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LAP6/WVU

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INTRODUCTION

LAP6/WVU is a modified version of the LAP6 system described by M.A. Wilkes in "LAP6 HANDBOOK", Technical Report No. 2, Computer Research Laboratory, Washington University, St. Louis, Missouri (May 1, 1967). LAP6/WVU is designed to take advantage of the additional 1024 words of memory available on the basic LINC-8 or PDP-12 manufactured by the Digital Equipment Corporation. The extra memory has been used to add (1) character by character deletion during the editor mode which facilitates the preparation of input data as well as program manuscripts, (2) eight character symbolic names of which there can be a maximum of 192, (3) tape identification, and (4) a date which is available for listings. A high speed version of LAP6/WVU has been developed in which the LAP6/WVU system resides on a disk. This system requires an 8K LINC-8 with at least 64K of disk storage.

This manual was designed to function as a supplement to the "LAP6 HANDBOOK" and assumes that the user has a copy of it available. All conventions of LAP6, not specifically contradicted, are identical in the two systems. Minor changes in PROGOFOP have also been made.

LAP6/WVU became operational in October 1968 and has remained in its present form since January 1969.

1. OPERATING PROCEDURES

1-1 Initial Start Up

1-1-1 Mount the LAP6/WVU system tape on unit \emptyset .

1-1-2 Clear all hardware interrupts by the following procedure:

- Raise SING INST key.
- Press START key [executes power clear and sets Upper Memory Bank (UMB) to 3 and Lower Memory Bank (LMB) to 2].
- Lower SING INST key.

1-1-3 Raise LCAD toggle switch to read in the auto-loading program which starts up PROGOFOP and begins to execute the DATE program. The following display will appear on the oscilloscope screen when the tape stops moving.

OCTOBER 20, 1968

This date has been saved from the previous time that the tape system was used and will appear at the top of each page of the listings produced when the \rightarrow PM, \rightarrow LI, and \rightarrow PX meta commands are used.

1-1-4 At this point you may either change the date (section 1-2) or enter the editor mode by striking L on the keyboard.

1-1-5 Two problems occasionally arise on entering the editor mode that are the result of failing to exit properly (section 1-4) during a previous loading of the LAP6/WVU system. The first is manifested by a display of scrambled characters on the scope. The second is manifested by the tape drive failing to stop after the display appears on the screen. Both of these problems can be solved immediately executing a \rightarrow EX meta command. When the tape stops moving, press the START 20 toggle.

1-2 Change of Date

1-2-1 To change the month, strike M on keyboard.

??????????20, 1968

Enter correct month through the keyboard.

NOVEMBEX??20, 1968

Character by character deletion can be accomplished by striking RUBOUT on the keyboard.

- Type RUBOUT

NOVEMBE??20, 1968

- Type R

NOVEMBER??20, 1968

- Strike RETURN key (↵) to return to DATE program.

NOVEMBER 20, 1968

1-2-2 To change the day, strike D on the keyboard.

NOVEMBER ??, 1968

- Type 21↓

NOVEMBER 21, 1968

1-2-3 To change the year, strike Y on the keyboard.

NOVEMBER 21, ????

- Type 1969↓

1-2-4 To enter editor mode from the DATE program strike L on the keyboard. This new date is saved on the tape and will be displayed the next time that the initial load procedure is executed.

1-3 Console Restart

LAP6/WVU occupies blocks 74-157 of a system tape and starts at block 100. If PROGOFOP resides in core and is intact, the system can be restarted by the following procedures.

1-3-1 If the LINC LMB is not 2 and the LINC UMB is not 3, reset them in the following manner:

- Press STOP toggle.
- Set left switches (LSW) to 0643 (UMB 3); raise DO toggle.
- Set LSW to 0602 (LMB 2); DO.
- Set LSW to 6602 (JMP X); DO (to change LMB)

1-3-2 Then read blocks 100-107 into quarters 0-7 by the following procedure:

- Set LSW to 0701 (RCG).
- Set right switches (RSW) to 7100 (7/100); DO.
- Press START 20 when tape motion stops.

It is sometimes easier to execute an initial load procedure (section 1-1) than to execute a console restart, particularly, if the LINC 8 has extended memory or a complicated interrupt system.

