CONTROL DATA

PLATO

SYSTEM OVERVIEW

CONTROL DATA CORPORATION

CONTROL DATA PLATO
System Overview

A Multimedia Computer-based Educational Delivery System

ROGER F. PAULSON

Control Data Corporation
4201 North Lexington Avenue
St. Paul, Minnesota 55112

Address comments concerning this publication to:

Control Data Corporation
Publications & Graphics Division
4201 North Lexington Avenue
St. Paul, Minnesota 55112

PREFACE

The CDC PLATO ® System† is a multimedia computer-based educational delivery system. It is a production version of the PLATO research system developed at the Computer-based Education Research Laboratory, University of Illinois (CERL), Urbana, Illinois. Also, the CDC PLATO author language is the production version of the TUTOR language originated and developed at CERL, University of Illinois.

As the title indicates, this publication provides an overview of the CDC PLATO System and is designed for general readership. It serves as a basic introduction to the concepts, the capabilities, and the features of the PLATO system. More detailed and extensive information can be found in CDC PLATO reference manuals and other associated publications. Further, the PLATO medium is far richer and obviously, more dynamic than a printed publication. For that reason, it is strongly recommended that the reader see a PLATO demonstration – either before or shortly after reading this publication.

RELATED CDC PLATO PUBLICATIONS

Control Data Publication	Publication No.
CDC PLATO Terminal User's Guide (Describes the use of the PLATO terminal. Written for system personnel, this publication includes the basic characteristics of the PLATO terminal and includes maintenance, troubleshooting, and hardware installation information.)	97404800
CDC PLATO Author Language Reference Manual (Describes the PLATO author language used by the CDC PLATO Subsystem. As a detailed reference source, this publication is not designed as a self-teaching or tutorial guide for the new lesson author. However, it is written for the relatively experienced lesson author familiar with the CDC PLATO author language.)	97405100
CDC PLATO Subsystem Operator's Guide (Provides system personnel with the information needed to operate the CDC PLATO Subsystem.)	97405200
CDC PLATO Subsystem User's Guide (Details PLATO concepts and provides information for using the CDC PLATO Subsystem.)	97405900

ACKNOWLEDGEMENTS

The author wishes to acknowledge and express appreciation to the CERL staff members at the University of Illinois for their expert guidance and assistance throughout the preparation of this publication – from the draft outline to the review of the final publication. Additionally, written permission has been granted to Control Data Corporation to use – in part – information from the following published sources:

SOURCES

CERL PUBLICATION SOURCES

"Introduction to TUTOR," James R. Ghesquiere, Celia R. Davis, and Charlene A. Thompson

"The TUTOR Language," Bruce Arne Sherwood

"The PLATO IV Architecture," Jack Stifle

"The PLATO IV Communications System," Bruce Sherwood and Jack Stifle

"PLATO Highlights," Elisabeth R. Lyman

PLATO LESSON SOURCES

"Acid/Base Titrations," Stanley G. Smith

"AIDS," James R. Ghesquiere et al.

"Animal Bagger," Bonnie Anderson Seiler

"Area Summary and Analysis Package," Kumi Tatsuoka, Martin Siegel, and R.A. Avner

"CC TEST Group Data Presentation," Tamar A. Weaver, R.A. Avner, and Steven Boggs

"Computer Guided Experimentation," James P. Neal

"A Conversational Information System," David Eland and Jean Pradels

"Constellation Study," Elaine S. Avner

"Darts," Sharon Dugdale, David Kibbey, and Barry Cohen

"Driver Education: Rules of the Road," Lisa Parker

"Electron Microscope Simulator," Daniel Davis

"Esperanto – Leciono 1," Judith Sherwood

"The Excitability of Nerve and Muscle Cells," Russ McKown

"Fetal Circulation," Jean Helper, Pat Tymchyshyn, and Susan Frazer

"Fractional Distillation Experiment," Stanley G. Smith

"The Fruit Fly Experiment," Gary Hyatt, David Eades, and Paul Tenczar

"La Geographie de la France," Fernand Marty

"Hebrew Roots," Roberta Stock, John Eisenberg et al.

"How the West was Won," Bonnie Anderson Seiler

"Instrument Landing Simulation," Stanley Trollip

"Introduction to Vectors," Bruce Arne Sherwood

"INTROTUTOR," James R. Ghesquiere, Celia R. Davis, and Charlene A. Thompson

"Judging Algebraic Expressions and Equations," Bruce Arne Sherwood

"Mechanics – A Problem Solving Lesson Using Newton's Laws of Motion," Bruce Arne Sherwood

"The Metric System," Ruth Chabay

"The Mountain Game," Carol Bennett

†PLATO is an acronym for Programmed Logic for Automatic Teaching Operations.

"Persian Language Lesson," Roberta Stock, John Eisenberg et al.

"Phases of the Moon," Elaine S. Avner

"Rose," Danny Sleator

"Schreiner's and White's Advanced BASIC," Axel T. Schreiner and Lawrence A. White

"The Sentence Maker," Robert Yeager and John Risken

"Speedway," Bonnie Anderson Seiler

"The Tangent to a Curve," Paul Mitchell and Axel T. Schreiner

"Twelve Days of Christmas," Lezlie Fillman

MICROFICHE FROM PLATO LESSON SOURCES

"Driver Education," Lisa Parker

"Elementary Reading Lesson," Lezlie Fillman

"Animal Science," George Brant

"Animal Science," Darlene Chirolas

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FIGURES

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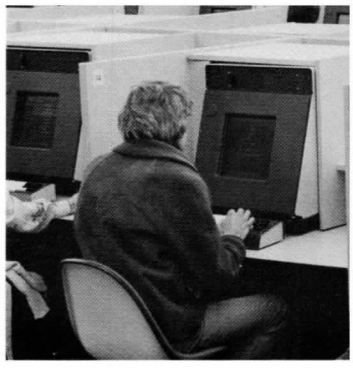
1

INTRODUCTION TO CDC PLATO



The CDC PLATO System is specifically designed for individualized and distributive education in a computer-based, interactive environment. Using the resources of a large, modern computer (CDC CYBER 70 or 170 Series) for purpose of instruction, the PLATO system allows students to receive individualized instruction, and at the same time frees the human instructor to help each student in his individual problem areas. The time-sharing characteristic of the system allows multiple users concurrent access to the computer, while giving each user the impression that he has exclusive use of the computer. Further, the speed and flexibility of the system permit many forms of information presentation.

The CDC PLATO Terminal is the principal vehicle through which users of the PLATO system interact with the computer. The student uses the terminal to receive PLATO instructional material and interact with the computer. Instructors use terminals to assign lesson materials to these students and track their progress. The authors of lesson material use the terminal to create or revise lesson material. Thus, students can be tutored individually at terminals by interacting with PLATO lesson materials.

Users communicate with the computer by means of the terminal's keyboard or optional touch panel. The computer communicates with the user by generating alphanumeric characters or graphics on the terminal's plasma-display screen or by showing color images from the terminal's optional microfiche slide projector.

The CDC PLATO author language is used by teachers to create lesson materials (courseware) on the PLATO system. Teachers use the PLATO author language, therefore, to express to the computer how the PLATO system should interact with individual students. Using this language, a lesson author can tell the PLATO system how to display text, line drawings, and animations on the student's screen. The author (via the computer) can ask the PLATO system to perform calculations for the student, to offer the student various sequencing options, and to analyze student responses.

SHORT HISTORY OF PLATO DEVELOPMENT

PLATO has been in development since 1960 by a dedicated staff of educators and scientists at the Computer-based Education Research Laboratory (CERL), University of Illinois, Urbana, Illinois. This research and development effort has been lead by Dr. Donald L. Bitzer, director of CERL and inventor of the PLATO system. The efforts at the University of Illinois have been directed toward using the computer and its associated equipment to assist in the teaching process and provide more individualized instruction. The result, PLATO, is the most advanced system developed for educational purposes. The CDC PLATO System is a production version of the research system developed at CERL, University of Illinois.

Research started in the Coordinated Science Laboratory at the University of Illinois. This research was to explore the possibilities of automation in individual instruction. The first PLATO system used a high-speed digital computer as the central control element for teaching a number of students simultaneously. In the first seven years of PLATO's existence, the system evolved from one terminal to 71, utilized two different computers (ILLIAC I and the CDC 1604), and employed four programming languages (ILLIAC Machine Language to the beginning of the TUTOR language). Additionally, about 180 teaching lessons were written for the system to illustrate or demonstrate its flexibility for teaching as well as for educational and other research.

The University of Illinois organized the Computer-based Education Research Laboratory in early 1967. The PLATO project moved from the Coordinated Science Laboratory into the new laboratory, with direction continuing under Dr. Bitzer. From 1967 to 1972 (in cooperation with CDC), development started and evolved on the first economical, large-scale, computer-based educational system – the current PLATO system. The TUTOR language was originated by Paul Tenczar and extensively developed by him and other CERL staff members. The CDC PLATO author language is the production version of the TUTOR language. Lesson material proliferated rapidly and work in many new subject areas was tried.

Concurrent improvements to the computer system, to the design and construction of auxiliary equipment, and to the scope of the TUTOR language and curricular materials have been the PLATO development pattern from 1973 to the present. Every phase of the system has been improved and expanded; the result is the current CDC PLATO System discussed in this publication.

PLATO AND MAJOR EDUCATIONAL TRENDS

Several trends to improve educational effectiveness have emerged in recent years. They enhance the ability of individual teachers to reach students while, at the same time, reduce the routine drudgery of repetitive teaching. These trends are:

- Individualized Instruction – Tailoring courses and lessons to the needs of individual students.
- Distribution of Education – Bringing courses to students at convenient locations.
- Use of Technology – Employing modern teaching techniques and equipment.
- Use of Computers – Increasingly applying computers as an educational resource as well as an administrative tool.

Moreover, the technological advance with perhaps the greatest potential and promise for the future of individualized instruction and distribution of education is computer-based education. Basically, the use of a computer in a teaching or learning situation is described as computer-based education (CBE). CBE, however, is not only a system of hardware (equipment), software (computer programs), courseware (educational materials); rather, CBE is an educational environment characterized by specific applications of educational and computer technologies to aid the learning process. Further, two major components of

CBE are direct-instructional interaction (sometimes referred to as computer-assisted instruction or CAI) and computer-managed instruction (CMI).

Direct-instructional interaction allows the student to communicate with an instructional lesson using a terminal that permits him to send and receive information. He interacts with the lesson much as he interacts with a teacher in a tutorial setting. This interaction can take one or – more typically – a combination of the lesson forms discussed in section 2: drill-and-practice, tutorial, inquiry, dialogue, simulation, computer games, and problem solving.

Another education use for a computer is to manage a student's progress through a course of study – the second basic component of computer-based education. Computer-managed instruction (CMI) is a series of evaluative and prescriptive processes involving interaction between and among the student, the instructor and/or education administrators, and the computer. Under CMI, each student is guided through a curriculum along a learning path that is designed for him. The learning path strategy is created by the instructors or education administrators who are the managers of the educational process. Further, each student's educational needs are diagnosed by an analysis of ongoing test results. Based on these results, appropriate learning activities are prescribed. Records of the student achievement are maintained by the system for use in evaluating each student's progress individually as well as in evaluating the effectiveness of the instructional material. (Section 4 of the publication details the CMI capabilities and features of the CDC PLATO System.)

HIGHLIGHTS OF CDC PLATO FEATURES

The photographic series of a student's screen in figure 1-1 represents a capsule view of an interesting PLATO lesson. Figure 1-2 shows some individual examples from PLATO lessons and curriculum management tools, thus giving some idea of the broad range of capabilities available in the CDC PLATO System. Further, each example in both figures is an actual photograph of the plasma-display screen at a significant or representative point in a lesson or management feature. Actual photographs of the plasma-display screen are used throughout this publication to illustrate PLATO functions, features, and capabilities. (The actual PLATO display presents text and drawings in orange color on a black background. But most of the pictures shown in figure 1-1, figure 1-2, and throughout this publication are black and white and reduced for ease of reproduction.)

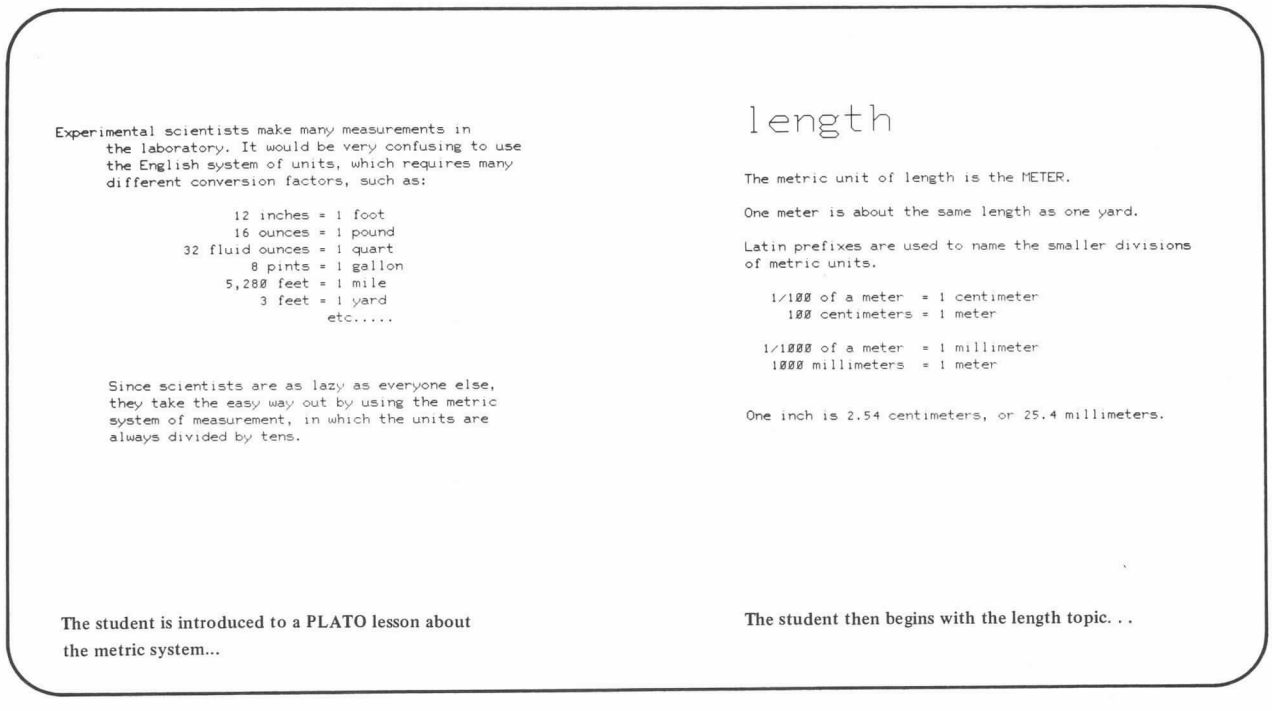
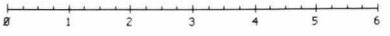


Figure 1-1. Capsule View of a Single PLATO Lesson

centimeters

This line is 10 centimeters long:

This line is 6 inches long:



And the student is shown the relationship between centimeters and inches. . .

How many centimeters are there in 0.9 meters?

> 9 no

90 centimeters = 0.9 meters

Try another problem.

The student is asked a question, and he responds with an incorrect answer. . .

How many millimeters are there in 0.9 meter?

>

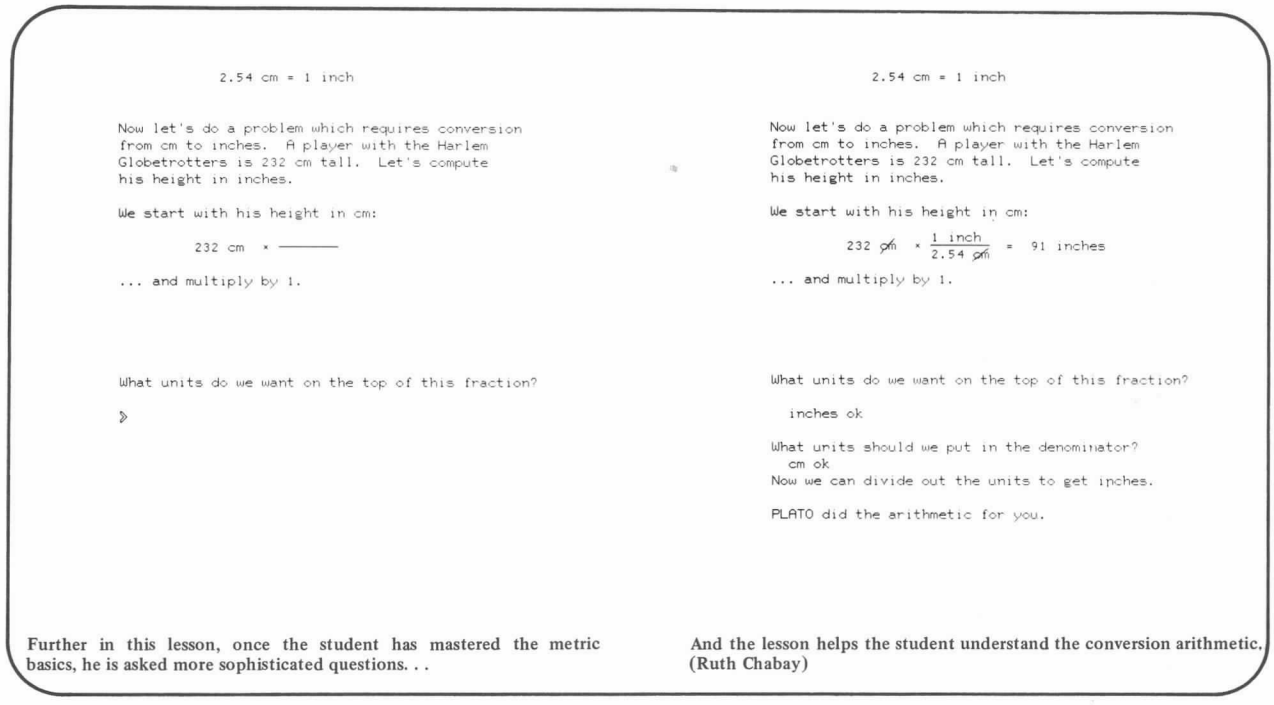
The student again is asked a question. . .

How many millimeters are there in 0.9 meter?

> 900 ok

And he responds correctly. . .

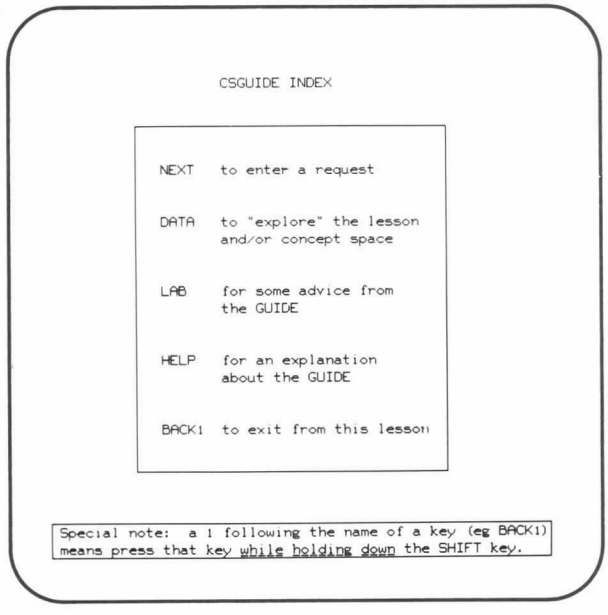
Figure 1-1. Capsule View of a Single PLATO Lesson (Cont'd)



Further in this lesson, once the student has mastered the metric basics, he is asked more sophisticated questions. . .

And the lesson helps the student understand the conversion arithmetic. (Ruth Chabay)

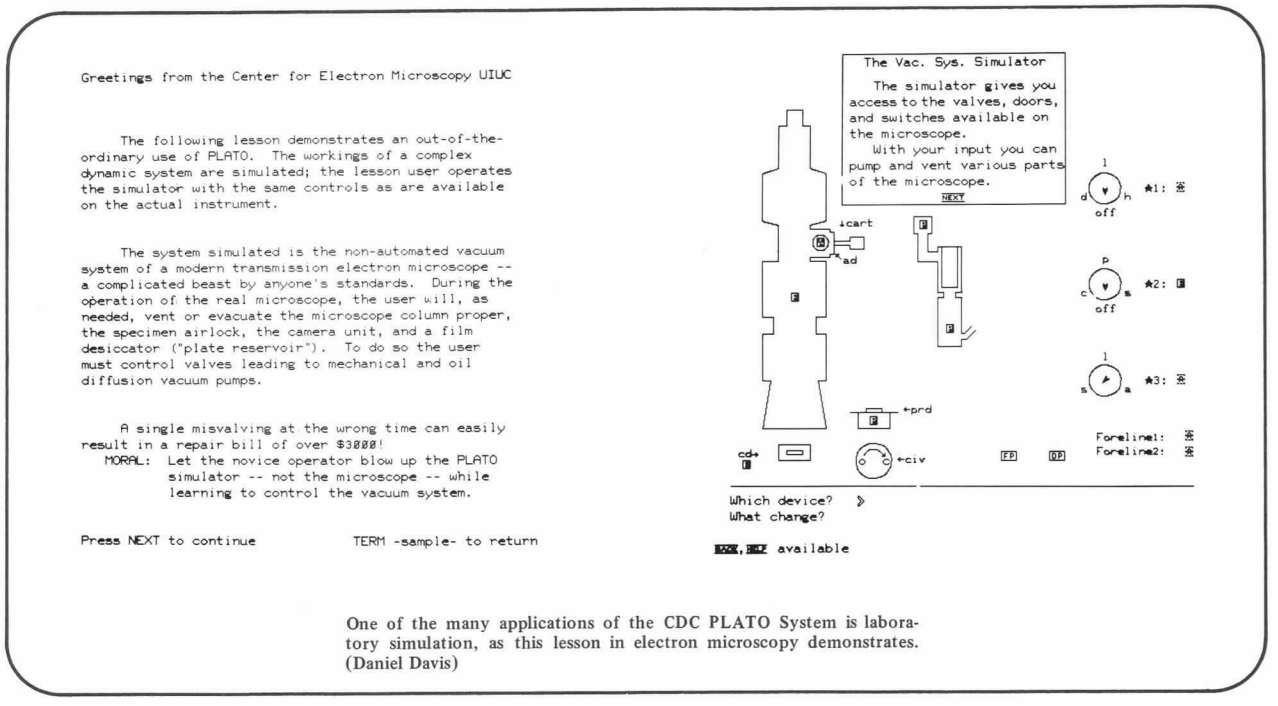
Figure 1-1. Capsule View of a Single PLATO Lesson (Cont'd)



Student-initiated branching options are highlighted in the index to this PLATO lesson. (David Eland and Jean Pradels)

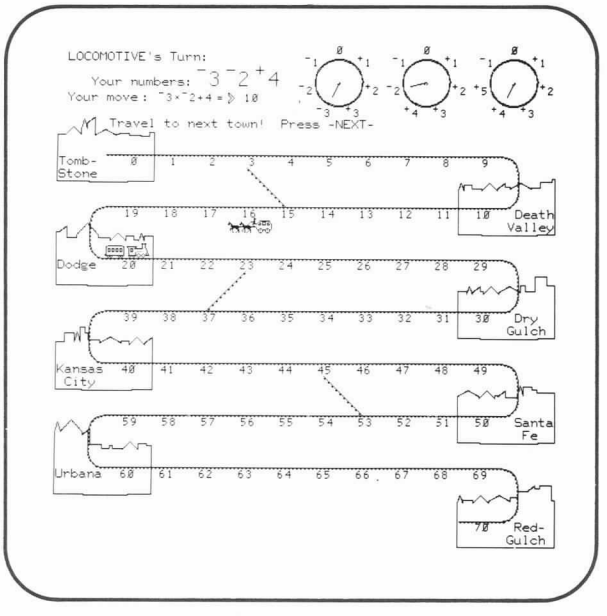
This lesson in Hebrew shows PLATO's ability to present characters from right to left (Hebrew) and from left to right (English). (Roberta Stock, John Eisenberg et al.)

Figure 1-2. Representative Examples of CDC PLATO Features



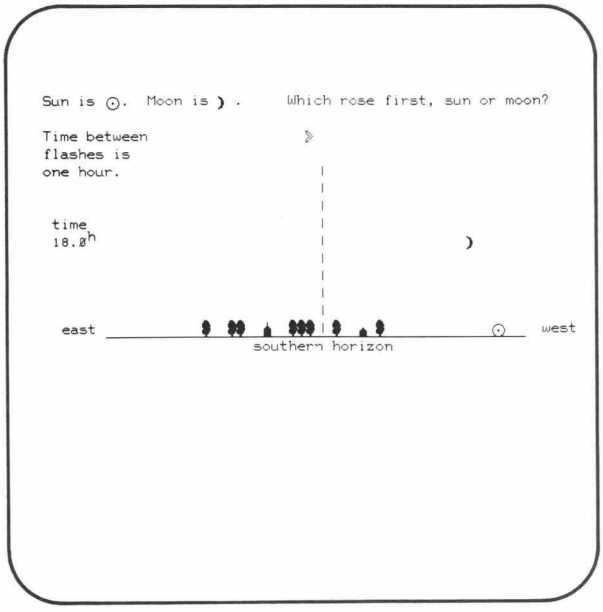
One of the many applications of the CDC PLATO System is laboratory simulation, as this lesson in electron microscopy demonstrates. (Daniel Davis)

This lesson – the student is taking a driver's examination – shows two of the optional features available on the CDC PLATO Terminal: touch panel (left-half of screen) and microfiche slide projection (right-half of screen). (Lisa Parker)

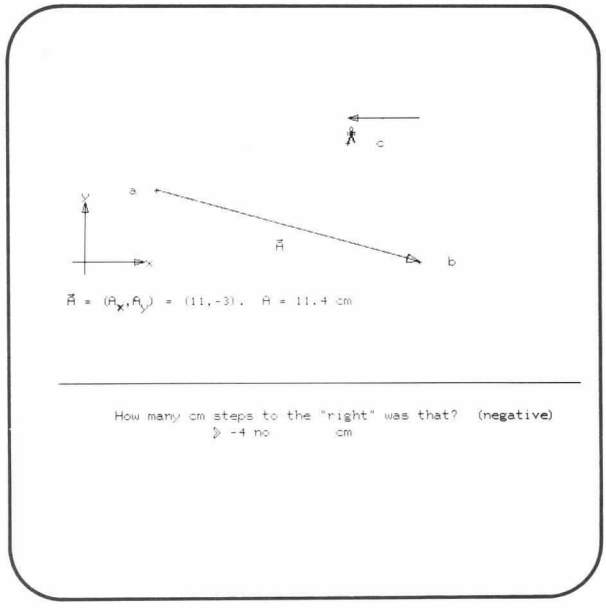


Game of mathematical strategy in which two grade-school children compete in constructing advantageous mathematical expressions from random numbers appearing on the spinners. (Bonnie Anderson Seiler)

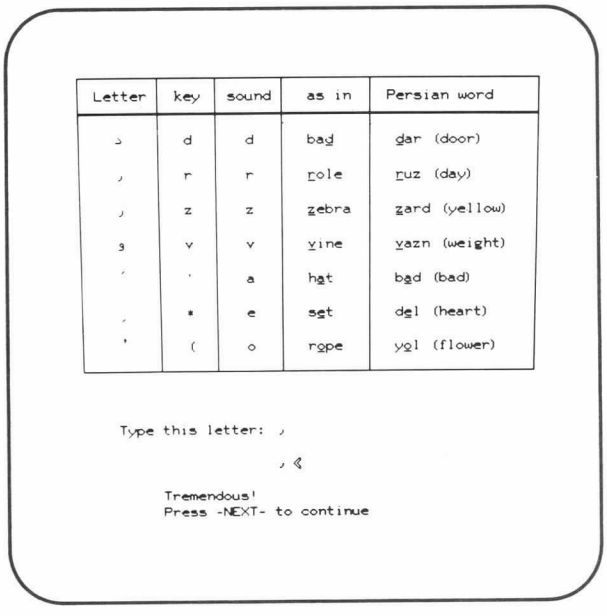
Figure 1-2. Representative Examples of CDC PLATO Features (Cont'd)



Astronomy lesson in which animated sequences enhance the overall instructional dialogue. (Elaine S. Avner)



Tutorial on vectors in which student walks a boy around the screen and measures the vector displacements. (Bruce Sherwood)



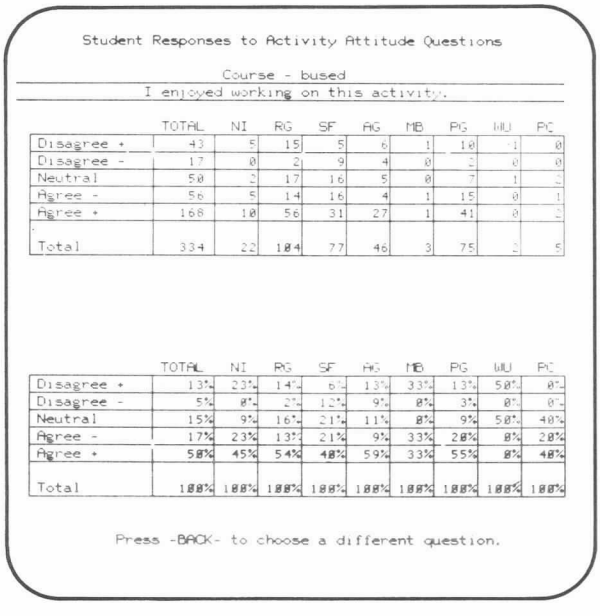
From a lesson that teaches how to speak, read, and write Persian; note the direction of the arrow when the student is asked to type a letter. (Roberta Stock and John Eisenberg et al.)

The CDC PLATO System offers the lesson author a number of special alphabets, as in this example of a script character set.

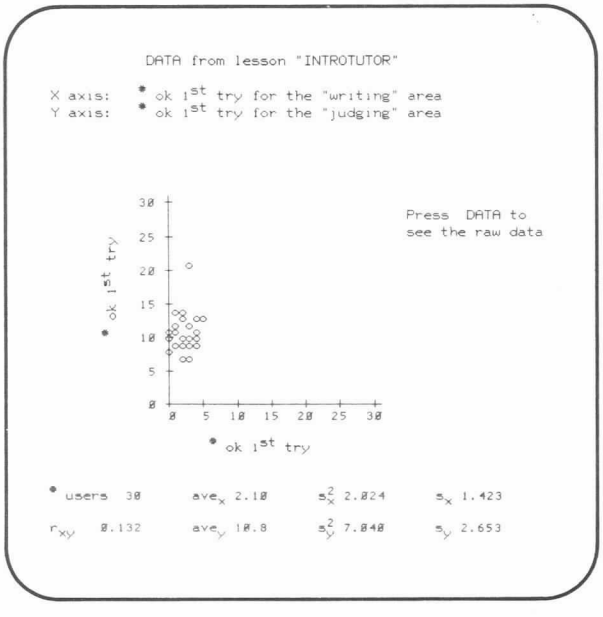
Figure 1-2. Representative Examples of CDC PLATO Features (Cont'd)

The PLATO author language allows implementation of other programming languages. (Axel T. Schreiner and Lawrence A. White)

One of a number of capabilities built into the PLATO system, this feature allows site administrators to see and control all users currently running at his PLATO system site.



