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AUTHOR	Muller, Mark T.
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ABSTRACT

A 35mm random access slide projector operated in conjunction with a computer terminal was adapted to meet the need for a more rapid and complex graphic display mechanism than is currently available with teletypewriter terminals. The model projector can be operated manually to provide for a maintenance checkout of the electromechanical system. Applications for this projector include pH laboratory identification, child development simulation, self-paced individualized instruction, and analysis of sentence structure in learning fundamentals of linguistics. (CH)

THE USE OF A COMPUTER-CONTROLLED RANDOM ACCESS SLIDE PROJECTOR FOR RAPID INFORMATION DISPLAY

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Mark T. Muller, Project Coordinator, PROJECT C-BE
The University of Texas at Austin, Austin, Texas 78712

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DIRECTORS:

Dr. John J. Allan III
Dr. J. J. Lagowski

ADDRESS:

413 Engineering Lab Building
The University of Texas at Austin
Austin, Texas 78712

(512) 471-4191

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INTRODUCTION

The use of computer-based instructional techniques employ mainly teletypewriter terminals as an input/output device to the computer where a written record of the student interaction is required. This imposes several limitations. One is the slow 10-character per second typing speed of the teletypewriter, students have to wait an unduly long time on lengthy computer printouts. Another is the limitation of the terminal to alpha numeric characters only and simple two-dimensional graphs. In addition, exotic formulae or symbols as such used in chemistry and mathematics cannot be displayed on teletypewriter output terminals. There was a need to find a more rapid method to display lengthy information as well as complex formulae, graphs and colored pictorial materials. To meet this need, PROJECT C-BE adapted a 35 mm "off the shelf" random access slide projector. This projector would be operated in conjunction with the computer terminal through use of a controller. The decision was made to use an "Eastman Kodak EKTAGRAPHIC RA-960 random access slide projector". This model projector has a capacity for handling a maximum of 80 slides contained in a circular plastic tray. Included with the RA-960 slide projector was a manually operated control device which could select (on a random basis) desired slides. The manual control allowed for independent (off-line) operation and could provide for a maintenance checkout of the electromechanical system of the projector itself when adapted for use with the computer controller.

DESIGN OF THE CONTROLLER

The Slide Projector was designed to operate mechanically through two self-positioning wafer switches with nine positions each. The "home" or initial position was equal to the zero (00) position. This made it possible to use the following two digit base nine to operate with the controller interface:

High Order:	0, 9, 18, 27, 36, 45, 54, 63, 72
Low Order:	0, 1, 2, 3, 4, 5, 6, 7, 8

The above values (high order + low order location) when added provide the real (decimal) location of the slide in the projector.

We used the characteristics of the slide projector high and low order addressing system as the interface with the computer controller to match or parallel the addressing system using standard teletype functions and characters (as published by the American Standards Association (ASII)) in Octal, to drive the slide projector. The three states of operation were as follows:

a. Teletype disabled when commands were intended for the slide projector (receipt of escape function in 033 octal).

b. Slide projector enabled to locate and show a slide (receipt of two characters).

c. Slide projector disabled and the teletype enabled to print (receipt of control function 127 in octal).

SOFTWARE AND HARDWARE ELEMENTS

The entire command repertoire which performed the operations are shown in Tables 1, 2, and 3 and Flowcharts of the operation are shown in Figures 1 and 2. The two aspects of design included the software design in the form of a FORTRAN IV program called FILMPF (not included here) and the hardware design. The controller used TTL logic components and consisted of an 800 Hz clock, a buffer, two 8-bit shift registers, and two latching decoders. The rearview projector system employed two 45-degree front surface aluminized mirrors which projected the slide image on a POLACOAT screen from the rear. The unit was able to search, select and project a slide in no more than three seconds through use of the shortest path logic. The terminal unit controller and projector were connected to the CDC 6600 multiplexor via a data line or a dial telephone. A model ASR-33 teletype terminal was used on conjunction with the controller and the RA-960 slide projector with all electronic interface being designed in accordance with E.I.A. RS-232/c interface specifications.

