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ABSTRACT

This report describes a program aimed at the demonstration, test, and evaluation of the educational and economic effectiveness of the PLATO IV computer-based education systems as implemented in several geographically dispersed military training sites. Also described is a program designed to increase the cost effectiveness of the PLATO system, both in its deployment in the Advanced Research Projects Agency (ARPA) community and in its continuing development as a national resource for education. (Author)

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DEMONSTRATION AND EVALUATION OF THE PLATO IV COMPUTER-BASED EDUCATION SYSTEM

(Computer-based Education for a Volunteer Armed Service Personnel Program)

For the Period

January 1, 1976 - June 30, 1976

IR004623

PREFACE

This report under Contract DAHC 15-73-C-0077 describes a program aimed at the demonstration, test and evaluation of the educational and economic effectiveness of the PLATO IV computer-based education as implemented in several geographically dispersed military training sites. It also describes a program aimed at increasing the cost effectiveness of the PLATO system, both in its deployment in the ARPA community and in its continuing development as a national resource for education.

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PART I

SITE SUPPORT PROGRAM FOR SERVICE TEST OF PLATO IV

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INTRODUCTION TO THE SITE SUPPORT PROGRAM

During the first half of 1976, the Military Training Centers (MTC) group began shifting their responsibilities from direct site support to the project evaluation phase of the proposal. This shift coincides with efforts of personnel at most of the remaining sites to wind up their investigations within the next few months.

Part I of this report summarizes the interaction of the MTC group with the remote sites. Part II describes the progress of the MTC and PEER (PLATO Educational Evaluation and Research) groups in evaluating the effectiveness of the ARPA/PLATO project.

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1.1 MTC ACTIVITIES

1.1.1 TRAINING

The MTC author training package was updated in several ways to keep abreast of system improvements. One programming problem (and the associated parts of "ppcode" and "ppsoln") was completely rewritten. Access to the various on-line components of the package was extended and simplified.

Five new authors at Chanute were trained during this half-year. Also, the Federal Aviation Administration (FAA) Academy staff used the MTC package to teach TUTOR to a new author group from American Airlines.

1.1.2 CONSULTATION

As in the past, MTC members spent considerable time consulting on-line with personnel at the various remote sites. Because of the loss of experienced authors at Chanute AFB and their replacement with inexperienced personnel, on-line consulting with that site has been especially high. In addition, one MTC staff member worked ½ time on site at Chanute consulting with the project personnel and preparing Technical Order lessons (see Section 1.1.3 Support Programming).

Support of the Chanute site by PEER staff members included basic work in criterion referenced test design intended to provide the site with improved procedures for selection of cut-off scores in testing for mastery learning and in development of methods of measurement of quality of lessons and of criterion referenced tests. A method for improving reliability of teacher-designed tests was successfully applied to a Chanute test. A

description of this method is now being prepared for publication. Additional work is being done in enhancement of reliability of gain-score measures and in correlational analysis of attitude scores. A staff member has just completed a chapter of a book (in press) describing techniques used on the PLATO system to improve lesson materials and assess individual performance with automatically collected performance data. This publication emphasizes the technological and methodological similarities and differences between measurement problems in CBE and in more general educational measurement situations.

MTC consulted with AFHRL and Chanute personnel on evaluation topics and provided Chanute evaluators with statistical data processing support.

1.1.3 SUPPORT PROGRAMMING

Several lessons using a gaming strategy were planned by the Chanute project staff as part of the Technical Order (TO) lessons. The programming for several of the TO games was done by MTC personnel.

Six of the TO lessons use a simulated TO library to present examples of the use of TO's and to facilitate testing the student. In order to maintain a large number of entries in the simulated library while keeping the amount of ECS consumed small, the TO entries are stored on disk rather than in ECS. The programs and routines needed to enter, modify, and retrieve the TO entries were created by an MTC staff member. Using a special editor produced by a member of the MTC staff, non-programmers can create the needed database in a minimum amount of time. Furthermore, because the coding of the editor is completely general, a database for another

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course could be rapidly constructed.

1.1.4 LIAISON

During this reporting period, a contract was formalized between CERL and Control Data Corporation (CDC) in order to begin commercial marketing of the PLATO system of computer-based education. As a clause of that contract, records of University of Illinois users have to be kept entirely separate from those of people not employed by the U. of I. Therefore, MTC staff members created new records for each remote site, set up independent notesfiles for each site and changed author signons. Lesson "mtcsignons," written by an author from the Naval Training Equipment Center at Orlando, contains a listing of the new signons.

As a result of the creation of separate courses for each site, certain types of author usage data were kept only until 1 May 1976, and will not be recorded after that time.

Parkland Community College in Champaign, Illinois has been using some Chanute lessons in their automotive courses. Data being collected at that site will be used in MTC's overall Chanute evaluation to measure how students from another site respond to the lessons. To facilitate this implementation, Parkland has received copies of the new set of slides Chanute is now using.

A problem causing poor quality in slides produced at Chanute was diagnosed as the result of a misguided effort to save money; the chemicals used to develop the film had been diluted and the developing times adjusted. As a result, all Chanute's fiche were purplish. Recently acquired developing equipment at CERL has resulted in shorter delays and better quality control

in fiche production. Since March, Chanute has utilized CERL photofinishing—exclusively.

A PEER staff member facilitated data collection at all sites by expanding an easily-used data package. The package is based on the system-provided "area" data collection option and allows transfer, editing, sorting, and printing of data for maximum ease in analysis. This package consists of a number of small segments which permit use during periods of peak system usage. Future development will permit access to display and analysis routines now available only in the "area" package already developed by the PEER group staff.

1.1.5 SITE CHANGES

Maxwell AFB, Redstone Arsenal, and the Air Force Academy were disbanded during this reporting period. As of June 30, only the Maxwell terminals had been relocated.

The ROTC program at the University of Illinois went on-line in April. They received one of the two terminals shipped from USC; the second terminal is now being used by PEER group staff.

1.2 SITE EVALUATION

In this section, we will discuss the progress towards fulfilling the requirements of the current ARPA contract.

Data gathering is well under way, including interviews with current and past personnel at Chanute, Sheppard and Aberdeen. The order of these interviews as well as the time span we had allowed for this activity in the production schedule has been modified because of the large number of transfers and relocations from the sites.

The evaluation reporting is slightly behind schedule, but overall is nearly on pace with what was originally planned. Several conditions forced modifications to the publication dates originally anticipated. The original production schedule was laid out before final contract negotiations were completed, and those negotiations consumed manpower that otherwise would have been used to generate reports; attrition at some sites forced rearrangement of interviewing schedules so that vital data would not be lost; late publication of site-produced reports will cause delays in the analysis of those reports and studies based on data contained in them (the final reports from Chanute are expected by September 1, 1976). Because of the rearrangements, some studies are ahead of schedule. The major reports for which work has begun are enumerated below.

1.2.1 THE ABERDEEN HISTORICAL SUMMARY

An analysis of the key issues in the Aberdeen project was made based on MTC's documentation of activities with that site and recent telephone interviews with the central figures in the project's staff. Upon completion,

a draft version of this historical analysis was submitted to the Aberdeen project director for review and corrections.

Reviews of Aberdeen lessons were based on the lessons themselves since the veracity of the student performance data we have found has not yet been determined. The analysis is carefully documented with examples and instances and provides as well a lively, picturesque perspective of the lessons.

The analysis of the Aberdeen Final Report includes omissions and corrections to that report.

1.2.2 THE CHANUTE HISTORICAL SUMMARY

An MTC staff member has completed lesson reviews of selected Chanute lessons as described in section 1.1.4 of the Semi-Annual Report of the period ending December 31, 1975. However, while reviewing those lessons, contamination was discovered in the criterion data which Chanute proposed for cross validation of the MTC lesson ratings. Therefore, a new independent variable was suggested by MTC and the data for it collected and analyzed. Rankings and ratings of the Chanute lessons were prepared by the MTC group for both pre and post validation versions of the lessons. Also, several additional measures of Chanute lesson characteristics were made.

An advanced draft of the analysis of the Chanute lessons has been sent to Chanute for a review by project staff. Studies on lesson development and Chanute's CMI uses are also underway.

1.2.3 OTHER REPORTS

A PEER group member spent extensive amounts of time during the early part of her work under this contract identifying effective performance

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measures for medical instruction in anticipation of planned support for the Sheppard site. Since the time when efforts of the Sheppard site were redirected, she has undertaken a literature search of work in the areas of the psychology of instruction (and, to a limited extent, the psychology of learning) and in computer-assisted instruction. This information will be combined with her own experience and that of other members of the CERL staff in preparation of an up-to-date practical guide to instructional design for CBE.

Another member of the PEER group has completed a base-line reliability study of PLATO hardware and software which identifies lowest reliability sub-systems. Current findings indicate negligible effects on quality of system support over a wide range of system loads. A set of general guidelines for evaluation of reliability of any CBE system were prepared and will be used in collection of data for the final report on the PLATO system hardware. He also continued work on analysis of data on factors affecting productivity of CBE instructional designers. Preliminary findings suggest that a "catastrophe theory" model provides a useful means of relating discontinuities in production stress, productivity, and quality-of-product measures for instructional designers with moderate amounts of CBE design experience.

1.3

SUMMARY INFORMATION

For a detailed explanation of the following tables, see section 3.2 "Summary Information" in the Second Annual Report (1/1/74 - 12/31/74).

System usage is monitored by a sampling procedure which surveys every terminal once each hour that the system is in operation (including holidays, weekends, and test periods). This information is provided for use by the PEER group.