1-4 Exit

The system can be left only through the → EX, → LO, or → F meta commands without courting disaster on the next load or restart procedure.

2. OUTPUT FORMAT

2-1 Scope Display

The display format conventions of LAP6/WVU are the same as LAP6 except that the line marker has been changed to a backward pointing arrow (←). The form of several of the characters have been modified, especially the right and left quotation marks (figure 2-1). The numerical codes of these characters are the same as in LAP6 and are listed in column one of the keyboard layout in appendix D.

```

      #B.L.P      * =
1234567890 :-

QWERTYUIOP ---

      [ 1 +
HSDFGHJKL ?

      * 1 < ?
ZXCVBNM ; . |

```

Figure 2-1 A photograph of all visual characters of LAP6/WVU arranged as a keyboard image. The upper row of each line pair represents upper case characters.

2-2 Teleprinter Output

The listings called forth by → PN, and → LI meta commands are printed as 8½ x 11 sheets with the date (section 1-1) at the top of each page. The set of characters printed depend on whether a LINC head or standard ASCII head is mounted on the teleprinter. The result of the use of either head is illustrated in columns 3 and 4 of the keyboard layout in appendix D.

3. KEYBOARD INPUT

PROGOFOP can be modified to suppress keyboard echo during input to conserve paper (appendix A). The various keyboard modifications that may be encountered are illustrated in appendix D. EOL, del, and CASE are equivalent to RETURN, RUBOUT, and ALTMODE on the teleprinter keyboard.

By striking L on the keyboard while in the DATE program (section 1-1), the scope display is changed as the editor mode is entered.

.1

*

At this point you may either enter the command mode by striking the LINE FEED key or continue in the editor mode.

3-1 Command Mode

3-1-1 Once the LINE FEED key has been struck, a forward point arrow (meta,) appears at the lower left hand margin and the line marker moves down opposite it.

.1

→CJ TEST:1

*

The meta commands described in section 5 may now be entered. Characters can be deleted one at a time, by striking RUBOUT key or the editor mode re-entered by typing either ALTMODE, RUBOUT or CTRL/L. The meta command is executed by striking RETURN key.

3-1-2 One problem that arises because of the single character deletion feature occurs when a RUBOUT is struck to correct an error in a meta command which has crossed the working area boundary (tape motion will occur) while being typed in. This command must be deleted with either ALTMODE, RUBOUT or CTRL/L and retyped.

3-2 Editor Mode

3-2-1 The following deletion options are available.

- START 20 - deletes entire manuscript in working area.
- ALTMODE,RUBOUT or CTRL/L - deletes all characters on the current manuscript line. If no characters have been entered on the current line, the previous line is deleted. The line number of the deleted line is retained as the current line number.
- RUBOUT - deletes the last character on the current manuscript line. If no characters have been entered on current line, the RETURN character of the previous line is deleted and the line number from which the RETURN character was deleted becomes the new current line number. At this point, more characters may be deleted or added. To end the line, strike RETURN.

3-2-2 Some of the locate requests have been modified to conform the conventions of LAP6-3L.

- A line can be located with meta command → line number ↓ as in LAP6.
- ALTMODE,1 - Forward one frame.
- ALTMODE,2 - Forward one line.
- ALTMODE,Q - Backward one frame.
- ALTMODE,W - Backward one line.

3-2-3 Because of the character by character deletion feature, it is possible to delete the RETURN which is automatically inserted after the 511th character of the current line and continue to add more characters. This must be avoided because the manuscript cannot be processed by the → FM, → LI, or → CV meta commands.

3-2-4 The current line must be completed before a meta command can be issued.

4. FILES

Both manuscripts and binary programs can be entered as files on any tape of any unit. A file tape does not require a LAP6/WVU system on it.

4-1 File Index

When a tape is used as a file, blocks 246 and 247 are automatically reserved for the index. Entry names must follow the same rules as those in LAP6.

4-2 File Entry Placement

When a tape is used as a file, blocks 250-777 are reserved for file entries. Blocks 20-73 are free on the LAP6/WVU system tape. Blocks 0-245 are free on file tapes (appendix E).

5. META COMMANDS

All meta commands have the same format and function in the manner described in LAP6 unless specifically contradicted in the following section.

