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DECUS NO.	8-191
TITLE	FIELDS
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DATE	September 13, 1968
SOURCE LANGUAGE	PAL III

FIELDS

DECUS Program Library Write-up DECUS No. 8-191

INTRODUCTION

Fields is a demonstration program which calculates and displays the surface potential of a given boundary conditioned plane. Each output facility is called by a 338 display push button giving a numeric and/or pictorial result.

HARDWARE REQUIREMENTS

PDP-8 with 8K store and 338 display
HSR for Punch Display File
Teletype for Print Matrix

THEORY

Given a point in a matrix it can be shown that the potential at that point approximates to the average of the potentials at the adjacent points.

$$\text{i.e. } Vx,y = \frac{Vx-1,y + Vx+1,y + Vx,y-1 + Vx,Y+1}{4}$$

The matrix is continually scanned with the above equation until the overall change is within the specified error.

The calculation is more accurate if all eight adjacent points are used but the calculation time was found to be excessively long for a demonstration program.

Reference for Theory: Modern Computing Methods NPL. Pages 117-118. Solution of Elliptical Differential Equations.

OPERATION

Push Button Functions

PBØ Redevelop display after each iteration
PB1 Print results on Teletype
PB2 Loop with display on

PB9 Punch Display file on HSP
PB10 Display angle (y increment 200)
PB11 Display angle (y increment 100)

Operating Fields

The Binary Tape contains the Floating Point Package eleminating the need for a separate load.

Start Address = 2ØØ

Starting the Push Button 2 set will cause the program to loop having initiated the display. Initially this is a simple vector formed:-

Resetting Push Button 2 causes the program to escape from the loop and enter the input routine.

Data Input (via Teletype)

This order of input must be strictly adhered to.

Size of net - Example: 2Ø 11 (integer)

The program assumes an origin at 0,0 so the above input will give 21 by 12 matrix points. The size of the net is limited by the storage available for the display file which starts in location Ø1714. An input of 20 by 20 is close to the limit although the shape of the net will determine the real limit i.e. 30 by 10.

Calculation error - Example: Ø.Ø1 (fractional)

To read the error value the program enters the Floating Point Package.

Boundary values - Example:

```
2Ø Ø 3Ø1
2Ø 1 15Ø.5
2Ø 2 1Ø
2Ø 3 -15Ø.5
2Ø 4 -3Ø1
```

The coordinate pairs are read by the programs own subroutine which will ignore LEADER, LF, and DELETE.

An asterisk on the end of a numeric string will cause that string to be ignored, i.e. 29*2Ø Ø 3Ø1 = 2Ø Ø 3Ø1

To read each boundary value the program enters the Floating Point Package. If a mistake is made in the value it can be corrected by overwriting, i.e.

```
2Ø Ø 3011
2Ø Ø 301
```

The boundary point will be set to the last value read.

Start Iteration - Example:

This causes the program to escape from the input routine and begin the calculation.

The push buttons should be set as required before giving this instruction.

OUTPUTS

Display

Before entering the calculation routine the program develops and initiates the display. This has a fixed width but the angle of view is dependent vertically on the setting of push buttons 10 and 11.

Example: Net size 5 3

Push Buttons:	10,	11
0	0	0
1	0	1
2	1	0
3	1	1

When the iteration is complete the program will enter the second display routine to generate the final picture. See FIG.1.

If Push Button Ø is set, during the iteration, the display will be redeveloped after each pass. This enables the process of iteration to be viewed pictorially.

Punch

With Push Button 9 set the program enters the routine TAPE and punches out in binary format the complete display file.

This can be read in with binary loader and displayed using the Push Button 3 Loop, allowing interesting results to be stored.

Print

This routine is entered when Push Button 1 is set and gives a print of the matrix on the Teletype.

The output is broken into blocks of ten complete columns and continues until each row is completed.

The format can be altered by changing the output routine in the Floating Point Package.

