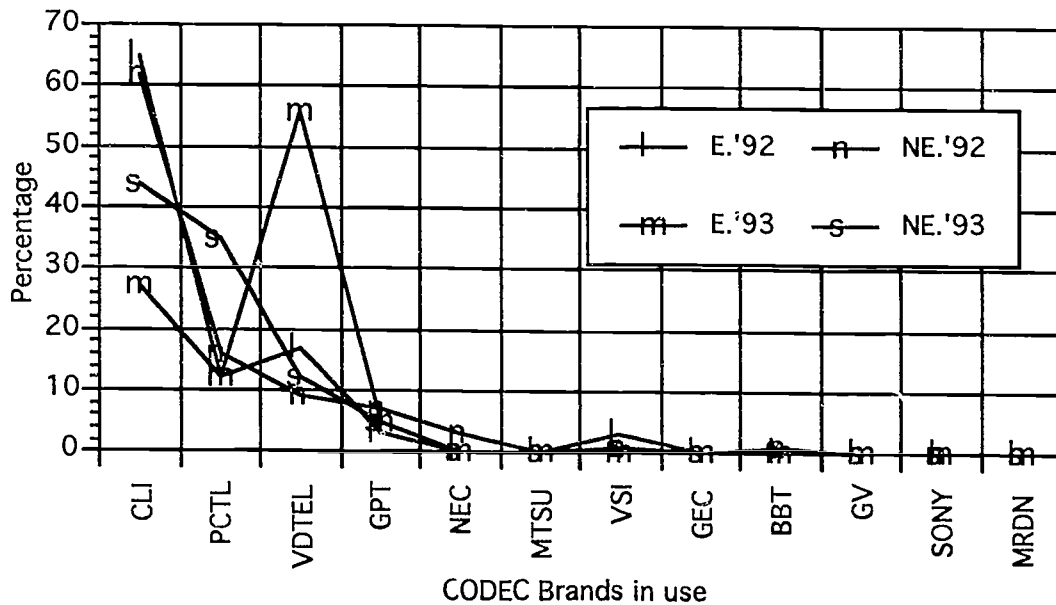

Figure 7: Codecs employed in educational (E) and non-educational (NE) sites, 1992 and 1993.
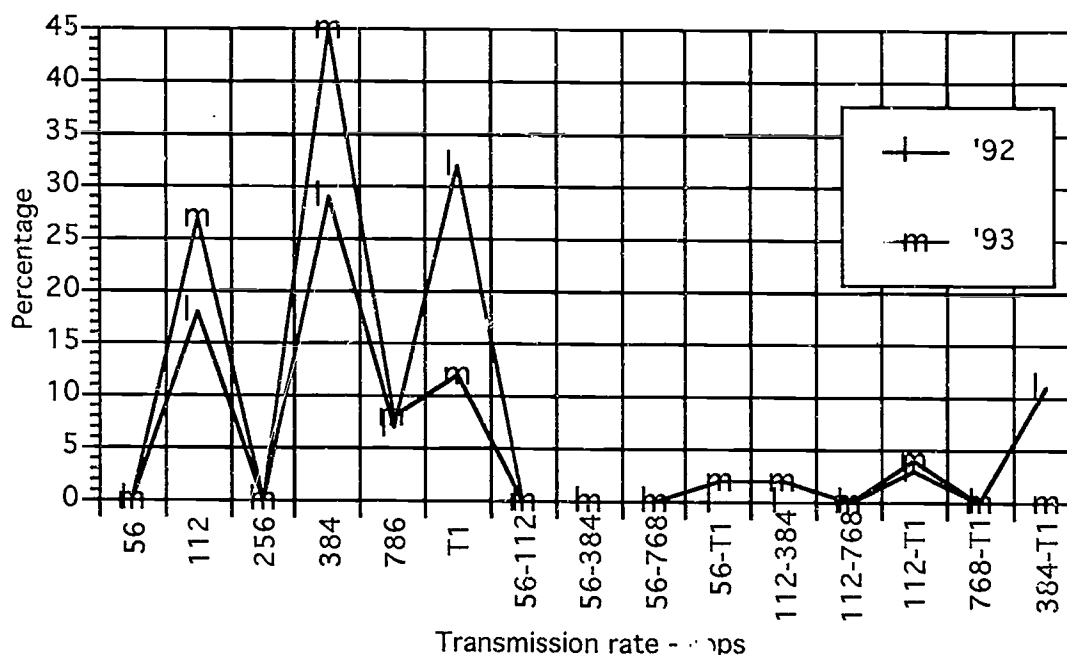
Figure 8: Transmission rates for educational compressed video sites, 1992 and 1993.