The ability to abort execution during →SM, →CM, →CB, →CF, and →SB meta commands and return to the system has been removed because of the difficulty that PROGOFOP has in recognizing a keyboard interrupt when a tape instruction is being executed.

5-1 Unchanged Commands

5-1-1 →SM

Blocks 170-245 are used as the working area on a file tape on unit 1.

5-1-2 →AM

5-1-3 →CM

5-1-4 →CB

5-1-5 →CF

5-1-6 →SB

5-1-7 →EX

The system can be re-entered by a console restart (section 1-3) or under program control (section 5-1-9).

5-1-8 →LO

5-1-9 →F

When this command is given, LAP6/WVU reads block 157 into quarter 0 and JMP's to 20. The programmed return from →EX, →F, and →LO is the same as in LAP6 except that the LMB must be 2 and the UMB 3 before a return is attempted.

5-2 Modified Commands

5-2-1 →DX

The meta Display Index has a tape identification displayed at the top of the scope.

```

ID:  LAP6/WVU TAPE
      NAME          EN #BLKS
MARK.WVU  B  250    3
PWDRS-8  M  260    3
QA SUB   B  403    1
MATHPACK B   34    4

```

A group of right arrowheads or blank spaces will be displayed if there is no tape identification present. To change the tape identification, type I. The following display will appear in the middle of the scope.

```
ID:  ????????????????
```

Character by character deletion is available as the new tape identification is being typed. To end the tape identification, strike RETURN. Any question marks which appear when the RETURN key is struck are filled with blanks when the original display returns.

NOTE: The tape identification is not used at any time or by any of the LAP6/WVU programs. Both it and the date are printed out when a →PX meta command is requested.

The display can be relocated by striking the following keys:

```

1 - Forward one frame
2 - Forward one entry
Q - Backward one frame
W - Backward one entry

```

5-2-2 →CV

The Convert meta command can convert a manuscript residing in either the LAP6/WVU working area (→CV) or from a tape file (→CV MATHPACK, ∅). The binary from either type of conversion is stored in blocks 160-167 of the LAP6/WVU system tape on unit ∅.

```

1 [SAMPLE PROGRAM TO I
LLUSTRATE TEXT AND ERRO
R HANDLING CAPABILITY
2     ERROR = NOTHING
[ERROR IS UNDEFINED BEC
AUSE NOTHING IS NOT YET
DEFINED
3     B20
4     LDA 1
5     TABLE
6     STC NOTHING
7 #TABLE JMP 20
10 #NOTHING 0
11 #TABLE 'A TABLE OF T
EXT'
12                                     ←

```

In addition to the normal display procedure, individual displays can be called in any order by:

- Typing E - Error display
- Typing M - Memory allocation display
- Typing S - Symbol table display

Multiple defined symbols may appear twice on the Error Display, if they are related to an undefined symbol.

ERRORS

NOTHING	10	2
NOTHING	10	2
TABLE	11	7
ERROR	2	

MEMORY ALLOCATION

20- 34

Undefined symbols are displayed in the symbol table with a \emptyset in both the value and the line columns.

SYMBOLS	VALUE	LINE
ERROR	0	0
NOTHING	24	10
TABLE	25	11

Any of these display modes can be moved forward one frame by typing l or moved backward one frame by typing Q.

5-2-3 → DS

The E, S, and M keyboard commands change the display mode to Error, Memory Allocation or Symbol table as described in the previous section. These displays can be moved forward one frame or backward one frame with the l or Q keyboard commands.

5-2-4 → CP

Either a RETURN or a SPACE can be used to terminate an answer.

5-2-5 → PK

The Print Index meta command lists the tape identification and date at the top of the page.

5-2-6 → PM

5-2-7 → LI

The date that is stored in the DATE program (section 1-2) is printed to the right of the page number, name, and line number at the top of each page of listing. The comment character (⌞) will be automatically printed in the 20th column unless it appeared in the first column of the scope display.