From a course in business education, this summary of student data is one example of PLATO's data-collection capabilities.

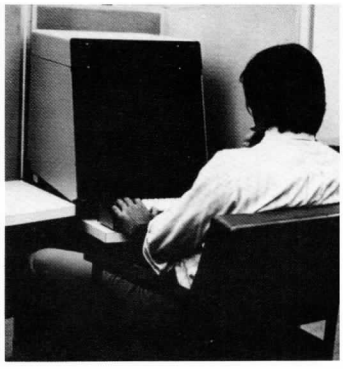


As this graph presentation shows, statistical data on student performance can be gathered during the instructional process and presented in a format that is easily interpreted. (James Ghesquiere)

Figure 1-2. Representative Examples of CDC PLATO Features (Cont'd)

2

THE USER AND CDC PLATO



EDUCATIONAL ENVIRONMENT

Developed by educators for educators, the CDC PLATO System is specifically designed for individualized student instruction in a computer-based, interactive environment. The student, the instructor, the author, the educational administrators, and the computer are all members of an interactive team in this educational environment. Typically, authors create and test instructional materials in the form of lessons. Instructors choose lessons to make up a course for their students. The computer presents this material to the students while monitoring and evaluating their performance. Each student, working at his own pace, can access special information and help when problems arise. Student interaction with the computer provides the instructor and lesson author with information on lesson effectiveness. With this information, the lesson material can be easily revised by the author to correct or improve instruction. The other members of the interactive team oversee the administrative aspects of courses, the operation of the PLATO system at a specific site, and the development of curriculum.

Most importantly, the PLATO system personalizes and humanizes interactions between users with terminal-to-terminal communications features: talking, consulting, notes, and messages. (These features are highlighted in section 4, Features of the CDC PLATO System).

The following brief descriptions examine each user's role in the CDC PLATO System.

STUDENT

A student is a user who studies (executes) assigned lessons. The student executes the lesson at the PLATO plasma-display terminal by sending and receiving information to and from the computer. He interacts with the computer in many of the same ways he would interact with a teacher in a tutorial setting. The computer also allows many other forms of interaction. The interaction between the student and computer can – in the form of a lesson – take one, or more typically, a combination of the following forms:

- The student is presented with a wide variety of exercises that help him memorize facts or concepts or master a skill, such as a computational skill in mathematics. The computer can also rapidly generate and select – by using a set of teacher-specified guidelines – *drill-and-practice* exercises that are tailor-made for each student.

- The student reads a series of informational statements interspersed with predetermined questions and responses. This form of instruction is called *tutorial* and is similar to a programmed text. But, with the advantage of a computer, the student is offered a number of automatic or voluntary branching capabilities. These branching capabilities may be based on the student's full performance history – not just his last response. Better students can bypass sections of the lesson, or slower students may be required to proceed through more sections of the lesson for new information or review.

- The *inquiry* form is a technique for teaching research and problem-solving skills. The student is placed in a structured situation in which he must pose unambiguous questions that efficiently lead to a solution to the problem. By storing and constantly evaluating the student's performance, the computer can provide the student with: helpful hints designed to improve the student's problem-solving skills and/or information that highlights the effect of poor problem-solving techniques.

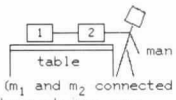
- The computer *simulates* actual experiences for a student, such as laboratory experiments or programming a computer.

- By adding a recreational flavor to a lesson, *computer games* motivate students to learn basic skills that require extensive practice.

- The computer provides direct support services to the student (that is, computation and information retrieval) to *solve problems.*

- *Dialogue* is a special approach that is used with any instructional form where natural language (for example, English) is a required part of the skill being learned.

The three lesson examples, shown in figure 2-1, are representative of student-PLATO interaction.



(m_1 and m_2 connected by a string; man touches m_2)

1) The man pulls horizontally with force F. Find the acceleration of the masses and the tension in the string, assuming the string does not slacken.

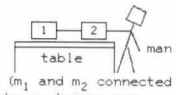
If you want to work on this problem, say "yes". Otherwise press NEXT to see the next problem.

yes ok

Do you want to include friction?

» yes ok

In this physics lesson, the student can choose a problem and its difficulty level. . .

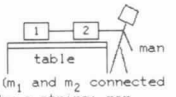


(m_1 and m_2 connected by a string; man touches m_2)

What do you want to do first?

» find the forces on object m_1

His response is judged for validity. . .



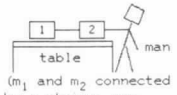
(m_1 and m_2 connected by a string; man touches m_2)

subsystem m_1

Name an object outside subsystem m_1 which can exert a force on the subsystem. (If there are none, type "none".)

»

The lesson then asks for more detail about the problem. . .



(m_1 and m_2 connected by a string; man touches m_2)

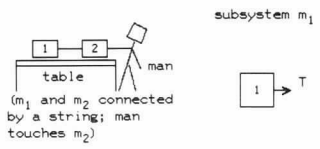
subsystem m_1

Name an object outside subsystem m_1 which can exert a force on the subsystem. (If there are none, type "none".)

» string

And the student responds. . .

Figure 2-1. Student-PLATO Lesson Interactions

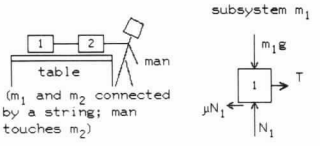


See the force displayed above?

Now name another object which can exert a force.
(Or type "none" if there are no more.)

» table

The display continues building, based on the student responses. . .

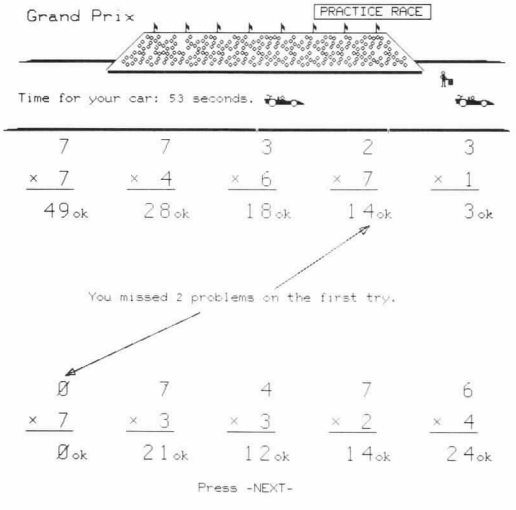


See the force displayed above?

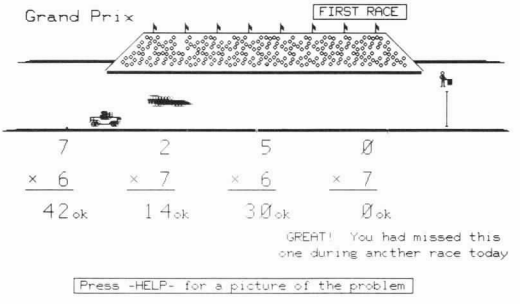
Now name another object which can exert a force.
(Or type "none" if there are no more.)

» none

. . .until this part of the problem is completed. (Bruce Sherwood)

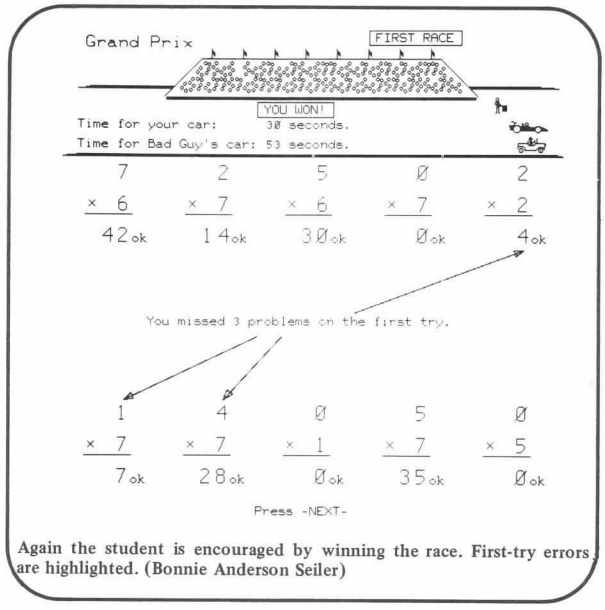


Game of mathematical drill and practice for which a grade-school student first establishes skill-level in a practice race. Note that lesson indicates errors.

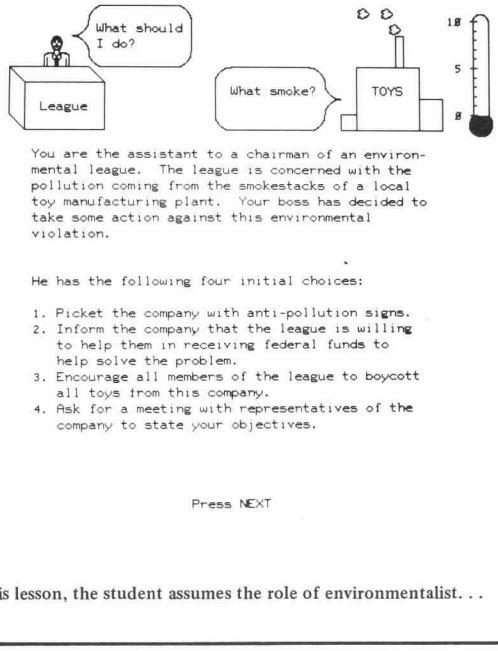


Student is positively reinforced while solving problems.

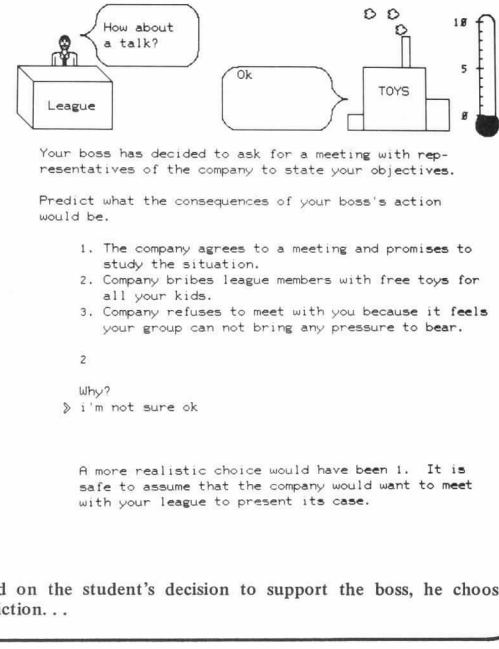
Figure 2-1. Student-PLATO Lesson Interactions (Cont'd)



Again the student is encouraged by winning the race. First-try errors are highlighted. (Bonnie Anderson Seiler)

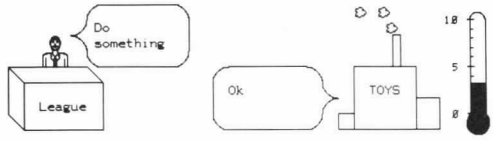


In this lesson, the student assumes the role of environmentalist. . .



Based on the student's decision to support the boss, he chooses a prediction. . .

Figure 2-1. Student-PLATO Lesson Interactions (Cont'd)



What do you think would be the best way to handle things from this situation?

1. Ask the transportation industry to stop hauling the toys until the company meets your demands.
2. Take the company to court.
3. Push the company to set deadlines for installation of pollution control devices.

3

Best choice for this situation. Problem shows signs of solution. The company is no longer allowed to stall if it wishes to avoid possible legal action. The league is doing much better now.

The student again is asked to make a choice. His choice is positively reinforced, and his score (thermometer) is advanced.

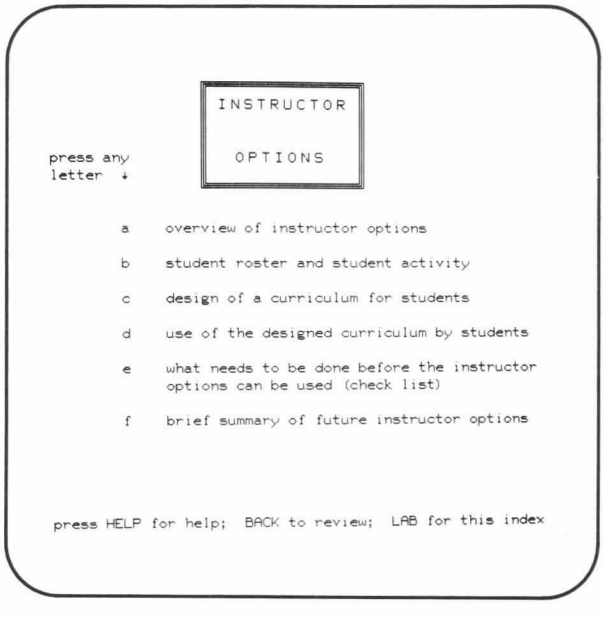
Figure 2-1. Student-PLATO Lesson Interactions (Cont'd)

INSTRUCTOR

An instructor is a user who evaluates and chooses available lessons from a library (or catalog) in the PLATO system to establish and design a student curriculum for a course. Typically, instructors also register students, monitor their progress, and leave messages for the class or for individual students. The instructor interacts with the computer to diagnose each student's educational needs in relation to a specific course, prescribes appropriate learning activities for each student, and periodically evaluates each student's achievement.

The CDC PLATO System provides basic tools for lesson selection, course management, and collection of course statistics (figure 2-2).

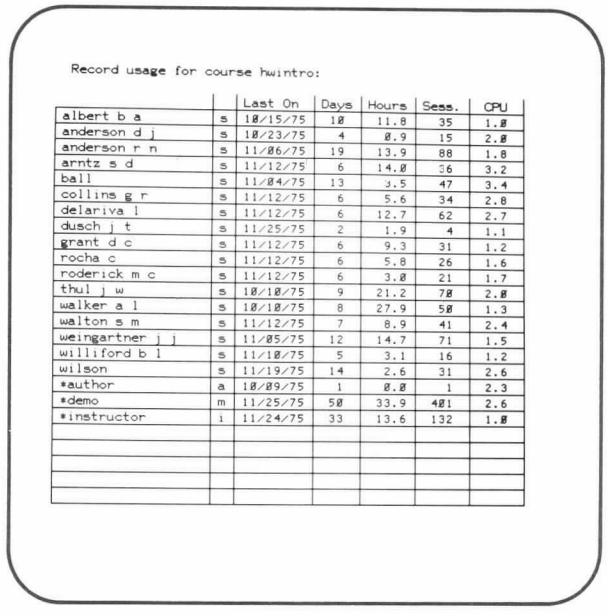
Other course-management tools available to the instructor are discussed in section 4, Features of the CDC PLATO System.



Options available to the instructor. (James R. Ghesquiere et al.)

Lesson index for a specific course. (James R. Ghesquiere et al.)

Figure 2-2. Typical Instructor Tools Available in the CDC PLATO System



Record usage for course hwintro:

		Last On	Days	Hours	Sess.	CPU
albert b a	s	10/15/75	10	11.8	35	1.0
anderson d j	s	10/23/75	4	0.9	15	2.0
anderson r n	s	11/06/75	19	13.9	88	1.8
arntz s d	s	11/12/75	6	14.0	36	3.2
ball	s	11/04/75	13	3.5	47	3.4
collins g r	s	11/12/75	6	5.6	34	2.8
delariva l	s	11/12/75	6	12.7	62	2.7
dusch j t	s	11/25/75	2	1.9	4	1.1
grant d c	s	11/12/75	6	9.3	31	1.2
rocha c	s	11/12/75	6	5.8	26	1.6
roderick m c	s	11/12/75	6	3.0	21	1.7
thul j w	s	10/10/75	9	21.2	70	2.0
walker a l	s	10/10/75	8	27.9	50	1.3
walton s m	s	11/12/75	7	8.9	41	2.4
weingartner j j	s	11/05/75	12	14.7	71	1.5
williford b l	s	11/10/75	5	3.1	16	1.2
wilson	s	11/19/75	14	2.6	31	2.6
*author	a	10/09/75	1	0.0	1	2.3
*demo	m	11/25/75	50	33.9	401	2.6
*instructor	i	11/24/75	33	13.6	132	1.0

Some of the course statistics available to the instructor.

Figure 2-2. Typical Instructor Tools Available in the CDC PLATO System (Cont'd)

AUTHOR

An author is a user who produces instructional materials for the PLATO System. He can create, modify, or delete the contents of his lesson. Using the CDC PLATO author language, an author of a computer-based lesson can tell the PLATO system how to display text, line drawings, and animations on the student's screen. Additionally, the author can ask the system to calculate for the student, to offer the student various sequencing options, to analyze student responses, and to collect student data.

The author creates and revises his PLATO author language lesson at the plasma-display terminal; he is not required to write out a complete lesson on paper, only to find upon testing that the overall structure is inappropriate. The PLATO author language, therefore, is designed for interactive use between the author and the computer. Typically, the author writes a short segment of a lesson, tries it, and revises it on the basis of the trial; this sequence takes only a few minutes at the terminal.

The CDC PLATO System also offers the author effective lesson-creation/editing facilities for writing and positioning text and for drawing pictures on the screen (by moving a cursor and marking points). The PLATO system then automatically creates the corresponding author language statements which produce the text and picture. The PLATO system actually writes a lesson segment for the author.

A few representative examples of authoring capabilities are highlighted in figure 2-3. More PLATO features designed for the author are discussed and illustrated in sections 4 and 5.

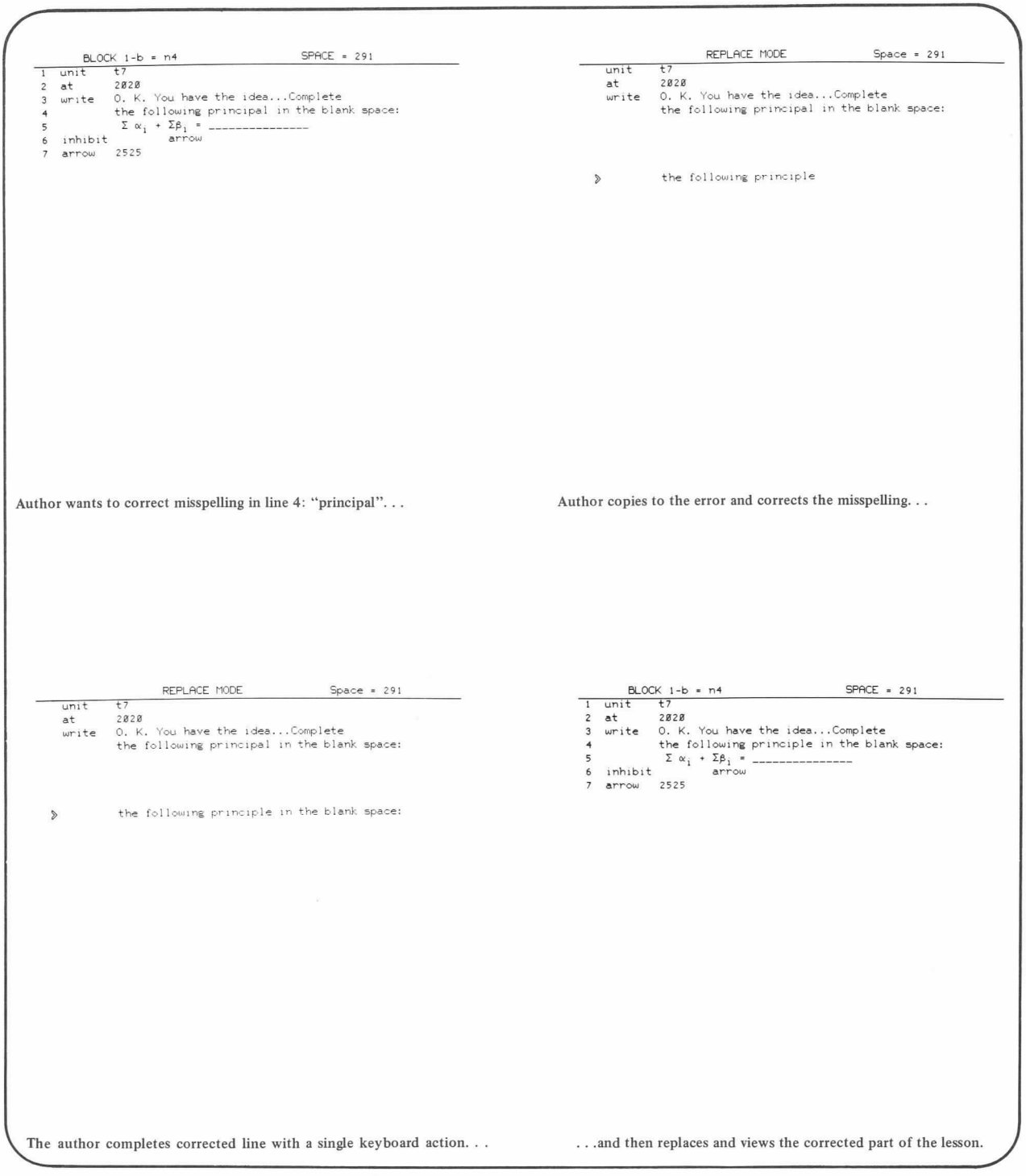
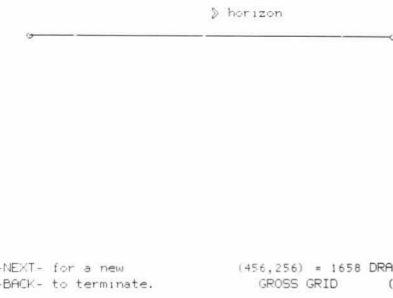


Figure 2-3. Authoring Capabilities of the CDC PLATO System

Author draws line for graphic display in lesson. . .



He then places and writes text relative to line. . .

```
      BLOCK a =start                    SPACE = 251
1  draw     1612;1658
2  at       1537
3  write    horizon
```

And with one keypress, automatically generates the corresponding author language statements.

Figure 2-3. Authoring Capabilities of the CDC PLATO System (Cont'd)

EDUCATIONAL ADMINISTRATORS

The CDC PLATO System offers a rich array of features to assist educational administrators. Since the actual roles of educational administrators are determined by the requirements of a specific course, a system site, and a curriculum, only basic functions can be outlined here.

Course Director features permit control over who may have author/instructor records and, further, provide means for examining student rosters and student statistics. Figure 2-4 highlights a few of the course director management features.

Typical course roster.

Typical student record.

Figure 2-4. Examples of PLATO Course Statistics

Site Director features provide control over a specific PLATO system site. The site is generally defined as a specific set of PLATO terminals which may or may not be physically resident at the same geographical location. The site director features allow decisions to be made about which courses and lessons may use the site at any one time and, further, display details about the current use of the site (refer to figure 2-5). Other features provide communication with site users at terminals.

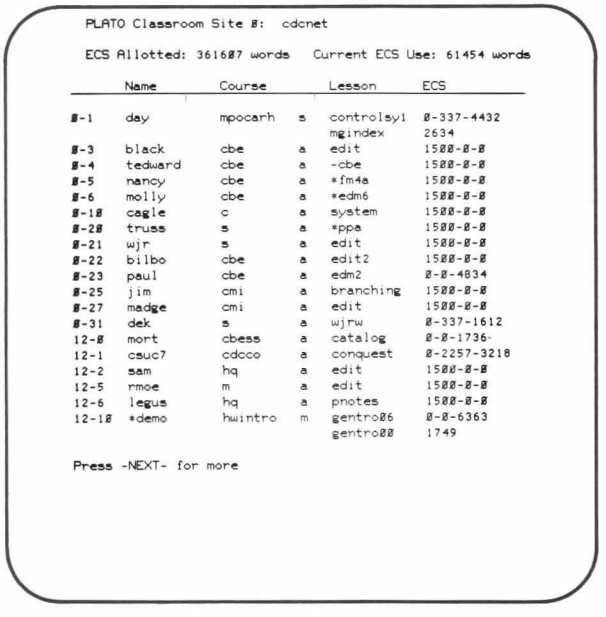


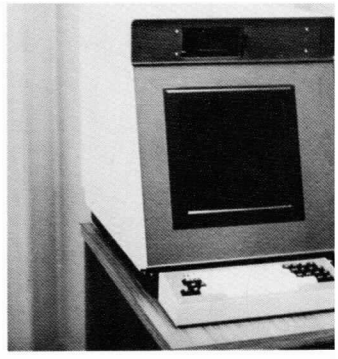
Figure 2-5. Site Director Examines List of Active Users at His Site

Account Director features provide a site director or the head of a large curriculum development project with access to all usage data on courses in his account. These features also provide a means to create, destroy, rename, and otherwise modify the lessons, courses, and files in an account. One of the account director features (a complete list of all lessons in an account) is shown in figure 2-6.

Figure 2-6. Account Director Examines a Complete List of Lessons in His Account

3

FEATURES OF THE CDC PLATO TERMINAL



The CDC PLATO Terminal is an interactive, plasma-display, computer-graphics terminal. It is designed for use in the CDC PLATO Computer-Based Education System as the principal vehicle through which users (student, instructor, author, education administrators) interact with the computer.

The basic CDC PLATO Terminal consists of a plasma-display screen, an electronic keyboard, and associated electronics. Optional features include a touch panel, a microfiche projector, and auxiliary connectors for attaching multimedia devices and external data-collection devices. Figure 3-1 highlights the components of the PLATO terminal.

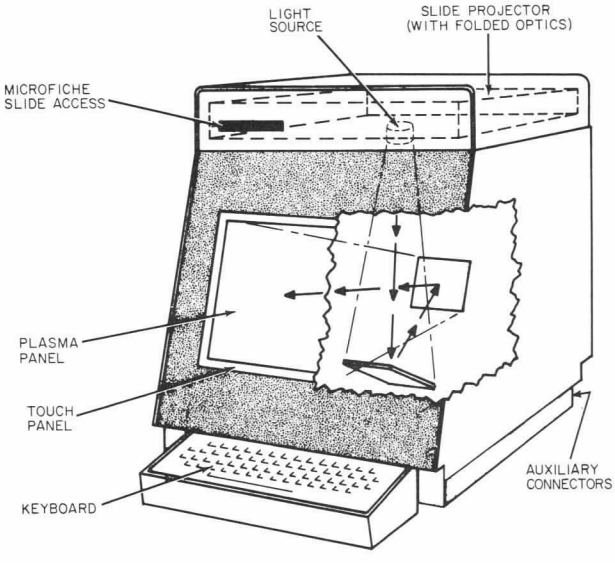


Figure 3-1. CDC PLATO Terminal Components

PLASMA SCREEN

The plasma screen is a translucent, plastic-covered, glass panel which provides a 8.5 by 8.5 square-inch viewing area. The screen consists of a 512 by 512 grid of fine electrodes embedded in two plates of glass separated by a space containing neon gas. The electrodes are horizontal on one glass plate and vertical on the other, forming a grid-work of 262,144 intersections. The computer writes on the screen by ionizing the neon gas at the intersecting charged electrodes. Any or all of the quarter-million (512 by 512) intersections of the horizontal and vertical wires can be addressed; that is, each intersection can be made to glow as a small orange dot. (The word plasma is the scientific name for the ionized gas; the orange glow is emitted by the ionized neon gas.) And, unlike a television display which must be continually refreshed, once a plasma-display dot is lit, it stays lit until directed by the computer to go off. Figure 3-2 represents the function of the plasma-display screen.

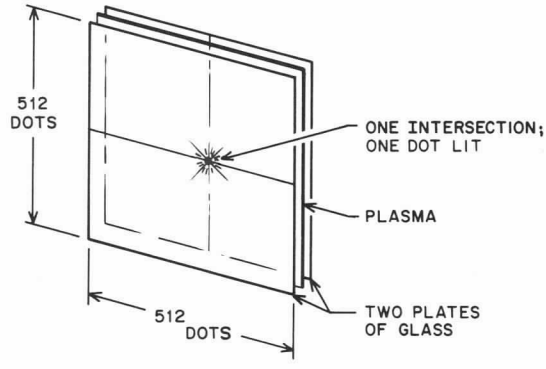


Figure 3-2. PLATO Plasma-Display Screen

The PLATO terminal can display text on the plasma panel by using a fixed-character set or author-defined character sets. Illumination of groups of plasma dots initiates a display presentation with 32 lines of 64 characters per line. (When a character key, for example, on the keyboard is pressed, the corresponding character is displayed on the screen. An enlarged view of a single character on the terminal screen is shown in figure 3-3.) The terminal can write 180 characters per second. These characters can also be erased at the same rate of speed, or the whole screen can be erased at once.

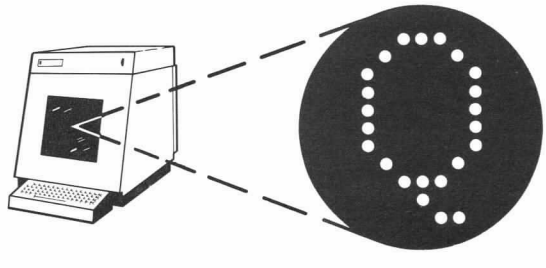


Figure 3-3. Enlarged View of a Single Character on the PLATO Plasma-Display Screen

The terminal's memory contains 126 fixed-characters: standard uppercase and lowercase alphabet, numbers, and user-oriented function characters. A complete fixed-character set is shown in figure 3-4.

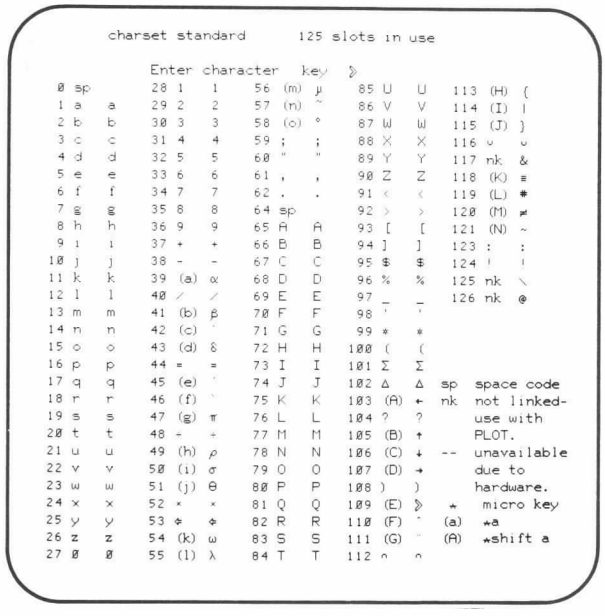


Figure 3-4. Fixed-Character Set in PLATO Terminal

A full character set for traffic signs.