1.3.1
Site Data

Site	Total # Authors[1]	Authors 3 hrs/wk[1]	Author Hours[1] 1/1 - 5/1	Disk Space Used	Terminals 6/30
AF Acad[2]	6	3	n.a.	13	3
ARI	4	1	n.a.	49	2
ARPA	1	0	n.a.	1	1
Belvoir	4	0	51	13	4
Chanute	10	7	2513	299	30
Eustis	4	2	n.a.	3	3
HumRRO	9	4	361	40	2
Lowry	7	4	444	40	8
Maxwell[3]	6	3	85	19	0
MTC	9	9	2526	248	3
Monmouth	2	2	299	38	1
NPRDC	10	6	1297	146	12
Orlando	4	3	575	67	4
Redstone[4]	4	3	n.a.	6	4[5]
Sheppard	12	12	939	279	20
USC	3	1	72	43	2
UCSB	1	0	n.a.	0	1
ROTC[6]	n.a.	n.a.	n.a.	n.a	1
Psych	n.a.	n.a.	n.a.	15	1
TOTAL	96	60	9162	1337	102[7]

[1]Data covers only the period from 1/1/76 to 5/1/76. These data will no longer be kept by MTC (see section 1.1.4 for an explanation).

[2]This site disbanded 6/11/76.

[3]This site disbanded 3/1/76.

[4]This site disbanded 4/1/76.

[5]These terminals are located at Redstone, but are not operating.

[6]ROTC accounts are not handled by MTC.

[7]This figure does not include two terminals at the Educational Testing Service (ETS), two terminals in the University of Illinois Electrical Engineering Department or one terminal at CERL used by the PLATO Educational Evaluation and Research (PEER) group.

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Terminal Delivery and Re-Assignment

12/75 - 6/76

Site	12/75	1	2	3	4	5	6	Total
afa	2				+1			3
ari	2							2
arpa	1							1
bel	4							4
cha	30							30
eus	3							3
hum	2							2
low	4				+4			8
max	4			-4				0
mon	1							1

Site	12/75	1	2	3	4	5	6	Total
mtc	3							3
NPRDC	12							12
orl	4							4
peer	0				+1			1
red	4							4
ROTC	0				+1			1
shp	20							20
ucsb	1							1
usc	4				-2			2

1.3.3.1

PLATO IV - Terminal Usage

January 1, 1976 - March 30, 1976

User	Terminals March 1976	Mean Hours per Week per Terminal					
		January		February		March	
		Prime	Total	Prime	Total	Prime	Total
CERL	66	21.9	30.7	21.3	35.6	25.5	37.2
U of I	261	23.6	33.1	26.3	44.9	27.6	42.6
Ill. Univ.'s	136	17.4	22.6	16.0	24.2	20.5	31.0
Other Univ.'s	66	30.7	48.1	27.3	52.9	35.0	54.4
Comm. Coll.'s	118	17.1	17.2	24.0	24.3	29.4	29.6
Schools	103	8.5	8.7	8.3	8.4	12.5	12.6
Government	35	15.6	19.1	9.7	13.0	13.3	15.7
Military	94	17.6	19.9	11.9	13.2	16.3	17.9
Commercial	15	17.7	26.7	16.5	26.0	21.7	27.8

April 1, 1976 - June 30, 1976

User	Terminals June 1976	Mean Hours per Week per Terminal					
		April		May		June	
		Prime	Total	Prime	Total	Prime	Total
CERL	67	26.8	37.2	27.1	37.0	26.7	36.5
U of I	262	33.5	47.8	20.9	32.5	19.6	27.4
Ill. Univ.'s	136	24.0	33.0	21.2	28.7	17.4	22.5
Other Univ.'s	66	39.4	58.2	35.6	56.9	37.9	55.7
Comm. Coll.'s	118	24.8	25.1	14.4	14.5	14.5	14.5
Schools	101	12.1	12.2	12.6	12.7	.2	.3
Government	36	16.0	17.8	16.0	18.2	19.7	21.6
Military	93	21.4	23.0	21.6	22.9	24.2	27.5
Commercial	15	19.7	27.0	19.0	22.7	19.7	24.4

1.3.3.2

ARPA Terminal Usage

January 1, 1976 - March 30, 1976

User	Terminals March 1976	Mean Hours per Week per Terminal					
		January		February		March	
		Prime	Total	Prime	Total	Prime	Total
AF Acad.	2	17.2	22.9	10.7	17.4	13.7	20.9
ARPA-Main	1	0.0	0.0	4.7	4.7	17.0	17.0
ARPA-CERL	2	30.7	40.0	23.8	25.6	33.5	36.5
ARI	1	19.7	20.7	17.7	17.7	19.6	19.6
Belvoir	4	17.8	21.0	12.4	14.9	22.1	30.2
Chanute	30	20.4	21.3	14.2	14.4	16.9	17.5
Eustis	4	6.4	6.6	16.5	18.6	22.3	23.6
HumRRO	2	12.9	17.2	10.5	15.2	11.2	18.8
Lowry	3	21.8	22.3	15.1	15.5	24.4	24.7
Maxwell	-	29.8	32.7	6.2	6.6	----	----
Monmouth	1	43.8	47.3	27.6	30.0	43.2	53.2
Orlando	4	26.1	32.6	12.6	20.9	17.6	19.6
Redstone	4	17.7	25.4	3.9	8.3	.5	1.3
ROTC	-	----	----	----	----	----	----
San Diego	12	17.4	21.0	13.2	14.7	25.0	26.7
Sheppard	20	12.9	14.0	9.0	9.3	10.0	10.6
USC	4	2.1	2.2	1.0	1.0	2.0	2.0

April 1, 1976 - June 30, 1976

User	Terminals June 1976	Mean Hours per Week per Terminal					
		April		May		June	
		Prime	Total	Prime	Total	Prime	Total
AF Acad.	2	32.3	40.5	39.0	50.0	----	----
ARPA-Main	1	6.4	6.4	42.0	45.0	57.1	65.7
ARPA-CERL	2	38.5	41.7	34.4	38.3	35.5	53.1
ARI	1	14.6	14.6	20.5	20.5	22.1	22.1
Belvoir	4	22.3	25.7	23.2	26.4	29.9	37.7
Chanute	30	29.3	30.4	29.4	30.4	36.4	40.0
HumRRO	2	14.8	18.9	8.9	11.3	12.3	16.1
Lowry	7	16.2	16.6	7.7	8.0	9.5	9.5
Maxwell	-	----	----	----	----	----	----
Monmouth	1	54.2	67.3	57.5	68.2	60.5	77.1
Orlando	4	13.7	13.9	15.1	15.1	10.8	14.1
Redstone	-	----	----	----	----	----	----
ROTC	1	----	----	11.7	13.9	16.6	16.9
San Diego	12	24.4	27.6	23.4	24.9	21.6	24.0
Sheppard	20	11.2	11.8	15.6	16.5	17.0	19.7
USC	4	5.8	5.8	8.2	8.2	2.5	2.6

1.3.4

PLATO IV System Performance*

(January 1, 1976 - June 30, 1976)

	Jan.	Feb.	Mar.	Apr.	May	June
Mean hours to interruption	4.99	14.11	26.40	25.17	21.57	7.10
**Mean down time (hours)	.26	.23	.18	.24	1.48	.32
Proportion of class hours interrupted once or more	.17	.09	.03	.04	.11	.23
Weeks to terminal failure	12.10	8.90	13.60	8.10	12.10	12.80
Days to repair a terminal	1.50	.80	1.70	1.40	1.40	1.40
% of terminal-hours usable	93.50	97.10	97.40	97.00	92.00	88.60
Terminal hours used	67100	126400	124600	116800	91800	71500

*Times are prime times for the indicated months. In general 70 to 80 hours were scheduled for such non-experimental use each week.

**Down time includes time required for 99% of users to return to normal operation.

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PART II

TECHNICAL PROGRAM

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INTRODUCTION TO THE TECHNICAL PROGRAM

The technical program at CERL has for over a decade been guided by considerations of both performance and cost in the delivery of high quality education through the interactive use of computers. This work has led to a new display device, the Plasma Display Panel, a new interactive graphics--oriented language, TUTOR, and a new architecture for information processing. What is perhaps most important is that these and other developments fit together in a highly effective system which is greater than the sum of its parts. Part II of this ARPA report describes the status of a program that with ARPA support is maintaining the momentum of technical development at CERL.

2. AUXILIARY MASS STORAGE

The AMS II project has progressed from the conceptual to design stages. To progress to this point, it has been necessary to evaluate two major areas. The first option area was in determining what type of memory to utilize. The second option area was in determining exactly where to place the chosen memory in the existing memory hierarchy.

The question of what type of memory should be used centers around cost and availability. At this time, it is not possible for a full memory system to be physically constructed within the laboratory due to manpower considerations. This limits the range of available choices to commercially available memory systems. The only immediately available memory system satisfying this criteria is what is commonly called IBM "add-on" memory. Several manufacturers offer a memory system designed to plug into IBM 370 series mainframes. These memory modules are available in sizes up to 8 megabytes.

The 8 megabyte module corresponds to 1 million words in the PLATO system (1 byte = 8 bits, 1 word = 60 bits). Bid proposals were issued for 1 to 8 of these modules and the most favorite response was issued by Intel. One module with options on three additional ones was ordered from Intel.