→PM ↵

TEST,1 LN=1 MARCH 2, 1970[SAMPLE PROGRAM TO ILLUSTRATE TEXT AND ERROR HANDLING CAPABILITY
ERROR = NOTHING [ERROR IS UNDEFINED BECAUSE NOTHING IS NOT
YET DEFINED

```

      B20
      LDA 1
      TABLE
      STC NOTHING
#TABLE JMP 20
#NOTHING 0
#TABLE :A TABLE OF TEXT:

```

→LI ↵

TEST,1 LN=1 MARCH 2, 1970

P CONT

[SAMPLE PROGRAM TO ILLUSTRATE TEXT AND ERKOR HANDLING
CAPABILITY
ERROR = NOTHING [ERROR IS UNDEFINED BECAUSE
NOTHING IS NOT YET DEFINED

```

      B20
20 1020    LDA 1
21 0025    TABLE
22 4024    STC NOTHING
23 6020 #TABLE JMP 20
24 0000 #NOTHING 0
25 2414 #TABLE :A TABLE OF TEXT:
26 4724
27 2537
30 3014
31 4231
32 1447
33 3053
34 4714

```

TEST,2 MARCH 2, 1970

NAME	VALUE	LINE
ERROR	UNDEFINED	
NOTHING	0024	10
TABLE	0025	11

Since the symbol table is printed last, the connotation of the \rightarrow LI 1 (,Name,Unit)RETURN meta command has changed. The symbol table can be deleted from a listing by striking RETURN, once the manuscript listing is complete. The symbol table is listed in three columns because of the increased length of the symbols. Undefined symbols are labeled as such in the symbol table.

If the manuscript contains "text" the "P" and "CONT" columns are listed after the corresponding manuscript line of text.

5-3 New Commands

5-3-1 \rightarrow RU RETURN (U = unit; e.g. R1 RETURN)

The Rewind Tape (\rightarrow R) meta command returns to the LAP6/WVU editor after execution is complete.

6. CONVERSION CONVENTIONS

LAP6/WVU conversion conventions are similar to those of LAP6. The following features have been either modified or added:

6-1 Location Statements - \square

A location statement must begin with the location symbol, \square , followed by an octal constant, a previously defined symbol name or a symbolic expression which consists only of octal constants and previously defined symbol names.

EXAMPLES:

	\square 200
#1A	\square
	\square 1A+77
#1B	\square
	\square P+30

6-2 Tags -

The tag symbol, #, must be followed by a symbol name. The tag symbol must immediately follow a RETURN or a comma. The assembler assigns the current value of the location counter to the symbol name. Note: Both \square and # can be part of a symbol name as long as they are not the first character of a statement.

6-3 Equality Statement - =

Equality symbol, =, can be used to assign a value to a symbol name. The value can be a symbolic expression consisting of octal constants and previously defined symbol names.

EXAMPLES: TAPEUNIT = u
SALLY = TAPEUNIT - ATR + 20
BLOCK# = 400

6-4 Symbol Naming Convention

A symbol name can consist of up to eight of the following characters: the numerals 0-9, the alphabet A-Z, and certain special characters ?, ., *, :, <, >,], #, and @. The symbol name may not begin with #, @, or 00 and must have at least one character which is not one of the numerals 0-9.

EXAMPLES: SALLY
 <1>
 KEYBDST?
 BLOCK#
 <#@.*>
 0912
 LINC.8
 CLARK
 <4000>

6-5 Comments - [

Comments must begin with the comment symbol, [, and are terminated with a RETURN. Comments which do not begin in first column of text or after the twentieth column are tabulated to the twentieth column during a listing ordered by the → PM or → LI meta commands.

6-6 Special Symbols - p, i, u, and |

These are used in the same way as with LAP6.

6-7 Plus and Minus - + and -

These are used in the same way as with LAP6.

6-8 -[^] and >

LAP6/WVU treats [^] and > as LAP6 uses " and ". The [^] is used to initiate a text field and a > is used to terminate the field.

6-9 Spaces and Statement Format

6-9-1 Spaces are permitted anywhere in a manuscript, except between characters in a symbol name, and before the tag symbol and the location symbol.

6-9-2 Spaces are required between symbolic operation mnemonics and sybolic names when they are not separated by special characters such as =, p, i, u, /, +, and -.

6-9-3 The elements of a statement may appear in any order within the statement so long as tags come first as in LAP6.

6-9-4 Several statements may appear on the same line separated by commas if there are no intervening comment symbols.

EXAMPLE: LDA1, 4000, #LOOP2 SETi 1, -100

Is Equivalent To:

```

LDA1
4000
#LOOP2 SETi 1
-100

```

6-10 List Psuedo Command - .