The terminal's memory also contains space for an additional 126 characters; but, in contrast to the fixed-character set, these characters may be created or changed by an author to represent other alphabets or portions of pictures. Figure 3-5, for example, shows a Persian character set; figure 3-6 depicts how pieces of a stop sign can be used as characters to create a complete picture of the stop sign.

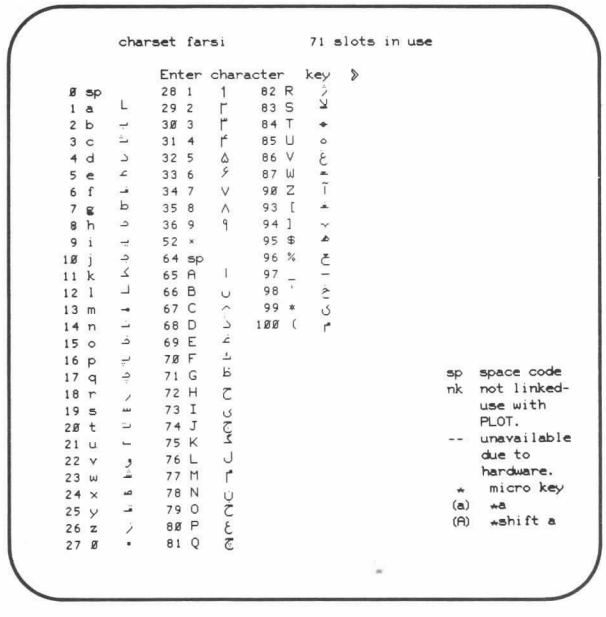
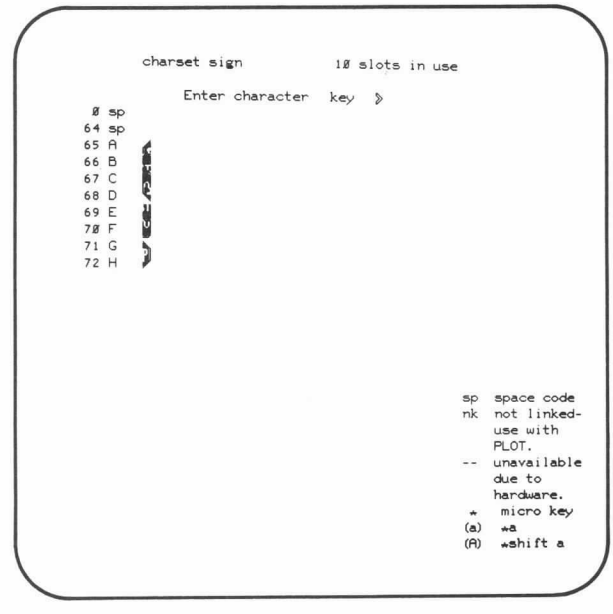
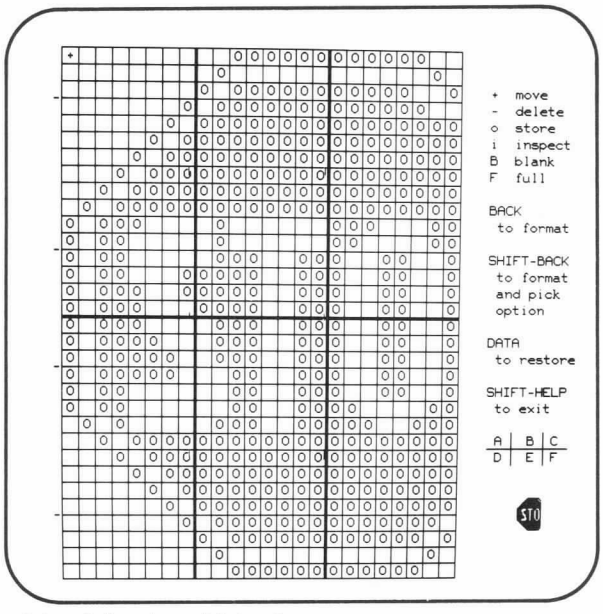


Figure 3-5. An Author-Defined Character Set: PERSIAN



Characters only for the stop sign.

Figure 3-6. Special Characters Defined as Pieces of a Picture (another capability of author-defined sets)



Enlarged view of a partial stop sign.

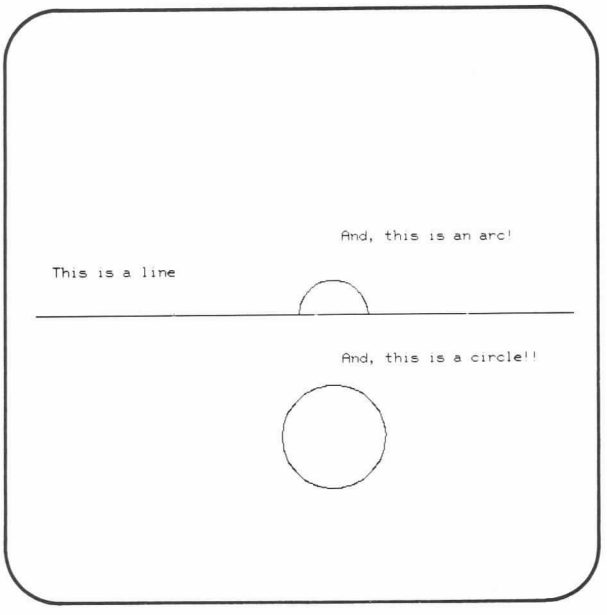


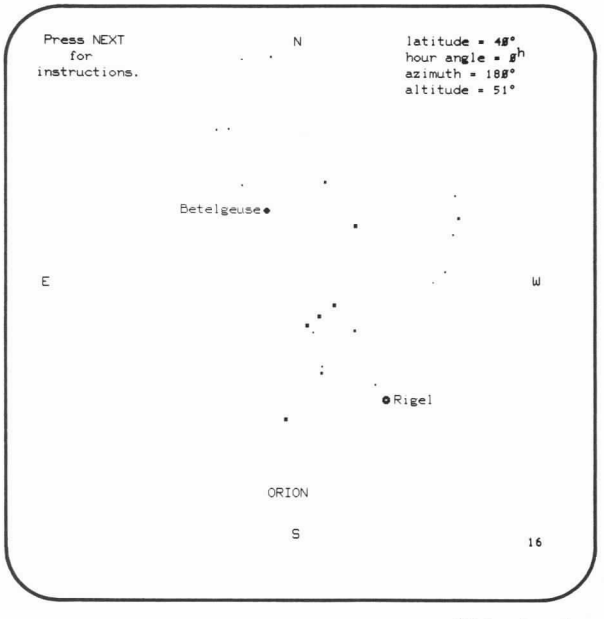
Figure 3-7. Simple Example of Graphics Capabilities on the PLATO Terminal

Complete and partial stop signs are constructed of pieces from the full character set. (Lisa Parker)

Figure 3-6. Special Characters Defined as Pieces of a Picture (another capability of author-defined sets) (Cont'd)

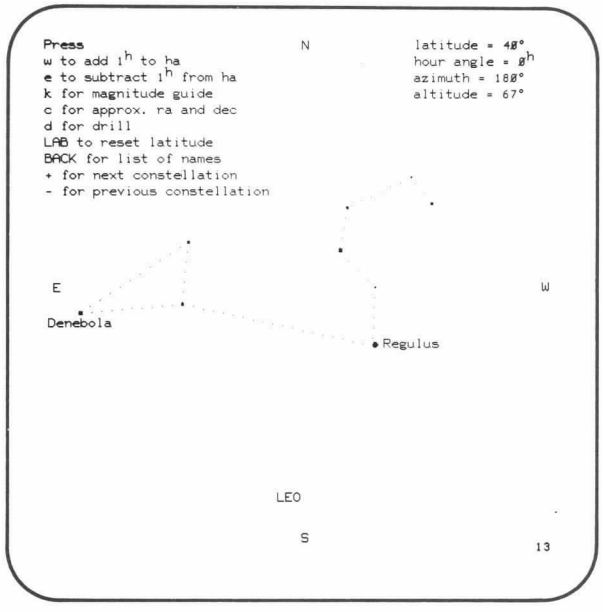
The PLATO terminal can also draw straight lines on the plasma panel without defining each dot in the line. Curves and circles are approximated as a series of straight lines. Among other capabilities, this lets the terminal draw up to 60 lines per second. Again, the lines can be erased at the same rate of speed. A simple example of PLATO's graphics capabilities is shown in figure 3-7.

Since it is possible to explicitly light and erase a single dot on the plasma panel, many interesting graphic effects can be created on the PLATO terminal (figure 3-8).



(Elaine Avner)

Figure 3-8. Dot Mode as Used in an Astronomy Lesson



(Elaine Avner)

Figure 3-8. Dot Mode as Used in an Astronomy Lesson (Cont'd)

ELECTRONIC KEYBOARD

Each PLATO terminal has a keyboard similar to the one pictured in figure 3-9. The keyboard has the same characters as a standard typewriter, with some additions. The additions include some special keys for extra symbols and functions that under the control of the lesson affect display presentation or lesson execution. For example, the HELP key permits students to access optional sections of a lesson. (The normal lowercase and uppercase characters are also illustrated in figure 3-9.) The student, therefore, can type letters, numbers, words, or sentences, or press one of the special keys to communicate with the interactive lesson.

Not all of the 126 permanent characters available to the PLATO terminal appear on the keyboard. There are additional characters, called standard micro characters, defined by the system and resident in the terminal. Further, there are both lowercase and uppercase standard micro characters (figure 3-10). These additional characters are accessed by first striking the MICRO key and then striking a second key defined as a standard micro character.

Figure 3-9. CDC PLATO Terminal Keyboard

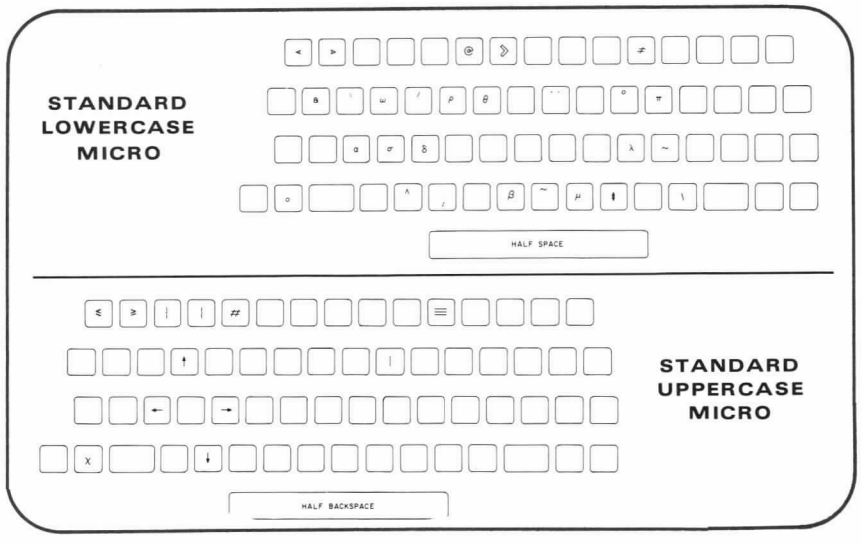


Figure 3-10. Standard Micro Characters Available on the PLATO Terminal Keyboard

Additionally, the PLATO system permits an author to redefine the keyset (a microtable) which, in response to key-presses, displays a string of up to 40 characters. Access to the microtable is controlled by the MICRO key. More typically, however, access to the microtable is controlled by the author in his lesson; thus, the student is never required to press the MICRO key.

And, finally, there are as many as 126 other character positions available for redefinition by the author. The characters are created by the author to be used in his particular lessons. When these characters are used, the author accesses them with the FONT key, which acts as a toggle switch (standard position is off until FONT is pressed and this character set is then on until another FONT toggles it off again). In this manner, an author may create an alphabet (Cyrillic, for instance, as shown in figure 3-11) or graphics (a picture of a car, for instance) which, under lesson control, may be displayed by using the redefined keys. Typically, the author specifies FONT or non-FONT in his lesson; the student need not make the decision. For example, when a student takes a lesson in Russian and types on the keyboard, he automatically gets the correct Cyrillic characters. (The ability to create new character sets is discussed further in section 5.)

Figure 3-11. Cyrillic Alphabet Used to Write Russian Text

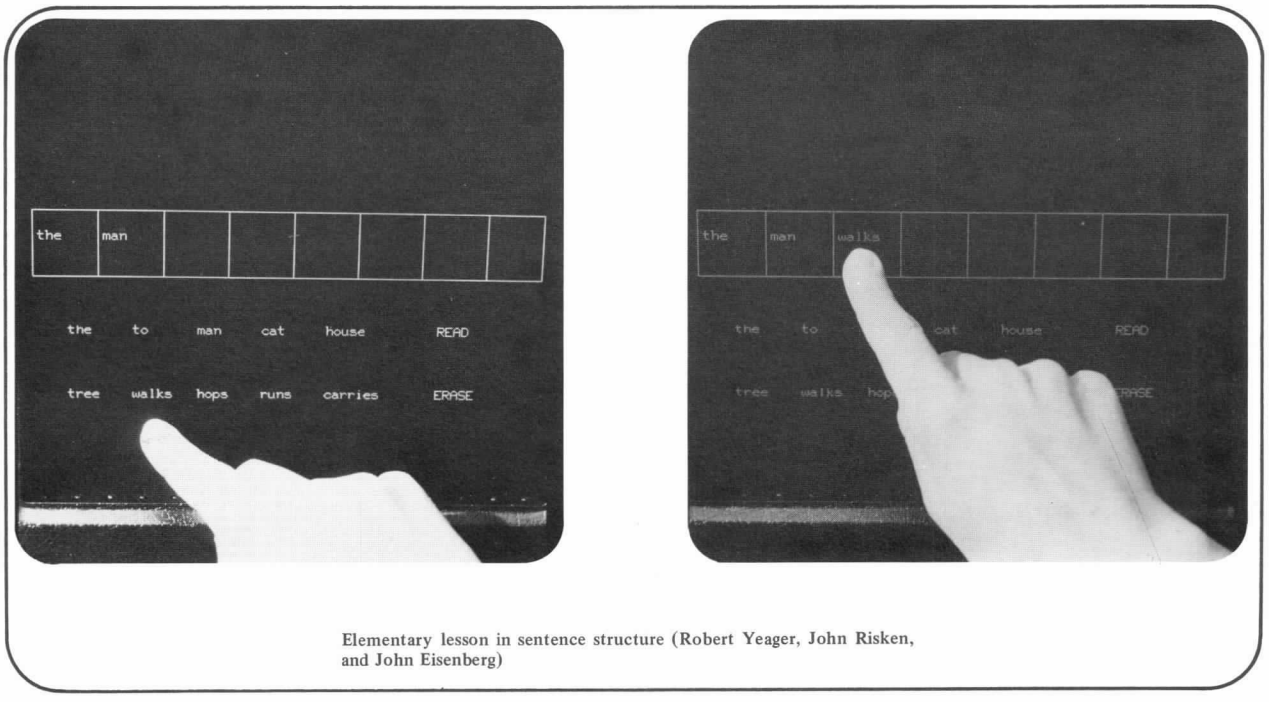
TOUCH-PANEL OPTION

Users communicate with the computer by means of the keyboard, as discussed earlier, or the optional touch panel. The touch panel permits interaction with the lesson by simply touching a designated area on the screen with a finger or other opaque objects. It consists of a 16 by 16 grid of infrared beams with 256 intersections covering the screen. When the student's finger interrupts the beams, the touch panel detects the location and sends a message of the student's touch to the computer. The lesson author specifies when the touch panel should be active.

Figure 3-12 presents a few typical uses of the touch-panel feature. In the first example, an elementary lesson in sentence structure, the student is asked to construct a simple sentence from the words listed beneath the boxes. By touching the word "walks," for instance, the student can put it into any box desired by touching the empty box of his choice. Once he has placed the word "walks" in the appropriate box, he continues to build the simple sentence. When the student has finished, the PLATO lesson – via the computer – reads the sentence to determine if it is a proper sentence. If it is, the lesson illustrates what the sentence says by means of animation. If the sentence is not a proper one, the lesson – again via the computer – writes a message:

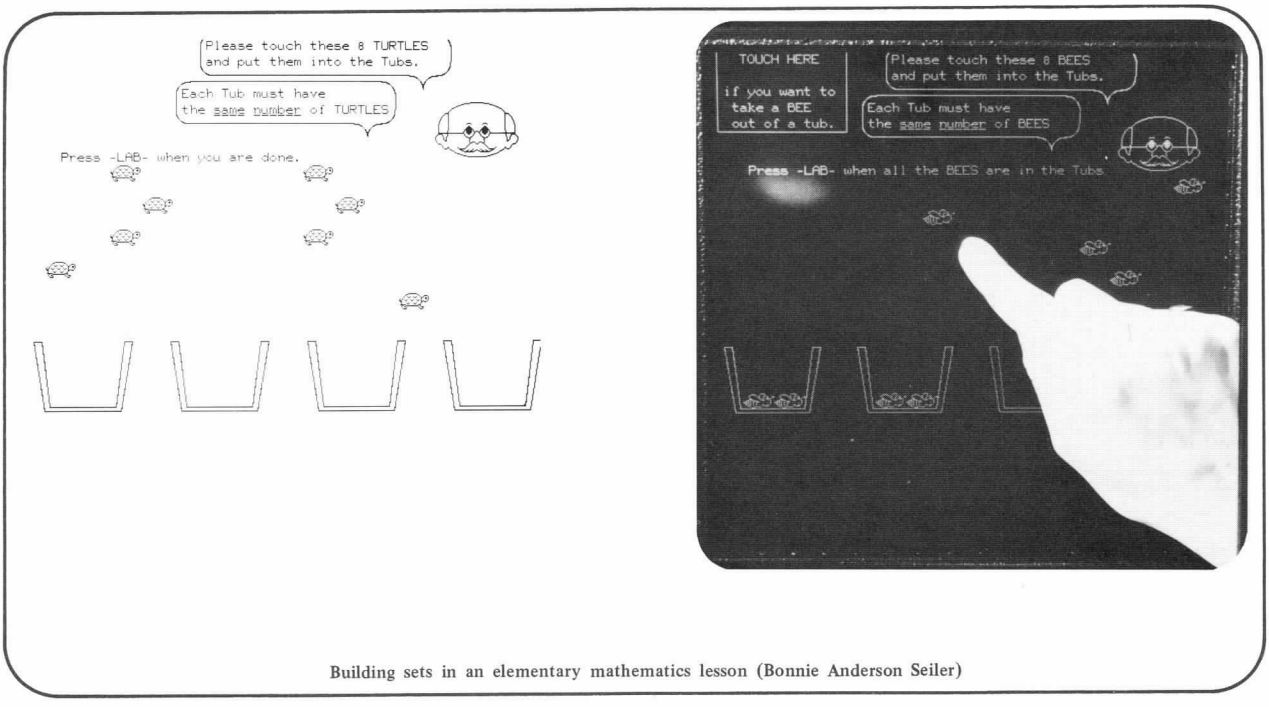
"THIS SENTENCE IS INCORRECT; PLEASE TRY AGAIN."

In the second example, the same touch-panel technique is used for elementary mathematics. With this lesson, the student is taught to divide up groups of objects by placing the desired number of turtles or bees in each tub. The touch-panel feature can also be used effectively in a laboratory setting. The third example shows a lesson in which the student is asked to construct a distilling apparatus.



Elementary lesson in sentence structure (Robert Yeager, John Risken, and John Eisenberg)

Figure 3-12. Touch-Panel Feature Used in PLATO Lessons



Building sets in an elementary mathematics lesson (Bonnie Anderson Seiler)

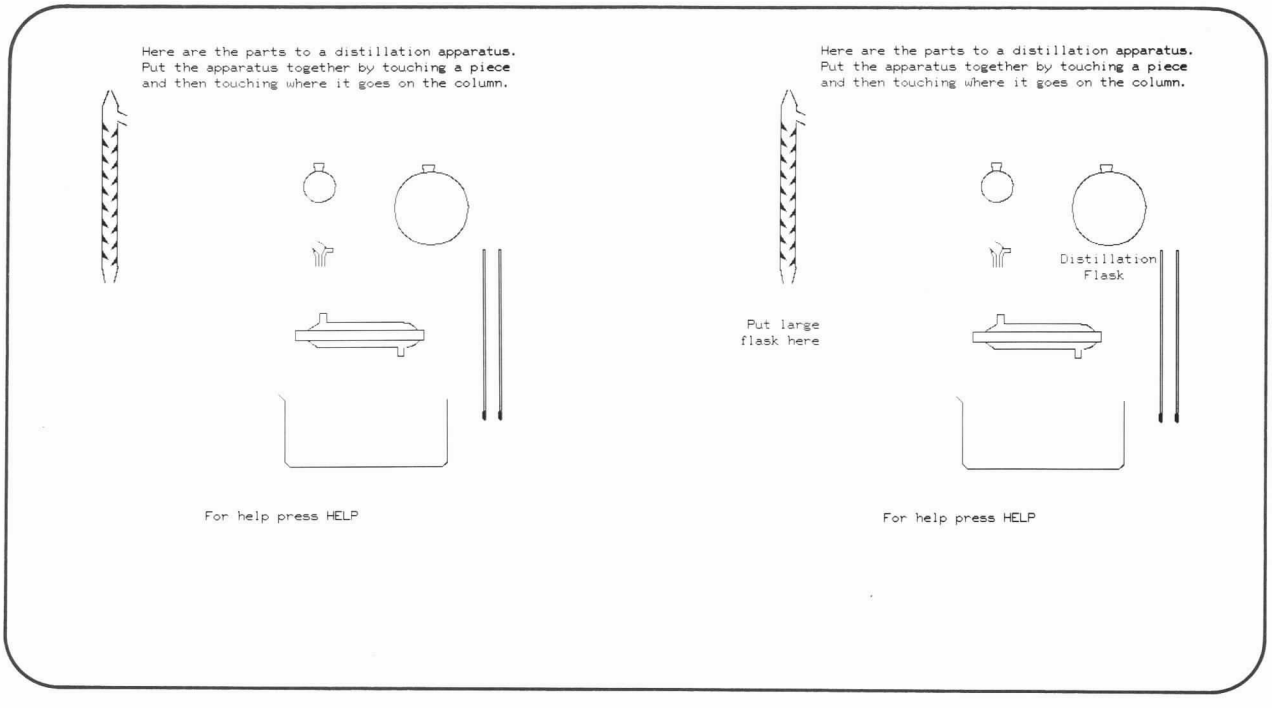
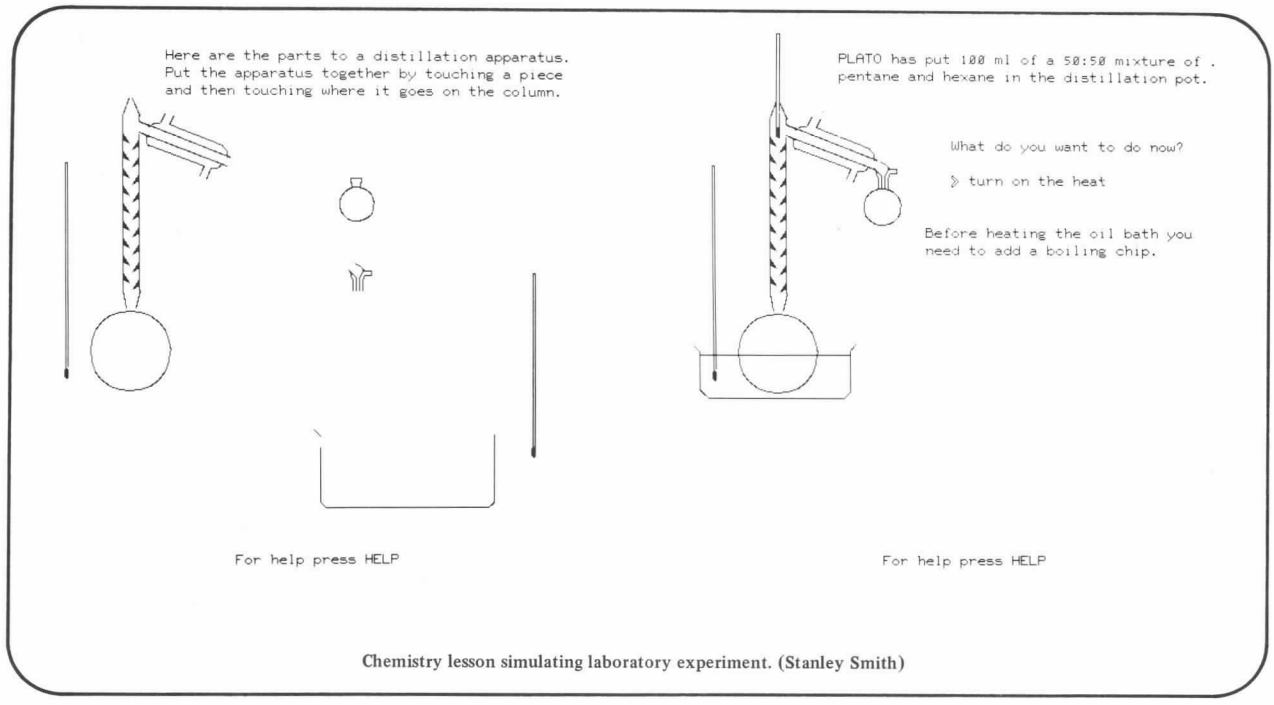


Figure 3-12. Touch-Panel Feature Used in PLATO Lessons (Cont'd)



Chemistry lesson simulating laboratory experiment. (Stanley Smith)

Figure 3-12. Touch-Panel Feature Used in PLATO Lessons (Cont'd)

MICROFICHE-PROJECTOR OPTION

Since the plasma-display screen is translucent and flat, it is possible to rear-project color transparencies on the screen with the microfiche slide-projector option. (The microfiche is a sheet of film carrying up to 256 color slides, as shown in figure 3-13.)

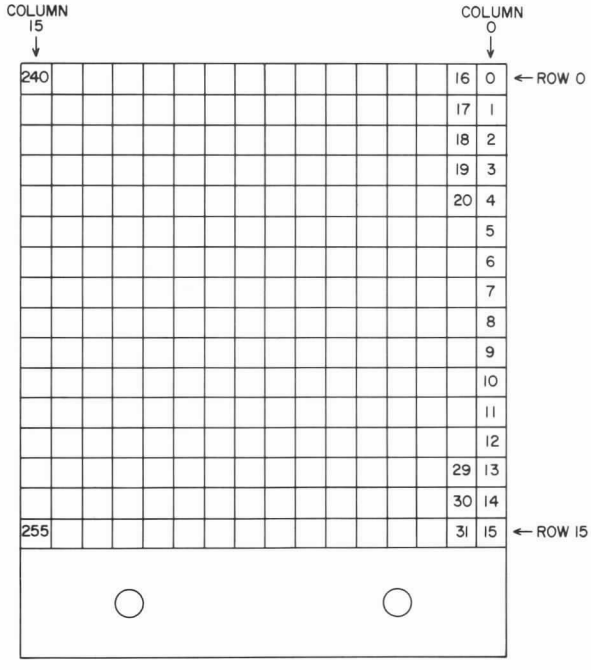
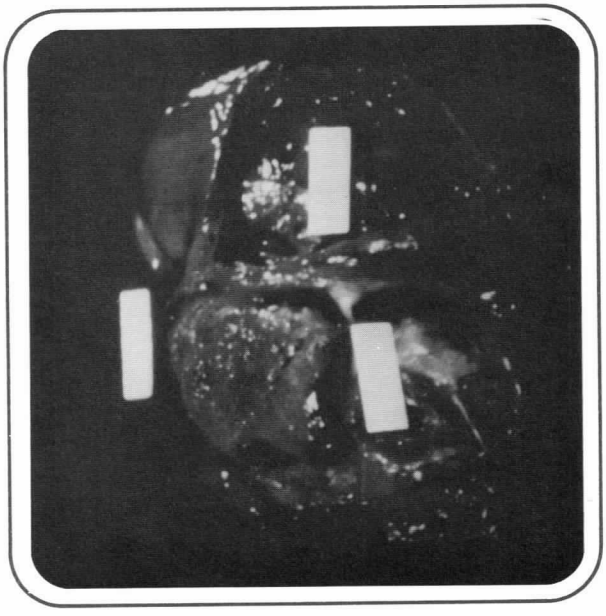


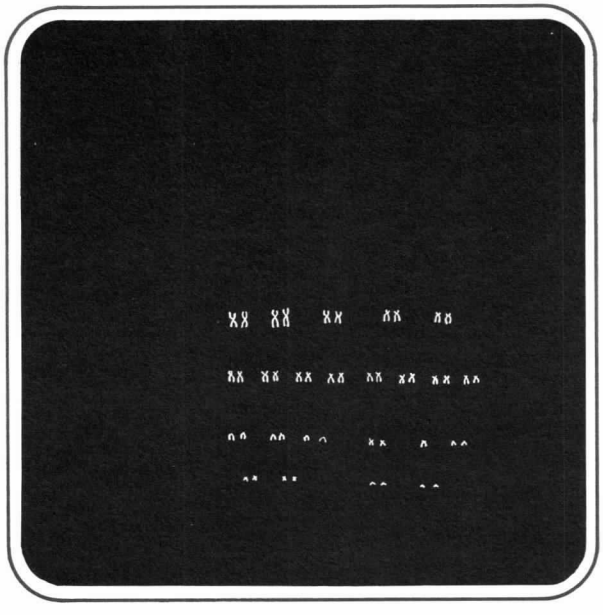
Figure 3-13. Microfiche Layout

Each slide on the microfiche can be accessed randomly in less than 0.4 second upon command of the computer; the microfiche slide projector itself is driven pneumatically. As with the touch-panel option, the lesson author specifies when the microfiche slide projector should be active. The microfiche slides can be superimposed on display-screen text and line drawings. Students or instructors can insert the appropriate microfiche in the terminal for the subject to be studied. The following slides are examples of transparencies (originally in color) projected through the plasma-display screen (figure 3-14).

