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TITLE	A SYSTEM FOR PRODUCTION OF PROBLEM SETS WITH INDIVIDUALIZED DATA
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SOURCE LANGUAGE	PAL III

A SYSTEM FOR PRODUCTION OF PROBLEM SETS WITH INDIVIDUALIZED DATA

DECUS Program Library Write-up

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ABSTRACT

The system produces problem sets for use in science and mathematics instruction, in which input data are changed for each student. Two programs are involved, (1) a FOCAL program into which the instructor inserts the algebra required to perform the calculations, and (2) a program which accepts a text with data positions marked, and then inserts individualized data from the FOCAL program (without the answers) and prints the copies. The system will work on any family-of-8 machine for which FOCAL is available.

1.0 INTRODUCTION

This system enables an instructor in a course involving calculations to prepare a number of sets of problems for his students. The problems have the same text except for varying input data. The type and complexity of problem possible is limited only by the imagination of the instructor and the very considerable capacity of the FOCAL programming system.

2.0 SYSTEM REQUIREMENTS

2.1 Hardware: Required: Basic PDP-8/I or equivalent plus ASR 33.

Useful: Extended memory. (See Section 4.3)

2.2 Software: Required: FOCAL (Any version having a random number function (but see sec. 4.1).

Useful: Symbolic Editor; 8K FOCAL.

3.0 PROGRAM DESCRIPTIONS

Two programs are involved, a FOCAL program which calculates data and answers, and a Text-Assembly Program which introduces the data into a prepared text. The FOCAL program produces a tape bearing both data and answers. The Text-Assembly Program (TAP) discards from this tape everything but the answers, which it inserts into copies of the text printed on the teletype. Detailed descriptions of the two programs follow. Examples are presented in Section 5.

3.1 Problem-Set Generator (FOCAL)

3.1.1 Description: The FOCAL program consists of two sections (1 and 2) of basic text, plus statements prepared by the user for particular problems. Section 1 controls over-all program flow, determines the number of data sets desired, punches out leader, provides the loop containing the user's prepared statements, punches a terminating clue, punches trailer, then quits. Section 2 is essentially a random-number generator (See 4.1), producing a random number HI and a complementary value LO=1-HI.

3.1.2 Problem Preparation: The user must supply for the FOCAL program the limits to be set on the input variables, the algebraic and logical statements by which answers are obtained, and statements which print a table and punch a tape containing data and answers. The user-prepared statements must begin with section 3, and from there can use all of the higher section numbers allowed by the user's version of FOCAL.

3.1.2.1 Random Data Generation. For each input variable, the user prepares a statement of the form

```
3.xx DO 2; SET X=HI*(upper limit)+LO*(lower limit)
```

thus producing a random value of X lying between these limits.

3.1.2.2 Answer Determination. Most commonly, the user will simply calculate each answer by SET statements. For complex problems, he has at his disposal the full arithmetic and logical power of FOCAL.

3.1.2.3 Data Output. The format of the output table must contain those clues required by the program TAP to distinguish data from format characters and answers. The basic requirement is quite simple: each item of data must be preceded by an = (as is normal in FOCAL), and each answer must be preceded by the letter A ahead of the = . The symbols A and = should not occur elsewhere on the tape. Further specifics regarding tapes are given in section 3.2.4. The symbols : and ; should not be used immediately following the last digit of a datum, since they serve as special clues. They may be used elsewhere on a data tape. A typical data tape generation statement might be:

```
4.xx TYPE %5.02, !, ?X?, ?  Y?, ?  Z?, "  A", V
```

where X, Y, and Z are data to be inserted in the problem texts, while the answer V will be printed in the FOCAL putput, but omitted from the texts.

The user may, of course, choose different formats for different numbers. He may output the data and answers intermixed, and have any number of data and answers, provided that (1) the data are typed in the order they are to appear in the text, and (2) each answer is preceded by an A. (Two or more A's will cause the program TAP to skip the corresponding number of output numbers.)

