ESD-TR-77-345

ESD ACCESSION LIST
DRI Call No. 88148
Copy No. 1 of 2 cys.
ESD

Technical Note

1977-13

R. C. Butman

The Lincoln Terminal System (LTS-5)
A Brief Description

28 December 1977

Prepared for the Bureau of Mines
under Contract J0366078 by

Lincoln Laboratory
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LEXINGTON, MASSACHUSETTS

Approved for public release; distribution unlimited.

AD A048692

BEST AVAILABLE COPY

This report was prepared by Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, Massachusetts 02173, under USBM Contract Number J0366078. The contract was initiated under the Coal Mine Health and Safety Program. It is being administered under the technical direction of PMSRC with Mr. James C. Ault acting as the Technical Project Officer. Mr. David R. Williams is the contract administrator for the Bureau of Mines.

This report may be reproduced to satisfy needs of U.S. Government agencies.

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies or recommendations of the Interior Department's Bureau of Mines or of the U.S. Government.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

Raymond L. Loiselle

Raymond L. Loiselle, Lt. Col., USAF
Chief, ESD Lincoln Laboratory Project Office

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LINCOLN LABORATORY

THE LINCOLN TERMINAL SYSTEM (LTS-5)
A BRIEF DESCRIPTION

R. C. BUTMAN
Group 27

TECHNICAL NOTE 1977-13

28 DECEMBER 1977

Approved for public release; distribution unlimited.

LEXINGTON MASSACHUSETTS

Abstract

The LTS-5, a self-contained, computer mediated training system, presents audio messages and visual images to a trainee and interprets the trainee's response which is entered via a keyboard. The basic subsystems of the LTS-5 are outlined, and the format of the student-machine interaction is described. The required support facilities are discussed. Several pictures of the LTS-5 are included. This report is an update of TN-1972-26*.

* R.C. Butman and F.C. Frick, "The Lincoln Training System: A Summary Report," Technical Note 1972-26, Lincoln Laboratory, M.I.T. (3 October 1972), DDC AD-750748.

THE LINCOLN TERMINAL SYSTEM
(LTS-5)
A BRIEF DESCRIPTION

A. INTRODUCTION

The Lincoln Terminal System (LTS) is an interactive training system which, under the control of a microprocessor, presents visual images and audio messages to a user and responds appropriately to keyboard inputs. It is a self-contained equipment -- only AC power need be supplied for its operation. The basic information storage medium is microfiche. Visual images on the fiche are stored and projected in a conventional manner. Audio is stored on the fiche as a width-modulated track, similar to that used in motion picture film except that the dimensions are smaller and the track is stored as a spiral. See Figure 1. A unique photodiode is used to read the audio spiral. Lesson control logic, which enables the terminal to make appropriate responses to student keyboard selection, is also recorded on each audio spiral preceding the audio message.

The LTS stores up to 750 microfiche in a carousel. Each fiche holds up to 12 visual images and a corresponding number of audio/logic spirals; the storage capacity of the system is, therefore, 12 x 750 = 9000 audio/visual images.

In operation, an interaction sequence begins with the presentation of a visual image to the student. Simultaneously, the control logic associated with the visual image is read into the microcomputer from the audio/logic spiral. Following the logic read-in, the audio message is presented to the student. The student then responds to the audio-visual presentation through the LTS keyboard. The keyboard permits the student to enter numerical answers and to respond to simple or compound multiple-choice questions, where a compound choice is defined to be more than one choice, ordered or unordered from one or more lists of choices. The LTS then

Fig. 1. Audio/graphic fiche.

responds by branching to another fiche as directed by the stored program, the frame control logic, and the user keyboard input.

Figures 2, 3 and 4 and 5 are pictures of the equipment and the keyboard.