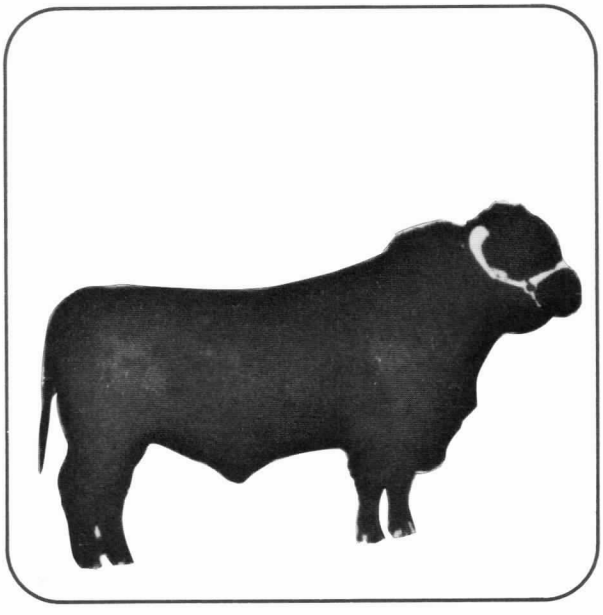
Anatomy is displayed in this slide (originally in full color) as part of a lesson in medicine.



As can be seen in this slide, the microfiche option also can be used to display x-rays – another valuable tool for medical students.



From a lesson in microbiology, this slide shows a spread preparation of chromosomes (40-power magnification). (Darlene Chirolas)



Other possible microfiche applications include the following from PLATO lessons: "Animal Science." (George Brant)

Figure 3-14. Microfiche Slides Used in PLATO Lessons

"Elementary Reading." (Lezlie Fillman)

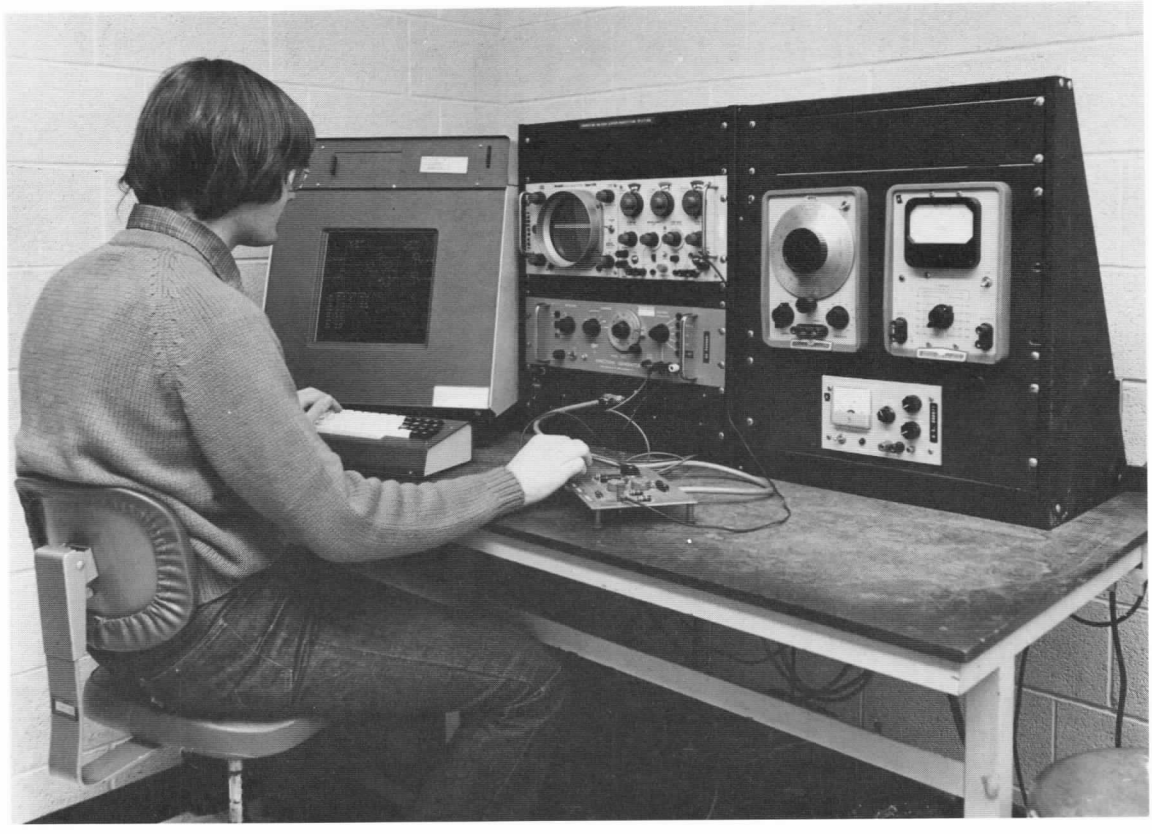
"Driver Education." (Lisa Parker)

Figure 3-14. Microfiche Slides Used in PLATO Lessons (Cont'd)

MULTIMEDIA DEVICE AND RESEARCH-TOOL CONNECTIONS

The basic PLATO terminal has auxiliary connectors for attaching optional multimedia and external data-collection devices. For example, a random-access audio device (currently under development) can store about 22 minutes of speech, music, or other sounds. This material can be played back to the student, upon computer command, during any author-specified section within a lesson. Other possibilities for future connection to a PLATO terminal might be multimedia devices for voice synthesis and recognition.

Additionally, the external output connectors at the back of the PLATO terminal can attach the terminal to an almost limitless variety of research/laboratory tools. These external tools, then, become part of a PLATO lesson, thus enriching the whole laboratory experience for the student. Figure 3-15 shows a PLATO terminal being used with attached laboratory tools and a few typical displays from an electrical engineering lesson; PLATO uses external data from the laboratory tools as part of the lesson.



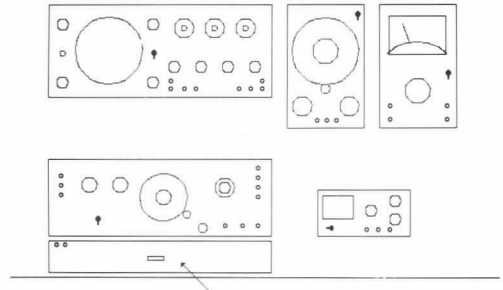
The CGE-PLATO Interface Logic System enables any author to order the automatic sensing of the interconnections between 30 terminals on the rack-mounted equipment or on the currently-used circuit board and/or the settings of 22 of the dials, knobs, or switches on the equipment.

The panel layout of the present CGE station is illustrated in the next display. The present CGE rack-mounted instruments are:

Analab Dual-trace Scope Type 1120 and Plug-In Type 700
Exact Function Generator Type 251
Hewlett-Packard Audio Oscillator Model 200AB
HP Vacuum Tube Voltmeter Model 400D
Harrison Lab. Model 865B Power Supply

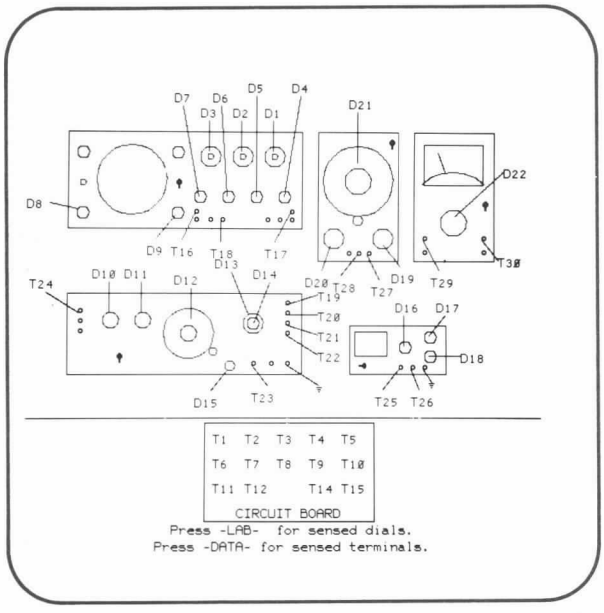
The CGE-PLATO Interface Logic System is mounted behind the instrument rack panel, beneath the Function Generator.

On the next display, the automatically-sensed terminals may be identified by T numbers, and the automatically-sensed dials may be identified by D numbers.



Location behind the panel of the complete and operable CGE-PLATO Interface Logic System

Figure 3-15. Example of External Laboratory Tools Used in a PLATO Lesson



(James Neal)

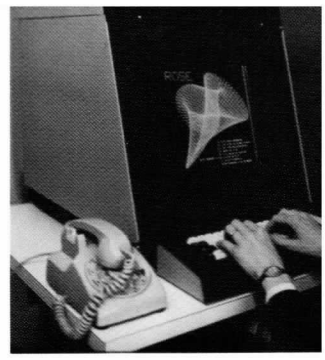
Figure 3-15. Example of External Laboratory Tools Used in a PLATO Lesson (Cont'd)

TERMINAL CAPABILITIES COMBINED

The CDC PLATO Terminal's capabilities for displaying lesson-generated material, displaying color images, collecting external data for use in a lesson, and using the keyboard and touch panel can be employed in any combination. Thus, when the appropriate terminal delivery media are orchestrated into a well-planned lesson, a significant advance in educational delivery is realized. The variety of types of interaction and reinforcement, together with the capacity for individualization and self-pacing, makes for a powerful learning experience.

4

FEATURES OF THE CDC PLATO SYSTEM



The CDC PLATO System incorporates special software features designed specifically to assist and personalize interactions between users and to aid in curriculum development, control, and administration. Depending on the user's function and role in the PLATO system (refer to section 2, The User and CDC PLATO), some or all of these system tools are available.

COMMUNICATIONS FEATURES

The PLATO system offers two basic forms of interactive communication:

1. Two users can communicate directly with one another from their respective display terminals when both are on-line, simultaneously.

2. System users can leave notes, messages, and/or announcements in the system for which they may or may not request a response.

Through two special features, actual terminal-to-terminal (on-line) communication between two users is established. Figure 4-1 shows representative examples of these communication features.

Typically, an author could use the talk feature to discuss a lesson problem with an instructor. Once the feature is active, it asks the author for the name of the instructor he wishes to talk to. The system then pages the instructor to determine if that instructor is working at a PLATO terminal. The instructor accepts the call, and the author and the instructor can then talk to each other at the bottom of the display screen – but neither can see what is on the other's screen. However, if the author wants the instructor to see his entire display-screen, both the author and the instructor can see the author's display (similar to the 'consult' feature).

The 'consult' feature notifies a PLATO consultant on the system of a user's (typically an author) request for help. (PLATO consultants are well-versed in the PLATO author language and have a great deal of experience in helping authors.) When the consultant becomes available, he talks to the author by typing at the bottom of the author's screen like the 'talk' feature. The consultant's screen reflects the same display as the author's screen. It is as though the consultant were looking over the author's shoulder as the author demonstrates a problem in a lesson segment. The author can talk to the consultant by typing and erasing sentences and, simultaneously, the consultant can talk to the author.

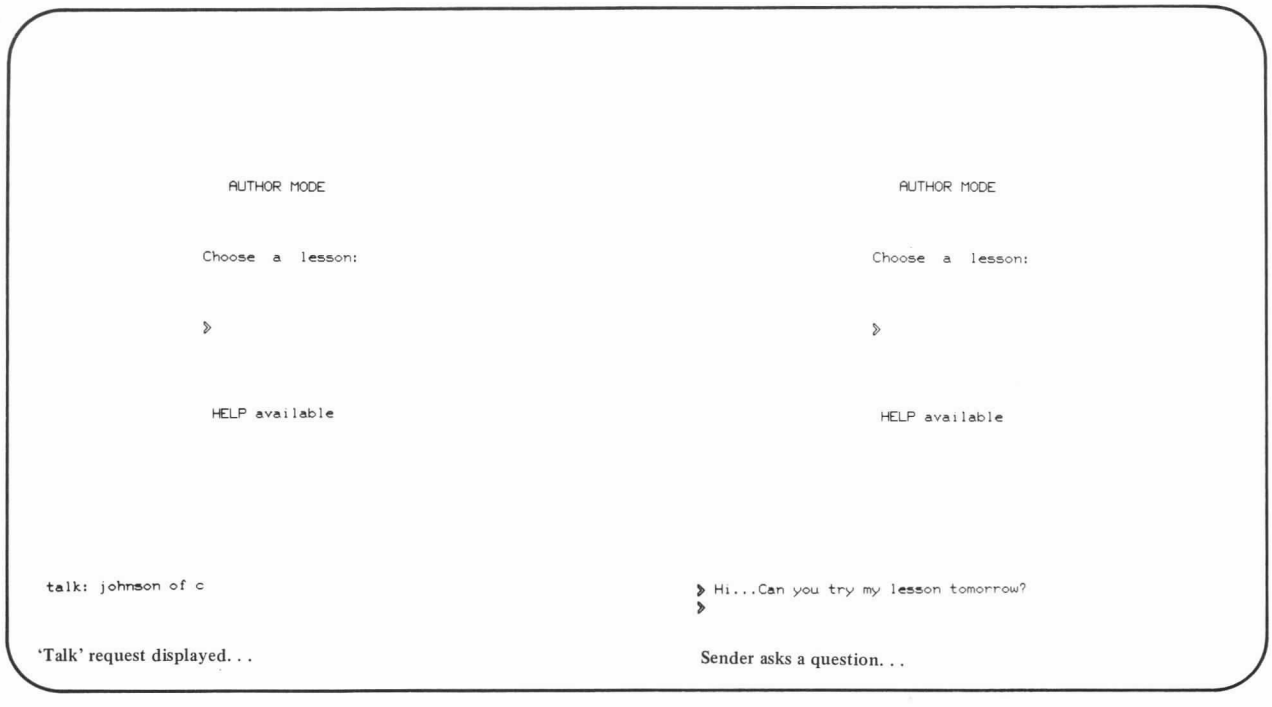
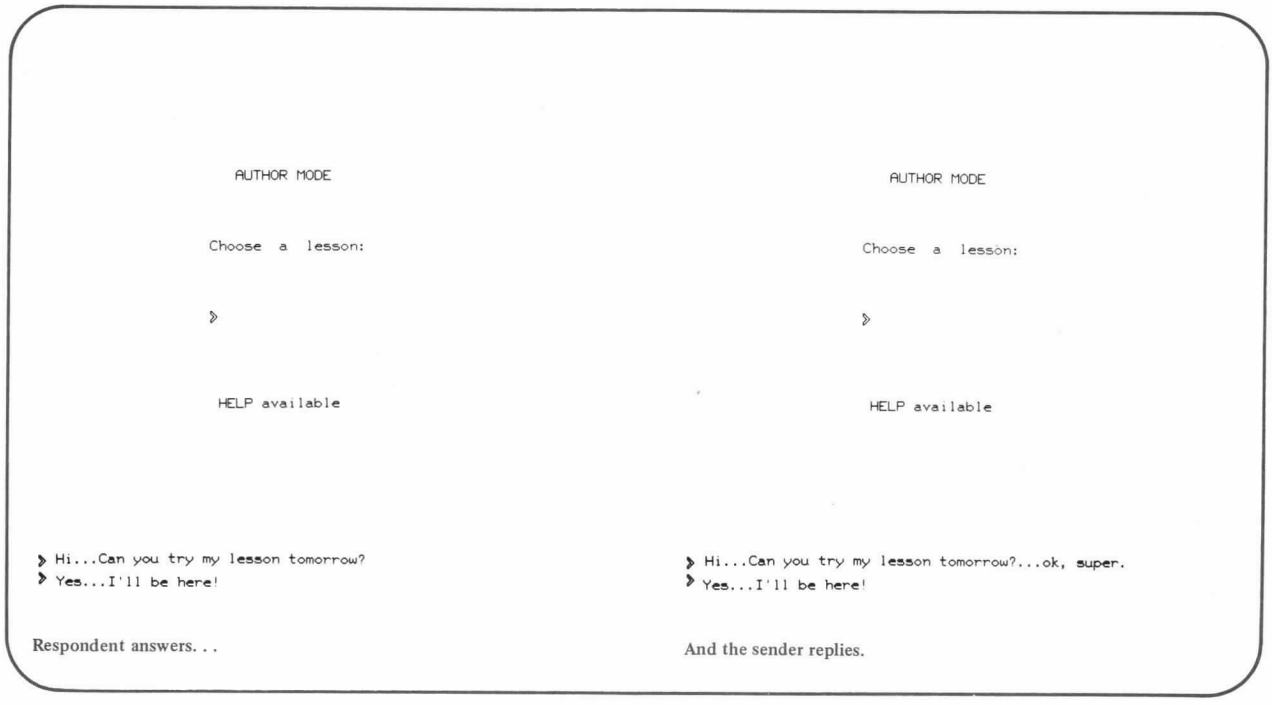
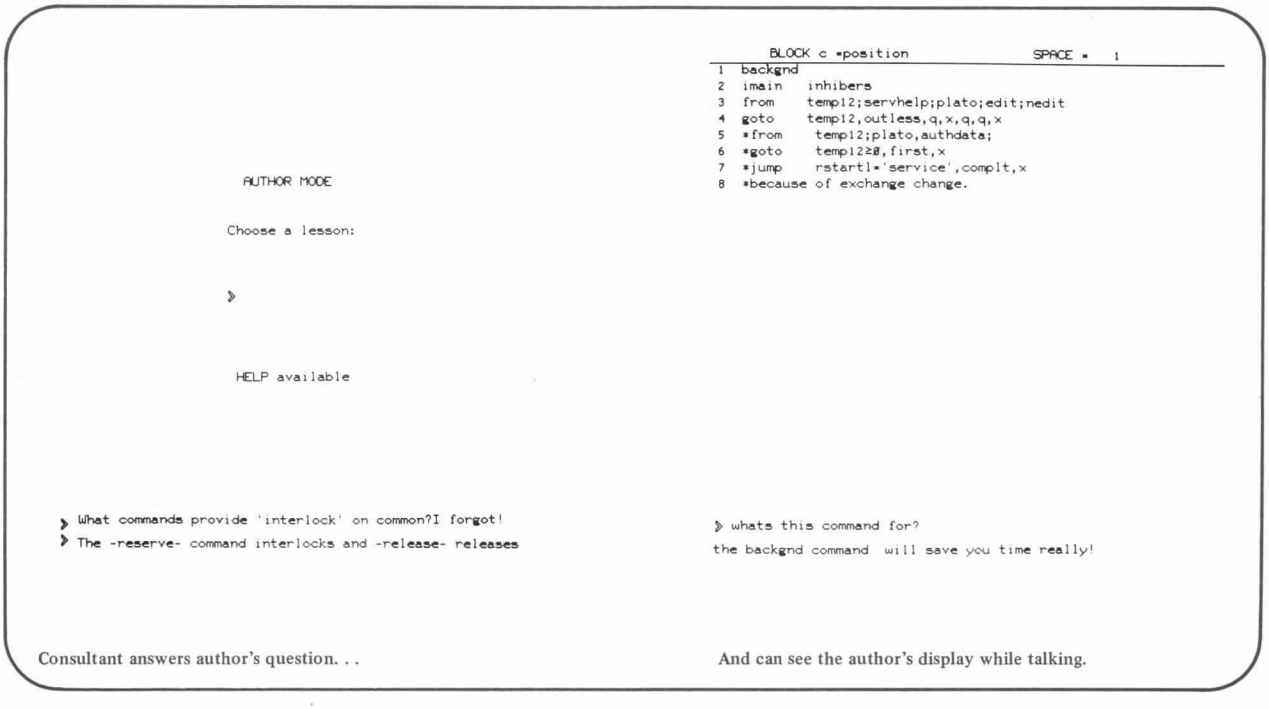


Figure 4-1. Examples of 'Talk' and 'Consult' Features



Respondent answers. . .

And the sender replies.



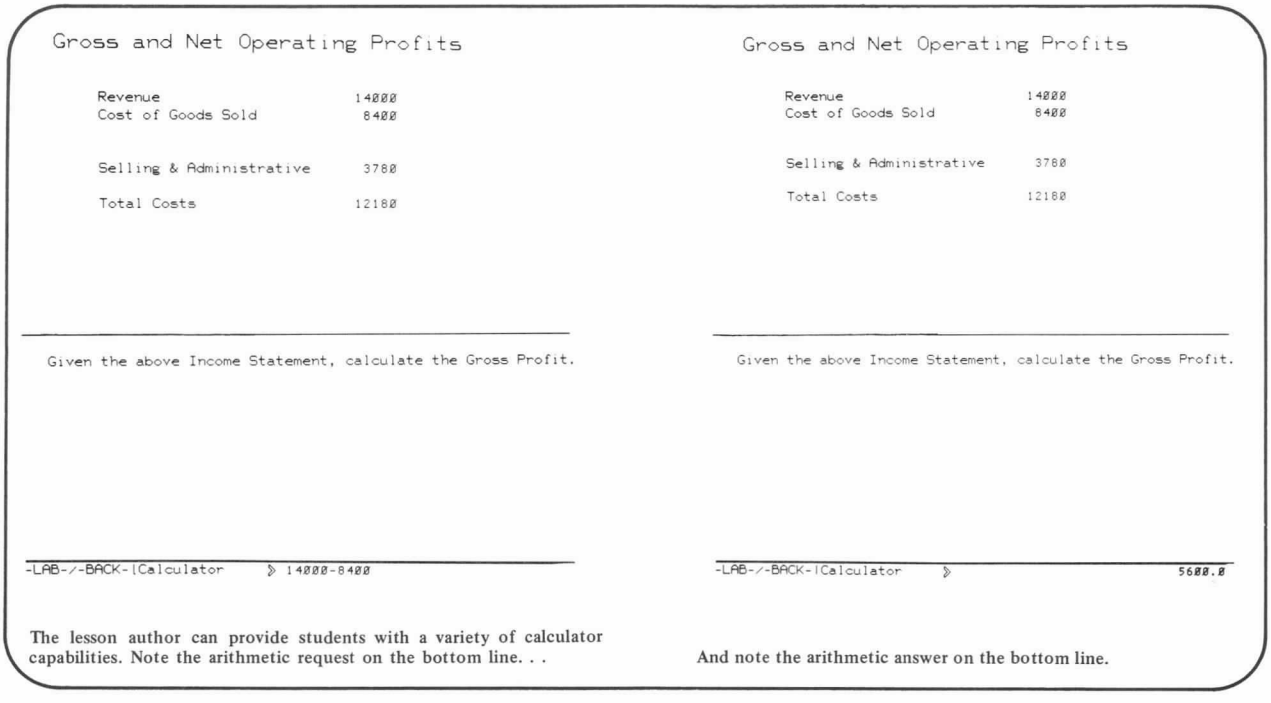
Consultant answers author's question. . .

And can see the author's display while talking.

Figure 4-1. Examples of 'Talk' and 'Consult' Features (Cont'd)

Another feature built into the PLATO system, called 'calc,' is designed to help users solve mathematical problems (refer to figure 4-2). A system-to-terminal feature, 'calc' uses the system's ability to perform calculations. All expression entries are made by using conventional mathematical notation.

'Calc' feature as used by an author.



The lesson author can provide students with a variety of calculator capabilities. Note the arithmetic request on the bottom line. . .

And note the arithmetic answer on the bottom line.

Figure 4-2. 'Calc' Feature Highlighted

Another basic communications tool available to PLATO users is the 'notes' feature. The main purpose of this feature is to provide a cataloged collection of questions, answers, and comments about the PLATO system. For example, an author can write notes to ask questions or to suggest new features that would be helpful in his work. The author can read notes written by other users, including replies to those notes. Once accessed at the terminal, the 'notes' feature displays a list of note categories that can be examined. Figure 4-3 shows the main notes index and a few representative examples of actual notes from the PLATO system.

The categories of notes generally are defined as follows:

- Public notes, for example, may be requests for help with a specific problem. Perhaps an author has a question about a programming problem in his lesson, or he has a question about a particular PLATO author language statement he is just learning to use. Authoritative personnel, whose function it is to support PLATO users, systematically respond to these notes.

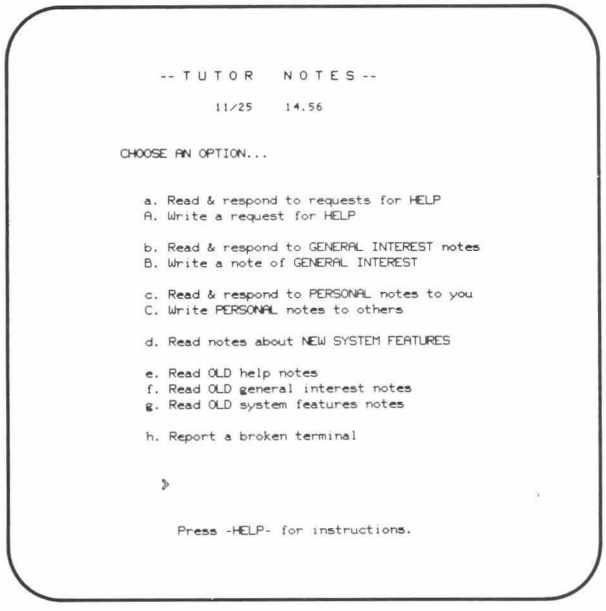
  Or a public note may be one of general interest to all PLATO system users: suggestions for new or modified instructions and procedures, and comments to policy or procedure. It should be emphasized that any author can respond to public notes.

- Personal notes are those directed to a specific user and are to be viewed only by that user. For example, an author might carry on an extended exchange with an instructor or course director about a lesson. Personal notes are a good substitute for the telephone or U.S. mail.

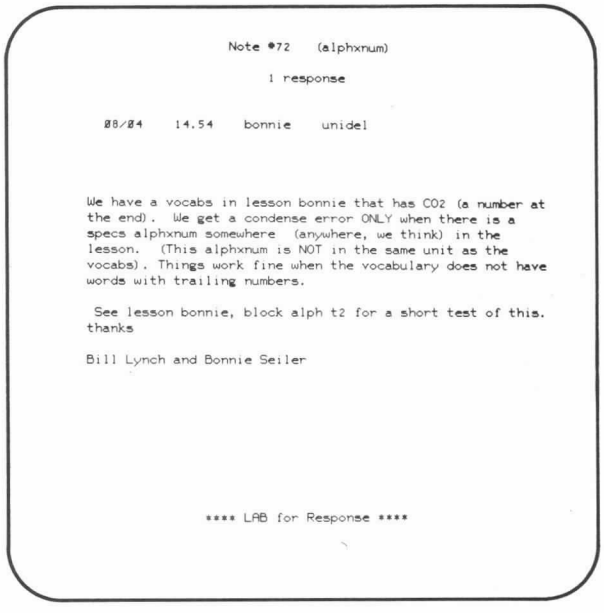
- Student notes are very helpful in student-to-instructor and instructor-to-student interactions. These notes are accessed when the student/instructor requests a specific lesson or course.

- System announcements, another form of the 'notes' feature, are directed to all authors from system personnel. These announcements include such important information as changes to the system, changes to operating procedures, new author language features or capabilities, etc.

In addition to the 'notes' capability, there is the interest-group forum. It is designed as a platform where a select audience can discuss a specific topic. A group of university professors who author lessons in physics, for example, could use their interest-group forum to announce new lessons or new PLATO methodology particularly helpful in their discipline.

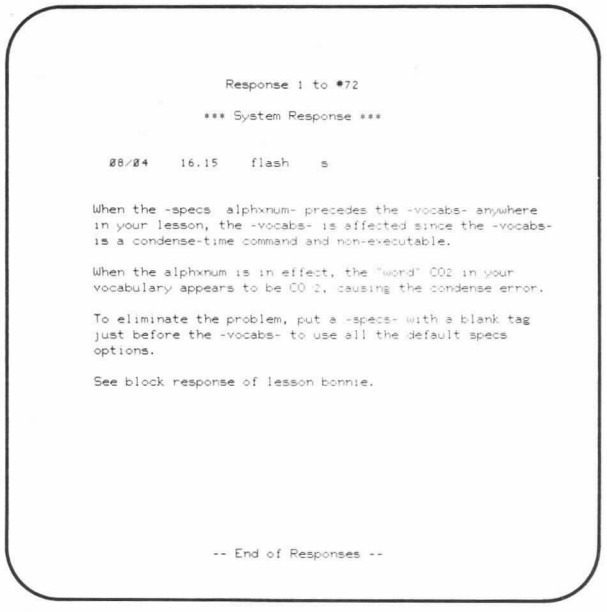


Main notes index.



A public note.

Figure 4-3. 'Notes' Feature Being Used in the CDC PLATO System



A response to the public note.

Another public note.

A system announcement.

Figure 4-3. 'Notes' Feature Being Used in the CDC PLATO System (Cont'd)

Of course, messages relevant to a specific course or the PLATO system as a whole can be broadcasted over the PLATO medium and accessed when the user signs on the system. Figure 4-4 shows examples of system-related and course messages.

Additionally, the capabilities of the CDC PLATO communications medium reach beyond the local site. It is possible to transmit system files and lessons from one PLATO system to another PLATO system, to run a terminal on either of two systems, and to transfer notes and other electronic mail between PLATO systems.

System messages appear on the Welcome page when a user signs on.

A convenient format for routine system messages.

Additionally, instructors can leave messages in a course for their students.

Figure 4-4. Example System Messages and a Course Message

One of the basic tools available to authors, instructors, and administrators in the system is the 'user' feature. When activated at the terminal, this feature displays a log of authors, who wish to be displayed, currently running on the system; it also gives a current total of active terminals on the system. On the user display, as shown in figure 4-5, three options are available:

1. The 'user' display can be updated to reflect additional users that may have signed on to the system since the display was accessed,

2. communication with another system user can be established with the 'talk' feature, and

3. access to a talk/records information page to inspect or modify the 'talk' feature options or inspect the usage statistics.

Figure 4-5. The 'User' Display

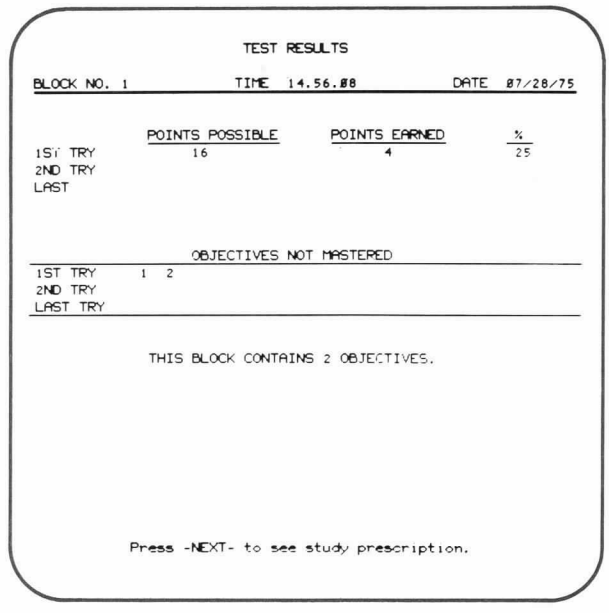
SYSTEM ADMINISTRATION

Computer-managed instruction (CMI), as defined in section 1, is a series of evaluative and prescriptive processes involving interaction between and among the student, the instructor, the education administrators, and the computer. The instructional evaluations and prescriptions are implemented in the CDC PLATO System by three basic functions: diagnostic testing, learner prescription, and generation and maintenance of records. These basic CMI functions are highlighted in figure 4-6.