3.1.2.4 Program Testing. The algebraic algorithm and answer printing sections can easily be tested with data giving known answers if the program is written with this in mind. Most simply, if all the random data generation statements are included in section 3, followed by a "DO 4" statement, section 4, containing the calculation and output sections can be tested on-line. The test input data can be specified by an on-line (i.e., unnumbered) SET statement, followed by an on-line GOTO 4. An example of this technique is given in section 5.1.

3.1.3 Usage: After preparation of the required FOCAL sections, the program is started by a FOCAL GO command. In response to NO. OF SETS DESIRED: the user gives the number of individualized data sets wanted. The paper tape punch should be turned on immediately after typing the terminating character (space or carriage return) following this number.

The program will immediately begin turning out problem set data and answers. The punched tape will consist of

```
Leader: spaces (Code 240)
Data and Answers
A termination clue (= 99999:)
Trailer:  spaces
```

The colon(:) terminating a number will halt the Text Assembly Program.

3.2 Text-Assembly Program

3.2.1 Description: TAP is a PAL III program which accepts a text tape in which the positions reserved for answers are indicated by @, then reads in the data tape from the FOCAL Problem Set Generator, abstracts the data, and inserts these values in copies of the text produced on the teletype.

3.2.2 Text Preparation: The text is printed using the DEC program DEC-18-U. Allowed symbols are:

Letters A to Z Digits 0 to 9 Symbols !"$&'()*+-./:;<=>?

Other symbols will cause errors if included as text. Particular note should be taken that the symbols % and + cannot be used. The symbol @ is to be used only at the point where a datum is to be inserted. (The Form Feed tape symbol will also cause a break for a datum.) Text tape can easily be prepared using the DEC Symbolic Editor. Leader tape should be blank (produced by HERE IS). (Leader with the code 200 will produce a string of Y's.)

3.2.3 Usage: TAP is provided as a binary tape loaded in the usual manner with the BIN loader. It has two starting points, one for text readin and one for data readin and text output.

3.2.3.1 Text Readin.

1. Insert the text tape in the tape reader and turn on the reader.
2. Set SR to 0200, LOAD ADDRESS, START. Text will read in up to first @ symbol.
3. Press CONTINUE to read in subsequent text segments.

3.2.3.2 Data Readin, Text Output.

1. Insert data tape in the tape reader and turn on the reader.
2. Set SR to 0220, LOAD ADDRESS, START. Check first two or three text copies, then go to coffee.

3.2.4 Summary of Allowed Symbol Usage: The table below gives the allowed symbol usage on text tapes and in two different cases on data tapes. "Search Mode" means the data tape is being inspected for the letter A and the symbol =. "Number Mode" means an = sign has been encountered, and the data tape is being inspected for a datum.

Symbols	In Text	On Data Tape	
		Search Mode	Number Mode ***
Letter A	Typed	Skip one = *	Terminate
Letter E	Typed	Ignored	Typed
B,C,D, F thru Z	Typed	Ignored	Terminate
+ - .	Typed	Ignored	Typed
Digits 0 - 9	Typed	Ignored	Typed
=	Typed	Change Mode	Terminate
Space	Typed	Ignored	**
@	End Segment	Ignored	Terminate
:	Typed	Ignored	Halt Program
;	Typed	Ignored	Terminate Set
Other Symbols	See 3.2.2	Ignored	Terminate

* Each time an A is encountered in Search Mode a counter is incremented which causes one = to be ignored. Thus "AAA" would cause the next three = to be ignored, and could cause the next three punched numbers to be bypassed.

** Spaces in Number Mode are ignored if they follow the = and precede any other symbol. Otherwise, spaces terminate the number.