The question of where to place this new memory within the PLATO hierarchy centered around two choices. The first choice was to place the memory at the same location as the original AMS, attached to one of the 6641 (ECS Controller) ports. Locating the memory here would cause it to be removed by one additional level over ECS from the software

system. The second choice is to place the additional AMS memory at the same level as the existing ECS. As detailed in a previous report, this would cause the loss of one ECS bay while providing access to AMS similar to that of ECS. The first option was chosen for the following reasons.
1) A large amount of controller re-wiring would be necessary to implement the second choice. This would have to be done by CDC personnel.
2) It is the business of CERL to perform research and under this guide, placing the memory at a new level in the memory hierarchy would help to explore the full utilization of a new memory level.

During the months of July, August, and September a new AMS controller will be designed and built. In November, Intel is expected to deliver and install their memory system. Working according to this timetable, it is hoped that the memory will be operational by the end of the year.

P. Tucker

3. DEVELOPMENT OF A PORTABLE TERMINAL

Three related projects are being pursued in developing a portable PLATO terminal. These are: 1) a high efficiency power supply for PLASMA type terminals, 2) a new sustainer waveform for PLASMA display panels, and 3) a new PLASMA display decode and driving technique. This project has progressed through most of its research phases and is presently in its development phase. All of the addressing, sustaining, and logic circuitry has been developed. The major sections of the power supply have been developed. Remaining to complete the project are the final regulators for the power supply and the complete system integration into one package. This should be completed in the next 30 days.

P. Tucker
L. Hedges
D. Hartman

4. PLATO TERMINAL DEVELOPMENT

A total of three versions of the new PLATO terminal are now in place in the PLATO system. Two are plasma panel units and the other is a CRT. A fourth unit utilizing the new panel electronics is still in development.

A report describing the terminal appears as part of the appendix (see attached copy of Report X-46).

Future efforts will be concentrated on developing firmware and system software to operate these terminals.

A floppy disk system has been developed for use as a peripheral for the new terminal. This disk system is a random access storage device utilizing a removable 7.8 inch diskette of mylar base magnetic tape as the storage medium. The disk system is connected to the PLATO terminal by a bi-directional data bus which transfers data and read/write commands. The development of the PLATO terminal flexible disk system has three primary objectives: 1) provide a large, locally (at the terminal) available data base for the microprocessor in the second generation PLATO terminal, 2) provide a high data transfer rate between the disk and the terminal and, 3) reduce the amount of ECS (extended core storage) being consumed by a given terminal by substituting the local storage of the flexible disk system in place of the more expensive mainframe computer memory. Upon satisfying these three objectives, we hope to enhance the terminal by adding more flexibility to the processor-based terminal.

The flexible disk system currently in use is a CDC 9472 dual drive system. Both drives, the analog read/write circuitry, and the

controller are incorporated within one enclosure. This is compatable with an IBM 3740 disk system having a storage of 256,256 bytes per drive. The 7.8 inch diameter diskette of mylar base magnetic tape is protected within an 8 inch square plastic case with openings for position sensing, the read/write head, and the drive hub. The entire diskette envelope is inserted through a slot on the front of the disk after which the diskette positions itself automatically inside the drive. Operation of the disk system is simple enough to permit its use by untrained personnel.

The diskette, rotating at 360 rpm, has a typical life of 2 million passes over the same section of the diskette. This represents about 4 days of continuous accessing of the same disk location or from 6 months to a year of average use. The diskette sells for less than $8 and is discarded after any wear is detected.

A dual drive system is desirable not only for the increased storage capacity but also to permit the rapid and easy duplication of diskettes by reading from one and writing on the other.

The IBM format divides the diskette into 77 tracks with each track containing 26 sectors with each sector containing 128 bytes.

Each sector is identified by an address recorded on the diskette by the manufacturer, a method of sector addressing referred to as "soft-sectoring."

The data transfer rate from the disk to the terminal is 250,000 bits per second while the data transfer rate from the main computer to the PLATO terminal is 1260 bits per second. One would expect to display text 198 times faster when using the local storage of the flexible disk. However, because of limitations in the plasma panel and the microprocessor, the over-all text writing speed is reduced to approximately 2000 characters

per second. This is one reason why increasing the data transfer rate into the terminal does not produce an increase of display speed beyond a fixed limit.

The diskette is organized as files of length up to 255 sectors (32640 bytes). The first track of the diskette is dedicated for the directory which contains the name, length, disk address, and the terminal loading address of every file on the diskette.

When a particular file is requested by the PLATO terminal, the terminal first reads the directory from track 0 of the diskette and scans it until the requested file name is found. Associated with the name are the address and length parameters that will be required to locate the actual file. Using the address information stored with the name, the drive is again commanded to access the diskette. The file is loaded into the terminal memory at the terminal address stored in the directory. After the last sector of the file has been read, the operation is complete.

The entire operation requires two disk accesses, one for the directory, and one for the file. The total file access time is a function of the actual physical file location on the diskette and the file length. Assuming an average file length of 10 sectors, the average file access time is one second with a worst case access time of 2 seconds.

Within the directory, the data identifying an individual file requires 16 bytes. The directory format is as follows:

File Name	Unused	Length	Disk Address	Ram Address
0 9	10	11	12 13	14 15

The directory uses the standard ROM character codes used in all PLATO terminals. The file name is limited to 10 characters with the unused characters filled with space codes. File data begins with bytes 0 through 9 containing the file name. The tenth byte is tentatively planned for use as a file type identifier. Byte 11 specifies the file length in sectors. Bytes 12 and 13 specify the file origin address. Byte 12 specifies the sector and byte 13 the track address. Bytes 14 and 15 specify terminal loading address. Byte 14 contains the lower bits and byte 15 the upper 8 bits of memory address. It is this 16 bit number that points to the terminal memory location into which the file will be loaded.

This file management system is transparent to the flexible disk system user. The disk control programs that reside in the terminal are written in a modular form so that the typical user need only know the basic calling sequence in order to load a file into the terminal. Programs already exist to create, delete, and copy files. The objective is to present a software package to the user so that he is not required to understand the hardware or write any control software.

One important goal in data communication systems is to have as high a data transfer rate as considered possible within the specifications of the system. Within the PLATO system, it is desirable to display pages of text, plot graphs, and draw pictures in as short a time as possible. It is for this reason that the flexible disk has been investigated.

One of the most common of examples where higher transfer rates would be evident is the loading of a character set into the student terminal. A full character set requires 17.1 seconds to load from the central computer

to the terminal. The same character set resides in 2 blocks of a TUTOR lesson space. If the character set was stored on the flexible disk system and connected to a processor-based terminal, the loading time from the local disk would be less than 2 seconds. In addition, 2 blocks in the TUTOR lesson would be free to be used for other purposes. One $8 diskette will store 123.5 character sets, or in equivalent TUTOR lesson space, it stores 11 single part (7 blocks per part) lessons.

The disk is used for local binary storage of programs that are executed locally in the processor-based terminal. Local circle generators, local animation and the game ping pong like those seen on video displays a few of the programs that reside on this prototype disk system.

There is also a resident BASIC compiler that allows the user to write programs in the BASIC language, and to compile and execute the program locally in the terminal using the compiler stored on the flexible diskette. With the aid of other software, such as resident assemblers, test editors, and the terminal system monitor, the PLATO terminal flexible disk system has complete stand-alone capability. The terminal contains enough processing power and memory to maintain itself without the aid of the central PLATO computer. The use of the terminal in this manner is more intended for the serious programmers or for some specialized research project requiring the use of a large data base for data collection. The average classroom environment may not find much need for off-line processing.

Within a research environment, the disk system is well suited to storing data that is taken in large volumes from a continuously running experiment. In this way, the user can analyze his data locally within the terminal in realtime, or he may wish to store the data on disk for later

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analysis. Other options exist, such as mailing the diskette to other interested parties.

For people who have the need to store confidential information, the local disk is a viable method of assuring data security. Since the information on the diskette may only be viewed by the person possessing the diskette, high data security environments are possible to create. The user has complete control of the information on the diskette.

In special cases, it may be possible to reduce the use of disk space at the central computer by providing local storage space in the flexible disk system. It may also be possible to reduce the ECS (extended core storage) usage of a terminal having a flexible disk. This is a rather broad topic that is just beginning to be investigated, but a few basic ideas should be presented.

It is most probable that the overall cost of a complete PLATO system, central computer and communication equipment could be reduced by proper distribution of intelligence and storage capacity. The question must be resolved as to how much processing power and data storage should be located at the terminal. The current processor-based terminal and the flexible disk system are the first step towards experimentation with distributive intelligence.

In applications, such as local text generation, flexible disk storage is used in place of the ECS that normally contains the text at lesson execution time. There is also the saving of central computer disk space which normally holds the lesson material. Thus, another problem that arises is what processing tasks should be moved to the terminal and executed locally in order to save central computer resources. Some text

generation, graphic display, and animation are a few examples which demonstrate such savings. There is a cost trade-off between the savings in central computer hardware and the remote terminal installation. The solution to the problem is hopefully found by being able to minimize the overall system hardware costs while simultaneously increasing the terminal performance.

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5. AUDIO VISUAL FACILITY

5.1 RANDOM-ACCESS AUDIO

The delivery of the 108th random-access audio device has marked the completion of CERL's initial order from EIS, Inc. Several of these devices are used in CERL's audio disc reproduction room for making audio disc copies under PLATO IV control.

An audio-sharing system in which twelve PLATO IV terminals share three audio devices has been developed, built and successfully tested as part of a Master's thesis by Dennis Stolarski. This system, which uses the Intel 4040 micro-processor for control, will be able to reduce the costs for random-access audio use in those cases where student request rates do not cause annoyingly large queries.