The period which is used for formatting the output of the →Li meta command must appear immediately following RETURN or a comma. This period must be followed by a number or an expression which specifies the number of blank lines to be inserted in the listing at this point. If the value of the expression or octal constant is zero, the listing will skip to the top of the next page. The statement containing the period space command is not printed. This feature is not active during a →PM meta command and the list psuedo command will be printed as any other line.

→PM ↓

LI TEST,1 LN=1 MARCH 2, 1969

[SAMPLE PROGRAM TO ILLUSTRATE USAGE OF DOT LIST FEATURE

```

.SKIP
#20
.1
LDA 1
TABLE
JMP 20
.4
TABLE=1000
.2
SKIP=3
.1

```

[END OF PROGRAM

→LI ↓

LI TEST,1 LN=1 MARCH 2, 1969

P CONT

[SAMPLE PROGRAM TO ILLUSTRATE USAGE OF DOT LIST
FEATURE

B20

20	1020	LDA 1
21	1000	TABLE
22	6020	JMP 20

TABLE=1000

SKIP=3

[END OF PROGRAM

APPENDIX A - CHANGES TO PROGOFOP

The PROGOFOP which is distributed with LAP6/WVU has been modified so that the LINC character set can be typed without using the ALTMODE (CASE) character. The characters which are affected are listed below:

LAP6		LAP6/WVU	
TYPE	DISPLAY	TYPE	DISPLAY
CASE,SPACE	?	shift,/	?
CASE,A	"	shift,N	"
CASE,B	"	;	"
CASE,C	<	shift,comma	<
CASE,D	>	shift,period	>
CASE,E]	shift,M]
CASE,F	*	shift, :	*
CASE,G	:	:	:
CASE,RUBOUT	none	CTRL/L	none

Since the usage of the RUBOUT character was changed from deleting an entire line of manuscript to deleting a single character, the last change was made so that PROGOFOP would recognize CTRL/L for deleting an entire line of manuscript.

It is sometimes convenient to suppress the echo of keyboard input on the LINC-8. This may be accomplished by a simple patch to PROGOFOP after it has been loaded as indicated below.

```

                                *LOWER + 3
1541 5257 JMP ACTOA

```

The echo may be restored by depositing 1362 at PDP-8 location 1541.

APPENDIX B - CHANGES IN LOAD PROGRAM

The load program has been modified so that when the LAP6/WVU system tape is loaded by raising the LOAD toggle, the following steps are performed:

1. PROIOFOP is read in from blocks 2-5 from the tape into PDP-8 memory locations ϕ -1777.

2. The RIM and BIN loaders are read from block 6 into locations 74 $\phi\phi$ -7777.

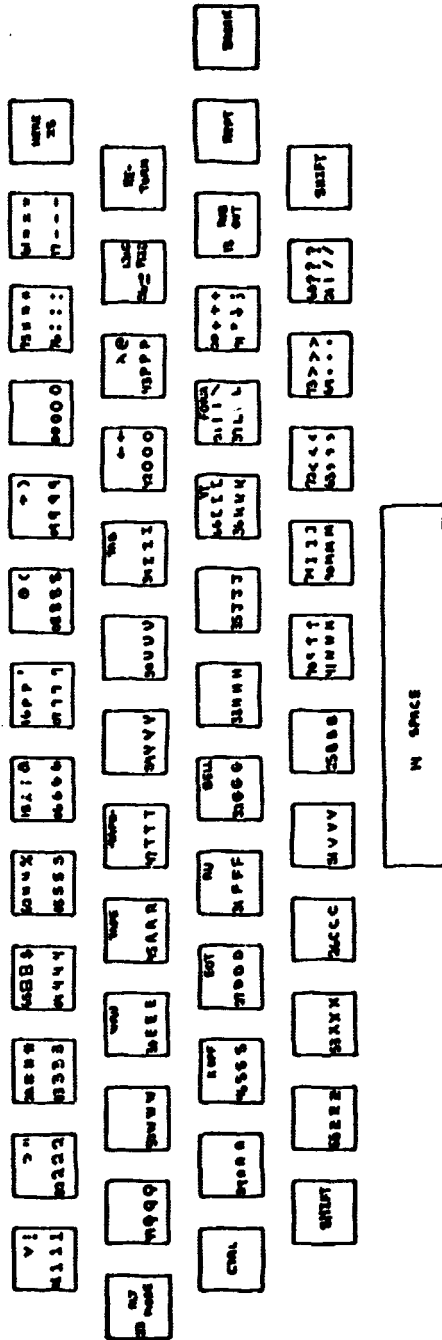
3. The DATE program is read in and started.