*** When Number Mode is terminated, the program returns to the next segment of text, and the terminating symbol is saved. When the next @ is encountered, the terminating symbol is recalled, and if it is an A or an =, it is used as indicated above under Search Mode. However, if the end of the text is encountered, the saved symbol is discarded.

When the terminating symbol is : the program halts. When the terminating symbol is ; the rest of the text is skipped and a new problem set is begun.

4.0 NOTES

4.1 Generation of the Random Number HI.

The FOCAL function FRAN is inadequate in two versions tested. In FOCAL.W (1968) FRAN had an annoying habit of repeating a value several times. In FOCAL, 1969, FRAN was apparently bounded in the rather unusual interval 0.5 to 1.0, and occurred nearly twice as often at the lower end as at the upper. In either case, the simple definition of HI in terms of FRAN given in statement 2.1 of this program produces a random number much better suited to this program.

If a version of FOCAL without FRAN is employed, statement 2.1 may be used with FRAN () replaced by some arbitrary six-number fraction.

4.2 Timing:

TAP is I/O bound by reader and printer speeds. A large number of copies will require essentially the teletype time needed to type them. The FOCAL program will be similarly limited by printer-punch speed unless the answer calculation is quite complex.

4.3 Versions and Modifications Tested:

The Program Generation System has been tested using FOCAL.W (1968) and FOCAL, 1969 in the 4K versions, and FOCAL, 1969 with the 8K patch. A standard tape has been constructed including the 8K patch and FWAT (see above), which is the present working version at Toledo. 8K FOCAL allows for a very extended set of problems, and is ideal for this system. However, the 4K version functions in a very satisfactory manner.

A modification using a fast tape reader and punch is planned.

```
                    /KEYBOARD READ
                    *2
0002  0000  READ,     0
0003  6031            KSF
0004  5003            JMP .-1
0005  6036            KRB
0006  5402            JMP I READ
                    /ALPHAMERIC MESSAGE INPUT (TO MATCH DEC 8-18-U
                    /CALL: JMS ALPHIN
                    /       (ADDRESS)
                    /       RETURN HERE
                    *20
0020  0000  ALPHIN,   0
0021  7320            CLA STL
0022  1420            TAD I ALPHIN          /OBTAIN STORAGE ADDRESS
0023  3071            DCA ADR
0024  2020            ISZ ALPHIN
0025  4002  READIN,   JMS READ              /READ A CHARACTER
0026  6046            TLS
0027  7450            SNA                   /BLANK TAPE?
0030  5025            JMP READIN            /YES. IGNORE LEADER
0031  1073            TAD CONST             /NO
0032  7450            SNA                   /CR?
0033  5061            JMP CR                /YES
0034  7001            IAC                   /NO
0035  7450            SNA                   /FORM FEED?
0036  5063            JMP TSYMR             /YES
0037  7510            SPA                   / NO. LESS THAN 214?
0040  5061            JMP CR                /YES. ASSUME LINE FEED
0041  1074            TAD CONST+1           /NO
0042  0075            AND MASK77            /OBTAIN 8-BIT CODE
0043  7450            SNA                   /@?
0044  5063            JMP TSYMR             /YES
0045  7430  JOIN,     SZL                   /RIGHT OR LEFT 8 BITS?
0046  5054            JMP RIGHT
0047  7106            CLL RTL
0050  7006            RTL
0051  7006            RTL
0052  3072            DCA CHAR
0053  5025            JMP READIN
0054  1072  RIGHT,    TAD CHAR
0055  3471            DCA I ADR
0056  2071            ISZ ADR
```

```
0057  7120          STL
0060  5025          JMP READIN
0061  1070  CR,     TAD CRCHAR          /GENERATE DEC 8-18-U
0062  5045          JMP JOIN            /CR AND LF CODES
0063  7430  TSYMR,  SZL                 /TERMINATE THIS INPUT
0064  1072          TAD CHAR
0065  3471          DCA I ADR
0066  1071          TAD ADR
0067  5420          JMP I ALPHIN
0070  0045  CRCHAR,  45
0071  0000  ADR,     0
0072  0000  CHAR,    0
0073  7563  CONST,   -215
0074  0214          214
0075  0077  MASK77,  77
0076  0000  CHARIN,  0
            *175
0175  0020  QALFIN,  ALPHIN            /PLANT ADDRESS
```

```
ADR     0071
ALPHIN  0020
CHAR    0072
CHARIN  0076
CONST   0073
CR      0061
CRCHAR  0070
JOIN    0045
MASK77  0075
QALFIN  0175
READ    0002
READIN  0025
RIGHT   0054
TSYMR   0063
```