The microprocessor-based audio sharing system is designed to accept serial data from any of twelve PLATO IV terminals at the rate of 1260 bits/sec. and to re-transmit this data to any of three random-access audio devices. Either the older CERL or the newer Education and Information Systems, Inc. audio devices can be employed.

The system block diagram is shown in Fig. 5.1. To participate in audio-sharing, an external output jack at the PLATO IV terminal is connected to the microprocessor controller. This line transmits the requested audio message address coordinates (track number, starting sector, message length and mode) to the microprocessor controller. When an audio message is requested, the controller interrogates the appropriate terminal. The audio message address is read and stored in the controller's FIFO memory, which can store up to seven requests. The controller then determines the

availability of one of the three audio units via the Audio Active lines. If all three are in use, a busy signal is sent to the student terminal via the External Input jack indicating that his request is in a querie until an audio unit becomes available and the request can be honored.

If the queries are small, an audio will most likely be available and the request can be processed immediately. The audio message address is read from the FIFO memory and the appropriate audio unit is serially addressed. The controller transmits switching control signals to the audio signal switching matrix, thereby connecting the selected audio unit output signal to the requesting terminal's loudspeaker. Allowing for 0.3 to 0.7 sec. for the audio unit's mechanical accessors, the requesting student hears the selected audio message through either a personal headset or loudspeaker.

Adding a second signal switching matrix connected to microphones would allow students to make recordings as well as hear them.

5.2 MICROFICHE PRODUCTION

An improved step-and-repeat microfiche production camera has been in full production during the last period. Its reliability has been so much improved that the two older, less reliable cameras have been pulled out of service. This camera allows image format adjustment which, at present, is restricted to square or rectangular. However, a particular microfiche can have only one type format for all of its images. This camera is more completely described in a forthcoming report on microfiche production.

A two-step microfiche system which may be able to produce microfiche from masters rather than from 35 mm slides is under development. This

system would decrease microfiche production time and costs, especially for those cases in which large numbers of copies are required. A simplified diagram of the optical system is shown in Fig. 5.2.

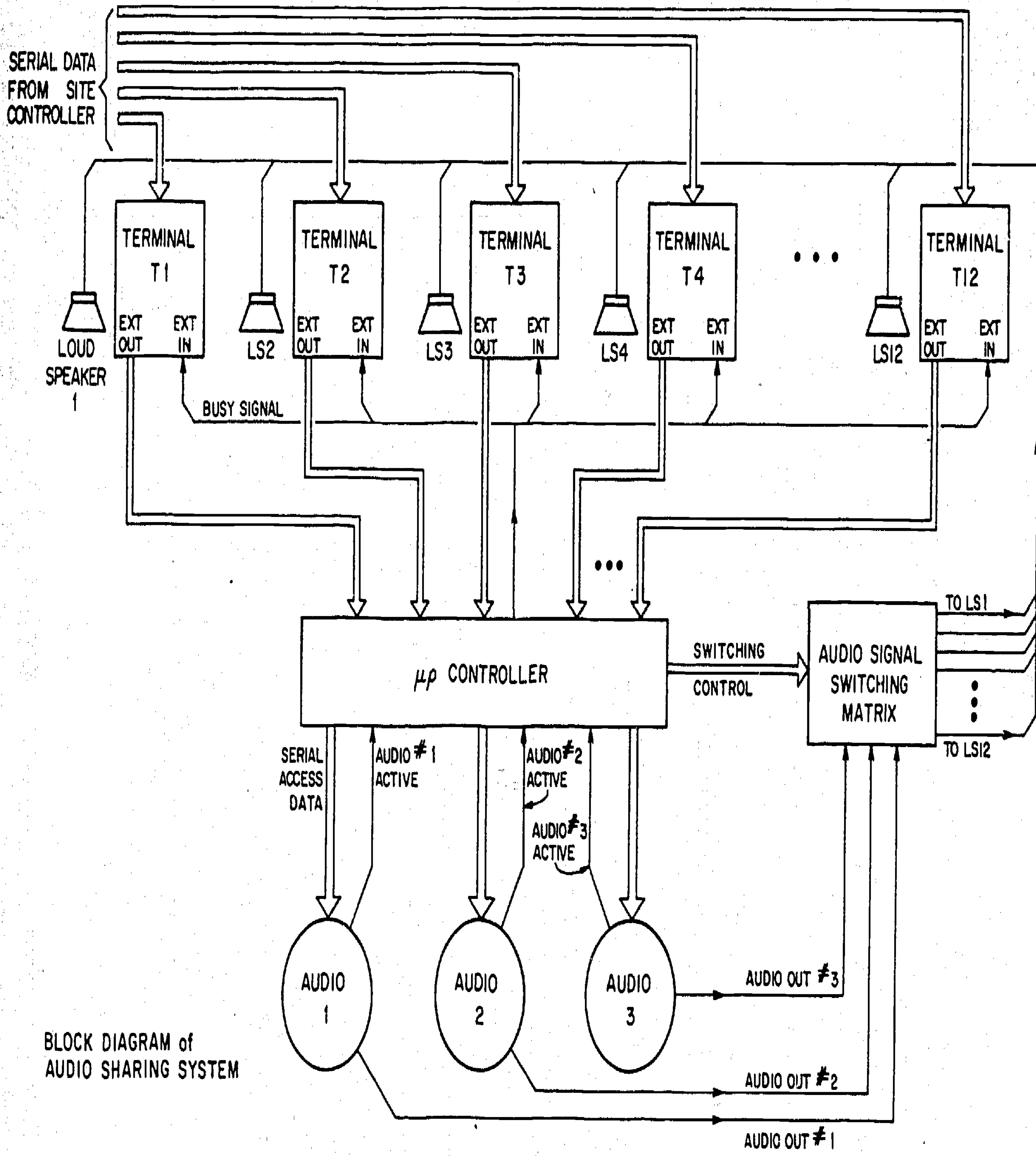
The objects to be made into microfiche will be 35 mm slides. An object will be focused onto the microfiche film via a 105 mm lens, an exposure shutter and mirror No. 1, which can be rotated about a horizontal axis (see Fig. 5.2), much as that of many single lens reflex cameras. Prior to making an exposure, however, the format and focus may be inspected by observing image No. 2. This is formed by rotating mirror No. 1 (dotted position) so that the optical beam strikes mirror No. 2 and traverses the 50 mm lens, which produces a magnification of approximately 9 onto a screen. Suitable protective shutters are arranged so that the microfiche film is not exposed during format inspection. The format may be composed by translating the 35 mm slide object along the X, Y, or Z axis and rotating it about the Z axis, and by translating the 105 mm lens along the Z axis.

When the desired format, as observed at image No. 2, is obtained, mirror No. 1 is rotated to deflect the optical beam downward, the protective shutters are suitably switched and the exposure shutter is activated, thereby forming the desired format as image No. 1 on the microfiche film. The reason mirror No. 2 was included is to allow access for loading the microfiche film in the camera section.

In order to check mechanical and optical alignment of the slide selector, a magnified image of a calibrated, standard alignment microfiche may be inspected. This image (No. 3) is formed by a 75 mm lens focusing image No. 1 (which now becomes the object) onto a screen. This feature has

proven indispensable in the step-and-repeat camera described above.