B. LTS-5 Subsystem Description

1. General

The LTS-5 performance and physical characteristics described are achieved with the aid of eight subsystems described below. Figure 6 is a block diagram of the eight LTS-5 subsystems. These subsystems are described in the following paragraphs:

2. Fiche Manipulation

The Fiche Manipulation subsystem consists of the necessary mechanisms to select any one of up to 750, 4- x 6- in. microfiche (with designation 1 through 999) stored in the carousel and coarse position that fiche so that the selected audio and visual frames are in the control range of the fine-positioning mechanism. The fine-positioning mechanism then acts to move the fiche so that the selected audio spiral can be read by the Audio Reader (Figure 7).

The Fiche Manipulation system responds automatically to computer-generated select commands which are activated by student keyboard inputs. The Fiche Manipulation system also responds to fiche select commands which are entered via the manual control panel. The basic fiche storage, the electromechanical selection mechanism, and the optical projection lens and mirrors use parts from the Image Systems Corporation CARD* Unit.

---

* Compact Automatic Retrieval Display -- a commercial microfiche display unit which selects fiche with a manual keyboard.

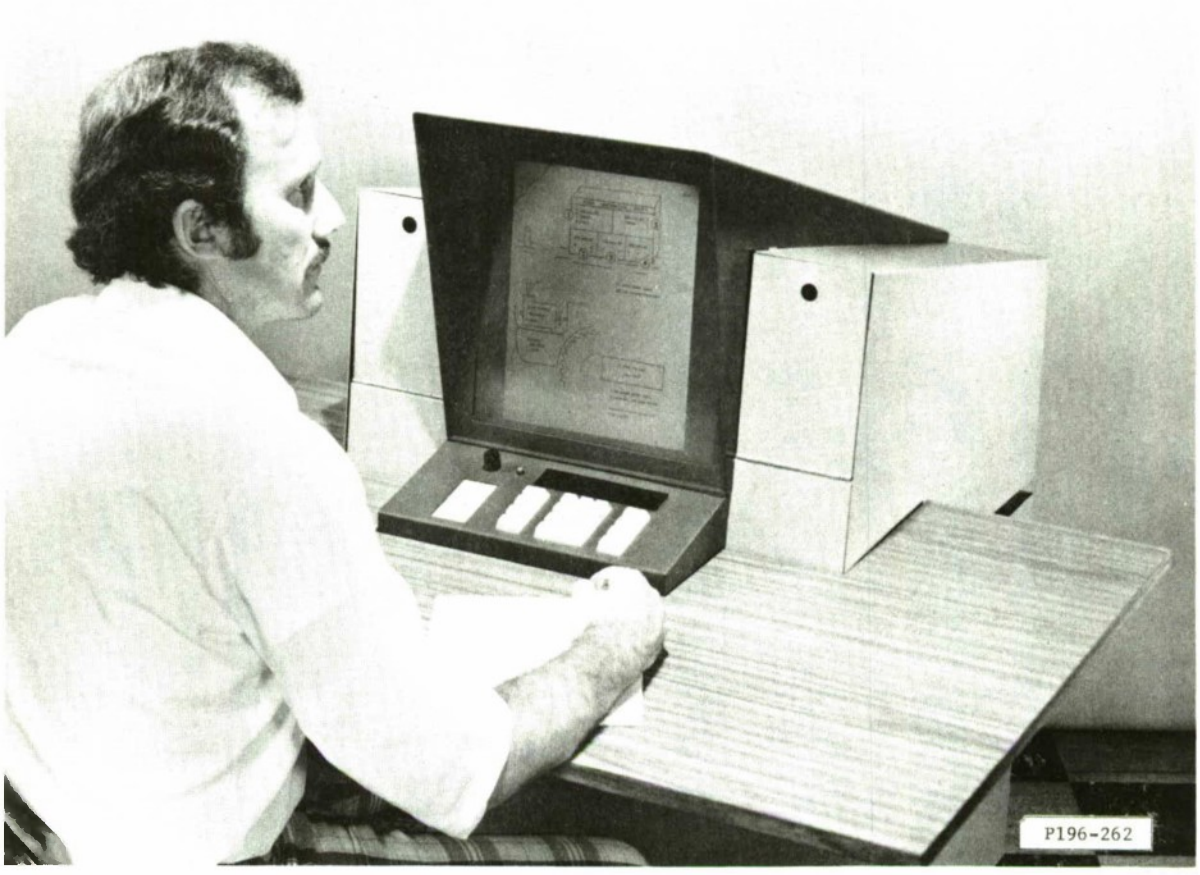


Fig. 2. LTS-5 in operation.