5.0 EXAMPLES

5.1 Gas Law Calculation: In this simple problem the number of moles of an ideal gas are calculated, given the pressure, volume, and temperature

```
*C SAMPLE GAS LAW PROBLEM
*
*W
C-FOCAL,1969

01.20 ASK ! "NO. OF SETS DESIRED", SQ
01.25 T !; F NQ=1,70; T " "
01.30 FOR NQ=1,SQ; DO 3
01.40 T %6.00, 99999, ":";D 1.25;Q

02.10 S HI=67*HI+FRAN(); S HI=HI-FITR(HI); S LO=1-HI

03.10 DO 2; SET P=.8*LO+1.2*HI
03.20 DO 2; SET V=22*LO+25*HI
03.30 DO 2; SET T=288*LO+295*HI
03.40 DO 4

04.10 SET N=P*V/(.08206*T)
04.20 TYPE %6.03,! ? P?, ? T?, ? V?, "  A", N
*
*C  TEST RUN WITH CHOSEN INPUT DATA
*SET P=1; SET V=22.4; SET T=273
*GOTO 4.1

 P=    1.000 T= 273.000 V=  22.400  A=    1.000*
*
*C  DATA RUN
*GO

NO. OF SETS DESIRED:10

 P=    0.882 T= 293.867 V=  24.160  A=    0.884
 P=    1.151 T= 292.377 V=  24.109  A=    1.157
 P=    1.015 T= 289.675 V=  24.565  A=    1.049
 P=    1.046 T= 290.498 V=  24.575  A=    1.078
 P=    0.971 T= 291.238 V=  22.658  A=    0.920
 P=    1.172 T= 293.041 V=  24.554  A=    1.197
 P=    0.835 T= 291.331 V=  23.247  A=    0.812
 P=    1.053 T= 294.756 V=  23.048  A=    1.004
 P=    0.933 T= 290.606 V=  22.241  A=    0.870
 P=    1.017 T= 288.414 V=  24.963  A=    1.072=  99999:
*
```

```
SAMPLE PROBLEM PRODUCED WITH INDIVIDUALIZED DATA ON THE PDP-8/I

HOW MANY MOLES OF AN IDEAL GAS AT A PRESSURE OF @ ATM
AND A TEMPERATURE OF @ DEGREES KELVIN WILL BE REQUIRED TO FILL
A @ LITER CONTAINER?
@
```

```
SAMPLE PROBLEM PRODUCED WITH INDIVIDUALIZED DATA ON THE PDP-8/I

HOW MANY MOLES OF AN IDEAL GAS AT A PRESSURE OF 1.Ø53 ATM
AND A TEMPERATURE OF 294.756 DEGREES KELVIN WILL BE REQUIRED TO FILL
A 23.Ø48 LITER CONTAINER?
```

```
SAMPLE PROBLEM PRODUCED WITH INDIVIDUALIZED DATA ON THE PDP-8/I

HOW MANY MOLES OF AN IDEAL GAS AT A PRESSURE OF Ø.933 ATM
AND A TEMPERATURE OF 290.6Ø6 DEGREES KELVIN WILL BE REQUIRED TO FILL
A 22.241 LITER CONTAINER?
```

```
SAMPLE PROBLEM PRODUCED WITH INDIVIDUALIZED DATA ON THE PDP-8/I

HOW MANY MOLES OF AN IDEAL GAS AT A PRESSURE OF 1.Ø17 ATM
AND A TEMPERATURE OF 288.414 DEGREES KELVIN WILL BE REQUIRED TO FILL
A 24.963 LITER CONTAINER?
```

```
SAMPLE PROBLEM PRODUCED WITH INDIVIDUALIZED DATA ON THE PDP-8/I

HOW MANY MOLES OF AN IDEAL GAS AT A PRESSURE OF 99999
```