D. Skaperdas
D. Stolarski
P. Stolarski
G. Traynor
L. Streff

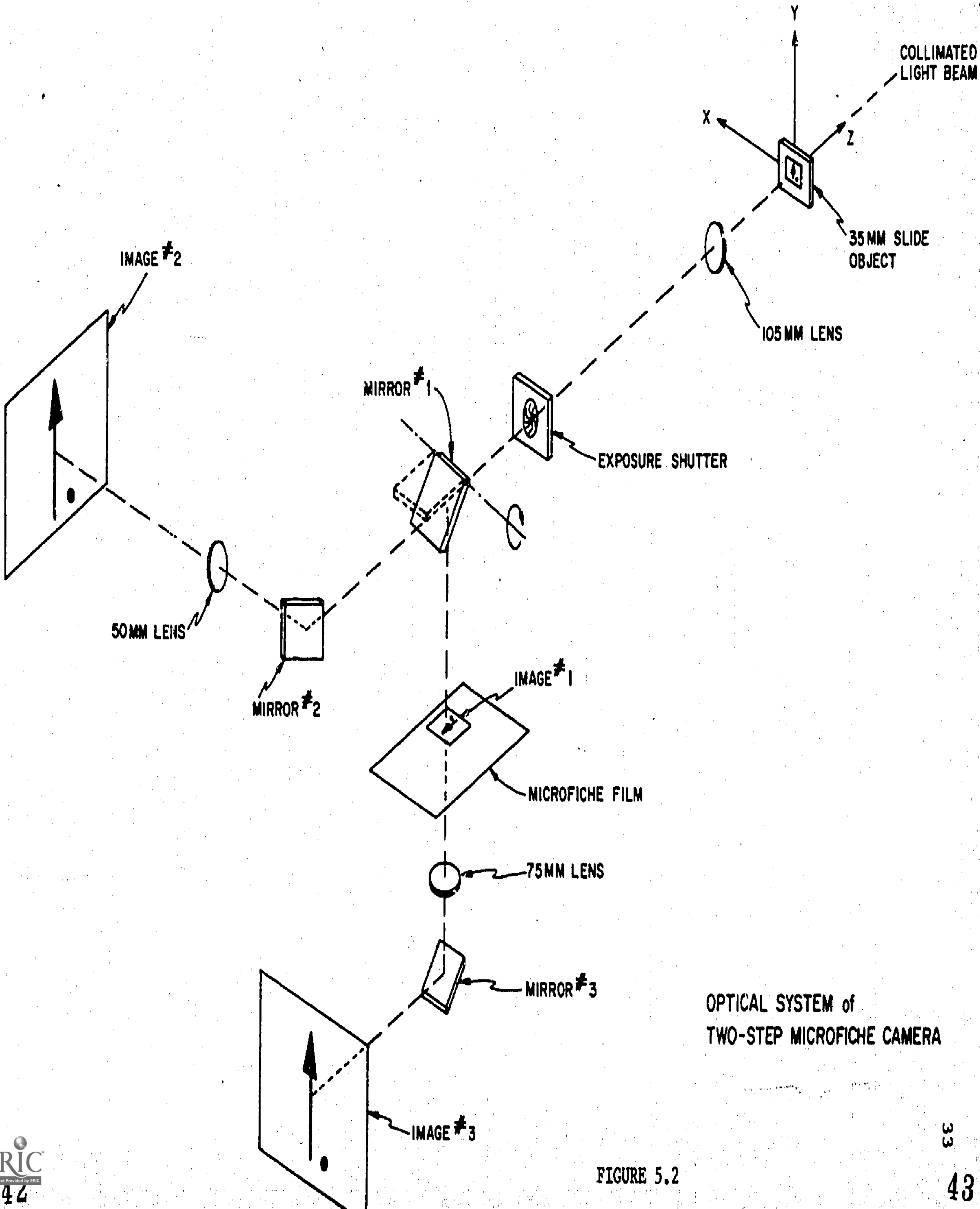


41

40

32

FIGURE 5.1



OPTICAL SYSTEM of
TWO-STEP MICROFICHE CAMERA

FIGURE 5.2

6. ADVANCED TERMINAL TECHNOLOGY RESEARCH

The research activities described in this section are a component of the larger ARPA program titled, "Demonstration and Evaluation of the PLATO IV Computer-based Education System." The principal objective of this component of the program is to devise human interface, terminal architecture, and system structure specifications for improving the cost performance characteristics of computer-based education systems. During the program, work has been carried out in five major project areas; these are:

1. Intelligent Terminal Architecture
2. Display Data Integration
3. Manual Data Manipulation (Touch Input)
4. Terminal-based Mass Memory
5. Network Concepts
6. Audio Input and Output

During the last work period, efforts have been concentrated in areas 1, 2, 3, 4 and 5. The results of the work have been used to begin identifying the specifications for a uniform communication's sub-system. This system would contain processors that all share the same basic instruction set.

6.1 INTELLIGENT TERMINAL ARCHITECTURE

6.1.1 THE OPERATING SYSTEM

During this period, the study of terminal architecture focused on memory requirements for various local functions. An informal process of program development was conducted where these functions were coded up in PDP-11 machine language. Examples include a simple flight simulator, local sizing of characters, support for high resolution touch panels, local PLATO linesets and a number of dynamic games using various analogue input devices.

Experience from these efforts indicated that 16 K of 16 bit per word memory was quite adequate whether or not local mass memory such as floppy disk was employed. The development of sophisticated and specialized local functions motivated a closer examination of what support services were needed. The notion of a TUTOR-11 high level language was examined. This centrally-resident compiler-like program would accept TUTOR commands and produce either machine code or higher order commands to be executed locally. Close examination of this concept raised certain basic questions about the purpose of a PLATO-like network of terminals. Since these questions emerged in the image studies as well and also in the area of operating system selection, we deal with them in Section 6.5.

Several test programs were developed. Internal reorganization and re-integration of the various standard terminal resident routines was completed. The routines have been modularized and a key-word oriented on line documentation system has been initiated. The major consequence of this effort has been a complete integration of terminal support functions with the RT-11 operating system. The terminal now is also the operating system console device.

6.1.2 IMAGE STUDIES

Analysis of computer generated and stored imagery was completed. Its role in instruction and communication was examined. There was little success in demonstrating its value in a quantitative way. A number of strategies for doing so were devised. The most simple being an examination of frequency of use for the various graphics commands in PLATO. However,

it was felt that this small number shed little light on the information content of a graph or diagram. Other strategies involving experimentation were beyond the scope of the resources available. They were incorporated in a proposal submitted to ARPA for research in this area.

An informal study of the use of graphics in the working environment of the laboratory indicated that the volume and mode of use would require significant additional memory and local processing power. The communication network architecture discussed in Section 6.5 would be representative of what would be minimally required to support such use.

6.2 DISPLAY RESEARCH

6.2.1 MEASUREMENT OF WALL CHARGE AND CAPACITANCE VARIATION FOR A SINGLE CELL IN THE AC PLASMA DISPLAY PANEL

Characterization of the AC plasma display cell has always been difficult. This is principally due to the small number of measurements that are readily applicable to this device. For instance, direct measurement of the voltage across the gas at various times is not possible because such a measurement would strongly perturb the discharge activity which is coupled to the outside world by a very high impedance of 10^{-2} pf. Thus, one is forced to guess at this voltage by measurement of other quantities such as dicharge light or firing voltages.

This report describes techniques for measuring two important quantities that should significantly advance the ability to characterize this display element. Both measurements are performable on a single cell in standard commercially available large panels. By carefully measurement of the charge coming out of a panel electrode due to a single cell discharge,

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a signal that is proportional to the wall voltage is readily obtained. Also, the time varying capacitance of a single cell can be measured to yield information about the charge trapped in the gas volume. The signal to noise ratios of both measurements are sufficient to allow real time determination without averaging.

To measure the wall charge, great care must be taken to separate the desired charge component due to the discharge from the displacement charge component induced by the changing sustain voltage. These measurements have not been accomplished previously because the displacement charge is many orders of magnitude larger than the discharge charge. However, the displacement charge can be balanced out by a carefully designed bridge circuit and a very high common mode rejection ratio differential amplifier.

In commercially available panels, the capacitance of a single cell varies in time by 10^{-3} pf or less. Since a typical panel electrode has a capacitance on the order of 10 pf, measurement of this variation looks difficult. However, since the 10 pf does not vary in time, it can be tuned out by an appropriate resonant circuit. If a small 10-50 MHz rf signal is placed on one line of the cell, the measurement of the rf voltage coupled to the other line gives an indication of the capacitance of the cell.

Measurement of the time varying capacitance of a plasma cell yields important information about the charge trapped in the volume by a long-lived plasma. Measurements in Digivue panels with MgO overcoat show that the capacitance is still changing as long as 10 μsec. after the discharge. Thus, this plasma plays an important role in the dynamics of the discharge.

The ability to measure the wall charge of a single cell in real time suggests a number of important quantitative measurements. By measuring

the magnitude of the wall charge transfer per discharge, or ΔV_W, as a function of the applied sustain voltage, V_s, one obtains the hysteresis curve of that cell, as shown in Figure 6.1. By means of a simple mathematical transformation, the wall charge transfer curve can be obtained as seen in Figure 6.2. This is the characteristic curve of this device. Since this technique allows this curve to be taken without great difficulty, it presents the possibility of designing a curve tracer for plasma panels.

A second use of direct wall charge measurement is the observation of dynamic behavior of a single cell. Figure 6.3 shows the wall charge for a growing series of discharges in which the sustain voltage was increased above the firing voltage. This single shot trace shows the cell in transit between the off state and the on state. Wall charge measurement can also be used when adjusting address pulses so that the wall charge is changed to the desired equilibrium value in one address period. Wall charge measurement in conjunction with capacitance measurement gives a much more complete picture of dynamic processes than the traditional light measurement alone.

6.3 MANUAL DATA MANIPULATION (TOUCH INPUT)

Direct touch-input coupled with graphic display capability is proving to be a powerful technique for coupling untrained users to computers. The objective of this research activity has been to determine the touch-input characteristics which will be desired in future PLATO terminals.

The prototype high (256 x 256) touch-input system and the evaluation experiments referred to in previous ARPA progress reports have been completed. A detailed description of this work and the results of the evaluation are presented in a Master's thesis titled, "A High Resolution Graphic Input System for Interactive Graphic Display Terminals" by P. Van Arsdall. A copy