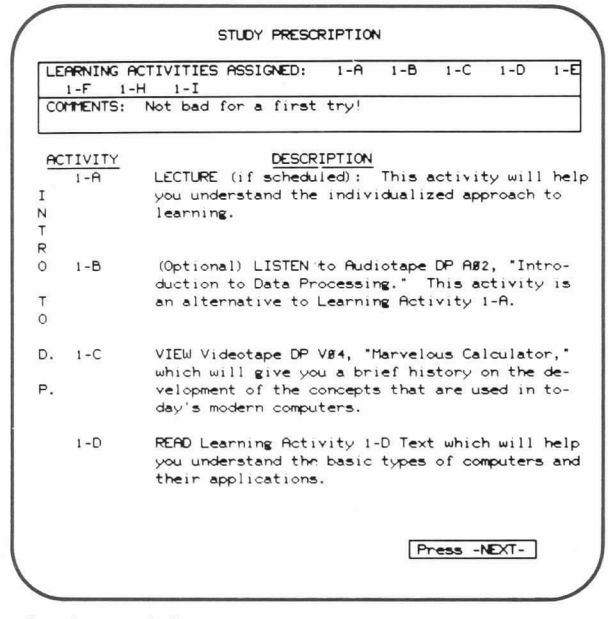
In the case of diagnostic testing, tests are tailored to the individual student's present or cumulative performance rewards in such a way that the system can diagnose and identify specific objectives that have not yet been mastered by the student.

The learning prescription concept is based on the outcome of diagnostic testing. Learning activities are recommended for those objectives yet to be mastered in such a way that the student is guided through the systematized curriculum design.

With respect to the generation and maintenance of records, the PLATO system is capable of generating records and profiles for individual students, groups of students, and individual segments of the curriculum. This allows the instructor and education administrators to examine achievement distributions and the educational effectiveness of the instructional program.

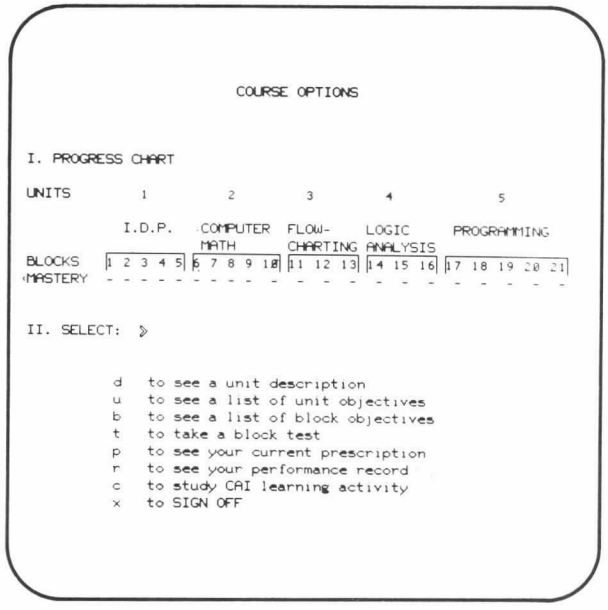


Student's test results.



Learning prescription.

Figure 4-6. CDC PLATO Basic CMI Functions



Index to student's course records.

Figure 4-6. CDC PLATO Basic CMI Functions (Cont'd)

The following paragraphs examine the primary record-management, system security, and site-control features available to the user in the CDC PLATO System.

USER RECORD MANAGEMENT

A special software routine in the PLATO system, called a router, can be used to route students through the many lessons that make up a complete course. A router is associated with a course and allows students to access the lessons assigned by the instructor, keeps track of their progress and work completed, and allows students to stop work at any point in a lesson and later resume work from that same point.

For example, a student registered in a course that uses a router is sent, upon sign-on, to the course's router, not to the lesson specified by the restart information. A typical router might ask the student, "Do you want to resume studying the lesson you last worked on?" If the student replies, "Yes," the course router takes the student to the last lesson studied. If the student says he does not want to resume studying his last lesson, the router may offer the student an index of available lessons. When the student chooses a lesson from the list, the router takes the student to the named lesson; and, upon completion of the lesson, the student is brought back into the router. The router than might ask the student what he wants to do next, or the router might immediately take the student to an appropriate lesson. Figure 4-7 illustrates displays used by authors/instructors with the router software routines.

There are two types of routers in the PLATO system: author-created routers and a system router. Author-created routers are written because of some special requirement(s) not included in the capabilities of the system router. The system router is an integral part of the PLATO system and is used typically by instructors and course directors. The following is a summary of those record-management features used in conjunction with the system router.

- Curriculum editor controls creation, modification, and deletion of the parameters used by the system router in guiding a student through the curriculum specified by his instructor. Options for this feature include: inspect or modify the list of existing lessons for use in constructing a curriculum for the course; inspect or modify lesson sequences; design or modify the index of lessons from which a student may select lessons to work on; specify criteria for advancing through the curriculum; and delete all existing index pages and sequences for the related course.

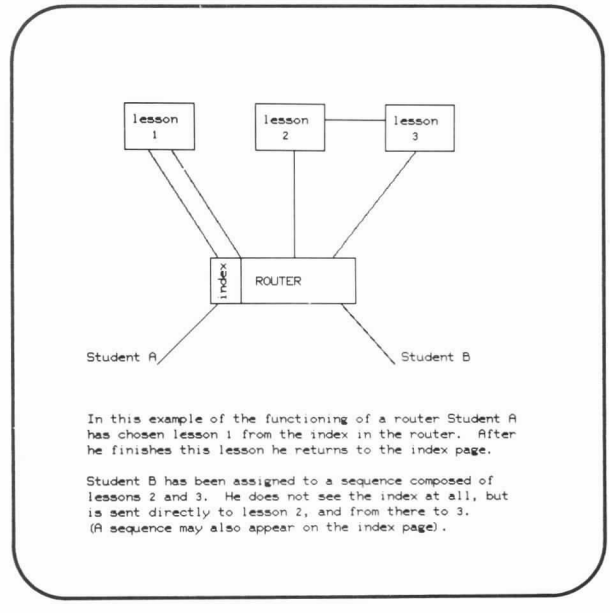
- 'Records' feature controls the basic record keeping tasks for a course and the statistics on the students in the course. Some of the principal options available with the 'records' feature are: display course roster; add and delete students from roster; display a student's record; display course users currently running; display sign-on statistics for course users; design a curriculum for the course via the curriculum editor; display a wide variety of statistical information on course users; display or modify the type of student data being collected for the course; inspect or change course description; communicate with other users on the system; create a template for the user record page; copy a record from another course; and delete all students from the course. A course roster, a curriculum summary, and a table of user statistics are depicted in figure 4-8.

- 'Data' feature controls the format and display of a variety of lesson execution information about students registered in a particular course. (Specific student-data-collection capabilities relevant to the PLATO author language are discussed in section 5.) Information collected can include:

  – a record of the time taken by a student to execute a given area of the lesson, the number of errors made, and the number of questions answered correctly on the first attempt;

  – special information selected for collection by the author of a lesson; and

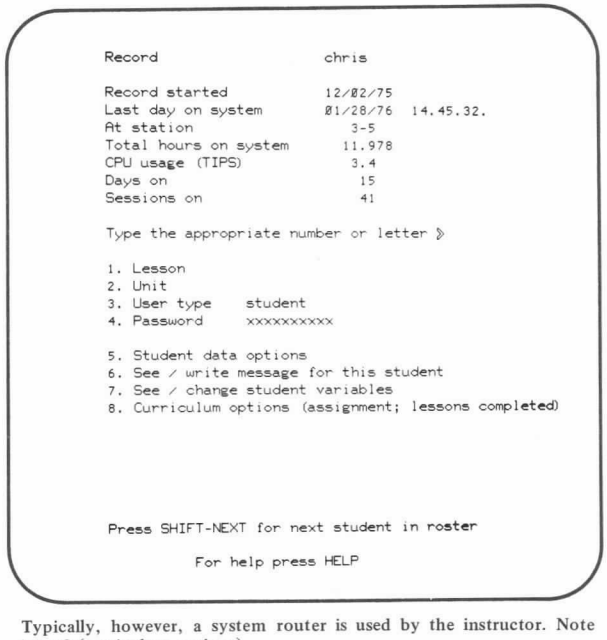
  – errors in the lesson that make it impossible for a student to continue executing the lesson.



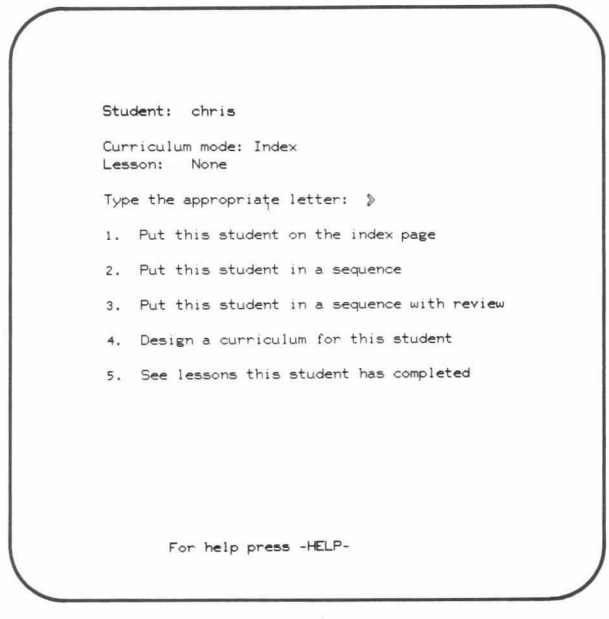
The help sequence explains router functions.

Figure 4-7. Examples of Displays Used with Routers

The author may create his own router.

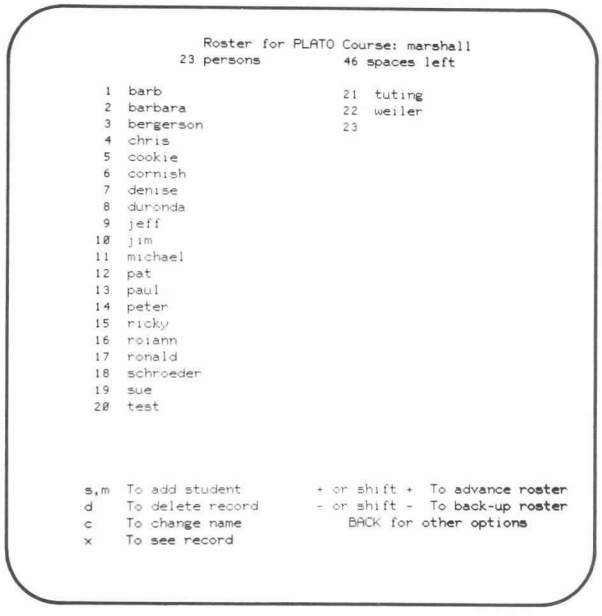


Typically, however, a system router is used by the instructor. Note item 8 (curriculum options). . .

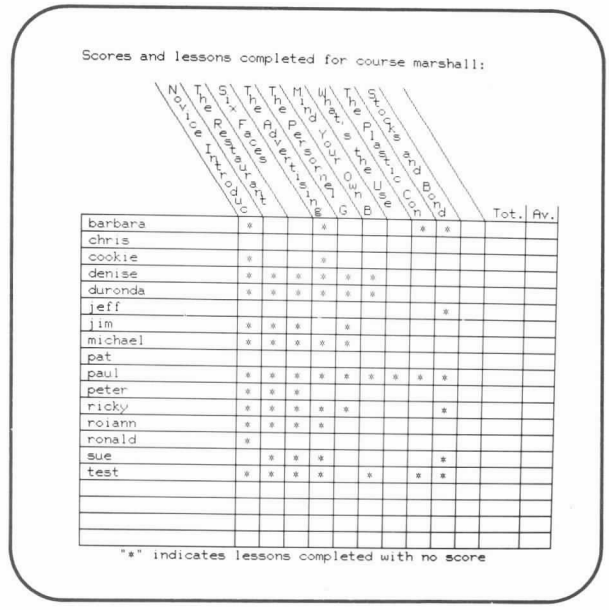


When the instructor chooses curriculum options, he can predetermine a student's path through a specified curriculum or allow the student to make his own choices.

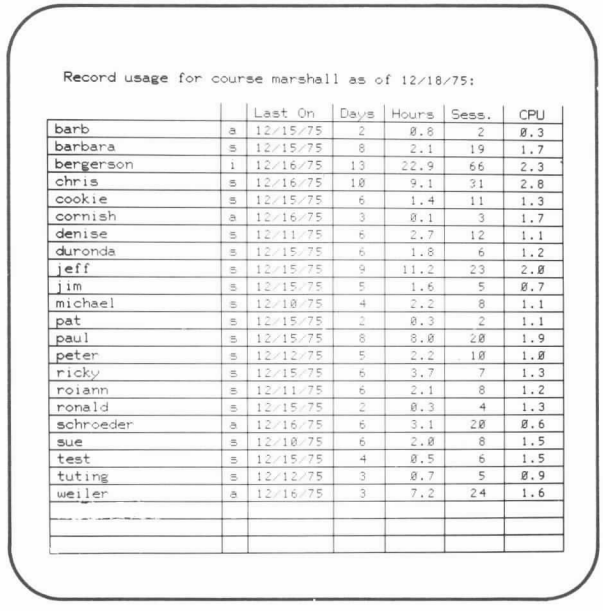
Figure 4-7. Examples of Displays Used with Routers (Cont'd)



Actual course roster.



Curriculum summary for a specified course.



		Last On	Days	Hours	Sess.	CPU
barb	a	12/15/75	2	0.8	2	0.3
barbara	s	12/15/75	8	2.1	19	1.7
bergerson	i	12/16/75	13	22.9	66	2.3
chris	s	12/16/75	10	9.1	31	2.8
cookie	s	12/15/75	6	1.4	11	1.3
cornish	a	12/16/75	3	0.1	3	1.7
denise	s	12/11/75	6	2.7	12	1.1
duronda	s	12/15/75	6	1.8	6	1.2
jeff	s	12/15/75	9	11.2	23	2.0
jim	s	12/15/75	5	1.6	5	0.7
michael	s	12/10/75	4	2.2	8	1.1
pat	s	12/15/75	2	0.3	2	1.1
paul	s	12/15/75	8	8.0	20	1.9
peter	s	12/12/75	5	2.2	10	1.0
ricky	s	12/15/75	6	3.7	7	1.3
roiann	s	12/11/75	6	2.1	8	1.2
ronald	s	12/15/75	2	0.3	4	1.3
schroeder	a	12/16/75	6	3.1	20	0.6
sue	s	12/10/75	6	2.0	8	1.5
test	s	12/15/75	4	0.5	6	1.5
tuting	s	12/12/75	3	0.7	5	0.9
weiler	a	12/16/75	3	7.2	24	1.6

Statistical information on course users.

Figure 4-8. Examples of Record-Keeping Tools Available in the CDC PLATO System

SYSTEM SECURITY (USER REGISTRATION)

The CDC PLATO System is designed to protect the integrity of all system records and files from access by unauthorized personnel. The security system is based on a user's need-to-know. A student, for example, can execute only those lessons assigned by his instructor; an author can create, modify, or destroy only that data contained in his own lessons files.

Any person about to use the PLATO terminal and system for the first time must first be registered to gain access to the system. Registration involves the submission of up to three user identification elements to the system. The user and the user's course director must decide on (1) a name by which the user is known to the system, and (2) the name of the course in which the user is registered. The course director then enters the user name in the course file. The third user identification element, the password, is optional for students, and its assignment to students is at the discretion of the related course director. Assignment of a password to an author or an instructor, however, is mandatory. If the password is required and not previously assigned, it is chosen by the user during his first pass through the sign-on sequence.

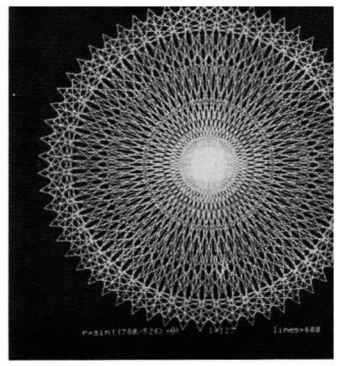
System security is also maintained by the sign-on sequence. The sign-on sequence is the identification exchange between a user and the PLATO system. This exchange determines whether or not the prospective user is allowed entry into the system (an unregistered or improperly identified user is not) and, if so, in what mode (student, multiple, author, or instructor). The sequence varies according to user category, but it is essentially the same for all users of a particular category. The sequence must be repeated each time a user accesses the system.

SITE CONTROL

A special feature, called 'site,' is available to site directors and system personnel registered in certain privileged courses. These users must first know the code word for the site. The site feature controls the following functions for a particular site: lesson reservation, course restrictions, intrasite communications (send a message to all active terminals at the site), and sign out all terminals at this site.

5

CDC PLATO AUTHOR LANGUAGE AND LESSON GENERATION FEATURES



HIGHLIGHTS

The CDC PLATO author language is one of the most important components of the PLATO system. The author language is designed for interactive, graphic use in an educational environment. As part of the PLATO system software, the author language is the vehicle by which the author creates, modifies, maintains, and improves computer-based lesson materials (courseware). The author can construct lessons, test for learning objectives, and change material directly from any PLATO plasma-display terminal. The PLATO author language, therefore, is designed specifically for interactive use between the author and the computer.

Additionally, the PLATO author language is a relatively simple language to learn, but a powerful language for controlling a complex computer system. The author language permits a person with minimum training and no previous computer experience to prepare, maintain, and improve courseware. Basic lessons can be written using only a small portion of the language's command repertoire.

The simplicity of the PLATO author language, however, does not limit its application. Since the author language has more than 200 commands in its repertoire, the ultimate complexity and flexibility of lessons are limited only by the vocabulary, ingenuity, and experience of lesson authors.

The author language is ideal for use in creating lessons that suit the various forms of computer-assisted instruction. Whether the form is drill-and-practice, tutorial, inquiry, dialogue, simulation, computer games, or problem-solving, the author finds that the comprehensive PLATO author language enables him to create the exact instruction form (or combination of forms) desired.

BASIC CONCEPTS

Lessons created by the author and administered by the PLATO system consist, in their simplest form, of a repeating sequence: a display on the student's screen followed by the student's response to this display. The display information may consist of sentences, line drawings, graphs, animations (moving displays) – most anything of a pictorial nature, and in any combination. The student responds to this display by pressing a single key (for example, the HELP or NEXT key), or by typing a word, sentence, or mathematical expression, or even by making a geometrical construction. Lesson authors provide enough details about the possible student responses so that the PLATO system can maintain a dialogue with the student. The sequence of a display followed by a response is called a unit: the basic building block of a lesson. However, often what conventionally is called the student response may be, in fact, a question or a command to the PLATO system to respond with some type of display.

The author constructs a lesson by writing one unit at a time. For each unit, the author uses the PLATO author language statements to specify:

- the display that appears on the student's screen,
- how the PLATO system is to handle student responses to this display, and
- how the current unit connects to other units.

A statement written in the CDC PLATO author language appears as follows:

write	What is your name?
command	tag

The first part of the statement (-write-) is called the command, while the remainder (What is your name?) is called the tag. Command names mnemonically represent functions of the PLATO system, and tags individualize commands for the particular function. Figure 5-1 shows an entire unit written in the PLATO author language and what a student sees on his screen while working on the unit.

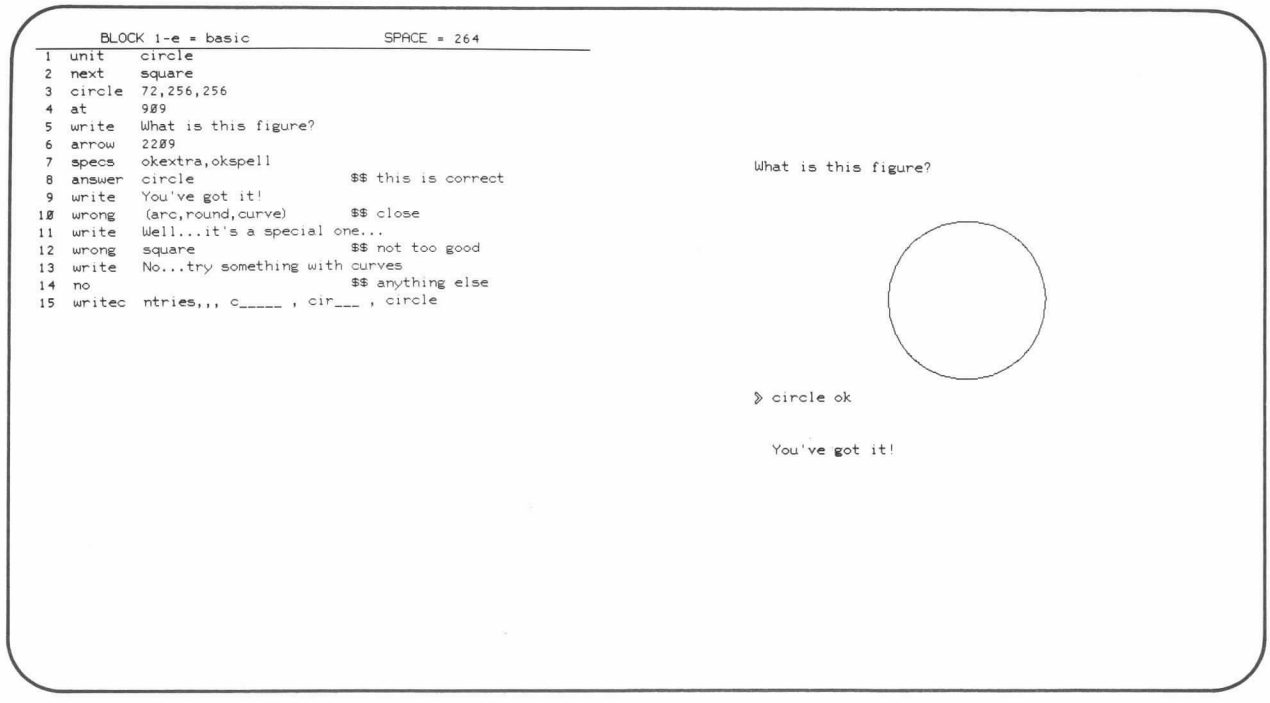


Figure 5-1. Sample Unit Written in CDC PLATO Author Language and Corresponding Display

DISPLAYS

The CDC PLATO author language includes a large number of statements for creating displays – from a simple line of text to elaborate pictures. Working at the PLATO plasma-display terminal, for example, an author can create eye-catching displays which use various sizes of characters and author-created symbols. Characters and lines of text can be written at any angle. Geometric figures and graphics also may be moved across the screen.

The displays produced by the lesson can follow instructions specified by either the author or the student. A constructed graphic display may be used, for example, to allow a student in a physics course to specify the shape and composition of an optical lens. The lesson could then produce a side view of the lens and, upon the student's request, the lesson would show the path of light rays through this model lens.

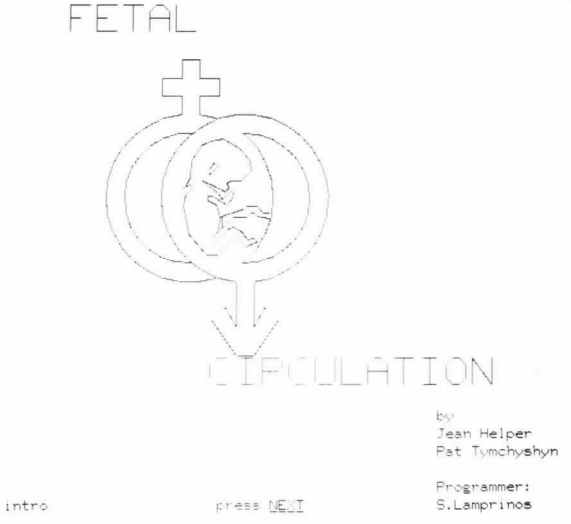
Some of the standard display functions available in the PLATO author language are:

- Position display activity (text or graphic) on the display screen in either coarse grid or fine grid.
- Display one or more lines of text.
- Conditionally display one text item or a group of items.
- Change size and angle of text.
- Construct line-drawn figures by specifying connecting points and/or points to skip to.
- Construct full circles, partial circles, and/or dashed circles.
- Construct figures that can be sized, rotated, and positioned anywhere on the display screen.
- Specify bounds outside of which line-drawn displays will not be presented.
- Erase or rewrite specified parts of the display or areas of the display screen.
- Display contents of lesson variables (numeric and/or alphabetic).
- Specify alternate character sets to be loaded into the terminal.
- Alter key(s) to be displayed when a given key is pressed on the keyboard (MICRO).
- Control timing of display presentation.
- Construct and generate graphs and charts.
- Create animated sequences.

Figure 5-2 highlights some of the displaying capabilities available in the PLATO author language.

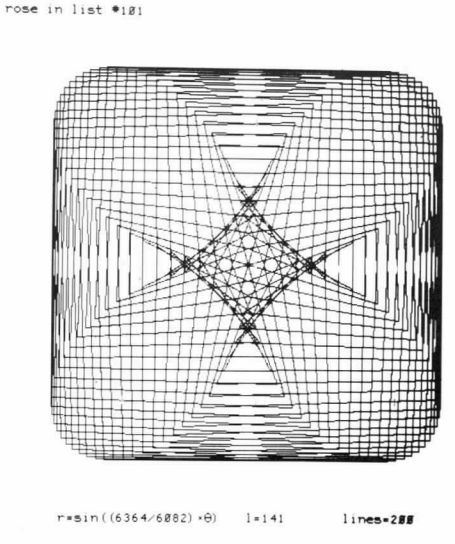
The PLATO author language also includes commands that activate and control the plasma-display terminal's optional features: touch panel, microfiche slide projector, and input from multimedia and external data-collection devices. If the PLATO terminal is equipped with a microfiche slide projector, for example, any one of up to 256 images per microfiche slide can be randomly accessed by the author's lesson and displayed on the display screen. The capability allows text, drawings, and color or black and white photographs to be superimposed onto lesson-generated information.

Change size and angle of text, and position anywhere on the display screen.



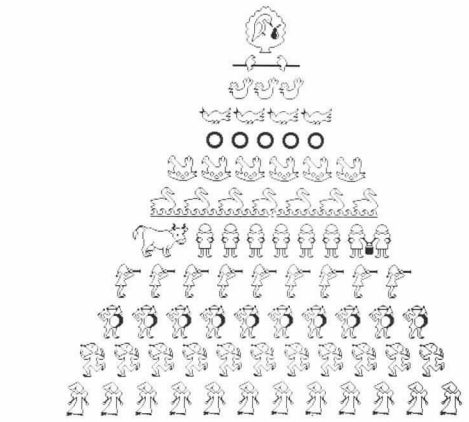
Sized writing and figure used to create an interesting title page for lesson. (J. Helper, P. Tymchyshyn, and Susan Frazer)

Construct line-drawn figures. (F. Marty)



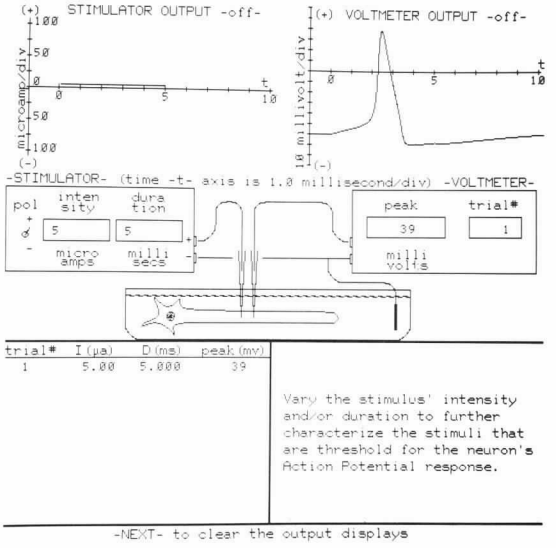
Geometric figures may be presented. (Danny Sleator)

Figure 5-2. Sample of Displaying Capabilities of the CDC PLATO Author Language



five golden rings

Specify author-created symbols for display from alternate character sets. (Lezlie Fillman)

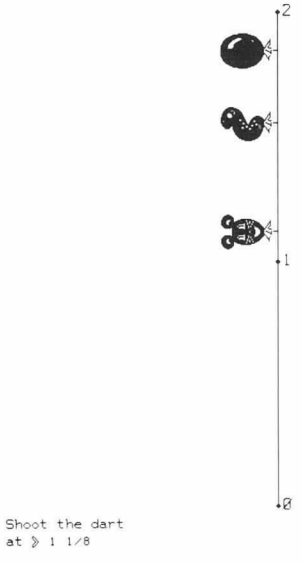


Construct and generate graphs and charts. (Russ McKown)

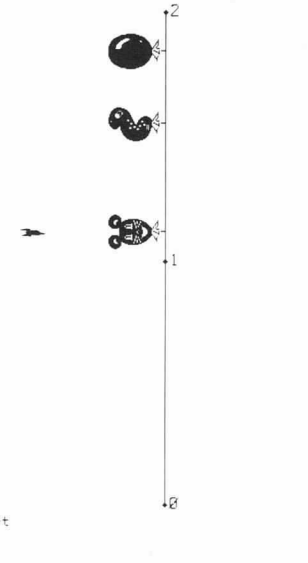
Figure 5-2. Sample of Displaying Capabilities of the CDC PLATO Author Language (Cont'd)

ANIMATION

The creation of animated sequences is an excellent example of the capabilities of the PLATO author language. Basically, specific display-type statements are combined by the lesson author to create an animated display. The lesson can construct a simple animated display, for example, by repetitively writing some text, pausing, erasing the text, and then rewriting the text in a new position on the screen. Special characters or symbols previously designed by the author to create whole pictures also can be used by the author for smooth and rapid animations. Figure 5-3 shows some typical examples of animated sequences created for PLATO lessons.

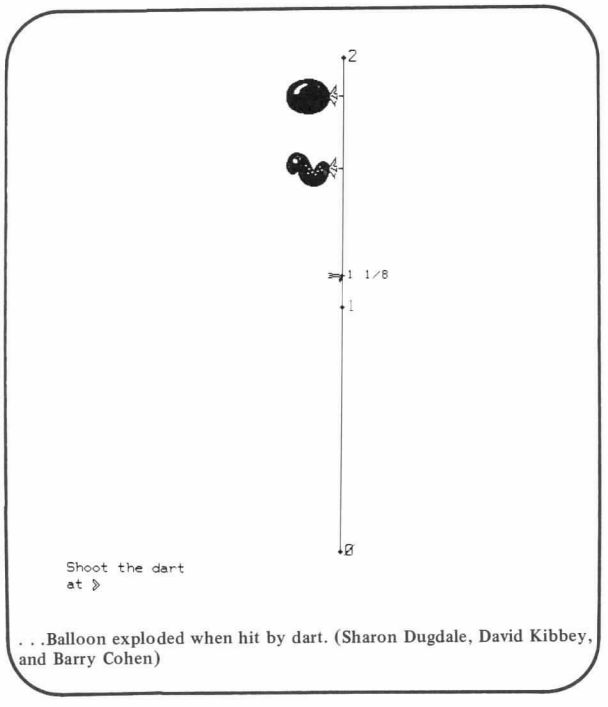


A simple animated sequence; the user is asked to shoot a dart. . .