5.2 Gas Sample Collected over Water: This example, provided by Dr. Duane F. Burow, uses two modifications worthy of attention.

```
*@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
*C-FOCAL,1969
*
*01.20 ASK ! "NO. OF SETS DESIRED", SQ
*01.22 FOR TC=10,40 ; TYPE %2.00,?TC?;ASK ?PT(TC)?
*01.25 T !; F NQ=1,70; T " "
*01.30 FOR NQ=1,SQ; DO 3
*01.40 T %6.00, 99999, ":";D 1.25;Q
*
*02.10 S HI=67*HI+FRAN(); S HI=HI-FITR(HI); S LO=1-HI
*
*03.10 DO 2; SET X=FITR(10.0*LO+300.0*HI)
*03.20 DO 2; SET Y=FITR(700*LO+750*HI)
*03.30 DO 2; SET TC=FITR(10*LO+40*HI)
*03.31 SET PW=PT(TC)
*03.40 DO 4
*
*04.10 SET V=<273*X*(Y-PW)>/(TC+273)*760
*04.20 TYPE %3.00,! ?NQ?, ?  X?, ?  Y?, ?  TC?, "  A", V
**@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
*
```

Note that the user wished to read in a table (vapor pressures of water at specific temperatures), and so introduced the line 01.22. He also desired to round off all data, and used the FITR function for this purpose.

Note also how Dr. Burow obtained problem sets with consecutive numbering by including " ?NQ? " in his TYPE statement.

6.0 PROGRAM LISTINGS

6.1 Problem-Set Generator (FOCAL):

```
@@@@@@@@@@@@@@@@@@@@@@@@@@@@
C-FOCAL , 8/68

01.20 ASK ! "NO. OF SETS DESIRED", SQ
01.25 T !; F NQ=1,70; T " "
01.30 FOR NQ=1,SQ; DO 3
01.40 T %6.00, 99999, ":";D 1.25;Q

02.10 S HI=67*HI+FRAN(); S HI=HI-FITR(HI); S LO=1-HI
*@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@
```