RESTART

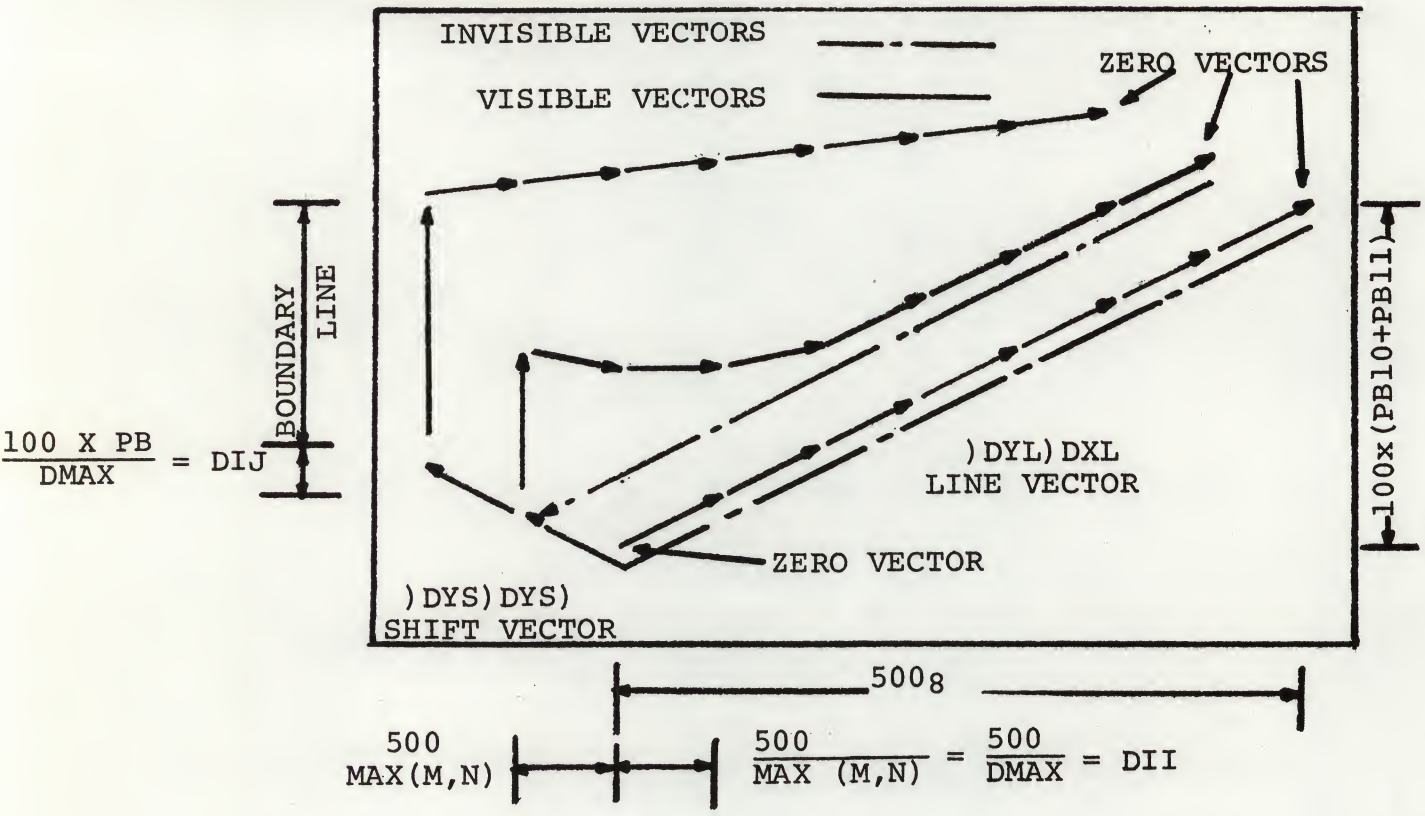
When the program has completed all requested operations it will return to the input routine for further data.

If it is required to display the field at a different angle restart at 201 with push buttons 10 and 11 set as required.

GENERATING THE DISPLAY

DISPLAY sets up the parallel line field as a series of vectors calculated from M,N and the push buttons 10 and 11.

DCALC calculates the modified Delta-Y vectors in the format and does not effect the fixed X vectors.