Applications:

A number of applications were used to realistically test the concept of use of a random access 35 mm slide projector for rapid display of information to the student. These are described as follows:

FILMPF COMMAND REPERTOIRE

Source	ASCII Octal Code	Function
CDC-6600 MUX Student TTY	033	(disables TTY (enables Projector via (control unit
FILMPJ	127	(ready status (sets projector to (zero position (if (this is initial command)
FILMPJ Subroutine	100	(@ character printed (= zero. Projector is (at home position.
FILMPJ Subroutine	100	@ character printed = zero
FILMPJ Subroutine	127	Ready for slide
FILMPJ Subroutine	101	High Order A = 1 x 9
FILMPJ Subroutine	104	Low Order D = $\frac{+4}{13}$
FILMPJ Subroutine	042	Execute (Projector goes Slide 13)
FILMPJ Subroutine	127	Ready status command. Returns control to teletype.
FILMPJ Subroutine	127	
CDC-6600 MUX to Student TTY	033	Start of next sequence, etc.

TABLE 1.

OPERATIONAL CODES

OP CODE	ASCII	MUX-BYTE	PARITY	DISPLAY CODE BYTE	
ecu	033	100 0 00 110 11	0	4066	Enable control unit
pon	040	100 0 01 000 00	1	4101	Turn on projector
pof	041	100 0 01 000 01	0	4102	Turn off projector
exc	042	100 0 01 000 10	0	4104	Execute command (cw)
---	043	100 0 01 000 11	1	4107	----
sho	044	100 0 01 001 00	0	4110	Open Shutter
shc	045	100 0 01 001 01	1	4113	Close Shutter
nop	000	100 0 00 000 00	0	4000	No-op
pjn	106	100 0 10 001 10	1	4215	Slide eq. number
	110	100 0 10 010 00	0	4220	
sra	127	100 0 10 101 11	1	4257	Status request
	130	100 0 10 110 00	1	4261	
0	140	100 0 11 000 00	0	4300	
1	141	100 0 11 000 01	1	4303	
2	142	100 0 11 000 10	1	4305	
3	143	100 0 11 000 11	0	4306	
4	144	100 0 11 001 00	1	4311	
5	145	100 0 11 001 01	0	4312	
6	146	100 0 11 001 10	0	4314	▸ DATA
7	147	100 0 11 001 11	1	4317	
8	150	100 0 11 010 00	1	4321	
9	151	100 0 11 010 01	0	4322	
-	152				
-	153				
-	154				
-	155				
-	156				
-	157				

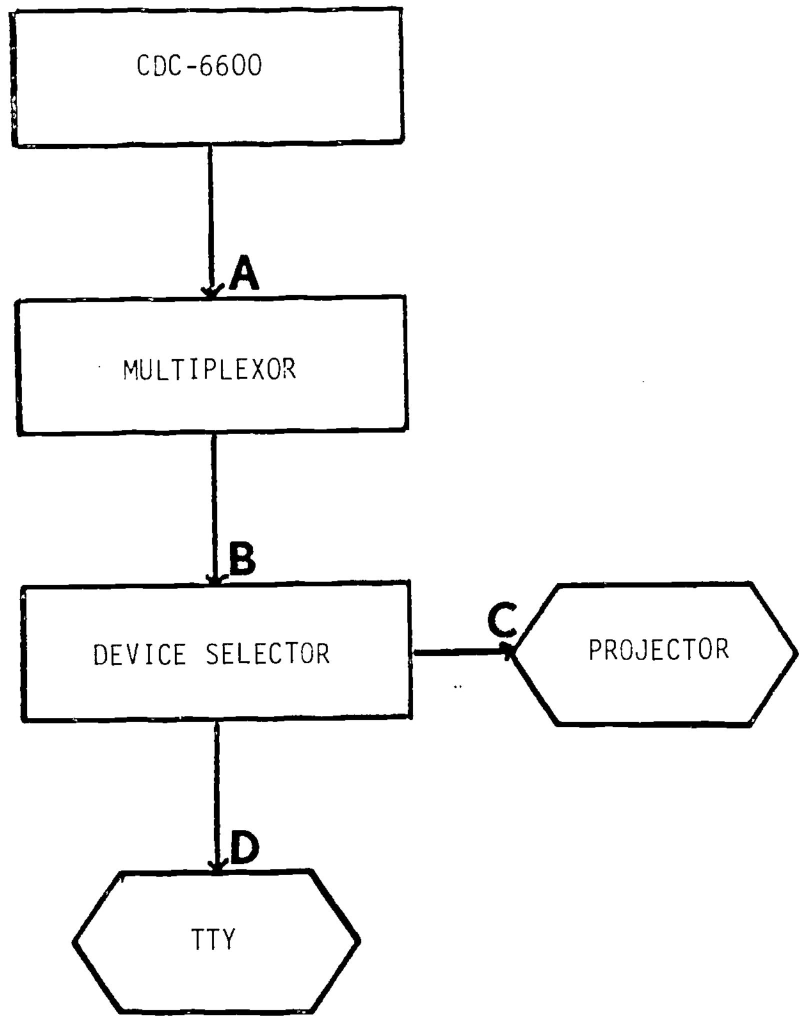
TABLE 2.