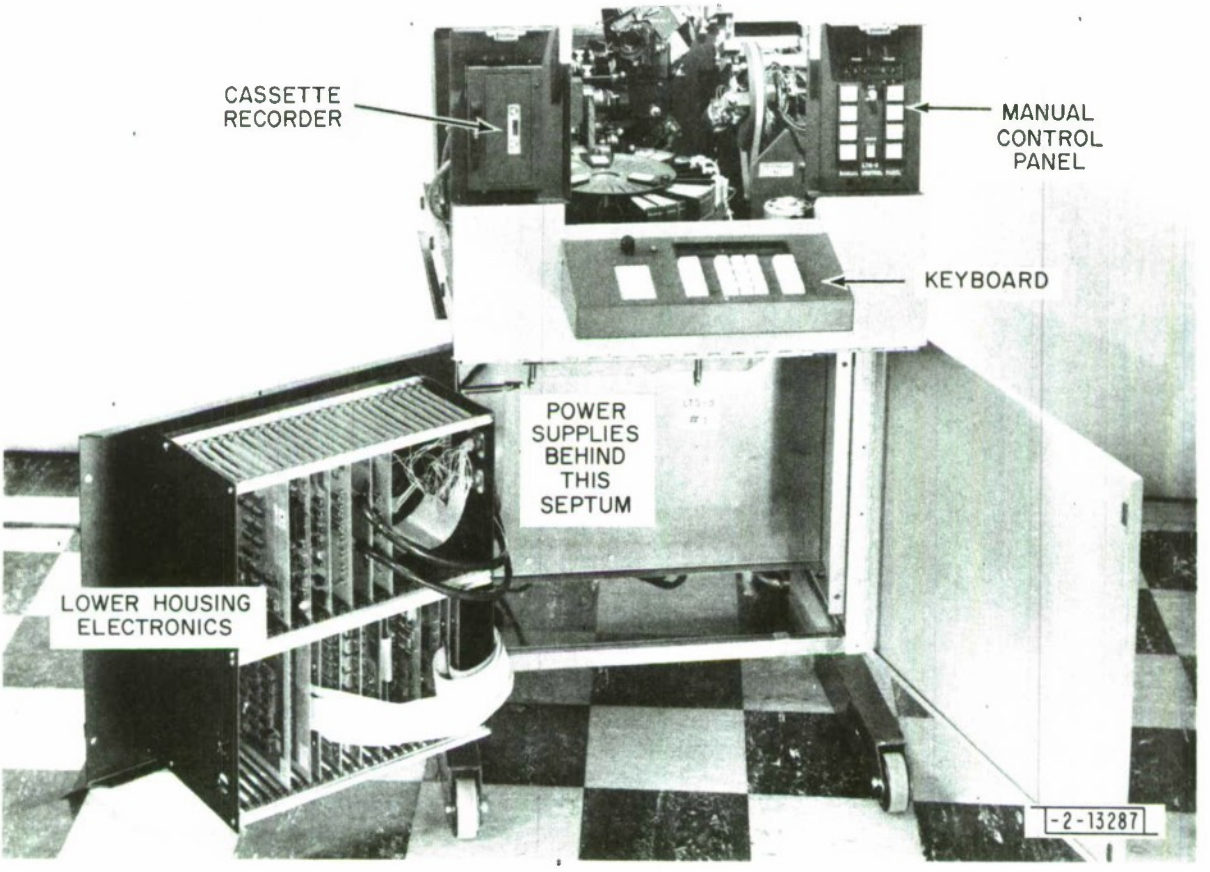


Fig. 3. LTS-5 open for inspection.