6.2 Text-Assembly Programs: An ASCII tape of TAP is available. It consists of three segments, a master segment at 0200, a version of DEC-8-18-u at 0100, and a text-input subroutine starting at 0006. Core from 0367 on is a text buffer, capable of holding approximately 7200 characters.

```
                /PROBLEM SET TYPEOUT PROGRAM

                /TEXT READIN SEGMENT
                *200
0200  6046               TLS
0201  3213               DCA  SEGCNT          /CLEAR SEGMENT COUNT
0202  1215               TAD  BUFFER
0203  4341  INLOOP,      JMS  CONALF          /READ A SEGMENT
0204  2213               ISZ  SEGCNT
0205  3214               DCA  BUF2
0206  7402               HLT                  /AWAIT ANOTHER SEGMENT
0207  1214               TAD  BUF2
0210  5203               JMP  INLOOP
0211  0000  BUFPTR,      0
0212  0000  SEG,         0
0213  0000  SEGCNT,      0
0214  0000  BUF2,        0
0215  0367  BUFFER,      BFAREA

                *220
0220  7200               CLA
0221  3333               DCA  CHATMP          /CLEAR CHARACTER HOLDOVER
0222  6046               TLS
0223  7300  BGN2,        CLA  CLL
0224  1213               TAD  SEGCNT
0225  7041               CIA
0226  3212               DCA  SEG             /PLANT SEGMENT COUNTER
0227  1215               TAD  BUFFER
0230  4361  NXTSEG,      JMS  CONTYP          /PRINT A SEGMENT
0231  3211               DCA  BUFPTR
0232  2212               ISZ  SEG
0233  5235               JMP  INDIN           /GET A NUMBER
0234  5223               JMP  BGN2

0235  7240  INDIN,       STA
0236  3331               DCA  AKLUE           /INITIALIZE COUNT OF A'S
0237  1333               TAD  CHATMP
0240  1332               TAD  M301
0241  7440               SZA                  /TEST FOR A
0242  5250               JMP  NOTANS
0243  7240               STA                  / ANSWER SIGNAL RECEIVED
0244  1331               TAD  AKLUE
0245  3331               DCA  AKLUE           /INCREMENT COUNT
0246  4324  SEARCH,      JMS  READR           /INPUT A CHARACTER
0247  5240               JMP  INDIN+3
0250  1337  NOTANS,      TAD  P4
0251  7450               SNA                  /SKIP UNLESS AN =
0252  2331               ISZ  AKLUE           / IF =, TEST FOR ANS
0253  5246               JMP  SEARCH
0254  4324  NUMBER,      JMS  READR
0255  3333               DCA  CHATMP
0256  1333               TAD  CHATMP
0257  1334               TAD  M240            /SPACE?
0260  7650               SNA  CLA
0261  5254               JMP  NUMBER          /SKIP INITIAL SPACES
```

```
                        PAUSE

0262  1333  NJOIN,    TAD CHATMP
0263  1335            TAD M305          /TEST FOR E
0264  7450            SNA
0265  5314            JMP DIGPRT
0266  1340            TAD P12
0267  7450            SNA               /TEST FOR;
0270  5223            JMP BGN2          /TERMINATE PROBLEM SET
0271  7001            IAC
0272  7450            SNA               /TEST FOR :
0273  7402            HLT
0274  7500            SMA               /TEST FOR CODES GT 273
0275  5322            JMP NXTSG2        / TERMINATE NUMBER
0276  1340            TAD P12
0277  7500            SMA               /TEST FOR DIGIT
0300  5314            JMP DIGPRT
0301  7001            IAC
0302  7450            SNA
0303  5322            JMP NXTSG2
0304  1336            TAD P3            /AC=CHAR CODE-254
0305  7450            SNA
0306  5322            JMP NXTSG2
0307  7500            SMA
0310  5314            JMP DIGPRT        /- OR .
0311  7001            IAC
0312  7640            SZA CLA           /TEST FOR +
0313  5322            JMP NXTSG2
0314  7200  DIGPRT,   CLA               /PRINT CHAR
0315  1333            TAD CHATMP
0316  6046            TLS
0317  4324            JMS READR
0320  3333            DCA CHATMP
0321  5262            JMP NJOIN
0322  1211  NXTSG2,   TAD BUFPTR
0323  5230            JMP NXTSEG

0324  0000  READR,    0
0325  6031            KSF
0326  5325            JMP .-1
0327  6036            KRB
0330  5724            JMP I READR

0331  0000  AKLUE,    0
0332  7477  M301,     -301
0333  0000  CHATMP,   0
0334  7540  M240,     -240
0335  7473  M305,     -305
0336  0003  P3,       3
0337  0004  P4,       4
0340  0012  P12,      12
```

```
                        PAUSE

                /CONSECUTIVE ALPHAMERIC ARRAY READ AND TYPE
                /CALL:  JMS CONALF WITH STORAGE ADR IN AC
                /(AC) ON EXIT = FIRST UNUSED ADDRESS
                QMESAG=176
                QALFIN=175
0341    0000    CONALF,     0
0342    3347                DCA ALFPTR
0343    1357                TAD INSTR1          /PLANT PRINTOUT CALL
0344    3747                DCA I ALFPTR
0345    2347                ISZ ALFPTR
0346    4575                JMS I QALFIN
0347    0000    ALFPTR,     0
0350    7001                IAC
0351    3347                DCA ALFPTR
0352    1360                TAD INSTR2          / PLANT PRINTOUT RETURN
0353    3747                DCA I ALFPTR
0354    1347                TAD ALFPTR
0355    7001                IAC
0356    5741                JMP I CONALF

0357    4576    INSTR1,     JMS I QMESAG
0360    4577    INSTR2,     JMS I QALPTR

                /CALL: JMS I CONTYP WITH STORAGE ADDRESS IN AC
                /(AC) ON EXIT = NEXT BUFFER ADDRESS

0361    0000    CONTYP,     0
0362    3364                DCA ALPTR
0363    5764                JMP I ALPTR
0364    0000    ALPTR,      0
0365    1364                TAD .-1
0366    5761                JMP I CONTYP
0367    0000    BFAREA,     0

                *177
0177    0364    QALPTR,     ALPTR
```

