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Notes on GIP 5.

Report by

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SUMMARY.

This report contains notes on GIP 5 (Programme No. 323, ZC01/3) for distribution to a DEUCE Programmers' Course. The report consists of Sheets 2-6 of Report NS t 1243.

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1. BRIEF DESCRIPTION

The General Interpretive Program 5 (GIP 5) will interpret and obey a master routine written in a 3-address pseudo-code. This master routine uses pseudo-instructions that cause other programs to be obeyed and pseudo-instructions that operate on pseudo-instructions.

The master routine is called a GIP program and the instructions that it is composed of are called GIP instructions to distinguish them from a DEUCE program of DEUCE instructions. Thus GIP 5 is a DEUCE program that interprets a GIP program that itself sequences other DEUCE programs.

The GIP instructions are stored one per word in a 96-word GIP instruction store. An instruction may cause any program stored on the drum to be given the three addresses as parameters and obeyed. This facility is used in conjunction with Scheme B bricks to write programs in a 3-address code for operating on matrices. Alternatively, the addresses may be used to refer to the instruction stores so that instructions can be modified and conditional jumps made.

If (as with Scheme B bricks) the programs already exist, the writer of a GIP program need not have detailed knowledge of DEUCE programming unless he uses an additional facility for obeying DEUCE-like GIP instructions. This is described in 3 and may be ignored by the reader if desired.

GIP 5 provides facilities for program testing that bear the same relation to GIP instructions as the facilities provided on DEUCE bear to DEUCE instructions. These are described in 5.

2. STANDARD BRICKS

A DEUCE program that is to be sequenced by GIP 5 must satisfy certain conditions and programs that do are called standard bricks.

For the benefit of someone writing a standard brick these are described in DEUCE News 10. However, the writer of a GIP program sequencing existing standard bricks need know only the following:

A standard brick consists of an initial card followed by one or more sections. Each section consists of instructions to be stored on some whole number of tracks of the drum from one up to ten.

3. GIP INSTRUCTIONS

GIP instructions are written in columns thus:-

Store	a	b	c	r	D	G
0						
1						
2						
3						
⋮						

a, b, c are integers in the range 0 to 255 inclusive;
 r is an integer in the range 0 to 62 inclusive;
 column D is either left blank or filled in with a "D";
 column G is either left blank or filled in with a "G".

The column headed D is left blank except in DEUCE-like instructions; (see 5). Normally each instruction leads to the one following it in the GIP instruction store. The exceptions to this are described in 3.2. A completely zero instruction has no effect except that of leading to the instruction in the next store.

3.1 Instructions that cause DEUCE programs to be obeyed

Instructions in which $0 \leq r \leq 31$ with the column headed G left blank or $32 \leq r \leq 62$ with a G in the column headed G are used to cause a DEUCE program stored on the drum to be obeyed. For this purpose all the DEUCE programs being sequenced are arranged in some order and all the sections of them are numbered consecutively starting at 1. The total number of sections may not exceed 62.

To cause a program to be obeyed it is merely necessary to obey an instruction referring to its section of entry. Unless otherwise stated this is its first section. (In fact most standard bricks have only one section). The sequencing of its sections then follows automatically until it is finished after which the GIP instruction in the next GIP instruction store is obeyed.

An instruction with $r = 0$ and no G will cause section number c to be obeyed. An instruction with $1 \leq r \leq 31$ and no G or $32 \leq r \leq 62$ and a G will cause section number r to be provided with the three parameters a, b and c and obeyed. It is possible to provide a program with three extra parameters by using the facility $r = 48$ (described in 3.2). Descriptions of standard bricks that require these auxiliary parameters refer to them as a_1, b_1, c_1 .