SYMBOL DATA

TABLE 3 shows the 8-level American Standard Code for Information Interchange (ASCII) character set. This character set is utilized by a 6676/8-level teletype communications system.

ASCII CHARACTER SET

OCTAL CODE	CHARACTER	OCTAL CODE	CHARACTER	OCTAL CODE	CHARACTER
000	Null	042	" (quotes)	112	J
001	SOM	043	#	113	K
002	EOA	044	$	114	L
003	EOM	045	[illegible]	115	M
004	EOT	046	&	116	N
005	WRU	047	' (apostrophe)	117	O
006	RU	050	(	120	P
007	Bell	051	)	121	Q
010	FE_0	052	*	122	R
011	H. Tab	053	+	123	S
012	Line Feed	054	,	124	T
013	V Tab	055	- (hyphen)	125	U
014	Form	056	.	126	V
015	Return	057	/	127	W
016	SO	060	0	130	X
017	SI	061	1	131	Y
020	DC_0	062	2	132	Z
021	X-ON AUX	063	3	133	[
022	Tape ON	064	4	134	\
023	X-OFF AUX	065	5	135	]
024	Tape OFF	066	6	136	[illegible]
025	Error	067	7	137	[illegible]
026	SYNC	070	8	140 ↓ 173	Not Used
027	LEM	071	9	174	ACK
030	S_0	072	:	175	Alt Mode
031	S_1	073	;	176	ESC
032	S_2	074	[illegible]	177	Rub Out
033	S_3	075	=		
034	S_4	076	[illegible]		
035	S_5	077	?		
036	S_6	100	@		
037	S_7	101	A		
040	Space	102	B		
041	!	103	C		
		104	D		
		105	E		
		106	F		
		107	G		
		110	H		
		111	I		