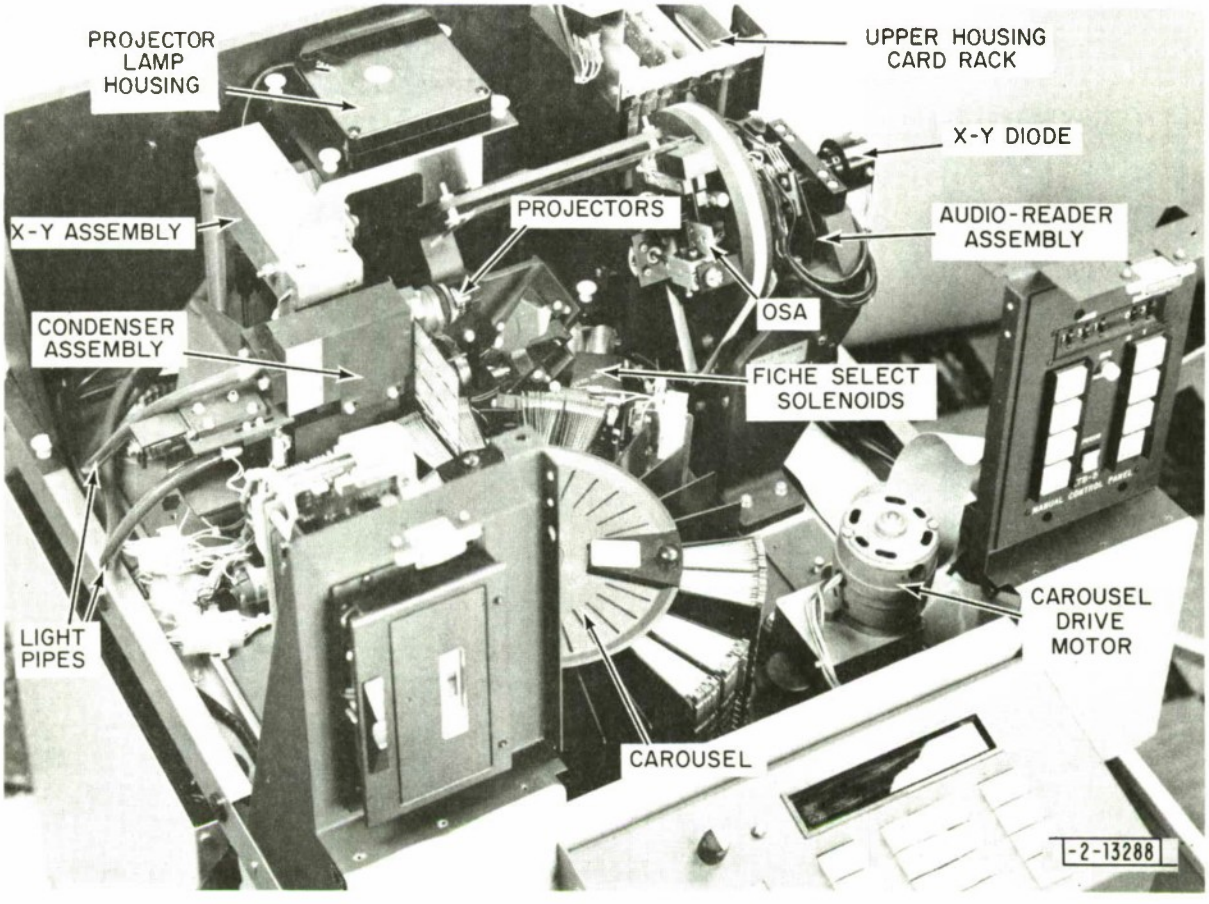


Fig. 4. Upper housing with cover off.