3.2 Instructions operating on GIP instruction stores

In instructions with $32 \leq r \leq 46$ and no G the numbers a, b and c usually refer to the GIP instruction stores (numbered 0 to 95) and have the following effects:-

r = 32	a \neq 0; b = 0; c \neq 0. Replace the c sections numbered a to (a+c-1) by c sections in the reader (which must not occupy more tracks than the ones they replace). b = 0; c = 0. Read NxP17 on data card then carry out preceding operation with a = 1, b = 0, c = N. b \neq 0. Pass one program through the reader and obey it with parameters a, b \neq 0 and c.
33	Jump to order c.
34	Jump to c if A negative, otherwise jump to b (where A is contents of store a).
35	Jump to c if A non-zero, otherwise jump to b.
36	Jump to c if B > A, otherwise continue normally.
37	Jump to c if B \neq A, otherwise continue normally.
38	A + B \rightarrow C.
39	A - B \rightarrow C.
40	A \rightarrow C.
41	Obey A + B, add P1 to B, jump to c.
42	Obey A + B, add P9 to B, jump to c.
43	Obey A + B, add P17 to B, jump to c.
44	Obey A + B, add C to B, continue normally.
45	Obey A + B, jump to c.
46	Obey the instructions in stores a to b inclusive, then jump to c.
47	Read a set of 32 instructions into store 32c onwards (where c = 0, 1 or 2), jump to b.
48	Place a, b, c as auxiliary parameters for the next program to be obeyed.

N.B. A, B, C mean the contents of stores a, b, c respectively.

4. DEUCE-LIKE INSTRUCTIONS

As well as the form a, b, c, r GIP instructions may have the form O, S-D(c), W, T. This is written across the a, b, c, r columns with a D in the D column. There is one other small difference from writing ordinary DEUCE instructions, namely that instead of stopped instructions being indicated by "X", unstopped instructions are indicated by "Q". Such an instruction is called a DEUCE-like instruction and is written and has the same effect as the corresponding DEUCE instruction obeyed in mc 30, except in respect of the selection of the next GIP instruction to be obeyed, which is determined as follows:-

T may only take the value 31, 0 or 1 (and not even 1 if the instruction is a discrimination). If T = 31 the instruction leads back to itself (unless it is a successful discrimination in which case it has the effect of T = 0). If T = 0 the instruction leads to the one following it in the GIP instruction store (unless it is a successful instruction in which case it has the effect of T = 1). If T = 1 the instruction leads to the next but one following it in the GIP instruction store.

DEUCE-like instructions take about 14 ms to be obeyed and consequently if they are stopped instructions (i.e. have no G) they can be obeyed on successive one-shots of a card being read.

DEUCE-like instructions will find the following information in the mercury:-

TS13)	whatever was left there by the last DEUCE-like instruction to be
TS14)	obeyed.
TS15)	
TS16)	
DS19 _{2,3})	whatever was left there by the last DEUCE-like instruction to be
DS20 _{2,3})	obeyed provided that this was the last GIP instruction obeyed.
DS21 _{2,3})	Otherwise nonsense.
QS17 ₀₋₃)	
QS18 ₀₋₃)	
DL1 ₀₋₈ ₃₁		nonsense
DL9 ₀₋₁₂ ₃₁		the contents of GIP addresses 0 to 127; (see 5)

It is forbidden to obey a DEUCE-like instruction that will change the contents of DLs 1-8 or 12. Furthermore if a DEUCE-like instruction with destination 31 is obeyed, then the heads so moved must be returned to position 15 before obeying a normal GIP instruction.

DEUCE-like instructions have three main uses:-

- transferring parameters from binarily punched cards to GIP stores;
- transferring blocks of 32 GIP instructions from the drum (where they have been previously stored) to GIP stores;
- performing shifts and multiplications on numbers in GIP stores.

5. THE USE OF THE STORE

GIP occupies 21 tracks from 235 to 255. These include a GIP store of 128 words numbered from 0 to 127, of which the first 96 (from 0 to 95) are the GIP instruction stores. Of the remaining 32 (from 96 to 127) the following are useful:-

96-99	contain whatever was left in	17 ₀₋₃	}	by the last section obeyed and will be found there by the next section obeyed
101	" " " " "	16		
104-5	" " " " "	19 _{2,3}		
106-7	" " " " "	20 _{2,3}		
108-9	" " " " "	21 _{2,3}	}	by the last DEUCE-like instruction and will be found there by the next DEUCE-like instruction
110	" " " " "	13		
111	" " " " "	14		
120		zero		
121		P1		
122		P9		
123		P1+P9		
124		P17		
125		P1+P17		
126		P9+P17		
127		P1+P9+P17		

The facilities described in 3.2 apply equally to stores 96-127, but it is forbidden to use GIP instructions that alter the contents of these stores except for 96-99, 101, 104-111.

