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M E M O R A N D U M

M-5001-4

TO: TX-0 Computer Users

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SUBJECT: OPERATION OF THE TX-0 COMPUTER AND THE USE OF GOLUX,
           A SYMBOLIC CONVERSION PROGRAM

DATE: December 4, 1958

There are only five buttons on the TX-0 Console, four of which are almost obvious in their use; 1.) the STOP button stops the computer, 2.) the READ IN button reads in a binary tape that has been placed in the photoelectric tape reader (PETR), 3.) the TAPE FEED button feeds paper tape from the computer's flexowriter, 4.) the RESTART button restarts the computer if it has been stopped by pushing the stop button, a program halt, or halt after read in.

The fifth button is the TEST button. Pushing TEST causes the computer to execute the command in the Test Buffer Register (TBR). Appendix I lists the orders done in the test mode of operation.

These five buttons are all the buttons that exist on the console and they completely control the computer as far as a programmer is concerned.

Appendix III of M-5001-1 describes the UT-3 program, the Direct Input Routine. Appendix II of this memorandum describes Golux, a symbolic conversion program written by Mr. Larry Gitten. Now that a conversion program is available, UT-3 should not be used to put complete programs into the computer, but used only to modify programs and for other man-machine communications. To use the computer as nothing but a typewriter is wasteful.

The purpose of Golux is to read programs which were typed on an off-line flexowriter into the computer, and to then produce a suitable binary tape which can be read into the computer without the aid of any other program such as UT-3 or Golux.

Appendix II of M-5001-1 is now out of date and should be ignored.

Earle W. Pughe, Jr.

EWP/dbh

Encls.

Appendix I

Appendix II

Attachment I

Attachment II

cc - Ad Hoc Committee on
Experimental Computation

Professors Reintjes, Brown, Shannon,
Fano, Rosenblith, Arden,
Fletcher, Susskind and
Mr. Wesley Clark

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Instructions in the Test Mode

TBR_0	TBR_1	CODE	DESCRIPTION
0	0	sto X	Store the contents of the test accumulator (TAC) in register X.
			The ACC and the MBR are set to what was in TAC. The previous contents of the ACC and register X are destroyed. If the Repeat switch is up, the order will be executed over and over again. If the Step switch is also up, the order will be repeated for successive registers.
0	1	add X	Add the contents of register X to the contents of the ACC leaving the sum in the ACC. The contents of register X are unchanged. The Step and Repeat switches are the same as for sto X.
1	0	trn X	Transfer to the normal mode and do the instruction in register X. The Step and Repeat switches have no effect.
1	1	opr n	Operate class commands are done according to the number n. The Repeat switch causes the order to be executed over and over again. The Step switch has no effect.

APPENDIX II

OPERATING INSTRUCTIONS FOR A SMALL MEMORY SYMBOLIC CONVERSION PROGRAM FOR TX-O -- GOLUX

The Golux program has been written in order to enable the programmer to write his programs in a flexible symbolic language and then leave for the computer the task of converting the program into the computer's binary language. The Golux program converts programs typed on a Flexowriter paper tape to a TX-O, absolute addressed, binary language, paper tape.

DEFINITIONS

The following definitions will be used in the description of the Golux routine:

A terminal character is a tab or carriage return. It will be identified in sample programs by the symbols ⟶| and ⟩ respectively.

A three letter tag consists of any letter character followed by a combination of any two visible symbols. It must contain three (3) and only three symbols.

Sample three letter tags are:

                pot   x7a   f77   r9?

Invisible symbols are color change, upper case, lower case, blank tape, and code delete.

The space bar character will be represented by the symbol ⟶▶ in several examples.

TAPE FORMAT

A tape for the TX-O Golux routine must be prepared on a seven hole Flexowriter. The seventh hole should be punched since the PETR (photoelectric tape reader) will ignore any character without the seventh hole.

TITLE

Each tape must begin with a title. The title may consist of any combination of Flexowriter characters, with the exception of terminal characters (⟶| or ⟩).

A carriage return is used to signify the end of the title. Consecutive terminal characters may precede the title.

VOCABULARY

The Golux routine has a permanent vocabulary consisting of the three letter tags defined in Attachment I, and are the same as for UT-3 (see M-5001-2) except for "start". The definitions of these tags cannot be changed by operation of the program. Other three letter tags can be

assigned temporary values by entering them following the title. The three letter tag is typed, followed by an equals (=) sign, and then the definition is typed. The definition must be an octal number, the sum or difference of previously defined tags, and/or a combination of both.

> e.g.   acl=600221   or   acl=opr 221
>
> or   acl=opr+221

Each definition of a new three letter tag must be followed with a terminal character.

At the end of the vocabulary additions a period (.) is required. The period must be preceded and followed by a terminal character. If there are no vocabulary additions a period is not required.

PROGRAM

After the title and any vocabulary additions have been finished the program is typed. The first thing to appear must be the octal address of the memory register in which the first program word is to be stored. This is followed by a slash (|), a terminal character and the first program word.

> e.g.   201→| cla

The address of any other program word is fixed relative to the first address by assigning a floating address to the word. This is done by preceding the specified word with a previously undefined three letter tag, followed by a comma (,) and a terminal character. All references to the specified word may be made by using the three letter tag for the memory address.