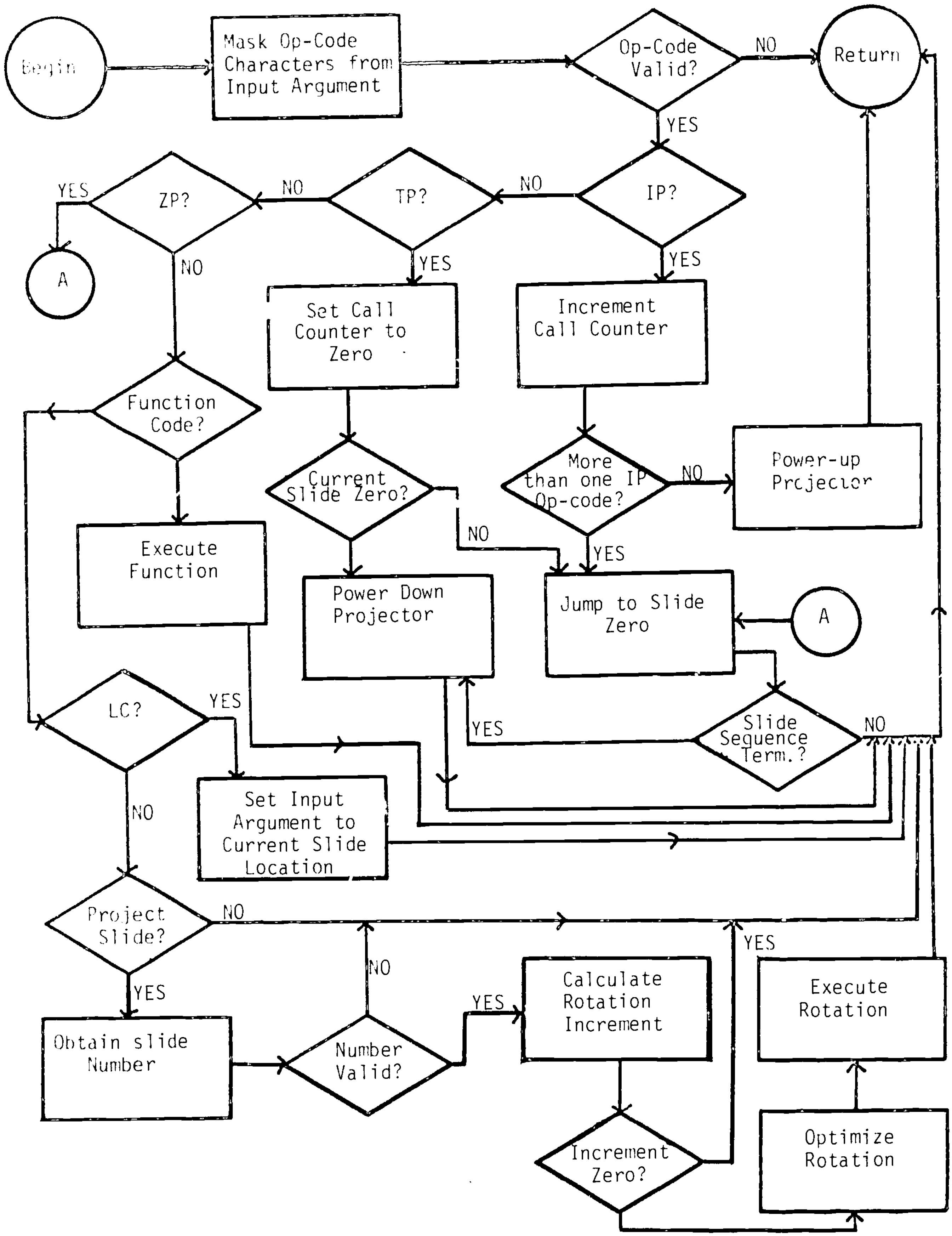
A BINARY WORDS FROM CENTRAL MEMORY ARRIVE AT THIS POINT WITH BIT-11 SET (i.e., 4XXXX)

B 8-BIT BINARY WORDS ARRIVE AT THIS POINT WITH EVEN PARITY

C ONLY ASCII CODES 140_8 to 173_8 ARRIVE HERE

D ALPHA NUMERIC ASCII CHARACTERS ON TELETYPE OUTPUT

FIGURE 1.



Begin
Mask Op-Code Characters from Input Argument
Op-Code Valid?
NO
Return
YES
IP?
NO
TP?
NO
ZP?
YES
A
NO
YES
Set Call Counter to Zero
YES
Increment Call Counter
Function Code?
Current Slide Zero?
More than one IP Op-code?
NO
Power-up Projector
Execute Function
NO
YES
Power Down Projector
Jump to Slide Zero
A
LC?
YES
YES
Slide Sequence Term.?
NO
NO
Set Input Argument to Current Slide Location
Project Slide?
NO
NO
YES
YES
YES
Calculate Rotation Increment
Execute Rotation
Obtain slide Number
Number Valid?
Increment Zero?
Optimize Rotation

FIGURE 2.

pH Laboratory Identification

Child Development Simulation

Use of the Computer Controlled Slide Projector

Chemistry Applications:

The slide projector was used for three different chemistry applications in C-BE comprising:

a. Display of information from a data base in response to a student question.

b. As a self-teaching (off-line, non-computer mode) device on how to sign on and use an instructional computer system.

c. With a computer based tutorial program for teaching laboratory identification technique using color discrete pH indicators shown on color slides.

These programs were using the University of Texas CLIC instructional language on the CDC-6600 systems.

Display of Information from a Data Base:

A slide information data base pilot model was created for providing introductory chemistry students with information of a fixed nature using an interactive computer program called "INFO". The student types in the word "INFO" and the computer program automatically displays a slide of twelve categories of information that is available to the student. The student types the letter in front of the category. This causes the computer to display a sub-category slide formatted in the same manner. The student selects the specific information which is then displayed on slide form. The limitation of eighty slides is the constraining factor in the use of this technique.