DELTA-Y Vector = Value (K) - Value (K-1) + DIJ
When K = 0 Value (K-1) is forced to Zero
When K = m Value (K) is forced to Zero

This causes visible, vertical vectors to be generated at each end of the line when a ± boundary condition is present.

CONCLUSION

FIELDS demonstrates the graphical and numeric capabilities of the PDP-8 - 338 system. It has served as a useful introduction to the PDP-8 Floating Point Package and in simple 3-dimensional representations of graphical results.

Neither the results nor the display can be termed accurate and the scientist would much prefer an equipotential plot, a venture I have yet to consider.

APPENDIX Sample Data and Results

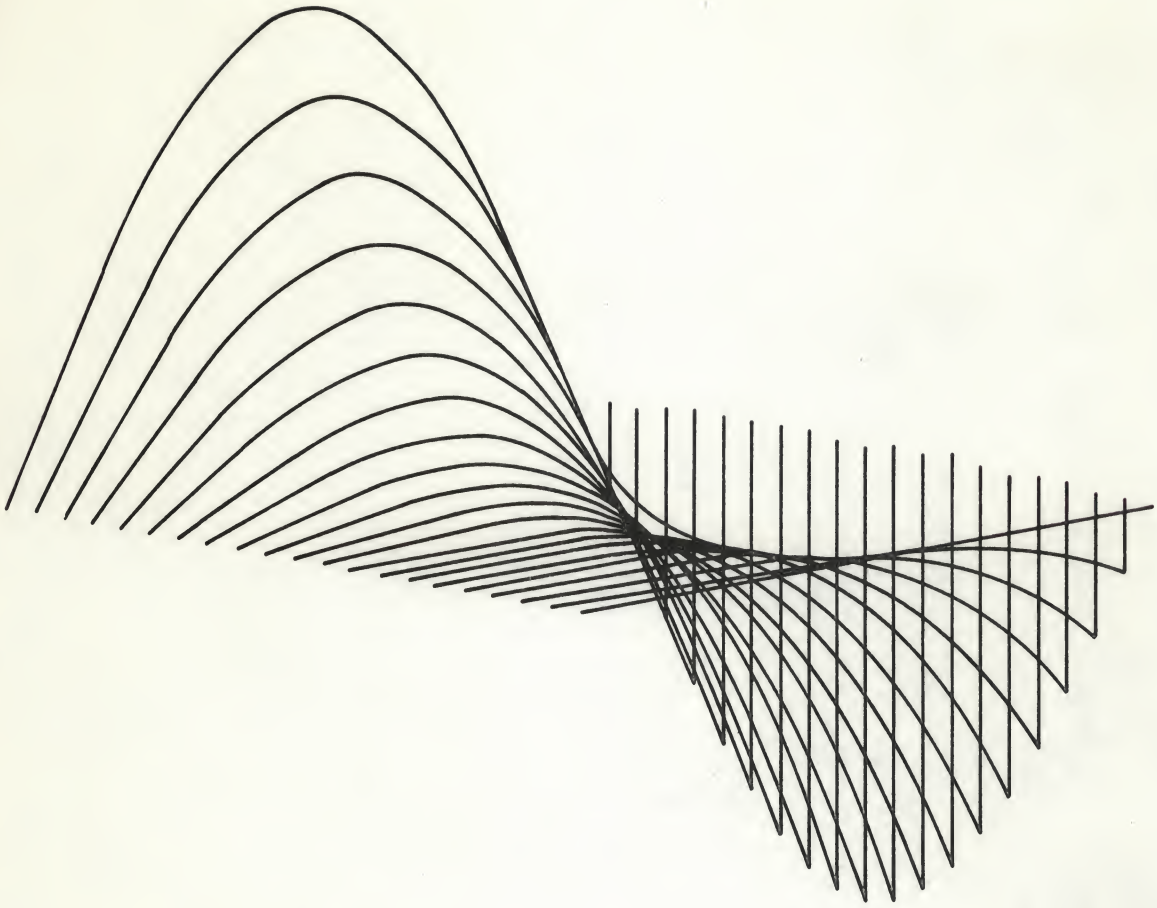
```
2Ø 2Ø

Ø.1
ØØ 2Ø Ø
1 2Ø 39
2 2Ø 77.2
3 2Ø 113
4 2Ø 147
5 2Ø 177
6 2Ø 2Ø2
7 2Ø 223
8 2Ø 238
9 2Ø 247
1Ø 2Ø 25Ø
11 2Ø 247
12 2Ø 238
13 2Ø 223
14 2Ø 2Ø2
15 2Ø 177
16 2Ø 147
17 2Ø 113
18 2Ø 77.2
19 2Ø 39
2Ø 2Ø Ø
```