> e.g.   cla
>
> rle,→ sto 27
>
> trn rle-3

Program words must be followed by a terminal character. Program words may be octal numbers, permanent vocabulary words, temporary vocabulary words, floating addresses or any combination of these separated by + or - signs as required. With the commands sto, add, trn, and opr, a space (→) or a + sign must separate the command from its argument.

> e.g.   add 3121+6-3 = add 3124 = 203124

Unless otherwise specified, 0 will be interpreted as +0. It should be remembered that cla+add does not become the two commands clear and add.

COMMENTS

Program comments may be hidden from the routine if they are preceded by a slash (|). The routine will ignore all characters from the slash until the next carriage return. This is the only time when carriage return and tab are not interchangeable.

END OF PROGRAM

At the end of the program the address at which the program is to start is to be specified. This is done by typing the command start followed by a space or plus sign, followed by the octal or symbolic starting address. The word start puts "add x" on the end of the converted tape. Using trn in place of start will put "trn x" on the end of the converted tape.

This starting command is followed by a carriage return and then a stop code symbol to indicate the end of the tape.

NOTES ON FORMAT

The routine will not be affected at all by the following tape symbols: color change, code delete, blank tape, upper case, or lower case.

The routine will handle several terminal characters or spaces in a row but will misinterpret three letter tags which include a space as a "fourth" letter.

e.g.   ca→t,

Errors on the tape may be removed by punching the code delete character over the erroneous characters.

Since the routine stops the PETR between the title and the rest of the program it is required that blank tape be fed after the title. This will compensate for slow operation of the PETR brake and reduce the number of reading errors.

There is no limit placed on the length of the tape to be processed.

The basic Golux routine has provision for only 108 (decimal) vocabulary additions. The program, Golux Program Extender, described in Attachment II, will increase this number when extra tags are required.

(NOTE: A previously defined vocabulary addition plus any constant is not counted as an additional vocabulary word.)

OPERATION OF THE ROUTINE

The Golux routine occupies register 0 to 2346 and uses most of the rest of the memory during operation. The core memory select switch must be up when the program is read in and used.

FIRST PASS

Place Golux in the PETR and "read in".

Then place the tape to be converted in the PETR and depress the restart button.

If the routine discovers an illegal Flexowriter character while

processing the tape it will place the illegal character in the accumulator and halt in register 1161. If the restart button is pushed the program will ignore the illegal character and continue.

When the first pass is finished the routine will halt in register 31.

An English printout of the tags may be obtained after the first pass by reading in the Golux English Printer. In so doing, the program to be converted is destroyed and will not convert on the Second Pass.

SECOND PASS

Reload the tape to be converted into the PETR and depress the restart button.

The machine will punch out the title followed by the read-in-mode format of the input routine, and then proceed to processing the rest of the program.

The computer will again stop when it discovers illegal Flexowriter characters. Pushing the restart will cause the routine to continue.

If the routine discovers an unidentified three letter tag, it will type the undefined tag on the Flexowriter and then halt in register 31. If it is desired to continue through the program looking for other undefined tags, the computer should be transferred to register 701 by the test mode.

At the end of the second pass, the routine will punch out the desired binary tape a block at a time. At the end of all the blocks the starting command will be punched.

ENGLISH PRINT OUT

To obtain the absolute address assigned to each of the floating addresses read in the Golux English Printer routine. The routine will type out all the three letter tags followed by their absolute address assignments. This routine destroys all temporary vocabulary additions.

NOTES ON PROCESSING

When processing long tapes, the program may read the tape in small sections. Do not be alarmed if the PETR stops in the middle of a tape unless the computer stops also.

The routine may be slow to process certain tapes. Do not push the STOP button unless you are sure that the routine has gone astray.

PROGRAM EXAMPLE

```
        this is the title
        lca=600261
        dog=opr 225
        .
20|         tac
mpo,        alr
            cla
            tbr
mpl,        add xxx
            trnmpl
            lac
            trn mpo-1
            com
            lac
            trn mpo+1
xxx,        ÷1
        start 20
        STOP CODE
```

PERMANENT VOCABULARY FOR GOLUX

sto = 0		tac = 740004
add = 200000		tbr = 740023
trn = 400000		dis = 622000
opr = 600000		ios = 760000
		rlc = 761000
cll = 700000		r3c = 763000
clr = 640000		rlr = 761600
cla = 740000		rlL = 761031
clc = 740040		prt = 624000
cal = 740200		pnt = 624600
iro = 600200		pna = 624021
com = 600040		pnc = 624061
lac = 740022		p6s = 766000
alr = 600201		p6h = 626600
lpd = 600022		p7h = 627600
lad = 600032		p6a = 626021
shr = 600400		p7a = 627021
cyr = 600600		
cyl = 600031		start = STA = 200000

GOLUX PROGRAM EXTENDER

The Golux Program Extender is used to enlarge the 108 (D) [154 (O)] register Golux FLAD table.

Operation

Read in Golux. Then read in Golux Program Extender and operate the Restart button. The program will print "How Far". Enter, immediately following, the octal number of Flads required beyond the 154 provided. Follow this by a carriage return. When Golux Program Extender has completed its operation it prints a carriage return, followed by two tabs and then halts in register 20 with Golux in control and ready to operate in the normal manner.

Golux Program Extender is a very unsophisticated program. It will not allow for typing mistakes. Nothing must be typed except the octal number specifying the number of additional Flads and a carriage return.