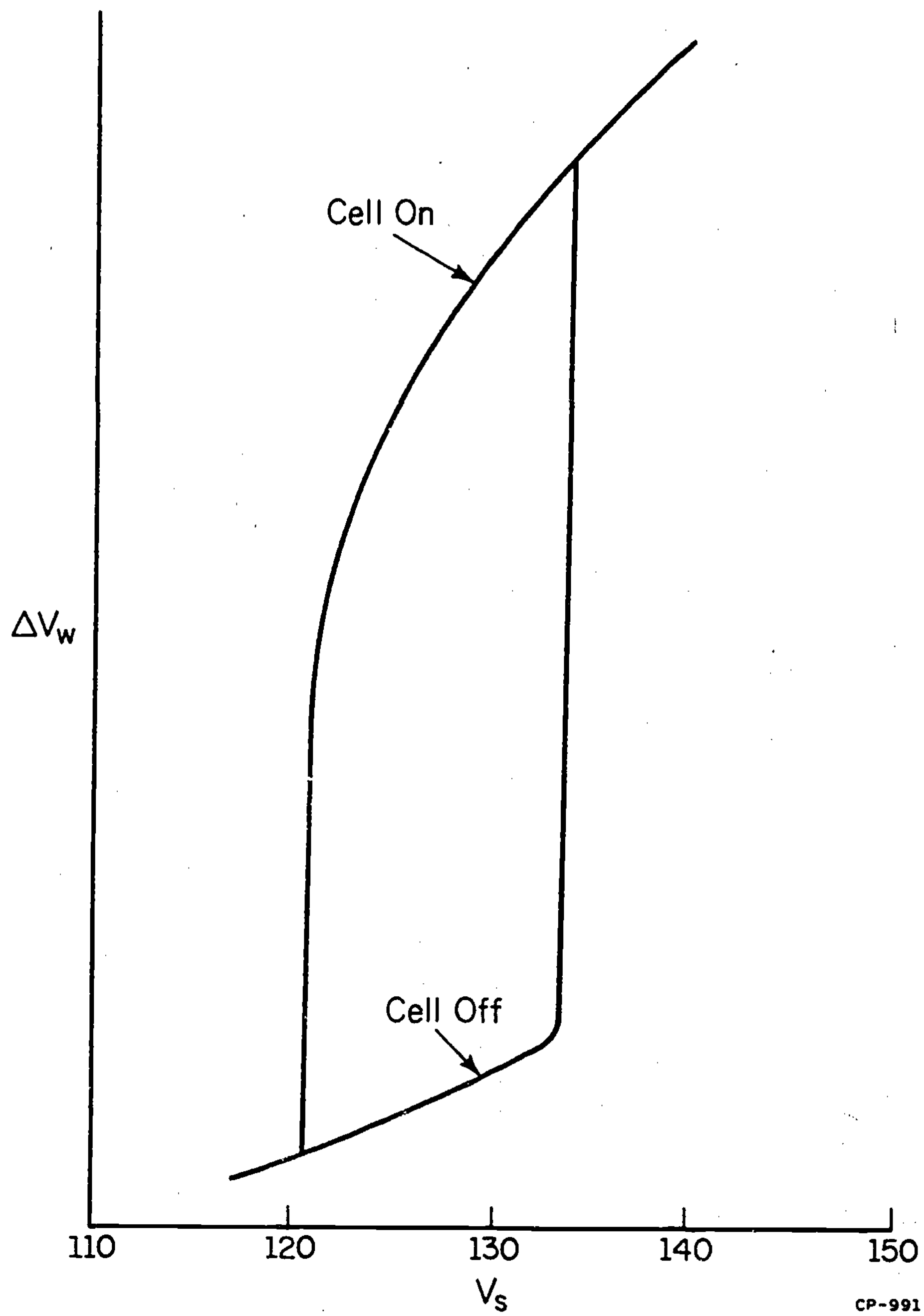

Figure 6.1 Hysterisis Curve of Single Cell

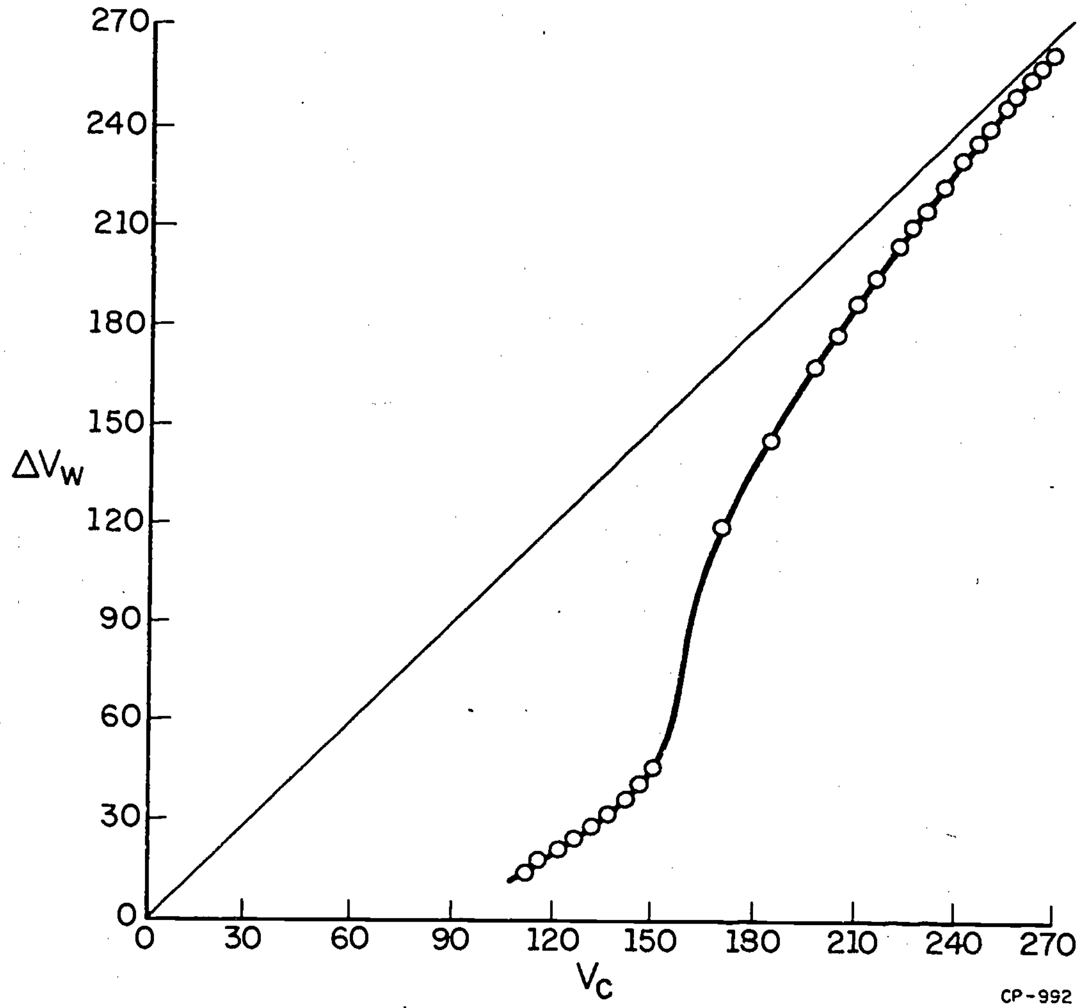

Figure 6.2 Wall Charge Transfer Curve

Figure 6.3 Wall Voltage of a Single Cell Going from the Off to the On State

of this thesis is attached as Appendix B.

6.4 TERMINAL-BASED MASS MEMORY

Work has been progressing on a new type of audio and data storage unit that uses an optical recording media instead of magnetic. The optical media will transmit or reflect a focused laser beam in a manner similar to that used in the recently developed video disk technology. The advantages of the optical technology are: ease of mass disk reproduction, very high information storage density, potential for fast random access, and low cost.

Once a master disk has been made then disks can be stamped out with a technique very similar to that used for phonograph records. This allows for very fast, widespread distribution of disks which will insure that the current disk will always be available to the user.

Optical technology allows bits to be spaced by about one wavelength of light on the storage media. The density currently used by the video disk technology allows 10^{10} bits to be placed on a 12-inch diameter plastic disk. This is more than enough room to store every PLATO lesson ever written. A memory of this size at every terminal would very significantly increase performance of the system with reduced demands on the central computer and the data communications system.

It should be possible to access any information on the disk with a worst case access time of about 35 milliseconds. This is due to the rapid rotation time of the disk of about 30 revolutions per second and the ability to rapidly deflect a laser beam to the desired disk track.

The research program at CERL has been devoted to investigating simple and economical ways to design a fast random access optical disk with

modest storage size and a compatibility for both audio and digital storage. The presently configured video disk systems use an optical system that requires mechanical translation of a massive objective lens. This necessarily limits the worst case access time to around one second or longer. The approach taken here is to re-design the optical system so that only the mechanical rotation of a mirror is needed to select any track. The inertia in this system is much less than that found in the translational system and thus, much faster access times are possible. In our lab, we have been able to rotate the required mirror through the worst case deflection in a critically damped manner with a rise time of .003 seconds. It is reasonable to expect that the additional time required for settling on a track will yield a worst case random access time of .01 seconds for radial selection.

One disadvantage of this system is that it reduces the amount of information that can be stored on the disk by about a factor of 10. This will still allow a very large 10^9 bits to be stored on a 12-inch diameter piece of plastic. Thus, it seemed quite reasonable to trade storage space for speed.

Since the optical disk can rotate at a very high speed of typically 30 revolutions per second, any sector will be available in less than 1/30 of a second. Thus, there is no need to make special rotations of the disk to access a sector as is done in the present PLATO audio units. However, the efficient storage of audio information on a rapidly rotating optical disk introduces an additional problem. The bandwidth of the signal received from the disk greatly exceeds that required for audio. Thus, some sort of multiplexing system is needed to put the maximum allowable number of audio signals in the given bandwidth. We chose a frequency division multiplexing system that places different audio messages at different subcarrier frequencies

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throughout the available bandwidth spectrum. The desired audio message on a track is selected by electronically tuning a system similar to a radio receiver to the correct subcarrier frequency. For instance, if the disk is rotating at 30 rps and 32 subcarrier signals can be put on one track, then one subcarrier signal has 1/30 second of audio information, but the entire track holds 32/30 seconds of audio.

Progress to date has been good. Data has been written on an optical disk by using a cavity dumped argon ion laser to burn holes in a bismuth coated disk of mylar. This information could then be read back with a focused He Ne laser beam. A simple servo system is operating that allows the beam to follow the track in spite of motion such as vibrations or disk excentricity. The necessary circuitry and memory for generating the audio modulated subcarrier frequencies has been completed and is being used to determine optimum frequency allocations. A microprocessor controlled servo track selection system is being designed with the aid of a hybrid computer. It is hoped that the microprocessor in the new generation of PLATO terminals can be used for this track selection.