PAUSE

AKLUE	0331
ALFPTR	0347
ALPTR	0364
BFAREA	0367
BGN2	0223
BUFFER	0215
BUFPTR	0211
BUF2	0214
CHATMP	0333
CONALF	0341
CONTYP	0361
DIGPRT	0314
INDIN	0235
INLOOP	0203
INSTR1	0357
INSTR2	0360
M240	0334
M301	0332
M305	0335
NJOIN	0262
NOTANS	0250
NUMBER	0254
NXTSEG	0230
NXTSG2	0322
P12	0340
P3	0336
P4	0337
QALFIN	0175
QALPTR	0177
QMESAG	0176
READR	0324
SEARCH	0246
SEG	0212
SEGCNT	0213

```
                    /DIGITAL 8-18-U MODIFIED
                    /MESSAGE TYPE-OUT
                             *100
0100    0000    MESAGE,     0
0101    7240                CLA CMA
0102    1100                TAD MESAGE
0103    3010                DCA 10
0104    1410                TAD I 10
0105    3116                DCA MSRGHT
0106    1116                TAD MSRGHT
0107    7012                RTR
0110    7012                RTR
0111    7012                RTR
0112    4117                JMS TYPECH
0113    1116                TAD MSRGHT
0114    4117                JMS TYPECH
0115    5104                JMP MESAGE+4
0116    0000    MSRGHT,     0

0117    0000    TYPECH,     0
0120    0150                AND MASK77
0121    7450                SNA
0122    5410                JMP I 10
0123    1151                TAD M40
0124    7500                SMA
0125    5130                JMP .+3
0126    1152                TAD C340
0127    5177                JMP MTP
0130    1153                TAD M3
0131    7440                SZA
0132    5135                JMP .+3
0133    1154                TAD C212
0134    5177                JMP MTP
0135    1155                TAD M2
0136    7440                SZA
0137    5142                JMP .+3
0140    1156                TAD C215
0141    5177                JMP MTP
0142    1157                TAD C245
0143    6177    MTP         TSF
0144    5143                JMP .-1
0145    6046                TLS
0146    7200                CLA
0147    5517                JMP I TYPECH
```

```
0150  0077  MASK77,   77
0151  7740  M40,      -40
0152  0340  C340,     340
0153  7775  M3,       -3
0154  0212  C212,     212
0155  7776  M2,       -2
0156  0215  C215,     215
0157  0245  C245,     245
                      *176
0176  0100  QMESAG,   MESAGE
            PAUSE

C212     0154
C215     0156
C245     0157
C340     0152
MASK77   0150
MESAGE   0100
MSRGHT   0116
MTP      0177
M2       0155
M3       0153
M40      0151
QMESAG   0176
TYPECH   0117
```