U. S. Non-education Compressed Video Sites-1992/3. In examining *The Source Book's* listings for all 938 compressed video installations in the United States the following observations were made. Some sites supported more than one codec operating at different transmission rates. According to entries made in *The Source Book* 121 sites did not provide information either on the model of codec or transmission rates being used. Of those providing complete information, 789 listed one or more brands of codecs. Thirty four sites supported at least two models of codecs and four sites supported three or more brands of codecs. The latter were primarily communications industries groups supporting public compressed video rooms. Of the 789 listings providing codec information 62% (581) supported CLI codecs; 16% (145) supported PictureTel; 9% (86) supported VideoTelecom; 7% (61) used GPT.; and less than 1% varyingly used Nec, Mitsubishi, Vistacom, BBT or GEC codecs. (see figure 7) Transmission rates (see figure 9) were reported in 836 of the entries. The following general pattern emerged after analyzing the entries. Approximately Forty-five percent of the CV sites transmit at 384 Kbps or lower, and fifty- five transmit 768 Kbps or higher
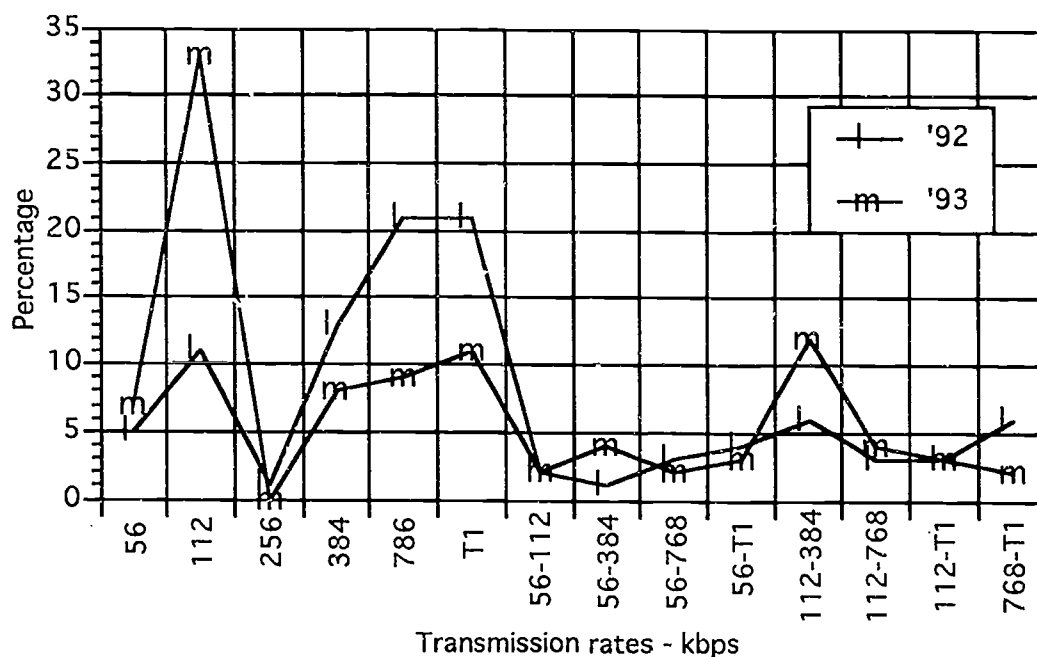
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Figure 9: Transmission rates for non-educational compressed video sites, 1992 and 1993.