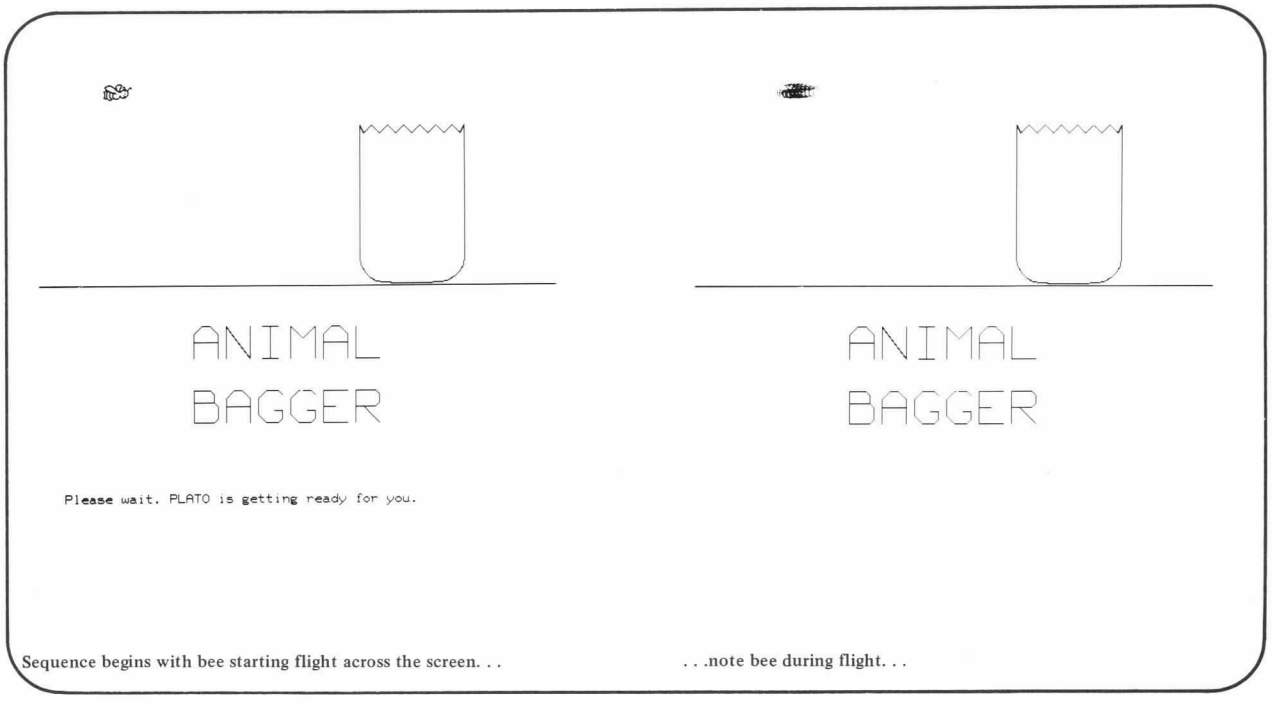


. . .Photo shows dart during animated sequence. . .

Figure 5-3. Examples of Animated Sequences Created for PLATO Lessons



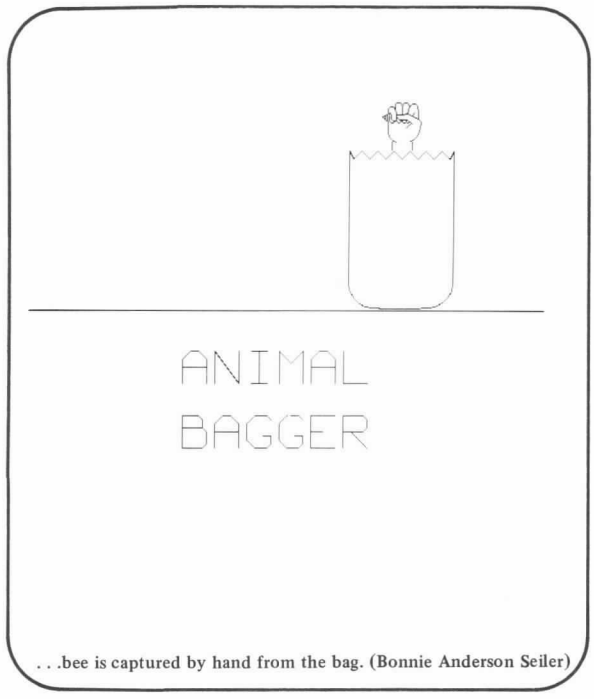
. . .Balloon exploded when hit by dart. (Sharon Dugdale, David Kibbey, and Barry Cohen)



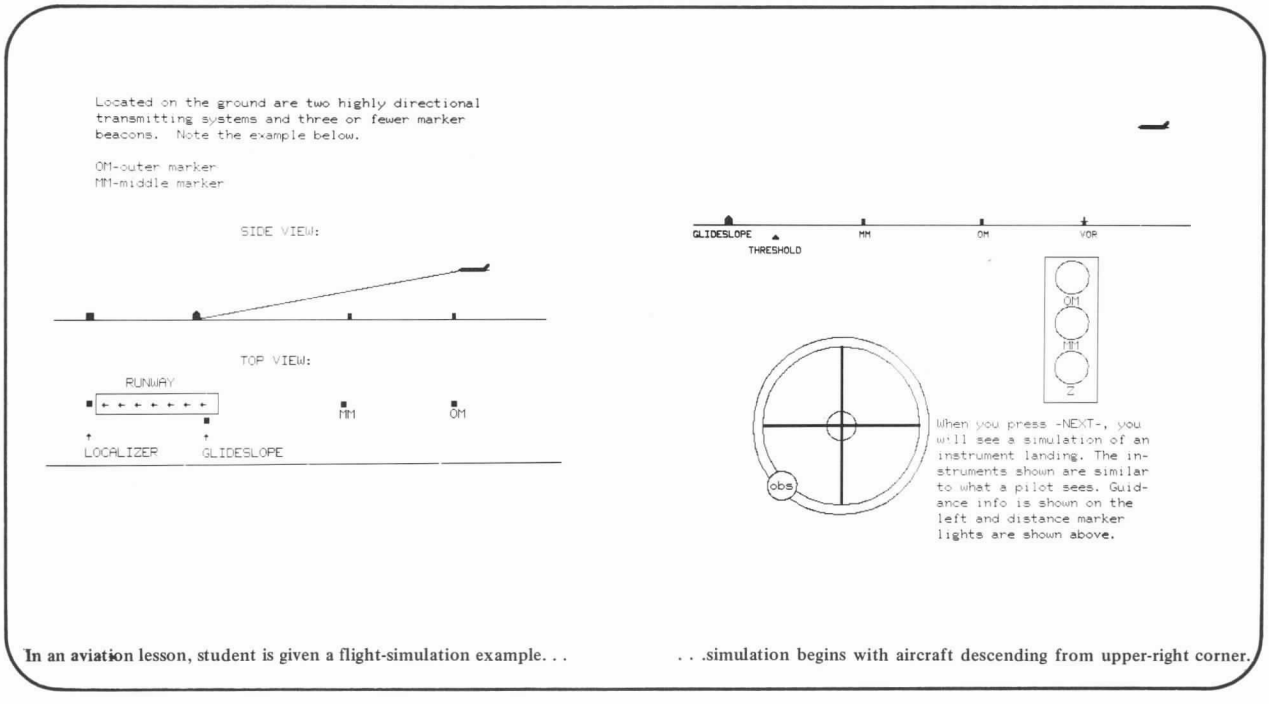
Sequence begins with bee starting flight across the screen. . .

. . .note bee during flight. . .

Figure 5-3. Examples of Animated Sequences Created for PLATO Lessons (Cont'd)



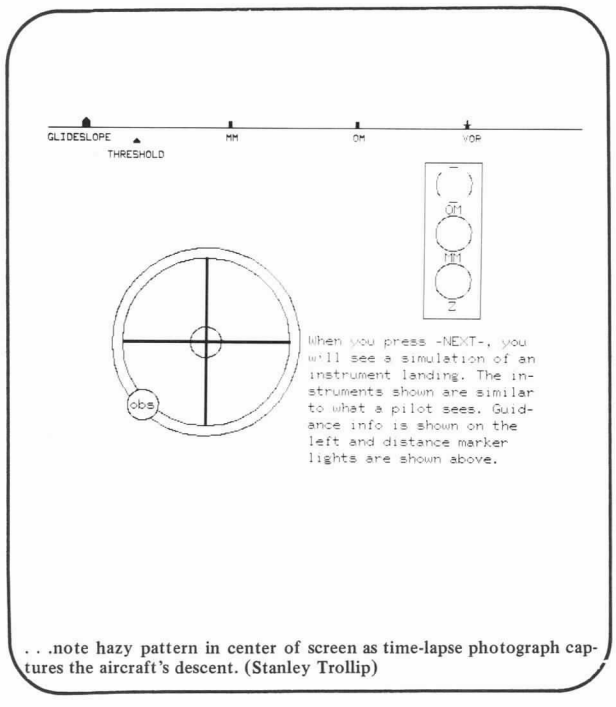
. . .bee is captured by hand from the bag. (Bonnie Anderson Seiler)



In an aviation lesson, student is given a flight-simulation example. . .

. . .simulation begins with aircraft descending from upper-right corner.

Figure 5-3. Examples of Animated Sequences Created for PLATO Lessons (Cont'd)



. . .note hazy pattern in center of screen as time-lapse photograph captures the aircraft's descent. (Stanley Trollip)

Figure 5-3. Examples of Animated Sequences for PLATO Lessons (Cont'd)

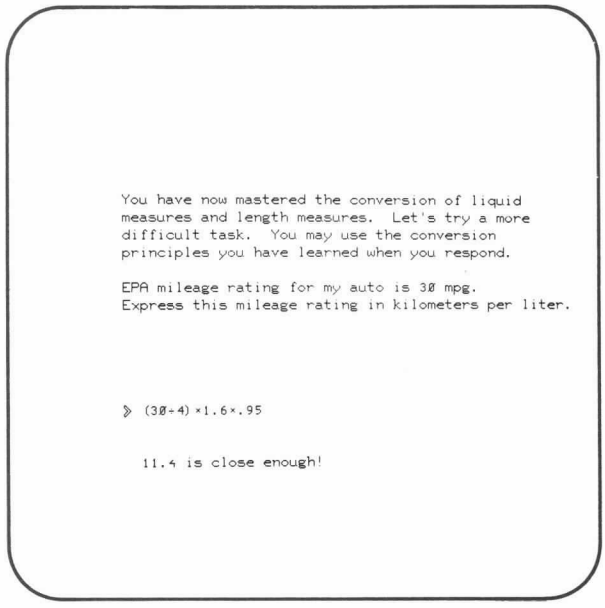
RESPONSE JUDGING

The powerful response-judging capabilities of the CDC PLATO author language enable author lessons to judge student responses with attention to capitalization, spelling, punctuation, vocabulary, and entire concept identification. Further, and more importantly, the author language allows the author to specify a wide range of criteria for acceptable and unacceptable student responses. At the simplest level, the lesson may require that the student respond in exactly one way; for example, the answer "4." The lesson also can allow the student to respond with any equivalent answer: "4," "4.0," "four," "2x2," or "8sin30^{o}." Thus, the flexibility of the language permits the author to specify the anticipated student response in one or many forms: numeric, alphabetic, or as a mathematical expression.

The PLATO author language also facilitates word-oriented response judging. The student's answer can consist of a single word, a phrase, or an entire sentence. The lesson can be directed to indicate to the student such things as possible misspellings, incomplete answers, duplicate terms in lists, incorrect words in sentences, or incorrect order of words in sentences. An author need not specify every possible form of correct answer. In certain instances, the author may let the PLATO system decide what the correct answer is. The decision would be based on rules given by the lesson author. For example, the student may be allowed to construct his own problems in addition. The correct answer would be determined by the rule "sum the addends given by the student." Additionally, a student response may not be an answer but a question. A medical student caring for a hypothetical patient, for example, might ask: "What are the results of this person's blood-serum analysis?" or "How old is the patient?" The author can construct the lesson, therefore, to allow the PLATO system to interpret these phrases and make appropriate replies.

Figure 5-4 highlights a few response-judging capabilities of the PLATO author language.

PLATO can judge a wide variety of alphabetic responses.



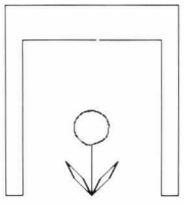
As in this example, PLATO can evaluate a wide variety of mathematical expressions in student responses.

This response is not only judged as incorrect, but the lesson also indicates misspellings, incorrect words in the sentence, and incorrect order of words.

Figure 5-4. Capabilities of the PLATO Author Language to Judge Student Responses in Lessons

Kie estas la floro?

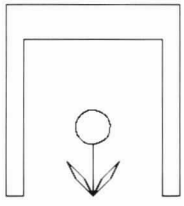
La floro estas sub la tablo.



In this Esperanto language drill in prepositions, the student first is shown the correct preposition. . .

Kie estas la floro?

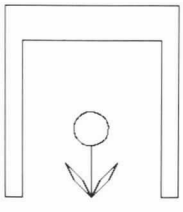
La floro estas _____ la tablo.



He then is asked to supply the missing preposition.

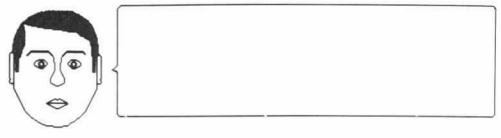
Kie estas la floro?

La floro estas sub jes la tablo.



When the student responds correctly, he is notified by "jes" ("yes" in Esperanto) and by the smiling face over the response. (Judith Sherwood)

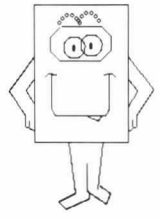
Figure 5-4. Capabilities of the PLATO Author Language to Judge Student Responses in Lessons (Cont'd)



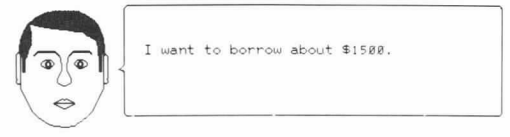
Ask Mr. Jones any question which you think is necessary for you to ask in order to give him your best advice.

» How much money do you want to borrow?

Press -DATA- if you want some hints as to good questions to ask, or if you are ready to answer my questions of you.



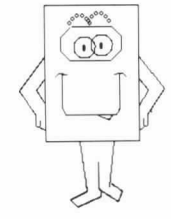
The student's response is actually a question in this lesson. . .



Ask Mr. Jones any question which you think is necessary for you to ask in order to give him your best advice.

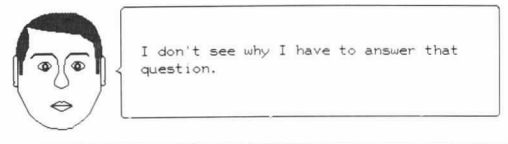
How much money do you want to borrow?

Press -DATA- if you want some hints as to good questions to ask, or if you are ready to answer my questions of you.



Press -NEXT- to ask another question.

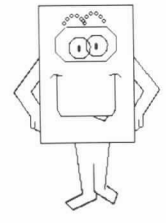
. . .and the lesson replies appropriately.



Ask Mr. Jones any question which you think is necessary for you to ask in order to give him your best advice.

What color is your hair?

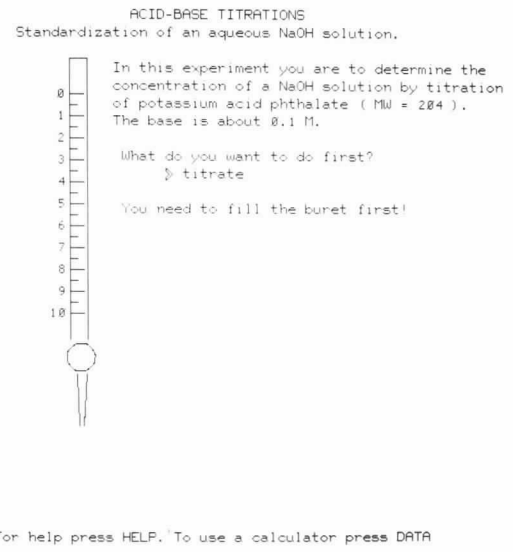
Press -DATA- if you want some hints as to good questions to ask, or if you are ready to answer my questions of you.



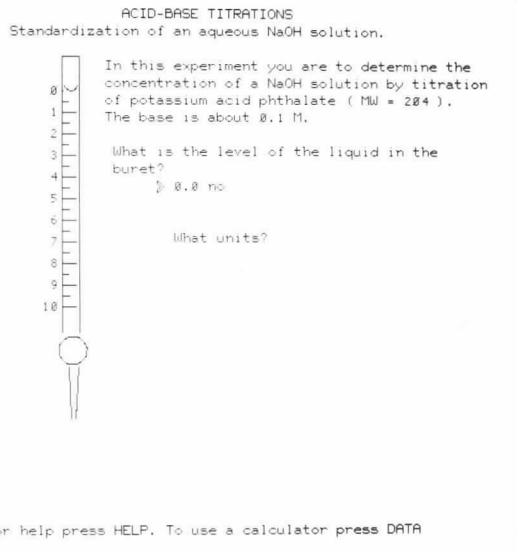
Press -NEXT- to ask another question.

In another response to a student question, the lesson judges the student's question as inappropriate.

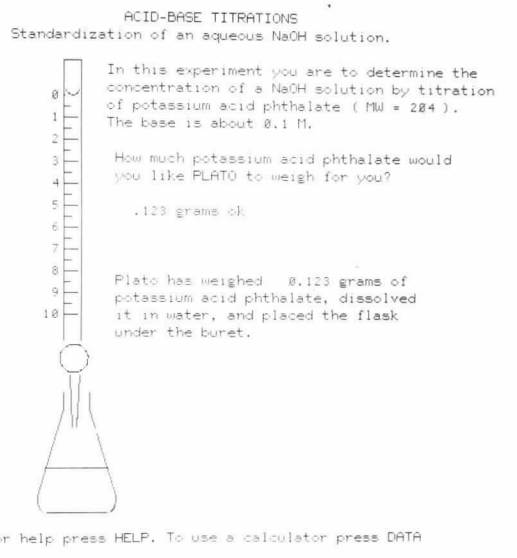
Figure 5-4. Capabilities of the PLATO Author Language to Judge Student Responses in Lessons (Cont'd)



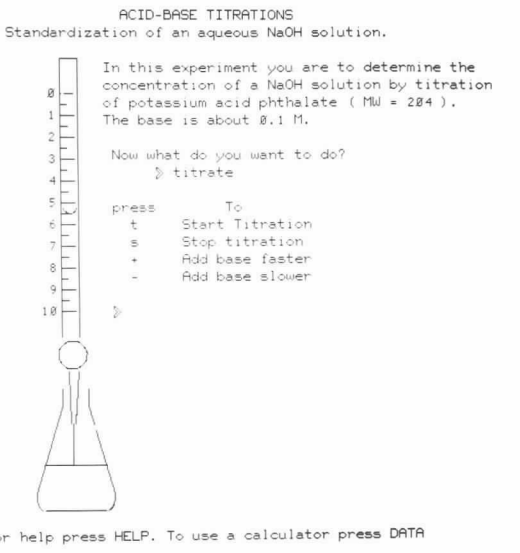
As shown in this chemistry lesson, PLATO is capable of accepting and evaluating a wide range of student responses.



. . .and, further, specifically evaluating the accuracy of student responses based on the laboratory simulation model. . .



The lesson then evaluates a correct student response, and the laboratory simulation continues with further instructions to the student.



The student then begins titration and controls the simulation model.

Figure 5-4. Capabilities of the PLATO Author Language to Judge Student Responses in Lessons (Cont'd)

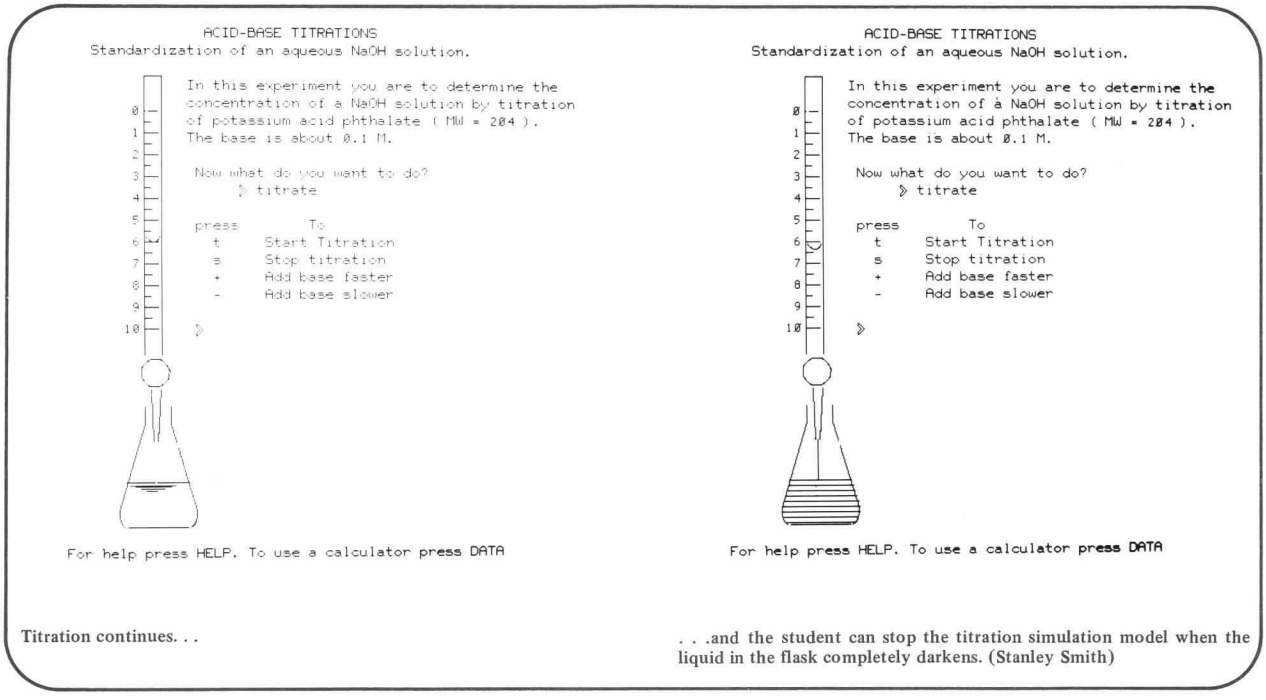


Figure 5-4. Capabilities of the PLATO Author Language to Judge Student Responses in Lessons (Cont'd)

CALCULATION

The PLATO author language is designed to understand and correctly evaluate standard algebraic expressions and notation – much in the same manner as people write them on paper. The following is a brief list of algebraic expressions and how they are evaluated by the PLATO author language:

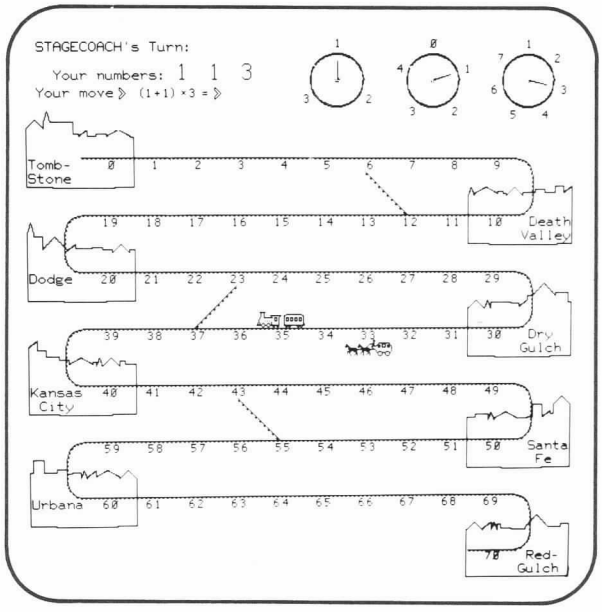
Expression	Author Language Evaluation
$3.4+5(2^3-3)/2$	15.9
2x3+8	14 (not 22)
sin(30°)	0.5
$49^{1/2}$	7
(4+7)(3+6)	99
$6/5x10^{-3}$	1200 (not $1.2x10^{-3}$)

Exponents can be specified as superscripts through use of the SUPER (superscript) key. A similar function is available for the subscript through the use of the SUB (subscript) key.

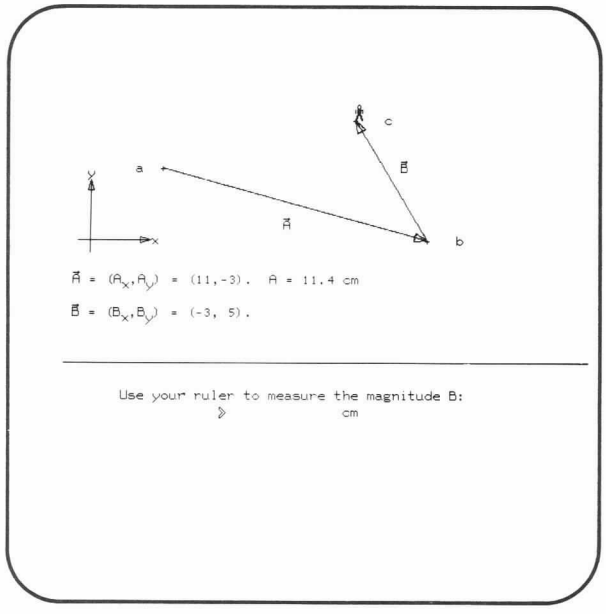
Some of the other calculation capabilities include:

- Store and use numeric information that may change in value as a lesson is executed. These special storage locations are called student variables, with 150 available for each student.
- Display the numerical value of an expression.
- Display stored alphanumeric information.
- Conditionally perform one of a list of calculations or assignments.
- Perform logical and bit operations.
- Generate random numbers (sampling with replacement or sampling without replacement).
- Perform matrix arithmetic on arrays of data (for example, a list of exam scores).

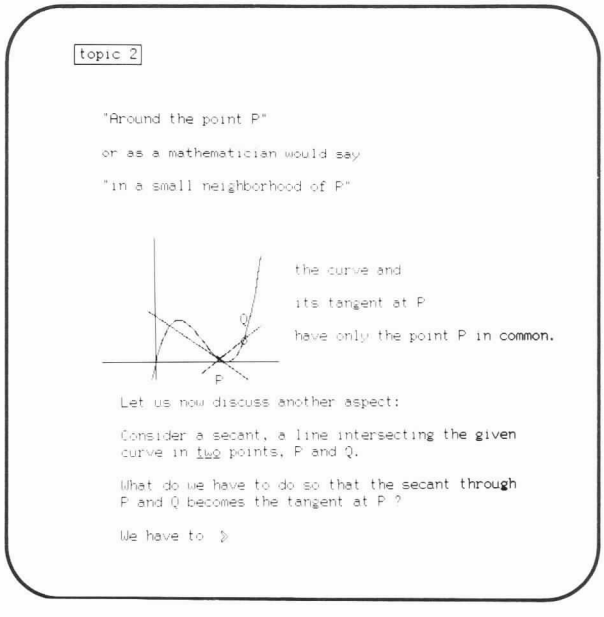
Figure 5-5 examines a few calculation capabilities of the CDC PLATO author language.



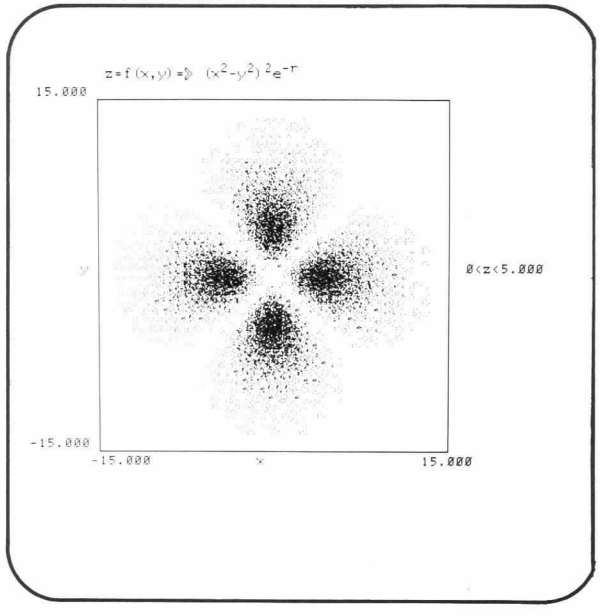
Mathematical expressions in this lesson are constructed from random numbers appearing on the spinners. (Bonnie Anderson Seiler)



The student walks a boy around the screen and measures the vector displacements. (Bruce Sherwood)

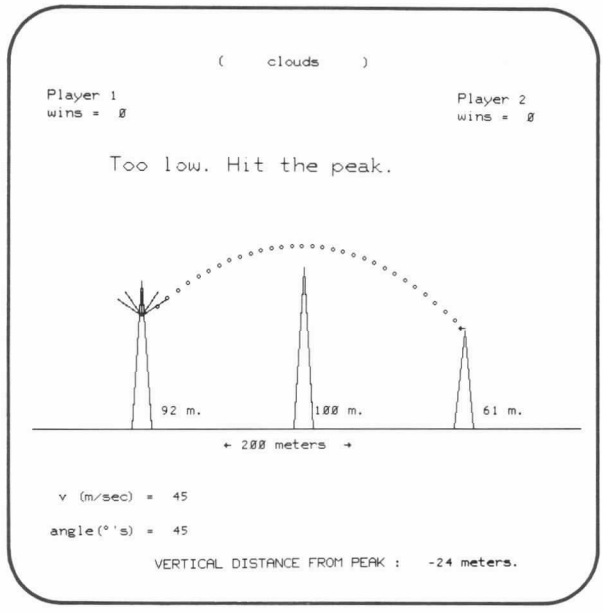


Basic principles of calculus are simulated in this tutorial lesson. (Paul Mitchell and Axel T. Schreiner)



Interesting mathematical functions can be evaluated and plotted by the PLATO system, as this lesson example demonstrates. (Bruce Sherwood, based on an idea of Arthur Luehrmann)

Figure 5-5. Calculation Capabilities of the CDC PLATO Author Language



Computer games are an interesting adjunct to physics concepts. Note the calculations performed. (Carol Bennett)

Figure 5-5. Calculation Capabilities of the CDC PLATO Author Language (Cont'd)

BRANCHING ON DECISIONS

Flexibility within a lesson can be achieved when the author/instructor uses the many branching capabilities of the CDC PLATO author language. Sequencing statements, for example, help the author/instructor individualize his lesson. And the conditional forms of appropriate author language commands cause branching within a lesson based on criteria established by the author or instructor.