6.5 NETWORK CONCEPTS

Our experiences with processor based terminals and preliminary efforts at networking have shaped our concepts of network architecture. These concepts have been further defined by the study of computed generated imagery. Two basic configurations have emerged. Each corresponds to a different set of goals. One is computer-assisted instruction (CAI) in the PLATO form. The other is computer-assisted communication (CAC). The following summarizes the contrasts between the two:

Table Comparison of Network Architectures

Aspect	CAI	CAC
Terminal Environment	Classroom	Office, work area, home
Processor Categories	Two (1) local (100's/remote) (2) remote	Two (1) local (10's/remote) (2) remote
Local Functions	(1) generate imagery (2) encode & transmit user key presses (3) activate peripheral display system like slide projector and audio	(1) generate imagery (2) encode & transmit user key presses (3) dynamically interact with local data stora media and hand copy devices (4) interface to user too such as phone and measuring equipment
Remote Functions	(1) record and interpret student responses (2) select imagery based on (1) and transmit it (3) allow special individuals called teachers to create programs for doing (1) and (2)	(1) store and forward messages with graphica imagery (2) allow all users to create and save messages containing graphical imagery
Processors		
local	Micro (8080)	Mini (DEC LSI-11/03)
remote	Maximum possible (CYBER)	Mini (DEC PDP-11/34)
Memory (fast)		
local	8-16 K of 8 bit words	8-24 K of 16 bit words
remote	2000 K of 60 bit words	24-48 K of 16 bit words
Memory (mass)		
local	None	dual floppy or single cartridge system
remote	60 large disks	multiple cartridge or single large disk
Communications Channels (average rates)		
local → remote	50 bits/sec.	1200-9600 bits/sec.
remote → local	1200 bits/sec.	1200-9600 bits/sec.
remote → remote	special 50 K bits/sec.	1200-9600 bits/sec.

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This CAC architecture reflects the goal of supporting communication between users of equal sophistication. It, thus, supports extensive communications by means of the existing techniques (phone) and newly emerging ones such as packet switching. All communications efforts on the CAI architecture are restricted by the typing speed for local to remote. They also must be channeled by the bottle neck of the swapping memory system.

The added processing power required to support fluent message creation in a CAC system is accomplished by the widespread dissemination of the remote processor systems. This strategy conforms with general trend of declining processor and memory costs.

The CAC architecture could be interfaced with the existing PLATO CAI architecture and assume some of the total instructional load. The amount and value of this share is dependent on definitions of instruction. The development of a TUTOR-11 is dependent upon the decision to allow local processors autonomy from local systems and the valuation placed on a CAC sub-structure.

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D. Sleator
L. Weber
J. Squire

7. 9600 BIT PER SECOND MODEM DEVELOPMENT

7.1 INTRODUCTION

The development of the 9600 bps modem (which was described in CERL Semi-Annual Report, 01/01/75-06/30/75) has continued and is now in the final stages. This modem takes digital data from the site controller interface unit at the computer, encodes it as an analog signal composed of amplitude and phase, transmits it across a telephone line pair, receives the analog signal; decodes it as five (5) bit packages, and then delivers this data respectively to each of eight (8) PLATO terminals. Once completed this modem can cut users telephone line costs by up to half. It will enable a particular site to use one telephone line to drive eight (8) PLATO terminals, instead of the four (4) terminals possible with the current 4800 bps modem.

7.2 TESTING AND DEVELOPMENT

The transmitter (see Fig. 7.1) normally would be fed data by a site controller, but for testing purposes the transmitter was rigged so that it would deliver a set of "no-op" signals to the receiver. This allowed the testing of the transmitter-receiver pair. The transmitter had previously been tested.

It was found that the receiver signal processing clock and signal processing timing chain had to be re-designed for the proper sequence control (see Fig. 7.2).

The modem uses 34 multiplexed channels and it was necessary to devise a test circuit in order to select an individual channel for investigation. It was also necessary to create a test circuit for the study of signals from a digital sine-cosine generator in the modem. The test results showed that redesign was needed in the intergrand sum and phase store circuits found in the digital integrator and digital oscillator sections of the receiver.

The task of the decision unit is to take the outputs of the 34 sin-cosine integrations and determine data and timing information. This task must be completed in the .9804 ms interval between integration intervals. Time is allotted for 40 pairs of sin-cosine decoding of 24.51 μs per decoding pair. The sequencing of the decision unit during the decision interval is controlled by two PROMs with .766 μs interval in 32 intervals per decoding operation. The decision unit employs four (4) PROMs (Programmable Read Only Memory). Two PROMs are used in the decision unit memory. These are both bipolar, one organized as 256 four bit words and the other as 512 eight bit words. Their function includes generating the signals necessary for clearing the bus line prior to the start of the decision unit cycle and for controlling the timing of the decision unit. They also enable the other two PROMs at the end of the decision unit cycle. It was necessary to reprogram the 512 eight bit PROM once and it has been found necessary to reprogram it again, but this has not yet been done.

The other two PROMs, both MOS eraseable 256 eight bit words, are responsible for delivering the original data in five bit packages to the terminal drivers. They also control correction circuits for amplitude and phase distortion picked up from the phone line and for the amplitude and

and phase recovery of the data. These PROMs have now been programmed, but they have not yet been proven correct.

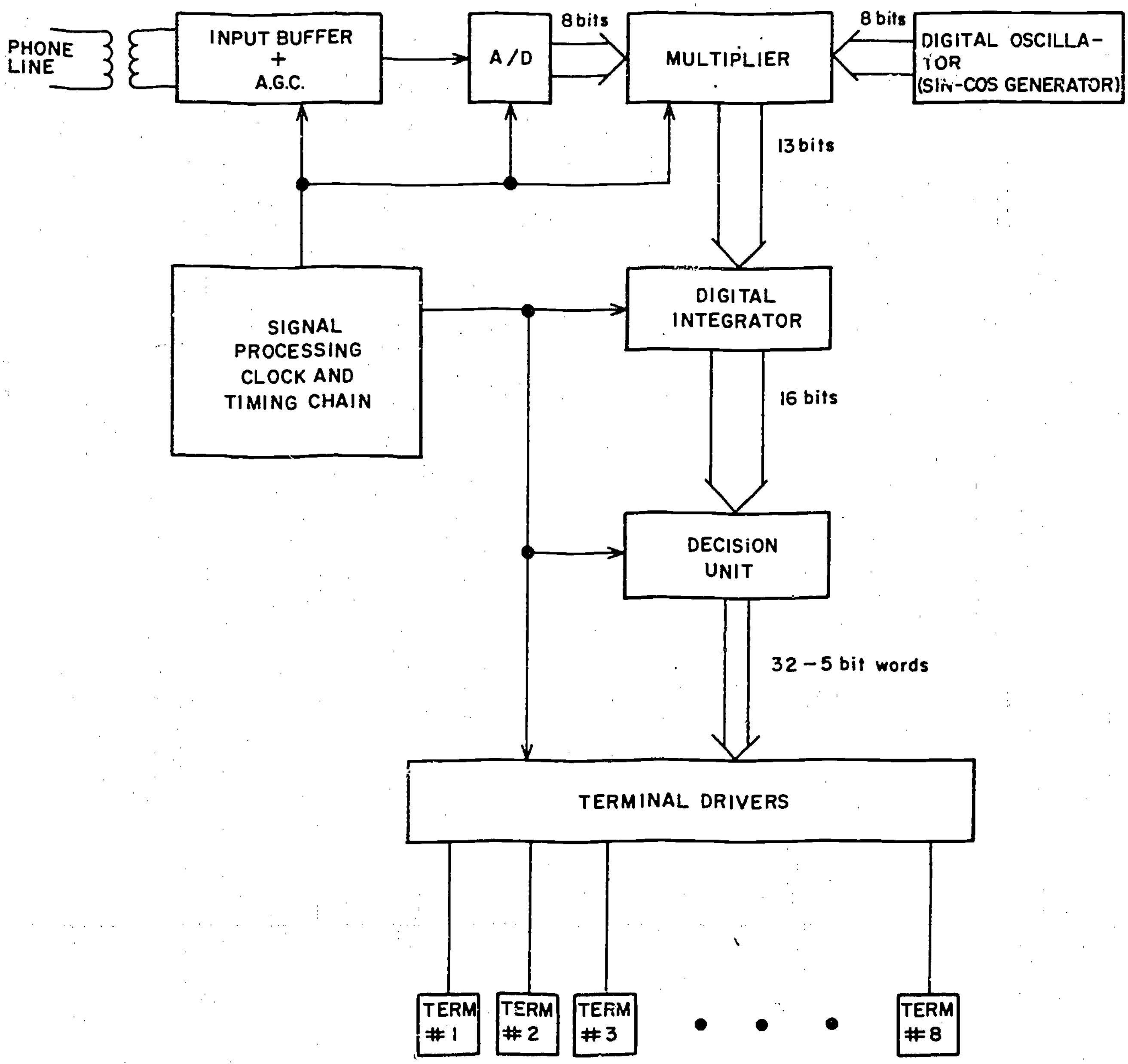
The next objective is to show that the decision unit is properly operating. Then there is some minor redesigning in the frequency correction circuit to be done. After this, the receiver should be fully operational.

The final testing step is to connect the transmitter-receiver pair to the site controller and a PLATO terminal, transmit data, and check for errors.