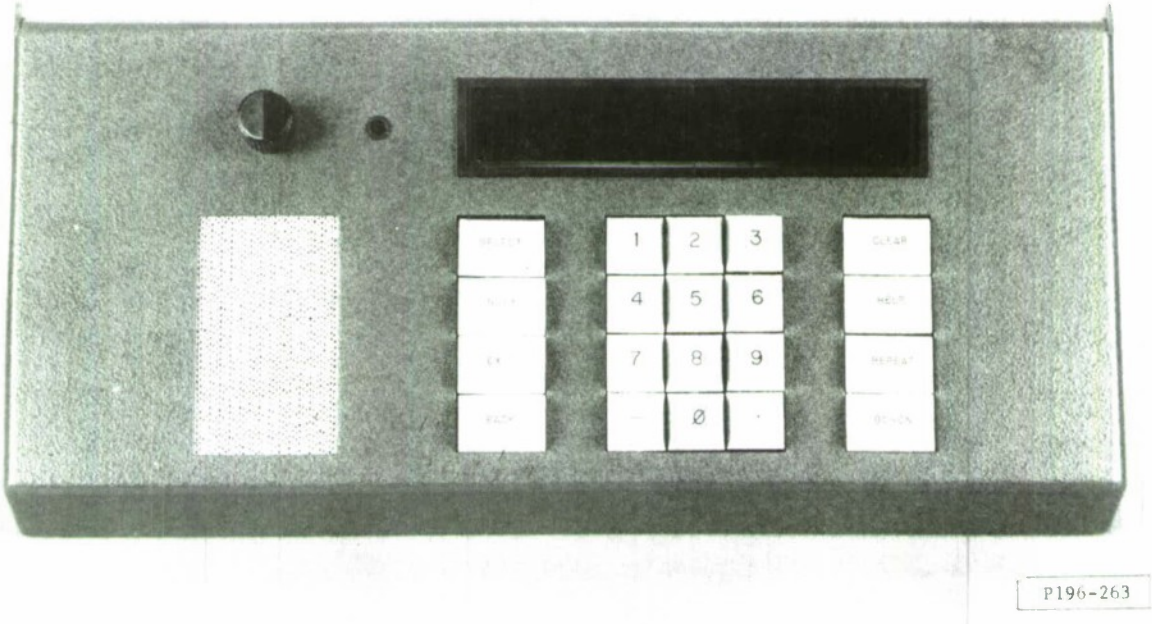


Fig. 5. Keyboard.