There are two types of branching: author-initiated and student-initiated. Author-initiated branching usually is used for moving between sequences of main lesson units, with the student possibly specifying those sequences that are to be executed next. Branching based on student performance allows the author, if desired, to send the student back to review material already covered or to an entirely different sequence of activities. For example, as shown in figure 5-6, an author may want to check unit C for errors made by the student in units N, O, and P. If the student makes more than 10 errors, he is returned to unit B for review. If two or less errors are made, the student is advanced to unit D. And, if the student makes three to 10 errors, he goes to unit R.

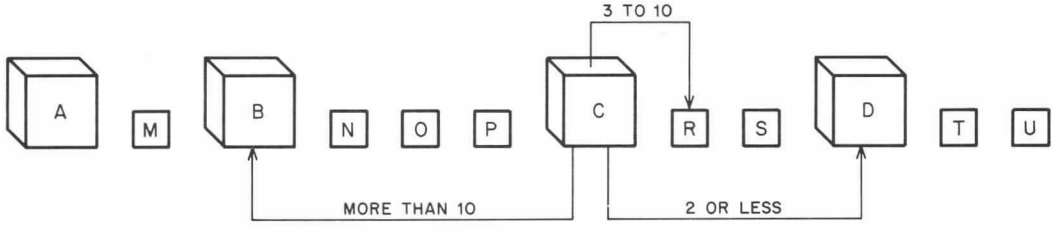


Figure 5-6. Example of Author-Initiated Branching Structure in a Lesson

Further, the PLATO author language allows the author to give a student the ability to branch within a lesson. Certain author language instructions activate the black function keys on the terminal keyboard: HELP, LAB, DATA, etc. When the author specifies these keys, as shown in figure 5-7, the student can branch into a sequence of help units or edifying information by pressing the appropriate key. Upon completion, these informative sequences usually return the student to the unit from which the help sequence was entered.

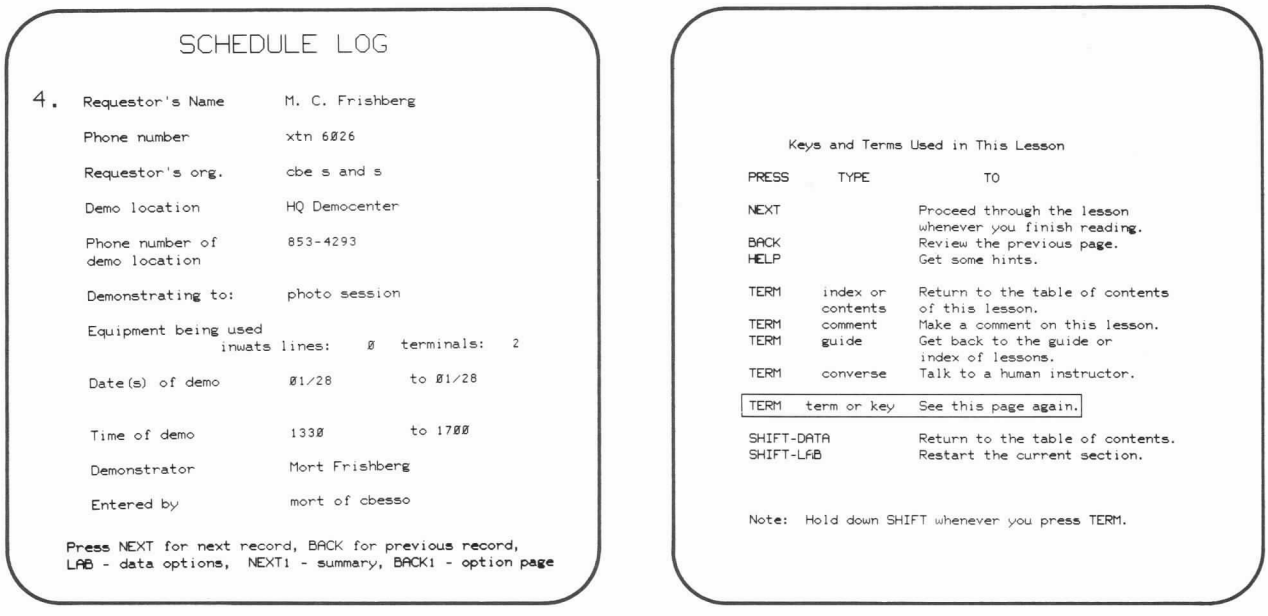


Figure 5-7. Key-Activated Sequences Available to Students from Actual PLATO Lesson

Student-initiated branching, therefore, permits the lesson to more satisfactorily fit the needs of an individual student by providing additional information or remedial background information. Figure 5-8 shows, for example, how from unit B the student gets help from units R and S or gets some background information in unit M. The PLATO lesson remembers to take the student back to unit B when he is finished with the information requested with the HELP or DATA key.

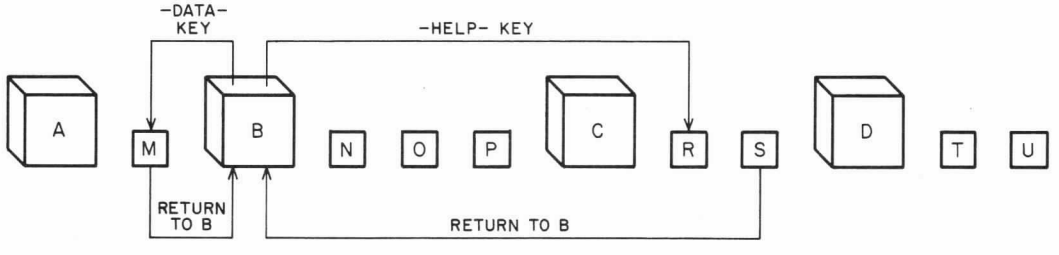


Figure 5-8. Example of a Student-Initiated Branching Structure in a Lesson

STUDENT DATA COLLECTION

The PLATO author language enables the author to collect data on student performance in a lesson, or in parts of a lesson. Detailed information can be collected: unanticipated "wrong" responses (which may have been correct but inadequately judged), requests for help, words not found in an author-specified vocabulary, etc. Summary information also can be collected: amount of time spent in an area of the lesson, number of correct and incorrect responses, number of times help was requested, etc. This detailed and summary data provides the author with an objective basis for improving and revising lessons. Figure 5-9 shows examples of some actual forms of data collection.

Tabulated:
Ø1/28/76

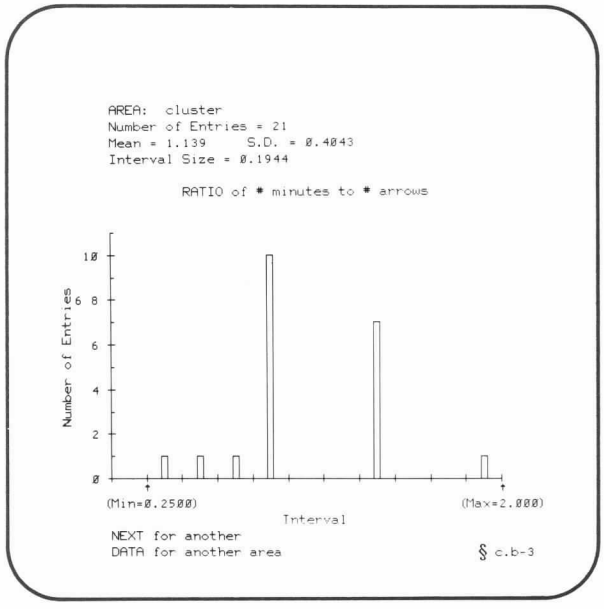
Course pmals.

LESSON USAGE. Page 1. Group Ø=all.

lesson	# of stud.	total time (min)	avg. stud. time	avg. comp. time	total arrows	%ok on first answer	#no per arrow	#int. per min
	3	23.5	7.83	14.5	19	57.9	Ø.63	1.3
anda	1	1.9	1.9Ø	1.9	2	5Ø.Ø	1.ØØ	2.1
deal	1	15.2	15.2Ø	15.2	1Ø	5Ø.Ø	Ø.7Ø	1.2
frca	1	1.9	1.9Ø	1.9	Ø	Ø/Ø	Ø/Ø	Ø.Ø
frcb	1	4.6	4.6Ø	4.6	2Ø	8Ø.Ø	Ø.45	6.3
frcc	1	1.4	1.4Ø	1.4	2	1ØØ.Ø	Ø.ØØ	1.4
frcd	1	17.8	17.8Ø	Ø.Ø	18	88.9	Ø.17	1.2
frce	1	3.7	3.7Ø	3.7	6	66.7	Ø.5Ø	2.4
frcf	1	6.Ø	6.ØØ	6.Ø	Ø	Ø/Ø	Ø/Ø	Ø.Ø
frcg	1	Ø.8	Ø.8Ø	Ø.8	2	1ØØ.Ø	Ø.ØØ	2.5
frch	1	7.3	7.3Ø	7.3	16	81.3	Ø.5Ø	3.3
frci	1	6.4	6.4Ø	6.4	17	88.2	Ø.24	3.3
hoice	29	1Ø43.6	35.99	8.6	3624	82.1	Ø.35	4.8
molecul	29	243.Ø	8.38	5.5	727	79.9	Ø.25	3.6
nstable	1	14.Ø	14.ØØ	Ø.Ø	13	46.2	1.77	2.4
ntro	44	116.9	2.66	2.1	119	3[illegible].Ø	Ø.4Ø	1.Ø
onideal	1	3.7	3.7Ø	3.7	6	83.3	Ø.17	1.9
quations	2	17.8	8.9Ø	16.Ø	14	71.4	Ø.43	1.Ø
ractice	3	12.3	4.1Ø	Ø.Ø	13	69.2	1.77	3.1
rill	5Ø	1343.Ø	26.86	21.3	7533	62.9	Ø.6Ø	9.Ø
snb	1	4.9	4.9Ø	4.9	1Ø	7Ø.Ø	Ø.3Ø	2.Ø
snba	1	4.Ø	4.ØØ	4.Ø	5	8Ø.Ø	Ø.2Ø	1.5
snbh	1	15.5	15.5Ø	15.5	24	54.2	Ø.71	2.6

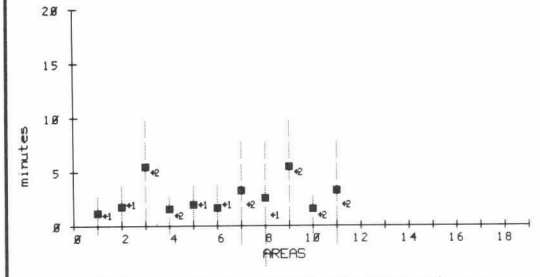
=m Press NEXT for more, BACK to quit.

Raw statistical data on lessons. (Tamar A. Weaver, R.A. Avner, and Steven Boggs)



Graphic summary showing information about an area of a lesson. Ratio of two variables shown. (Kumi Tatsuoka, Martin Siegel, and R.A. Avner)

	AREAS	Mean	S.D.	N	1Ø rotate	1.6	1.2	25
1	scatt	1.2	1.2	44	11 config	3.3	4.3	23
2	cluster	1.8	Ø.7	21				
3	method	5.5	4.8	35				
4	rotate	1.6	1.2	25				
5	variance	2.Ø	1.1	21				
6	totalvar	1.7	1.Ø	23				
7	config	3.3	4.3	23				
8	reliab	2.6	5.3	31				
9	method	5.5	4.8	35				



Numbers on the horizontal axis represent areas.
■ is the average for the area
+n is the nth entry of shapiro in the area
| is the range for 68% of the students
NEXT for more areas DATA for another option § b.c.a.NEXT.a-2

Graphic presentation showing the relationship between the average student time required to study each area of the lesson and the time required by a specific student to study each area of the lesson. (Kumi Tatsuoka, Martin Siegel, and R.A. Avner)

Figure 5-9. Student-Data-Collection Capabilities Highlighted

ON-LINE ASSISTANCE TO AUTHORS

A special on-line lesson, called 'introtutor,' is resident in the CDC PLATO system. This lesson is designed as an interactive part of an overall training program in the PLATO author language for new authors. Once an author has completed this introductory program, he always has ready access to lesson 'introtutor' for review of the basic author-language principles.

Lesson authors also can receive valuable on-line help when creating PLATO lessons. The author can call up special features on his terminal that are specifically designed to assist in lesson preparation. Some of the areas in which special assistance is available are: graphics and animation, design of special characters, student response judging, branching the student, collecting and analyzing student data, and others. Help sequences for authors are built into all PLATO special features.

Additional on-line help for authors is available from 'aids' – a comprehensive, on-line reference source about the PLATO author language and its use. An overview of all areas of the author language, complete descriptions of the author language statements, summary lists of the statements, and other information about the PLATO system can be found in the 'aids' package. Figure 5-10 highlights an actual author language statement as described in 'aids.'

Finally, all of the communication features ('talk,' 'consult,' and 'calc') and the 'notes' feature are always available to the author.

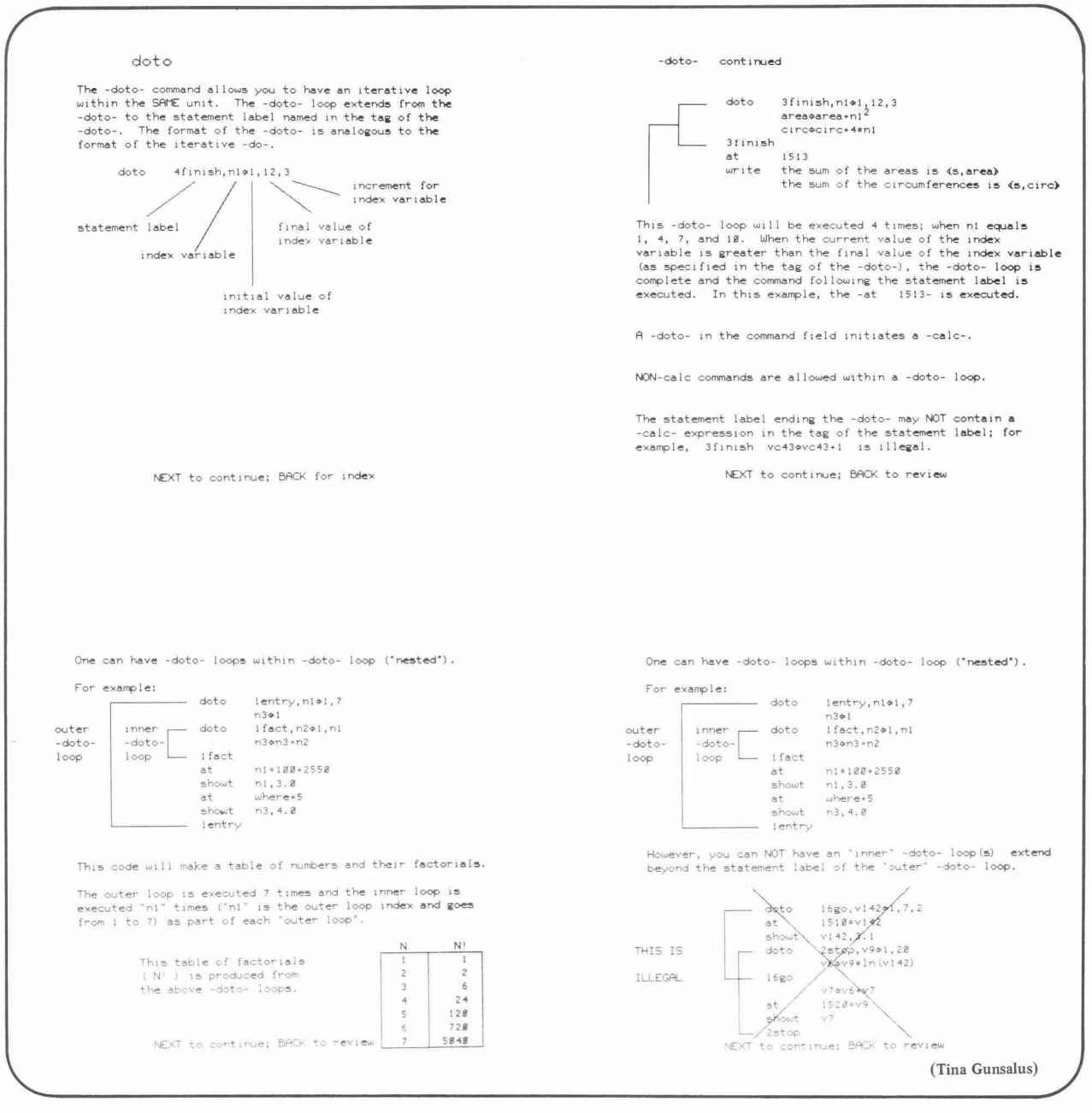
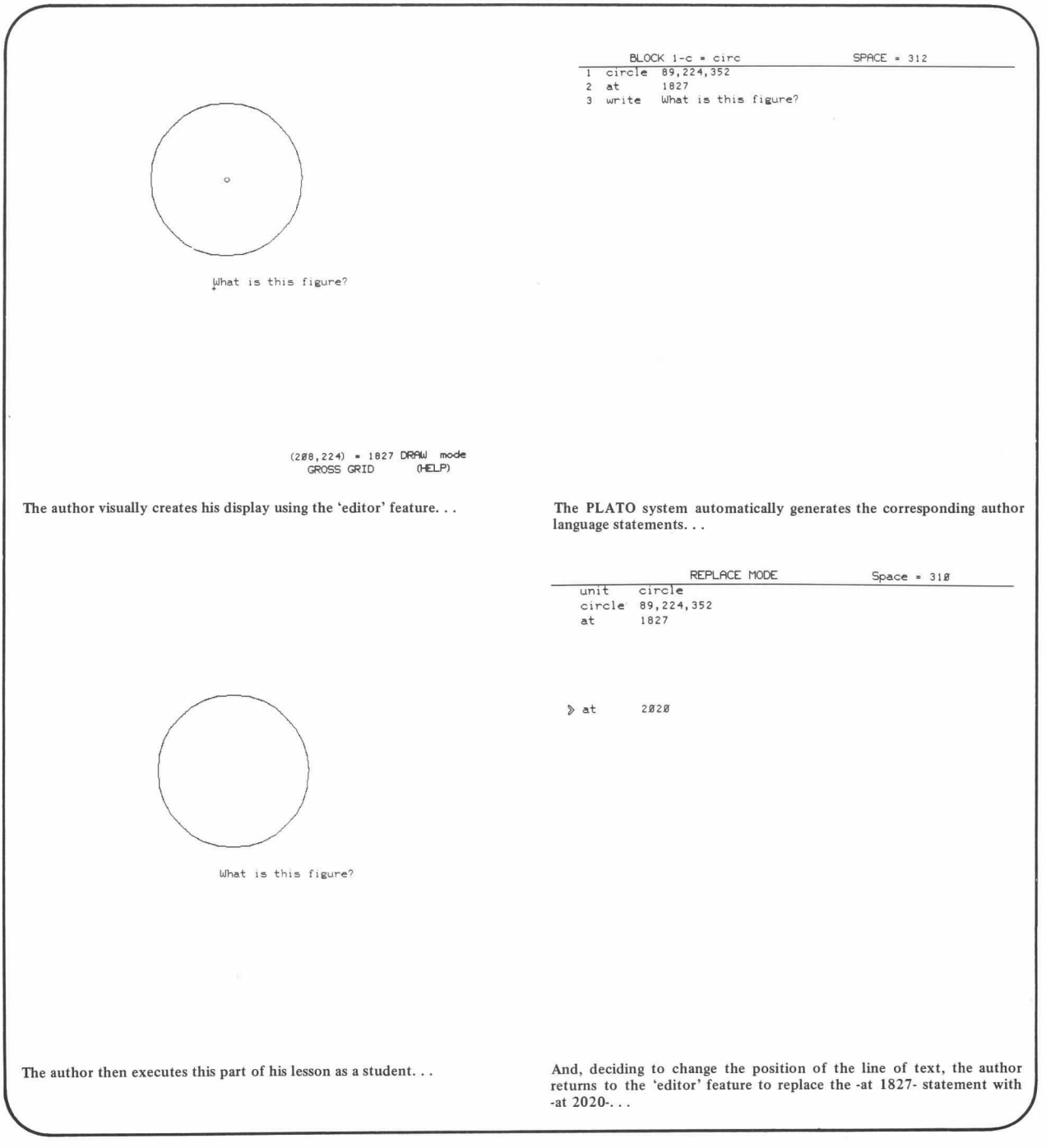


Figure 5-10. Sample Statement Description from 'Aids'

LESSON GENERATION

One of the most valuable authoring tools built into the CDC PLATO System is the 'editor.' Basically, this feature controls the creation, deletion, and modification of PLATO author language statements. With the directives available in the 'editor,' an author working at a PLATO terminal can use a moving cursor to design a display involving text, line figures, circles, and arcs. The system then automatically creates the corresponding author language statements which would produce that display. The author can alter these statements, convert them back into a display, and add to or alter the resulting display. In most cases, this capability makes it unnecessary for the author to worry about the details of screen positions.

With approximately 40 directives in the 'editor,' an author can affect the screen display of author language statements, automatically change or create blocks of author language statements associated with a graphic display, access a help sequence summarizing all available edit directives, exit to an on-line reference source ('aids') for more information on an author language statement or system feature, etc. Figure 5-11 illustrates a few capabilities of the 'editor' feature.



The author visually creates his display using the 'editor' feature. . .

The PLATO system automatically generates the corresponding author language statements. . .

The author then executes this part of his lesson as a student. . .

And, deciding to change the position of the line of text, the author returns to the 'editor' feature to replace the -at 1827- statement with -at 2020-. . .

Figure 5-11. Example of 'Editor' Feature Capabilities

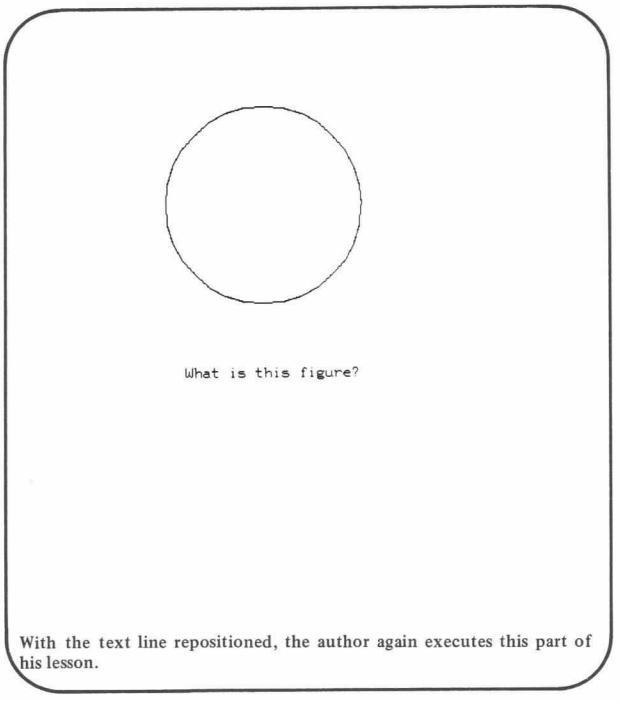


Figure 5-11. Example of 'Editor' Feature Capabilities (Cont'd)

The 'charset' feature, another valuable tool for the author, controls the design, modification and creation of special characters and symbols used in lessons. These characters or symbols are accessed by the author via the FONT key as discussed in section 3. The author can actually modify or create single characters or whole character sets for this lesson. Once created, the alternate character set designed by the author is loaded into the terminal's programmable memory; the alternate character set is retrieved when required by the lesson. Figure 5-12 shows some actual displays used to create an alternate character set.

The PLATO system includes a library of alternate character sets in the 'charsets' feature. If an author so desires, he can inspect, copy, and modify any of the available character sets for use in his lesson. Some of the character sets available include: Cyrillic, Arabic, phonetic alphabets, and symbols for electrical circuits and music notation.

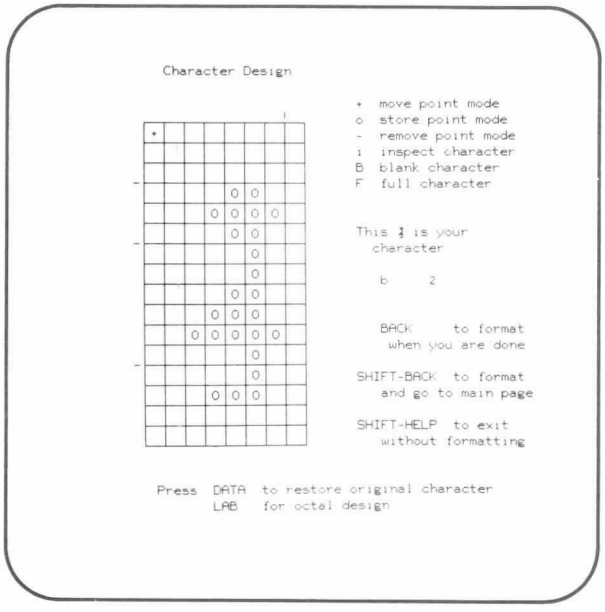
Many lesson-testing tools are also available to the author in the CDC PLATO System. For example, the author can execute his lesson as a student (that portion of the lesson he has written up to that point), and thus test his lesson in small sections and determine the validity of his methodology.

Another useful tool is the 'step-mode' feature. It allows the author to step through the statements in his lesson one at a time, and in the same sequence as the statements are executed. The ability to execute the lesson in this manner is helpful in finding program errors. As the lesson is being stepped through, the lower lines of the screen display certain information (refer to figure 5-13).

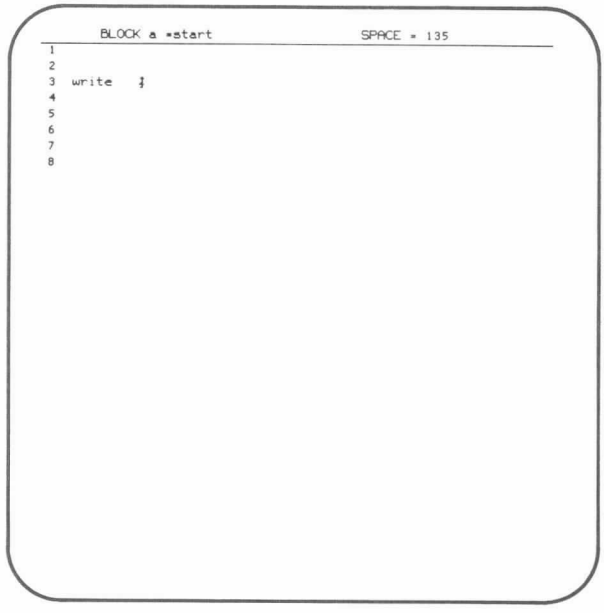
- Next instruction to be executed
- Base, main, and current units of the lesson
- Entry point for examining student variables

In addition to the 'step-mode' feature, the CDC PLATO System includes a number of other diagnostic tools available for the author via 'aids.' When an author language statement in a lesson cannot be interpreted by the system (flagged as a condense error), for example, the system diagnoses the error and displays a brief description of the error together with the statement in error. Also, that part of the statement that cannot be interpreted by the system is underlined. If the system is unable to condense the entire lesson (called a fatal condense error), the system displays a message explaining the error. These are but a few of the diagnostic features of the PLATO system.

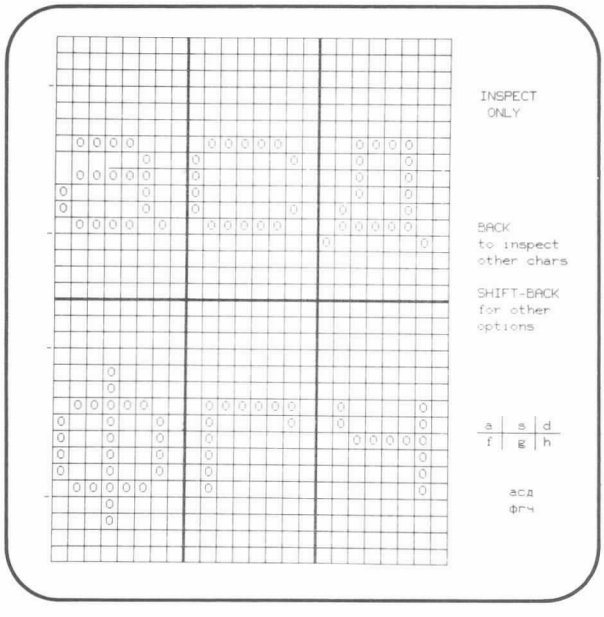
Of course, when authoring a lesson, the 'talk' and 'consult' features are available to answer questions about the PLATO author language. And, it should be noted, the author also has access to 'aids' for detailed and up-to-date information on author language statements and system features.



A simple character being designed.



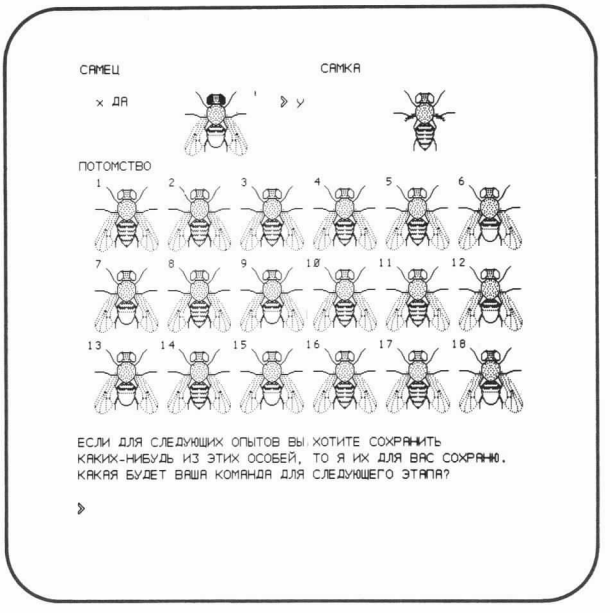
The same character being inserted into the author's lesson.



Editing several characters in a Cyrillic alphabet.

Completed character set containing uppercase Russian alphabet and parts of fruit flies for a Russian-language genetics lesson.