Self-Paced Individualized Instruction:

This application consisted of some seventy-two color slides which were used with the manual random selection slide projection device to teach undergraduates how to sign on and use the CDC-6600 TAURUS instructional computer system. The program had many options which included:

a. A straight sequential "step through" from start to finish on how to use the terminal.

b. Special situations which were shown on the index or first slide to solve problems.

This technique saved much time in explanations to students by the instructor.

pH Laboratory Identification:

This application consisted of a single lesson familiarization exercise which utilized the technique of specific color indicators for identifying precise pH ranges using test tubes. In each instance six test tubes were displayed on one slide - one of these was titled unknown with the balance identified by numerical pH values printed above the test tube. The random access slide projector called up the individual slides under program control. Some forty slides were used in the program which was part of the introductory chemistry course that used computer based techniques.

HOME ECONOMICS

Observational simulation techniques were used with students studying physical development of children in a home economics child development course. While the full course included topics of physical, language, emotional and social development, only the area of physical development was programmed to use the random access slide projector.

A pilot simulation model was used with students for testing their knowledge of physical development. After viewing a set of slides, the student fills out a checklist printed out under computer program control. The computer then provides immediate feedback to the students in response to questions on the physical characteristics of the children shown on the slides. Included is the requirement for the student to furnish relevant physical characteristics which warrant further identification. A profilé of the student answers is kept by the computer for scoring the students responses. This inquiry type of simulation technique is a generative program that provides a different experience for each student by presenting various case histories to illustrate relevance to normal and abnormal physical growth traits.

The pilot program operated quite successfully and full results are contained in the publication on the Home Economics Childhood Development Research Project. This module was programmed in BASIC on the NOVA system.

LINGUISTICS

Another application of the random access slide projector was in linguistics. A series of 35 mm color slides were produced to operate under program control for syntactical analysis of sentence structure in learning fundamentals of linguistics. Dr. Solveig Pflueger conducted the experiment with one class of thirty students using the slide projector coupled to a model KSF-33 teletypewriter for a one-hour introductory session using an interactive computer program. Thus, it was possible to instantaneously display the lengthy textual material on the slide under computer control eliminating the slow typing process of the terminal. This module was programmed in BASIC on the C-BE NOVA system.

Summary of Results:

While the unit operated successfully in the chemistry, linguistics and home economics courses, some improvements in the form of a lower cost device were apparent. The cost of the electronic components required to design the logic, buffering, shift registers and latching decoders in the controller were too high and too complex to build for the straightforward task required. A total of four hundred dollars for parts and two thousand dollars for labor were expended. Since then, the GAF Corporation has marketed the Model ESP 1000 ($475.00) with the Model 100 Randex ($225.00) which contains two (built-in) 4-bit binary (octal) registers as a part of the projector. This model is designed for a standard computer interface voltage level. Because of the requirement for a controller for use with a super-8 sound movie projector, work was discontinued on this project and all effort placed on this device. A separate report of the research on the super-8 sound movie projector controller is being published.

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Associate Dean of the College of Engineering who provided the funding and hiring of a digital design engineer, Mr. Robert Farrier (a graduate student within the electrical engineering department). Mr. Farrier was selected and given project guidance through the cooperation of his adviser, Dr. Charles Roth, Professor of Electrical Engineering. Software design was accomplished through the talents of Dr. Peter Rusch of the Chemistry Department using FORTRAN IV.

Mr. Steve Sherman:

Systems Programmer for the University of Texas CDC 6600 computer, provided the systems interface specifications within the TAURUS Operating System.

Dr. Sam J. Castleberry and Dr. George H. Culp:

Research Associates, developed the curriculum matter in chemistry which incorporated the use of the slide projector for a data (reference) base and laboratory simulation.

Dr. Solveig Pflueger:

Research Associate for the development of the slides and linguistics computer based curriculum.

Dr. Ellen Durrett, Chairman, Department of Home Economics;

Gayle Browne and Dr. Agnes Edwards, Research Associates:

For slides and curriculum materials furnished in the home economics computer based instructional course.

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