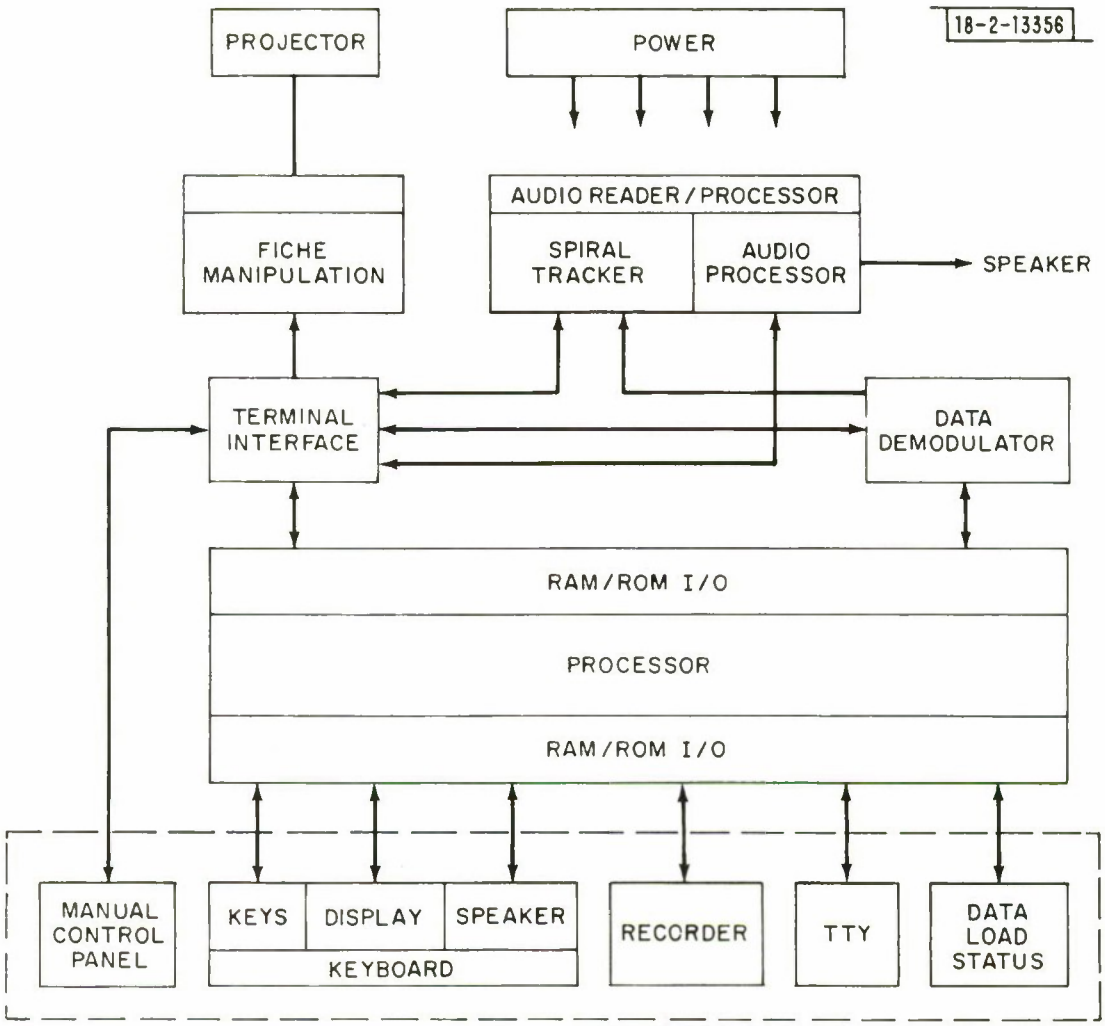
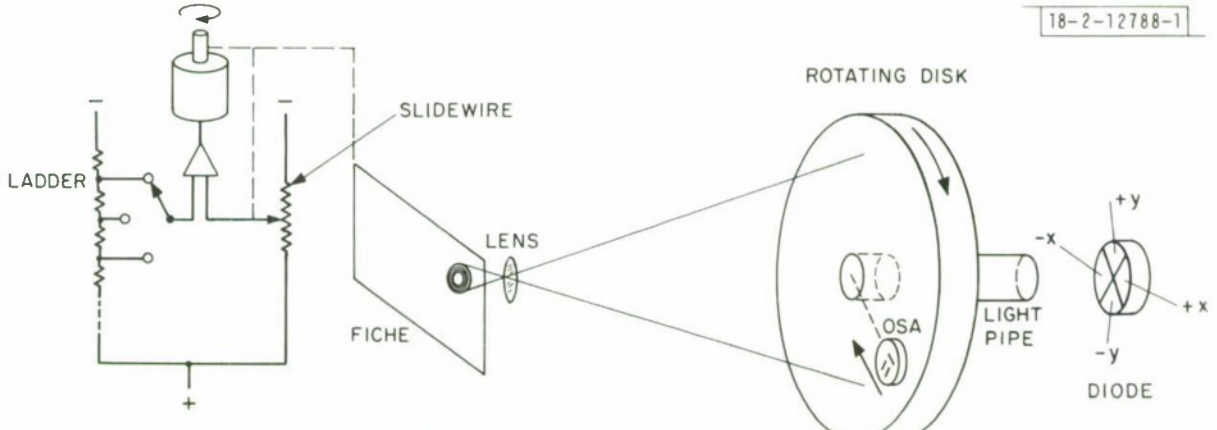
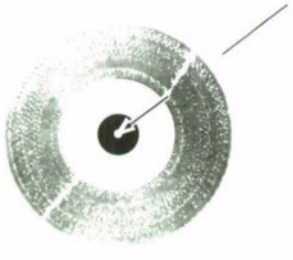


Fig. 6. Subsystems block diagram.