Figure 5-12. Character Set Design with the 'Charset' Feature



Genetics lesson in Russian using uppercase Cyrillic alphabet character set and parts of flies. (Gary Hyatt, David Eades, and Paul Tenczar)

Figure 5-12. Character Set Design with the 'Charset' Feature (Cont'd)

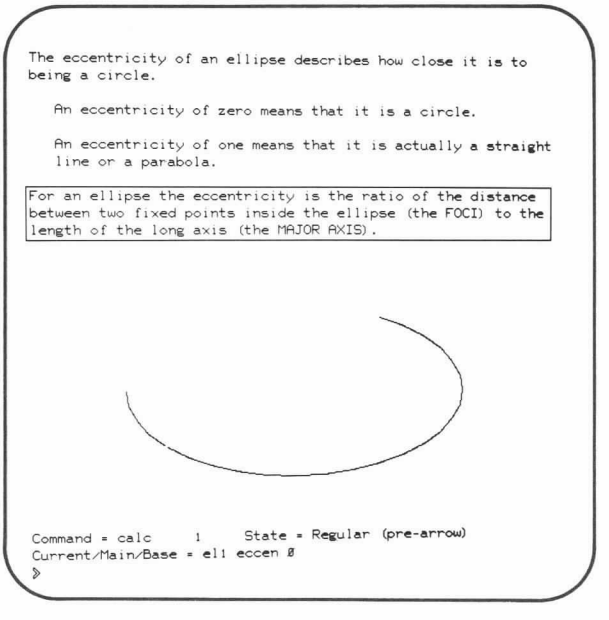


Figure 5-13. Example of the 'Step-Mode' Feature

6

SUMMARY OF CDC PLATO SYSTEM ARCHITECTURE

SYSTEM HIGHLIGHTS

The CDC PLATO System, as discussed in section 1, is a computer-based education system providing individualized and distributive education via a high-speed computer. This system is a combination of specially designed plasma-display terminals, a compatible communications network, and a CDC CYBER 70 or 170 Series Computer. System software includes a fast-response time-sharing operating system (CDC KRONOS/NOS) and a compiler and executor for lesson materials. Lessons are written in the PLATO author language.

Four characteristics of the PLATO system highlight its use as an instructional medium:

1. Unlike other multiterminal interactive systems, the PLATO system eliminates program swapping between the computer and mass storage (disk storage and/or drum storage). Instead, an electronic-swapping memory, called extended core storage (ECS), is used. ECS has a transfer rate one hundred times greater and an access time one thousand times shorter than those of disks or drums. These enormous quantitative advantages make it possible to provide fractional-second response times to hundreds of plasma-display terminals.

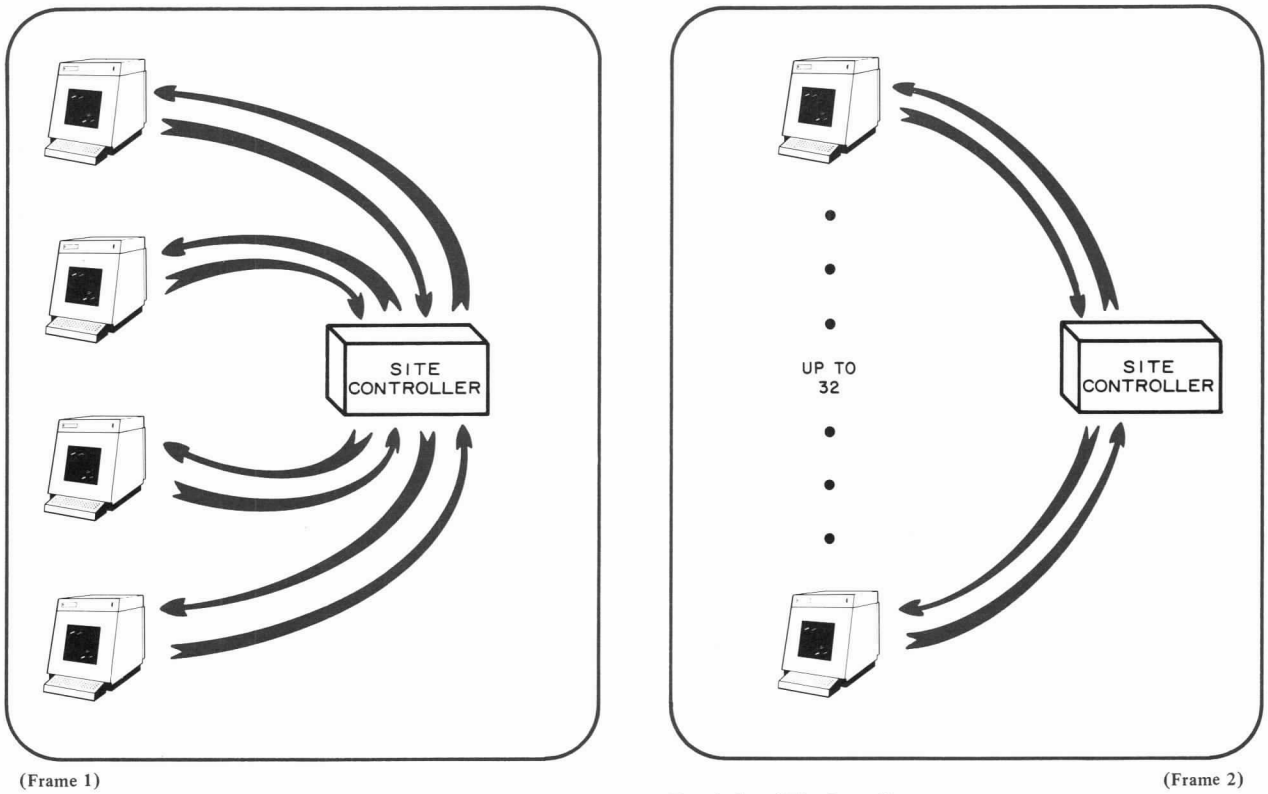
2. Each and every keypress at a PLATO terminal passes through the entire system, including the central computer, before anything appears on the terminal's screen. There is no local echoing of keys at the terminal. The terminal keyboard, therefore, is redefinable. For example, the "j" key is not restricted to causing a "j" to appear on the screen but may, in context, display a line drawing or an appropriate Cyrillic character.

3. The time-sharing properties of the operating system software allow multiple users concurrent access to the computer, while giving each user the impression that he has exclusive use of the computer.

4. The speed and flexibility of the computer permit many forms of information presentation.

INFORMATION FLOW IN THE PLATO SYSTEM

Most of the communications equipment used in the PLATO system are designed with classroom clusters in mind. The equipment, functions, and communications methods used in the PLATO system can best be understood by tracing the information flow from the terminal to the computer and back to the terminal. This flow is depicted in figures 6-1 (frame 1) through 6-5 (frame 7).



(Frame 1) (Frame 2)

Figure 6-1. Communications Between Terminals and Site Controller

The PLATO plasma-display terminal is used by the author or student for constructing or executing lessons. Instructors and education administrators use the terminal to construct and control the necessary courseware (lesson selection and lesson sequence lists, for example). The terminal, in more detail, is described in section 3.

Input data from the terminal comes from one of four sources:

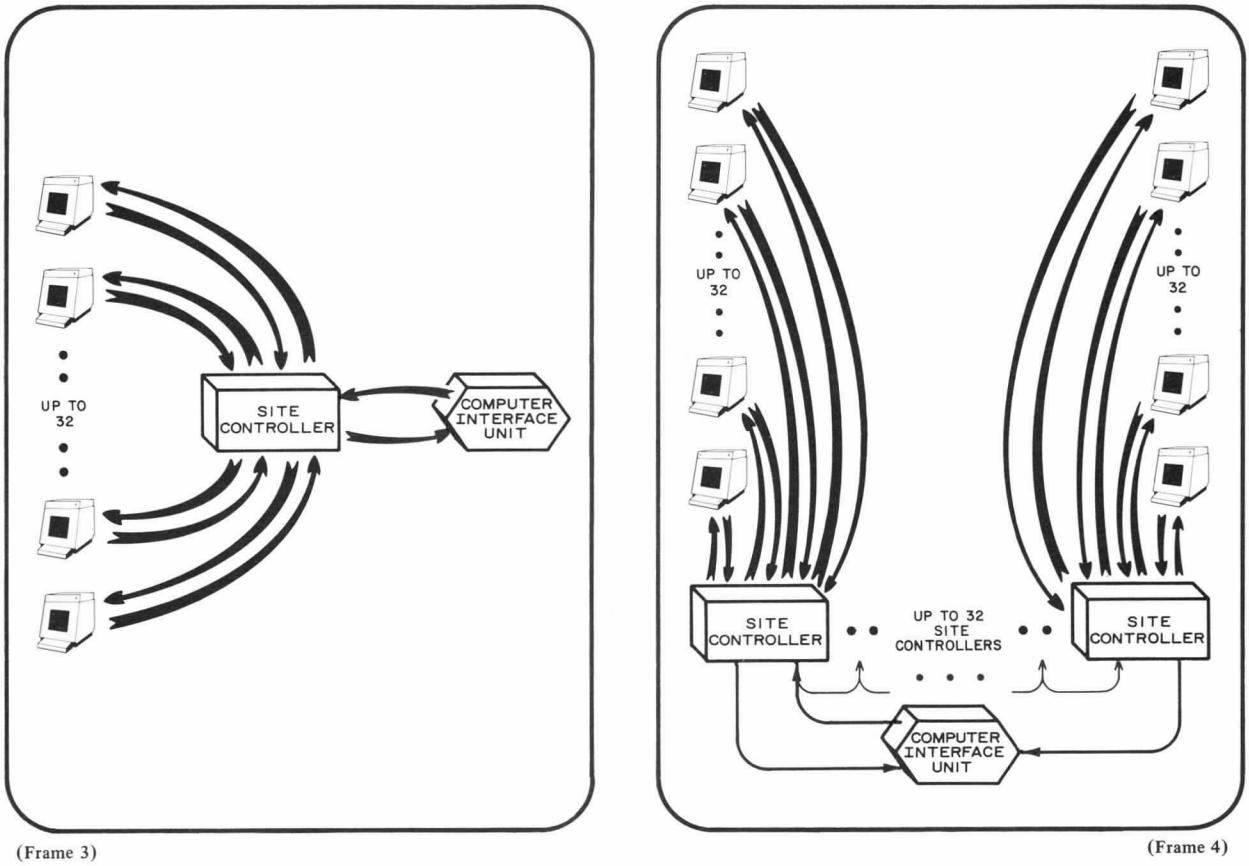
- keys which may be pressed at the keyboard,
- touch panel,
- external input devices connected to the terminal, or
- the terminal's own processing unit.

Terminals are connected to the site controller via communication lines, as shown in figure 6-1 (frame 1). This connection can be via either ordinary telephone lines (dial-up or dedicated line) or directly (hard-wired) via two twisted pairs of wires.

Up to 32 terminals can be attached to each site controller, as represented in figure 6-1 (frame 2). The site controller processes two-way digital data between the terminals and the computer interface unit, as shown in figure 6-2 (frame 3). Communication from the site controller to the computer interface unit is again via ordinary phone line or hard-wired. However, communication from the computer interface unit to the site controller can be via TV cable, hard-wired, or open-air broadcast.

The function of the computer interface unit is to prepare information coming from the site controller for use by the computer and, subsequently, to compose a video signal with information from the computer for the site controllers.

Up to 32 site controllers can be handled by one computer interface unit, as represented in figure 6-2 (frame 4). Theoretically, this would permit 1024 (32 by 32) terminals to be connected in the system. However, constraints imposed by the communications system reduce this number to 1008 actual terminals (maximum) that can communicate with each computer interface unit in a CDC PLATO System.



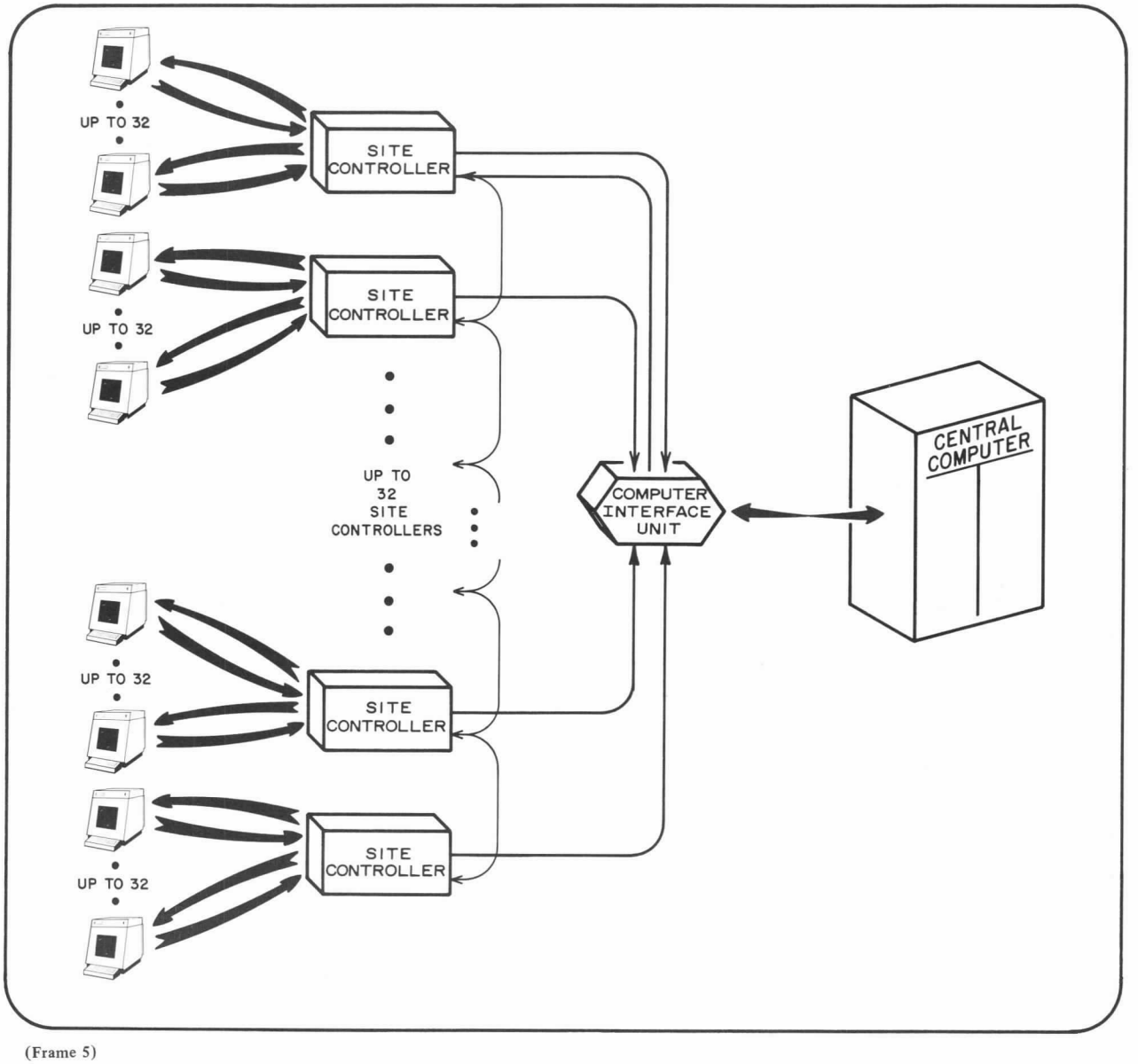
(Frame 3)

(Frame 4)

Figure 6-2. Communications Between Site Controller and Computer Interface Unit

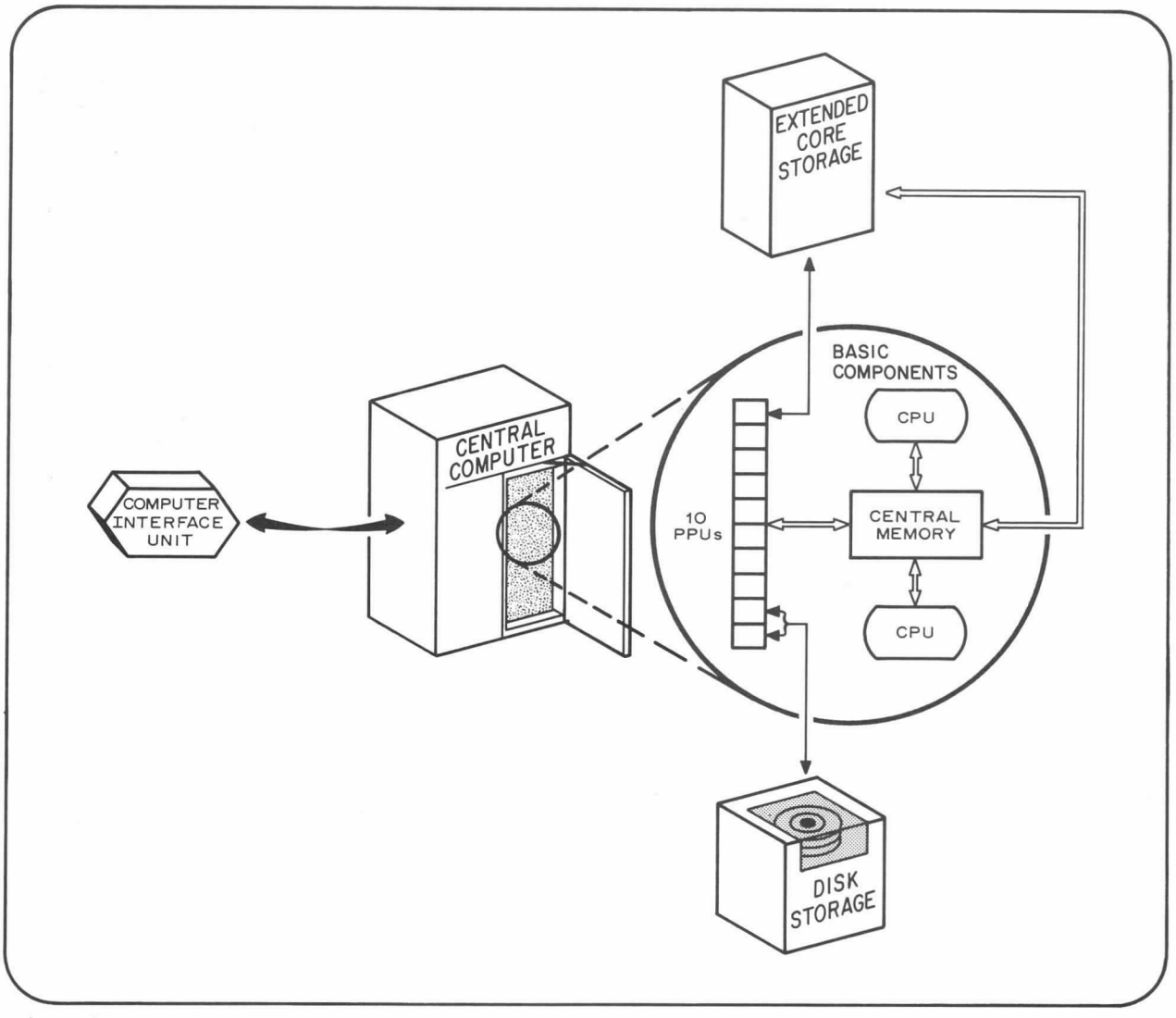
The computer interface unit is connected to the central computer by a coaxial cable (standard CDC CYBER 70/170 channel), as depicted in figure 6-3 (frame 5).

The central computer's architecture (CDC CYBER 70 or 170 Series) is unconventional. As shown in figure 6-4 (frame 6), the extended core storage (ECS) component is the heart of the system: ECS has ties to central memory (CM), and thus to the one or two central processing units (CPUs), and to the ten peripheral processing units (PPUs), which handle input and output to and from the computer interface unit.



(Frame 5)

Figure 6-3. Communications Between Computer Interface and Central Computer



(Frame 6)

Figure 6-4. Basic Components of the Central Computer (CDC CYBER 70 or 170 Series)

Before discussing further the more technical aspects of the central computer's architecture and the role of ECS in the system, it is helpful to understand the unusual structure of the PLATO system and the concept of "program-swapping." The following scenario was written by B.A. Sherwood, a CERL staff member, based on a suggestion by Jaroslaw Oleynick, Universidad Autonoma, Guadalajara, Mexico:

> "The fact that the PLATO system handles hundreds of graphical-display terminals is the result of an unusual structure. This structure can best be appreciated by comparison with standard time-sharing computer systems.
>
> "A time-sharing system is similar to a simultaneous chess match, in which one grandmaster plays 50 opponents. If the grandmaster can make 50 moves more quickly than an opponent can make one move, the opponent can have the illusion of playing the grandmaster alone. Similarly, if a computer can service all users in less time than the thinking time of one user, that user can have the illusion of working with a computer totally dedicated to serving him only.
>
> "To carry the analogy a step further, imagine that instead of walking from board to board, the grandmaster sits at a table and a messenger brings him chess boards from a large table around which the opponents sit. The maximum number of opponents which can be handled depends not only on the speed of the grandmaster but also on the speed of the messenger and on the size of the large table. In particular, if the messenger is too slow, the grandmaster may waste his time waiting for something to do. Employing a faster messenger, or multiple messengers, could enable the grandmaster to handle a larger number of opponents (provided that the large table is big enough), as long as the grandmaster's speed is adequate.
>
> "Time-sharing systems typically use rotating magnetic disks or drums as the 'large table' where individual programs are held, and these programs are swapped back and forth between these mechanical storage units and the central memory, the equivalent of the grandmaster's small table. The central memory need hold only one program at a time, and the computer's central processing unit plays the role of the grandmaster, processing whatever is available to be processed. As with the chess game, the speed of the transfer between the central memory and the disk or drum storage units is crucial. If the transfer speed is too slow, the central processing unit may waste time waiting for something to do.
>
> "Unfortunately, the transfer speed of disk and drum storage units is very slow compared with computer speeds, with 0.1 seconds being typical of the amount of time required to swap

a program into and out of the central memory. Our measurements show that, on the average, PLATO users request service once every 4 seconds. (On the average, users press a key once every two seconds, and fully half of these keys involve more than merely plotting the corresponding letter on the screen.) If a drum or disk were used for swapping programs, only 40 terminals could be handled, since the system would be able to swap only 10 programs per second, and each user needs to be processed every 4 seconds. Actual measurements on hundreds of physics and chemistry students over several semesters show that, on the average, fewer than 1000 computer operations per second are required to provide direct instruction. This means that a scientific computer capable of a million operations per second can service 1000 science students if the program swapping is fast enough. If disk or drum storage were used, only 40 students could be handled, even though the speed of the central processing unit is adequate for 1000. Many time-sharing systems do support more than 40 active terminals, but with lower interactivity rates. For example, if service is provided every 8 seconds instead of every 4 seconds, 10 swaps per second will handle 80 active terminals.

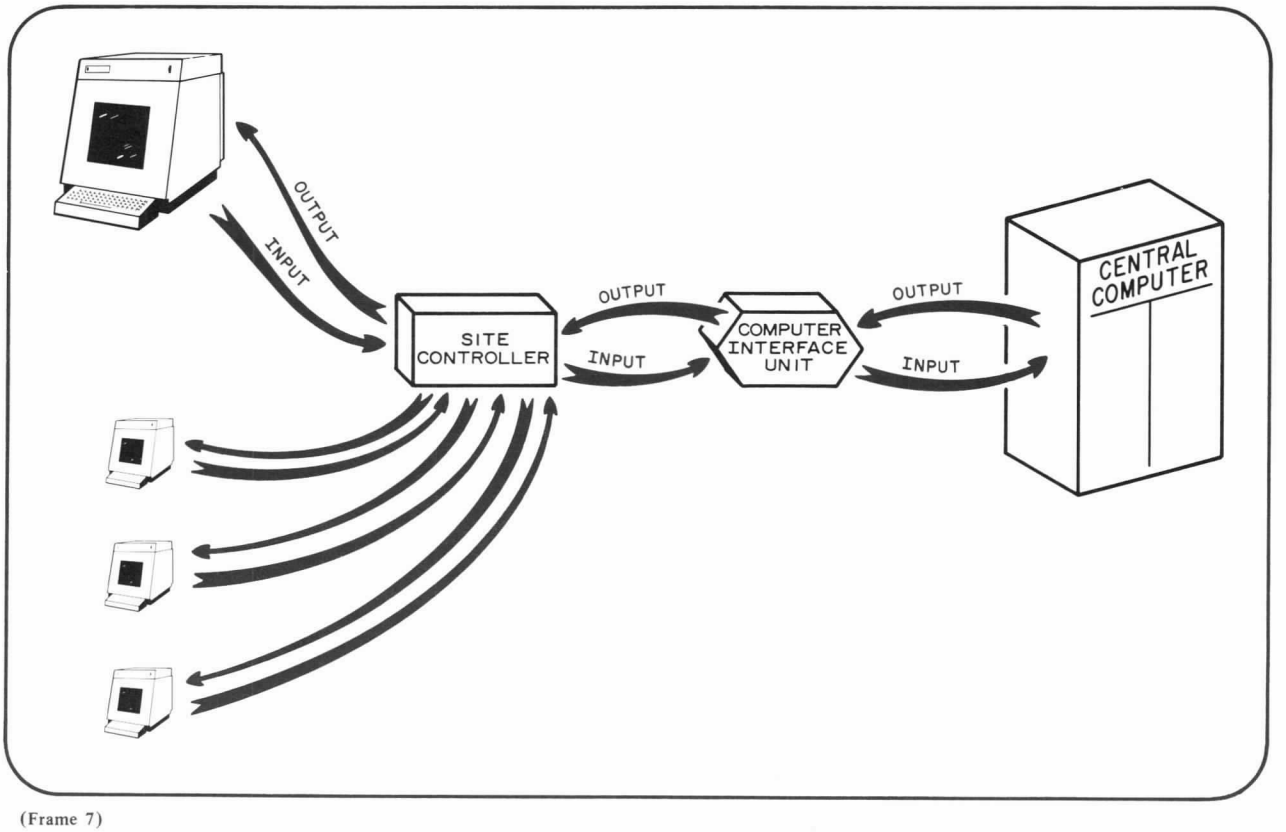
"The PLATO system uses a large auxiliary electronic memory (Control Data Corporation Extended Core Storage) whose transfer rate is 100 times faster than that of disk or drum memories. This electronic memory is less expensive than central memory and is specially organized to transfer blocks of information rapidly, as is required for swapping programs. Although this memory is more expensive than disk memory, the overall cost of service is lower, because the computer can be used more efficiently and shared by a much larger number of users. Moreover, disk-oriented systems are often constrained to simple modes of interaction such as the presentation and checking of multiple-choice questions: the slow transfer rate from disk memory can make it necessary to swap only small pieces of a program, which means that rich cross-connections within the program are not feasible. There are, therefore, both quantitative and qualitative advantages to using an electronic swapping memory."

ECS has an access time of less than five microseconds and, of equal importance, the ECS transfer rate is ten million 60-bit words per second. This enormous transfer rate is achieved through parallel and closely phased memory operations. Basically, programs and data in ECS are swapped in and out of central memory for processing by the CPUs.

This is far more efficient than swapping interactive jobs between central memory and mass storage (disk storage) because of the two orders of magnitude improvement in transfer rate and three to four orders of magnitude improvement in access time. Disk drives furnish permanent storage of programs and data but play no role in the swapping process once this material has been moved to ECS.

The architecture of the PLATO system, therefore, is balanced in such a way that the response time to each terminal is relatively unaffected by the number of terminals active on the system.

The basic information flow within the PLATO system is summarized in figure 6-5 (frame 7); that is, each keypress from the terminal (input data) is captured by the site controller, prepared by the computer interface unit, and then sent to the central computer for processing. Once processed, the information (output data) is sent to the computer interface unit for composition of a video signal to be broadcast or hard-wired to the site controllers, which pick out the data to be returned to the terminal as displayed information. All of the processing for hundreds of users is done in about 1/8 of a second.



(Frame 7)

Figure 6-5. Summary of Information Flow in the PLATO System

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GLOSSARY

ACCOUNT DIRECTOR	An individual who is responsible for and has access to all usage data on lessons and courses in his account.
AUTHOR	A person who develops instructional material.
AUTHOR MODE	The section of the CDC PLATO System that allows authors to edit lessons.
CAI	Computer-assisted instruction is an alternative term for CBE or certain subsets of CBE, such as direct-instructional interaction.
CBE	Computer-based education is any teaching or learning situation that makes use of a computer.
CMI	Computer-managed instruction is a series of evaluative and prescriptive processes involving interaction between and among the student, the instructor and/or education administrators, and the computer.
COMMAND	The first part of a PLATO author language instruction that controls or performs a unique task. Command names indicate the task the instruction performs.
CONDENSE	A process performed by the PLATO system in preparing a lesson for execution by the student (student mode).
COURSE	Roster of persons authorized to use the PLATO system. A specified curriculum consisting of one or more instructional lessons.
COURSE DIRECTOR	An individual who can access author/instructor records for a particular course.
COURSEWARE	Lesson material that authors prepare for students.
EDIT/EDITING	The process of changing PLATO author language instructions in a lesson.
FUNCTION KEYS	The black keys located on the right side of the terminal keyset that control various operations of the PLATO system; LAB, DATA, HELP, STOP, TERM, ACCESS, MICRO, EDIT, COPY, ERASE, and NEXT.
HARDWARE	Any of the component equipment that make up the computer system and associated communications equipment.
HELP SEQUENCE	A sequence of instructional material accessed when help-type keys are pressed.
HELP-TYPE KEYS	The HELP, LAB, DATA, SHIFT-HELP, SHIFT-LAB, SHIFT-DATA, and TERM keys.
INSTRUCTOR	A user who may study (access) any available instructional lesson, add or delete students from a course, and design a curriculum for a course.
KEYSET/KEYBOARD	The typewriter-like portion of a PLATO terminal that is used to input information. The keyset contains the typical typewriter keys as well as many function keys.
PLATO AUTHOR LANGUAGE	The computer language used for writing lessons for the CDC PLATO System.
ROUTER	A software routine in the PLATO system used to route students through the many lessons making up a complete course.
SITE	A specific set of PLATO terminals which may or may not be physically resident at the same geographical location.
SITE DIRECTOR	An individual who is responsible for a specific PLATO system site and the liaison between the various users at that site.
SOFTWARE	The coded instructions to which the hardware responds. Includes two types: machine and user. Machine software refers to instructions the computer can understand and use to perform its job. User software refers to the instructions in the form that is understandable by the user.
STUDENT	A user of the PLATO system who studies (executes) assigned lessons.
SYSTEM PROGRAMMERS	Persons responsible for developing the PLATO author language and other machine software for the PLATO system.
TAG	Explicit information for the execution of the specified command. Second part of the PLATO author language instruction.
USER	A person properly signed on to the CDC PLATO System.

CONTROL DATA

PLATO

SYSTEM OVERVIEW

CONTROL DATA CORPORATION

CORPORATE HEADQUARTERS, P.O. BOX 0, MINNEAPOLIS, MINNESOTA 55440
SALES OFFICES AND SERVICE CENTERS IN MAJOR CITIES THROUGHOUT THE WORL

LITHO IN U.S.