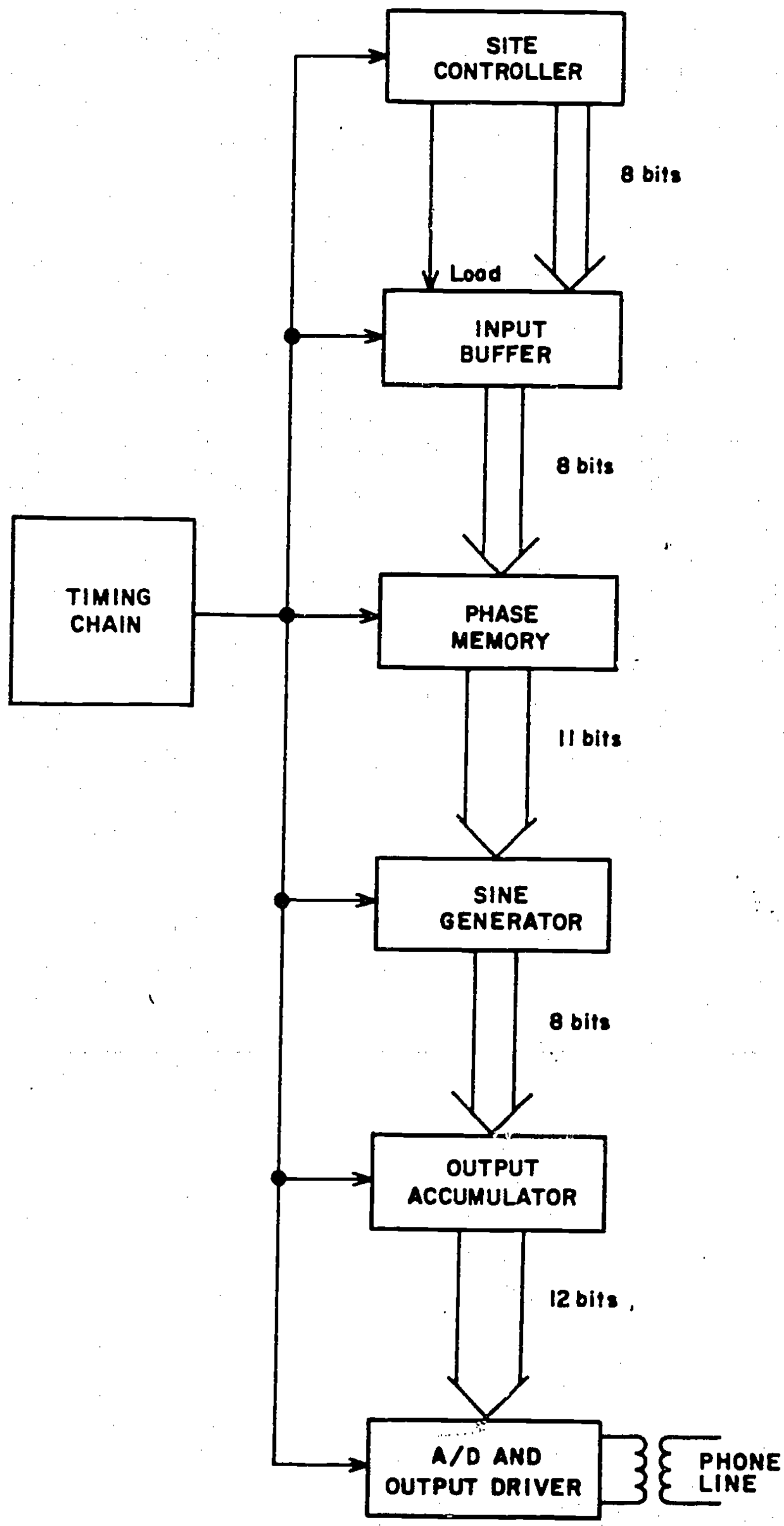
In the meantime, a printed circuit board for the transmitter has already been laid out and is awaiting final approval of the transmitter before being printed. The receiver will be on three printed circuit boards. The first of these three boards is presently being laid out and the other two will follow as soon as certain circuits (decision unit and frequency correction) on these two are finalized.

The 9600 bps modem is expected to be fully operational and in production in the last quarter of 1976.

J. Teeter
W. Keasler



7.1 9600 Bit Per Second Modem Receiver



7.2 9600 Bit Per Second Modem Transmitter

8. OPERATIONS

The PLATO IV Operations group has responsibilities in the following areas: installation, maintenance, microwave communications, data line communications, and supervision and technical support for demonstrations.

8.1 INSTALLATIONS

During this reporting period several sites were terminated and one new site was established. The Air Force Academy terminated on 6/14/76, Redstone Arsenal on 3/01/76, Maxwell Air Force Base on 3/14/76, and Orlando Training Center on 6/30/76. In addition, two terminals were returned to CERL from USC in Los Angeles for use at CERL. A new site was installed at the Department of Defense in Washington D.C. on 5/13/76 using a terminal from HumRRO. Installation of the idle terminal is expected to occur in the next quarter.

8.2 MAINTENANCE

Maintenance operations consist of two separate but interconnecting areas: the physical repairing of non-working terminals and the repairing of the parts that have been replaced. The diagnosis of a particular problem is either done by personnel at the site or in consultation with engineers at CERL. This exchange of information, either by terminal or telephone, has proven to be a valuable means of reducing the down time of equipment as well as improving the ability of on-site personnel to do their own troubleshooting. This has meant that the physical repairing of terminals can be accomplished by sending replacement parts to the site,

where physical replacement is then made. The changes made in lesson "Repair," which were discussed in an earlier report, have proven sufficient and no additional improvements are planned.

Table A shows an analysis of the repair program for the last reporting period. It also shows the number of repair reports and trips made in regard to the ARPA sites. When examining the table, one should be aware that a typical amount of time for shipping a part and installing same is nine days and a terminal is considered down (according to PLATO Operations people) from the time it is reported in repair until it is verified as operational by someone at the site. The down times, therefore, include the time to ship and install the defective part.

Table A also indicates higher down times for those sites where no personnel are available for troubleshooting and repair. The second greatest time builder is time required when it becomes necessary to send a man to a site for repairs.

Finally, telephone line problems on weekends and lack of available part replacements add to the down time for terminals.

Telephone line problems decreased from 39 in the last reporting period to 14 in this period. Sheppard Air Force Base again experienced more problems than any other site, having reported trouble a total of 16 times, but this was down from 17 during the previous period. Orlando had the greatest decrease, going from 9 trouble reports to 0.

The number of terminal down days decreased 304.41 or 4.2% resulting in a percentage down time decrease from 4.44% to 2.48%. The primary reasons for the decrease seem to be the decrease in the number of phone line problems as well as an improvement in the turnaround time for

parts replacement.

8.3 MICROWAVE SYSTEM

Except for some minor drift problems due to atmospheric conditions, the microwave system has had no problems during this period.

8.4 ERROR MESSAGES

The playback system described in an earlier report has functioned well except for some problems observed by a few users at single-terminal sites. These problems were traced to a site controller problem which has been corrected.

8.5 TECHNICAL ASSISTANCE

Technical assistance for the planning and setup of demonstrations is provided by the Operations section. This includes determining and pricing of the proper communications facilities and on occasion the setup and monitoring of equipment at the demonstration site. During the last reporting period, the Operations group supplied personnel for one demo and assistance in planning for two others. Operations personnel also worked closely with administrative personnel at the Washington ARPA Headquarters to inventory and certify the existence of all communications used by ARPA for the PLATO system.

8.6 REMOTE SITES FIELD SERVICE

The PLATO telephone line analyzer described in an earlier report had design changes made and a second model was subsequently built. It is

presently undergoing additional testing.

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TABLE A

Location	Number of Terminals	Number of Reports	Down Time Term Days	Number of Trips Required	Phone Line Problems
Air Force Academy[1]	2	2	12.93	0	0
Army Research Institute[2]	2	3	9.99	1	0
ARPA Headquarters[3]	1	1	1.00	1	0
Chanute Air Force Base[4]	30	57	96.07	23	1
Department of Defense[5]	1	1	00.00	1	0
Educational Testing Service[6]	2	1	1.02	0	1
Electrical Engineering[4]	2	14	5.02	13	0
Ft. Belvoir	4	0	00.00	0	0
Ft. Eustis	4	0	3.00	0	3
Ft. Monmouth	1	3	14.49	0	1
HumRRO[5]	2	3	21.06	1	1
Lowry AFB	4	1	1.00	0	1
Maxwell AFB[7]	4	0	00.00	0	0
Orlando	4	2	1.00	0	0
Redstone Arsenal[8]	4	0	00.00	0	0
San Diego	12	14	105.26	0	4
Sheppard AFB	20	13	141.11	0	16
UC-Santa Barbara[9]	1	0	00.00	0	0
USC-Los Angeles	2	3	4.87	0	1
	102[10]	118	417.82	40	29

Available Terminal Days = 16,785

Percentage Down Time = 2.48%

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Explanation of Superscripts in Table A

[1]Service terminated 6/14/76.

[2]Only one terminal is in use at a time.

[3]Shares a phone line with ARI.

[4]Is maintained as a local site by CERL and is shown for comparison purposes only.

[5]Installed 5/13/76 with a terminal from HumRRO.

[6]ARPA support ended 3/31/76.

[7]ARPA support began 4/15/76.

[8]Service terminated 3/01/76.

[9]UCSB is not hooked to the PLATO system.

[10]Two additional terminals are located within CERL.