Fiche is coarse positioned in X ond Y with servo motor drives to the desired spiral by motching the voltoge on a slidewire ottoched to the fiche with o selected voltoge on o divider. This moves the cleor boresight of the selected spirol onto the fiber-optics light pipe which conveys the boresight imoge to on X-Y diode. The differentiol error voltoges developed by the diode are then used to drive the servo motors in o fine positioning mode so thot the boresight will be within obout 0.06 mm overage, referred to the film plone, of the center of rototion of the reader.



Once fine positioning is completed, the opticol sensor ossembly (OSA) is octivoted. It moves olong the oudio-doto track by virtue of its locotion on the rototing disk of the reader. It mointoins its position ot the center of the track by on inword radiol motion, under the control of o servo motor whose error signol is derived from the track sensing diodes on the OSA.

Fig. 7. Audio reader.

3. Audio Reader/Processor

The function of the Audio Reader is to detect the audio modulation on the audio/logic spiral, converting that modulation into audible telephone-quality audio and transmitting the logic signals to the Data Demodulator.

4. Data Demodulator

The function of the Data Demodulator is to extract timing information and data (lesson logic) from the Audio Reader output signal and transmit it to the Terminal Interface.

5. Terminal Interface

In response to commands from the Digital Processor, the Terminal Interface generates timing and control signals to operate fiche and frame selection, control the X-Y positioning, Audio Reader tracker and the audio data subsystems.

6. Digital Processor

The Processor decodes data received from the spiral via the Data Demodulator and Terminal Interface, interprets student responses entered through the keyboard, and transmits control signals to other subsystems. The processor uses an Intel 4040 CPU; it exercises control over all terminal I/O functions. It controls the selection and presentation of a given frame in accordance with (a) its stored program, (b) frame specific data read into RAM from the audio spirals, and (c) keyboard inputs. It also controls the flow of I/O data to a teletype and a digital cassette recorder. The Processor schedules and transmits enabling commands to:

(a) Select a fiche

(b) Select a frame (one of the 12 images on the fiche)

(c) Control video on/off

(d) Control audio on/off

(e) Turn student keyboard error light on/off

(f) Activate keyboard display

(g) Control the audio tracker

(h) Control TTY I/O

(i) Control Cassette Recorder (to record keyboard actions)

The Processor decodes and responds to serial data input from the audio spiral and to keyboard data input from the student keyboard. The Processor accepts clock flag inputs from the interval timer.

7. Optical Projection

The Optical Projection system is a two-lens system which projects the audio spiral onto the image plane of the Audio Reader and its associated visual image onto a rear projection visual display. The two projection lenses are spaced so that when one is centered on an audio spiral image, the other is centered on the associated visual image.

8. Control and Recording

The user interacts with the LTS-5 through the Keyboard or the Manual Control Panel.

The keyboard allows entry of numbers 0 through 9, minus sign, decimal point, and 8 functions. Invalid entries are signalled by a red light on the keyboard. The audio speaker, earphone jack, volume control, and 10-digit LED display are also part of the keyboard assembly.

The Manual Control Panel contains an on-off switch, system reset, fiche select controls, fiche unload control, and audio repeat and focus control.

The maintenance panel uses a 10-digit LED indicator to display digits 0 through 9 which signify the status of the data load.

A Sycor magnetic tape cassette recorder model 135 is used to record all user keyboard actions for later analysis.

A teletype, not part of the LTS-5, is used as a maintenance aid. A TTY interface is, therefore, provided as part of the LTS-5.

9. Power Conversion

The Power Conversion system converts 110V AC into the DC and AC voltages required to operate the various subsystems.

C. Author Programs

The LTS processor supports several standard Author Programs and it can be reprogrammed to accommodate new ones as needed. The author programs are of two basic forms -- non-branching and branching. Non-branching programs are used when the author does not need to evaluate allowable keyboard inputs. These non-branching programs are supported by function keys -- GO-ON, HELP, BACK, INDEX, REPEAT and EXIT.

GO-ON	calls a (next) frame that has been pre-selected by the author.
BACK	calls a previous frame pre-selected by the author.
HELP	calls a frame designed to give extra assistance to the student in solving a problem.
INDEX	calls an Index.
REPEAT	replays the audio associated with the current frame.
EXIT	allows the student to leave the current lesson.