With some exceptions each section obeyed finds in the mercury whatever was left there by the last section obeyed. The exceptions are:-

- a) it occupies some of DLs 1-10 itself;
- b) TS13 and DL11 contain nonsense and so does DL1 unless it is occupied by the section in question;
- c) if the instruction a, b, c, r causes section r to be obeyed then it leaves axP5, bxP5, cxP5 in 18₀₋₂ (and r P₁₇ in 18₃);
- d) the instruction a, b, c, 46 leaves axP5, bxP5, cxP5 in 17₀₋₂ (as auxiliary parameters for a program that requires more than three parameters);
- e) an intervening GIP instruction may alter stores 96-99, 101 or 104-109 and hence alter what the next section will find in 17₀₋₃, 16, 19_{2,3}, 20_{2,3} or 21_{2,3};
- f) an intervening DEUCE-like instruction may alter 12₀₋₃, 12₅ or 12₈₋₁₃ and hence alter what the next section will find in 17₀₋₃, 16, 19_{2,3}, 20_{2,3} or 21_{2,3}.

These exceptions are not as significant as they might at first appear because most existing standard bricks leave their results on the drum or in DL12. The only exceptions that are relevant to the sections of a multi-section standard brick are (a) and (b) and all such bricks take account of these.

The first program to be obeyed as a result of a GIP instruction finds in the mercury whatever was in before GIP 5 was read from cards. The above list of exceptions also applies to this statement, with one more, namely that DLs 1-6 are all lost.

It is forbidden to refer at all to stores 100, 102-3, 112-119. Stores 120-127 contain constants useful for modifying instructions and counting.

The programs to be obeyed are stored on the tracks immediately preceding track 235. There may be up to 62 sections of program occupying up to 235 tracks. These sections are numbered consecutively from 1 upwards and are referred to by these numbers in GIP instructions. The remaining tracks are available for data and intermediate results.

6. PUNCHING GIP INSTRUCTIONS

GIP instructions are punched in blocks of 32 on triads of cards using the 32 column DEUCE field. The first four rows of each triad are left blank. D is punched as a hole in the P31 position; G is punched as a hole in the P32 position; and the remainder of the instructions are punched as follows:-

Instructions of the form a, b, c, r are punched as $axP1 + bxP9 + cxP17 + rxP25$; DEUCE-like instructions (of the form O, S-D(c), W, T) are punched in the usual layout.

7. PACK ASSEMBLY INSTRUCTIONS

To use a GIP program the following pack must be assembled:-

GIP 5 (Card Nos. 0-45).

Parameter card with $NxP17$ on the Y-row and the remaining rows blank;
 N DEUCE program sections in the same order as they are numbered for the purpose of referring to them in GIP instructions;

A triad of cards containing 4 blank rows followed by 32 GIP instructions;

Any data or other DEUCE programs or triads of GIP instructions assembled in the order in which they are to be read.

After the first 3 cards of GIP instructions have been read the first of them will be obeyed. What happens next is determined by the particular GIP program being obeyed.

8. PROGRAM TESTING FACILITIES

8.1 GIP "Stop Key"

A P32 on the ID will make all instructions except those called by function 46 stoppers, i.e. the instruction about to be obeyed will appear on the OPS, the machine stopping at 7, 1-1X. After a one-shot this instruction will be obeyed in the normal way.

8.2 GIP "Request Stop"

If an instruction has its address $xP17$ on the ID, this instruction becomes a stopper and remains so until the ID is altered. After a one-shot this instruction will be obeyed in the normal way.

8.3 GIP "External Tree"

If the GIP program is stopped on a stopper and a one-shot is given with the TIL key down, the instruction on the OPS will be replaced by whatever is on the ID. A further one-shot with TIL off will make the machine obey the new instruction. An instruction with a P32 cannot be inserted in this way. With a P32 on the ID and TIL on, a one-shot will have no effect whatsoever, the OPS remaining unchanged and the machine remaining at 1-1X.