APPENDIX C - INSTRUCTION MNEUMONICS AND CODES

LAP6/WVU recognizes the following mneumonics as legal. They are given with their octal equivalents. New mneumonics are underlined.

<u>Numerical</u>				<u>Alphabetical</u>							
0000	HLT	0452	LZE	0707	CHK	ADA	1100	KST	0415	SAE	1440
0005	ZTA	0453	IBZ	0740	EXC	ADD	2000	LAM	1200	SAM	0100
<u>0010</u>	<u>U</u>	0454	FLO	1000	LDA	ADM	1140	LDA	1000	SCR	0340
0011	CLR	0454	OVF	1040	STA	APO	0451	LDH	1300	SET	0040
0014	ATR	0455	ZZZ	1100	ADA	ATR	0014	LMB	0600	SHD	1400
0015	RTA	<u>0467</u>	SKP	1140	ADM	AZE	0450	LSW	0517	SKP	<u>0467</u>
0016	NOP	0500	OPR	1200	LAM	BCL	1540	LZE	0452	SNS	0440
0017	COM	0513	PDP	1240	MUL	BCO	1640	MTB	0703	SRO	1500
<u>0020</u>	<u>I</u>	0514	TYP	1300	LDH	BSE	1600	MUL	1240	STA	1040
0040	SET	0515	KBD	1340	STH	CHK	0707	NOP	0016	STC	4000
0100	SAM	0516	RSW	1400	SHD	CLR	0011	OPR	0500	STH	1340
0140	DIS	0517	LSW	1440	SAE	COM	0017	OVF	0454	SXL	0400
0200	XSK	0600	LMB	1500	SRO	DIS	0140	PDP	0513	TYP	0514
0240	ROL	0640	UMB	1540	BCL	DSC	1740	RCG	0701	<u>U</u>	<u>0010</u>
0300	ROR	0700	RDC	1600	BSE	EXC	0740	RDC	0700	UMB	0640
0340	SCR	0701	RCG	1640	BCO	FLO	0454	RDE	0702	WCG	0705
0400	SXL	0702	RDE	1740	DSC	HLT	0000	ROL	0240	WRC	0704
0415	KST	0703	MTB	2000	ADD	<u>I</u>	<u>0020</u>	ROR	0300	WRI	0706
0440	SNS	0704	WRC	4000	STC	IBZ	0453	RSW	0516	XSK	0200
0450	AZE	0705	WCG	<u>6000</u>	<u>RTN</u>	JMP	6000	RTA	0015	ZTA	0005
0451	APO	0706	WRI	6000	JMP	KBD	0515	<u>RTN</u>	<u>6000</u>	ZZZ	0455

APPENDIX D - KEYBOARD LAYOUT AND PRINTING CONVENTIONS



Each key:

- 1st Column - LINC Code
- 2nd Column - LINC Display
- 3rd Column - LINC-8 Teleprinter Output
- 4th Column - ASCII Teleprinter Output

APPENDIX E - LAP6/WVU TAPE ORGANIZATION

0 17	Load Program; RIM and BIN Loaders; PROGOFOP; and Reserved Blocks
20	UNUSED
73	
74	LAP6/WVU
157	
160 167	Binary Area
170	Current Manuscript Working Area
245	
246 247	INDEX
250	File Area
777	

STANDARD LAP6/WVU
(with file)

0	UNUSED
245	
246 247	INDEX
250	File Area
777	

STANDARD LAP6/WVU
file tape

APPENDIX F - BUILDING A NEW LAP6/WVU SYSTEM TAPE

To create a LAP6/WVU system, use the →CP meta command to copy 20 blocks from block 0 and then 64 blocks from block 74 on to a marked tape on unit 1.

On the initial loading of the newly created system tape it will be necessary to execute the →EX meta command immediately after entering the editor as described in section 1-1-5.