A CLEAR key allows the student to erase an entry.

Branching programs are used to evaluate student keyboard inputs in response to questions posed by the current frame. In all branching programs, the author designates, with his control logic, the next frame to be called by correct or incorrect responses. In some cases, varying degrees of correctness are recognized so that more than two branching frames may be available.

Branching Programs include:

NUMBER	accepts a student number input. Branches available for above, below and within tolerance.
ANYORD	asks the student to choose up to six items from a list of up to nine and enter these numbered choices. Branches for correct and incorrect.

FIXORD	same as ANYORD, but the choices must be in a specified order.
CHOOSE	asks the student to select a choice from a list of up to nine. Branches for each possible choice are provided.
QUIZ	evaluates answers up to six multiple choice questions on a single frame. Branches for High Pass, Low Pass and Fail.

D. LTS Utilization

The LTS is designed to teach facts, principles and computational skills. It can guide a user through maintenance or adjustment procedures, checking the accuracy of the student's actions at each step in a procedure. It has been used to teach basic electronics to Air Force trainees, Digital Systems Engineering to professional technical personnel, and maintenance procedures to Air Force Communications specialists.

E. Support Facilities

1. General

Support facilities available to date at Lincoln Laboratory are experimental. Under a current contract, these facilties -- author support, fiche production -- are being produced and documented in a form suitable for field use and for duplication.

2. Author Support

At this writing, author program logic for a given lesson are stored on punched paper tape. Corresponding audio messages are stored on magnetic tape. The author is provided with appropriate computer for making the logic tapes and audio recording facilities for recording the audio messages. A new system, now under development, records both audio and logic on a magnetic cassette tape. This new system will be operational in the spring of 1978.

3. Fiche Production

The audio and logic, associated with a visual presentation, are recorded as width-modulated spiral tracks on the microfiche. Visual frames are reduced in size and recorded as a conventional film image on the fiche. Conventional photographic facilities are required to place the images on fiche.

F. Summary

The LTS-5 is the first production engineered LTS equipment produced under the Lincoln Laboratory Educational Technology Program. As such, it is designed for reliable service and easy maintenance in field service. Complete electrical and mechanical and software documentation is available. It is our opinion that the LTS technology is now ready for incorporation, in moderate quantity, into job related training programs. As with any new technology, the initial operations must be constantly and critically evaluated so as to assure that the equipment is being used in a manner designed to produce greatest benefits to the user.

Lincoln Laboratory does not propose, at this time, any significant new LTS hardware developments, since it is believed that the equipment as now designed is well suited for its intended use. Should field evaluations reveal the need for changes, the Laboratory will propose appropriate action.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ESD-TR-77-345	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* The Lincoln Terminal System (LTS-5) A Brief Description		5. TYPE OF REPORT & PERIOD COVERED Technical Note 6. PERFORMING ORG. REPORT NUMBER Technical Note 1977-13
7. AUTHOR*(s)* Robert C. Butman		8. CONTRACT OR GRANT NUMBER*(s)* USBM J0366078
9. PERFORMING ORGANIZATION NAME AND ADDRESS Lincoln Laboratory, M.I.T. P.O. Box 73 Lexington, MA 02173		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS None
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Bureau of Mines 4800 Forbes Avenue Pittsburgh, PA 15213		12. REPORT DATE 28 December 1977 13. NUMBER OF PAGES 20
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)* Electronic Systems Division Hanscom AFB Bedford, MA 20331		15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

See also ESD-TR-72-237.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

LTS-5
computer mediated training system
microprocessor
visual images
audio messages
microfiche storage
support facilities

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The LTS-5, a self-contained, computer mediated training system, presents audio messages and visual images to a trainee and interprets the trainee's response which is entered via a keyboard. The basic subsystems of the LTS-5 are outlined, and the format of the student-machine interaction is described. The required support facilities are discussed. Several pictures of the LTS-5 are included.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*