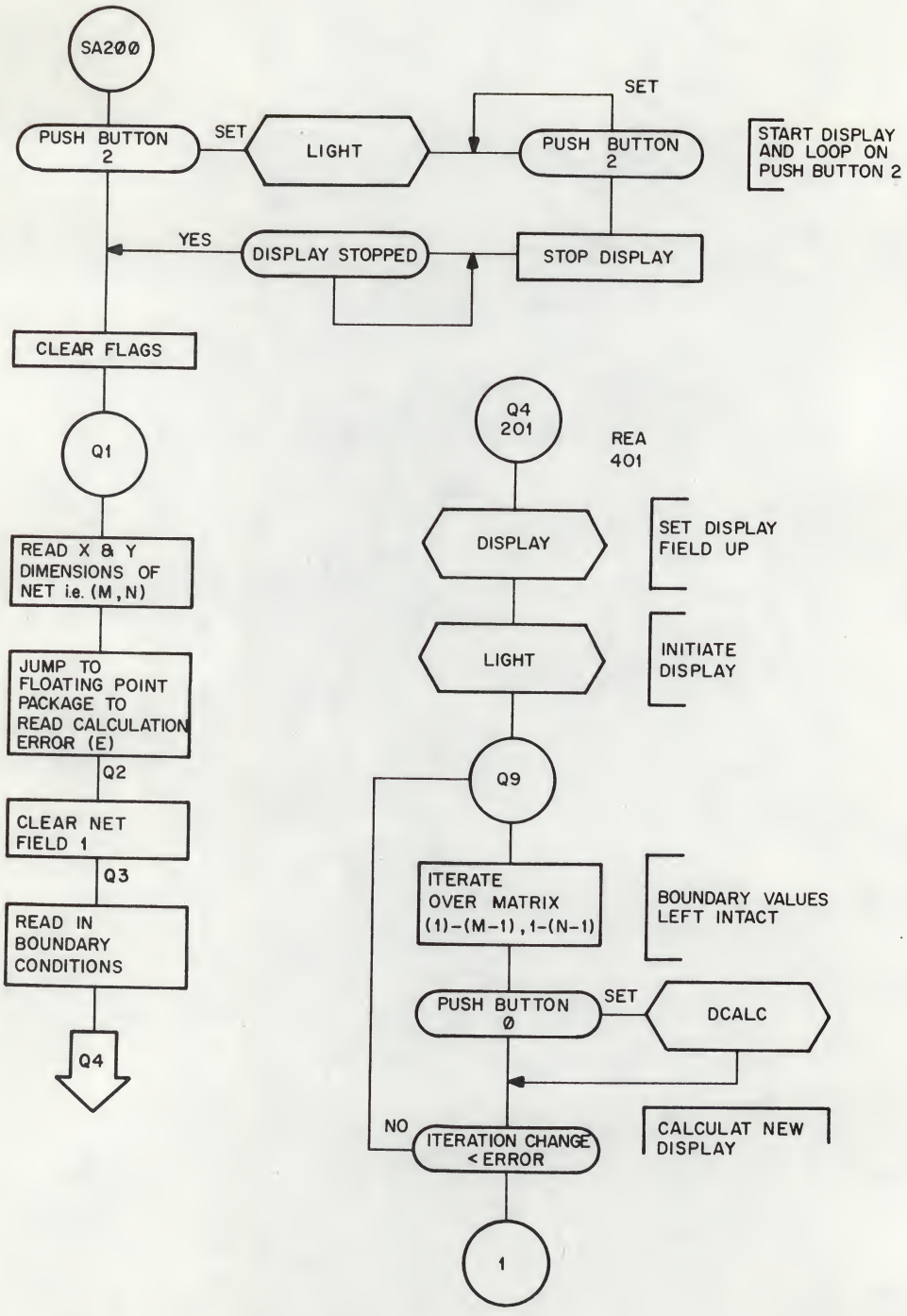
```
2Ø Ø Ø
2Ø 1 -39
2Ø 2 -77.2
2Ø 3 -113
2Ø 4 -147
2Ø 5 -177
2Ø 6 -2Ø2
2Ø 7 -223
2Ø 8 -238
2Ø 9 -247
2Ø 1Ø -25Ø
2Ø 11 -247
2Ø 12 -238
2Ø 13 -223
2Ø 14 -2Ø2
2Ø 15 -177
2Ø 16 -147
2Ø 17 -113
2Ø 18 -77.2
2Ø 19 -39
2Ø 2Ø Ø
```