U. S. Non-education Compressed Video Sites-1993/4. In examining *The Source Book's* for the 1993/4 edition listings for all 1,526 compressed video installations in the United States the following observations were made. Many sites supported more than one codec operating at different transmission rates. According to entries made *The Source Book* 64 sites did not provide information either on the model of codec or transmission rates being used, but 1428 sites listed one or more brands of codecs. Fifty-one sites supported at least two models of codecs and eleven sites supported three or more brands of codecs. The latter, again, were primarily communications industries groups supporting public compressed video rooms. Of the 1,428 complete listings providing codec information 44% (644) supported CLI codecs; 35% (524) supported PictureTel; 12% (86) supported VideoTelecom; 5% (74) used GPT; and less than 1% varyingly used Nec, Mitsubishi, Vistacom, BBT or GEC codecs. (see figure 7) Transmission rates (see figure 9) were reported in 1,428 of the entries. The following general pattern emerged after analyzing the entries. Approximately Sixty-six percent of the CV sites transmit at 384 Kbps or lower, and forty-four percent transmit 768 Kbps or higher.

NASTD 1993 Survey of the Western Region

During the spring and summer of 1993, Dennis Nincehelser, Manager of Data, Video and Telecommunications in the Bureau of Administration in the Division of Information Services for the state of South Dakota conducted a survey of compressed video operations or plans of the 16 states in the Western Interstate Commission for Higher Education cooperative. Dennis granted permission to include the results of that survey in this paper.

A summarizing discussion of the data is provided here. Of the 16 western states represented in the survey, Three are planning for the use of video teleconferencing and seven are already using it. Of the 10 states responding to the survey, two use broadband analog

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video conferencing. One of these states is in the process of changing to compressed digital video. Four states use CLI based systems operating at variable transmission rates while three states us VTEL codecs operating at 384 Kbps or lower and one additional state is planning to expand its use of two VTEL codecs statewide. Nine of the states either use or plan on using video bridges. Five of the states plan to use inverse multiplexers, three are considering the use of this technology and two are not planning to use it. Higher education represents the majority of use in all but three of the states where state government is the biggest user. However, those networks with a preponderance of use from higher education also share the network with state government and in some cases with K-12 and the private sector.

Trends and Results

Educational Institutions. Based on the data contained in two editions of *The Source Book,* it would appear that there is a trend toward the use of lower transmission rates among educational institutions. There were increases of 9% and 22% respectively in the use of 112 Kbps and 384 Kbps transmission rates. There was a decrease of 16 % in the use of T1 transmission. In the first edition of *The Source Book* only 46% of educational institutions used a transmission rate of 384 Kbps or lower. In the current edition, this percentage has increased to 71%.

Relative to the codecs being used at educational institutions when comparing the data presented in the two editions , there is an increase of 39% in the use of VideoTelecom (VTEL) equipment, a decline of 36% in the use of CLI and no change in the percentage of use of PictureTel codecs while GPT codecs rose approximately 2% and VSI declined by 3%.

Non-Educational CV Sites . Based on the data contained in two editions of *The Source Book,* it would appear that there is a trend toward the use of lower transmission rates among non-education CV users. There were increases of 2% and 22% respectively in the use of 56 Kbps and 112 Kbps transmission rates. There were decreases 5% in the use of 384 Kbps, and 12 % in the use of 768 Kbps and 10% in T1 transmission. In the first edition of *The Source Book* only 45% of the CV sites used a transmission rate of 384 Kbps or lower. In the current edition, this percentage has increased to 66%.

Relative to the codecs being used at these sites, when comparing the data presented in the two editions , there are increase of 19% in the use of PictureTel codecs; 3% in VideoTelecom (VTEL) equipment, and declines of 18% in the use of CLI; 2% in GPT and 3% in NEC and no change in the percentage of use of other vendors' products.

While CLI codes represent the largest number (644) in the latest directory ,any of these codecs were sold early to large clients such as SPRINT, Rockwell International, GE, Sears Technology, the U S Armed Services and others. Sales to these clients alone totaled some 250 units, all old model Rembrandt operating and 768 Kbps or full T1. PictureTel has temporarily gained a huge share of the market with its low bandwidth codecs. But CLI has countered with the Eclipse and VTEL also has announced low bandwidth products. In noting the higher percentage use of VTEL products in educational institutions the authors believe that the increased popularity of the VTEL line in education may be due to the integrated multimedia design of the System. In interviews with educational users they are quick to point out the advantages of a multimedia system in educational environments. But the trend does appear to be toward lower bandwidth technology.

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