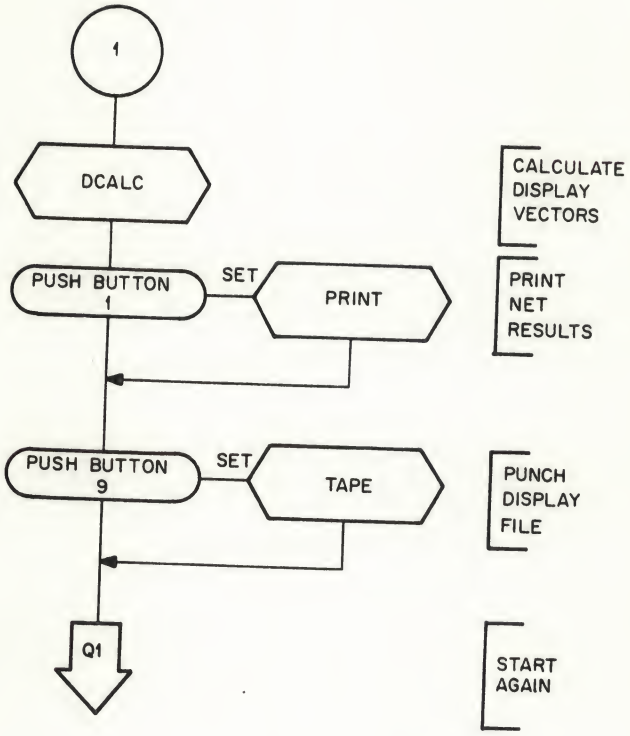
+		+	38	+	77	+	112	+	147	+	177	+	2Ø1	+	223	+	238
+		+	32	+	64	+	95	+	123	+	148	+	169	+	185	+	197
+		+	27	+	54	+	79	+	1Ø2	+	123	+	14Ø	+	153	+	162
+		+	22	+	44	+	65	+	84	+	1Ø1	+	115	+	125	+	132
+		+	18	+	36	+	54	+	69	+	82	+	93	+	1Ø1	+	1Ø5
+		+	15	+	3Ø	+	43	+	56	+	66	+	74	+	8Ø	+	83
+		+	12	+	24	+	35	+	44	+	53	+	59	+	62	+	63
+		+	9	+	19	+	27	+	35	+	41	+	45	+	47	+	46
+		+	7	+	14	+	21	+	27	+	31	+	33	+	34	+	33
+		+	5	+	11	+	16	+	2Ø	+	23	+	24	+	24	+	21
+		+	4	+	8	+	12	+	14	+	16	+	16	+	15	+	12
+		+	3	+	6	+	8	+	1Ø	+	11	+	1Ø	+	8	+	5
+		+	2	+	4	+	5	+	6	+	6	+	5	+	3	-	
+		+	1	+	2	+	3	+	4	+	3	+	2	-		-	3
+		+		+	1	+	2	+	2	+	1	-		-	2	-	5
+		+		+		+	1	+		-		-	1	-	3	-	6
+		+		+		-		-		-		-	2	-	4	-	6
+		+		+		-		-		-	1	-	2	-	3	-	5
+		+		-		-		-		-		-	1	-	2	-	4
+		-		-		-		-		-		-		-	1	-	2
+		+		+		+		+		+		+		+		+	

+	247	+	25Ø	+	247	+	238	+	223	+	2Ø1	+	177	+	147	+	112
+	2Ø4	+	2Ø5	+	2Ø1	+	192	+	177	+	157	+	133	+	1Ø4	+	72
+	167	+	167	+	161	+	151	+	137	+	117	+	93	+	66	+	34
+	134	+	133	+	127	+	116	+	1Ø1	+	82	+	58	+	31	-	
+	1Ø6	+	1Ø3	+	96	+	85	+	7Ø	+	5Ø	+	27	-		-	31
+	82	+	78	+	70	+	58	+	42	+	23	-		-	27	-	58
+	61	+	56	+	47	+	35	+	19	-		-	23	-	5Ø	-	82
+	43	+	37	+	28	+	15	-		-	19	-	42	-	7Ø	-	1Ø1
+	29	+	22	+	12	-		-	15	-	35	-	58	-	85	-	116
+	16	+	9	-		-	12	-	28	-	47	-	7Ø	-	96	-	127
+	7	-		-	9	-	22	-	37	-	56	-	78	-	1Ø3	-	133
-		-	7	-	16	-	29	-	43	-	61	-	82	-	1Ø6	-	134
-	5	-	12	-	21	-	33	-	46	-	63	-	83	-	1Ø5	-	132
-	8	-	15	-	24	-	34	-	47	-	62	-	8Ø	-	1Ø1	-	125
-	1Ø	-	16	-	24	-	33	-	45	-	59	-	74	-	93	-	115
-	11	-	16	-	23	-	31	-	41	-	53	-	66	-	82	-	1Ø1
-	1Ø	-	14	-	2Ø	-	27	-	35	-	44	-	56	-	69	-	84
-	8	-	12	-	16	-	21	-	27	-	35	-	43	-	54	-	65
-	6	-	8	-	11	-	14	-	19	-	24	-	3Ø	-	36	-	44
-	3	-	4	-	5	-	7	-	9	-	12	-	15	-	18	-	22
+		+		+		+		+		+		+		+		+	

```
+   77  +   38  +
+   37  -       -  38
-       -   37  -  77
-   34  -   72  - 112
-   66  -  1Ø4  - 147
-   93  -  133  - 177
-  117  -  157  - 2Ø1
-  137  -  177  - 223
-  151  -  192  - 238
-  161  -  2Ø1  - 247
-  167  -  2Ø5  - 25Ø
-  167  -  2Ø4  - 247
-  162  -  197  - 238
-  153  -  185  - 223
-  14Ø  -  169  - 2Ø1
-  123  -  148  - 177
-  1Ø2  -  123  - 147
-   79  -   95  - 112
-   54  -   64  -  77
-   27  -   32  -  38
+       +       +
```




SA200
PUSH BUTTON 2
SET
LIGHT
SET
PUSH BUTTON 2
START DISPLAY AND LOOP ON PUSH BUTTON 2
YES
DISPLAY STOPPED
STOP DISPLAY
CLEAR FLAGS
Q1
READ X & Y DIMENSIONS OF NET i.e. (M, N)
JUMP TO FLOATING POINT PACKAGE TO READ CALCULATION ERROR (E)
Q2
CLEAR NET FIELD 1
Q3
READ IN BOUNDARY CONDITIONS
Q4
Q4 201
REA 401
DISPLAY
SET DISPLAY FIELD UP
LIGHT
INITIATE DISPLAY
Q9
ITERATE OVER MATRIX (1)-(M-1), 1-(N-1)
BOUNDARY VALUES LEFT INTACT
PUSH BUTTON Ø
SET
DCALC
NO
ITERATION CHANGE < ERROR
CALCULAT NEW DISPLAY
1


1
DCALC
CALCULATE DISPLAY VECTORS
PUSH BUTTON 1
SET
PRINT
PRINT NET RESULTS
PUSH BUTTON 9
SET
TAPE
PUNCH DISPLAY FILE
Q1
START AGAIN