

SOME CHARACTERISTICS OF THE ANALYTICAL POLYMER JX

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Abstract

The paper describes some new concepts, new methods of the Analytical Plotter System JX (made in China), including the system structure, the development to small system, discarding operational redundancy, menu formation, user's interface, reduced digital map data, microcomputer-aided servo logic, general outline drawing in media of semi-conductor memory (keep track of collecting process), preliminary intelligence and etc.

By convenient with the cheaper, of higher capacity, more fast microcomputer, now the designers could stand at a more advanced stage than the previous ones. In order to avoid non-obsolescence of hardwares in the rapid developing process of microelectronics, and modification of softwares, the system should be consistent with the development of certain series of CPU unit. A new kind of Analytical Plotter has been designed successfully by Research Institute of Surveying & Mapping and Wuxi Instrument Factory of Surveying & Mapping through 4 years efforts (See fig 1). The Characteristics of the instrument are as follows.

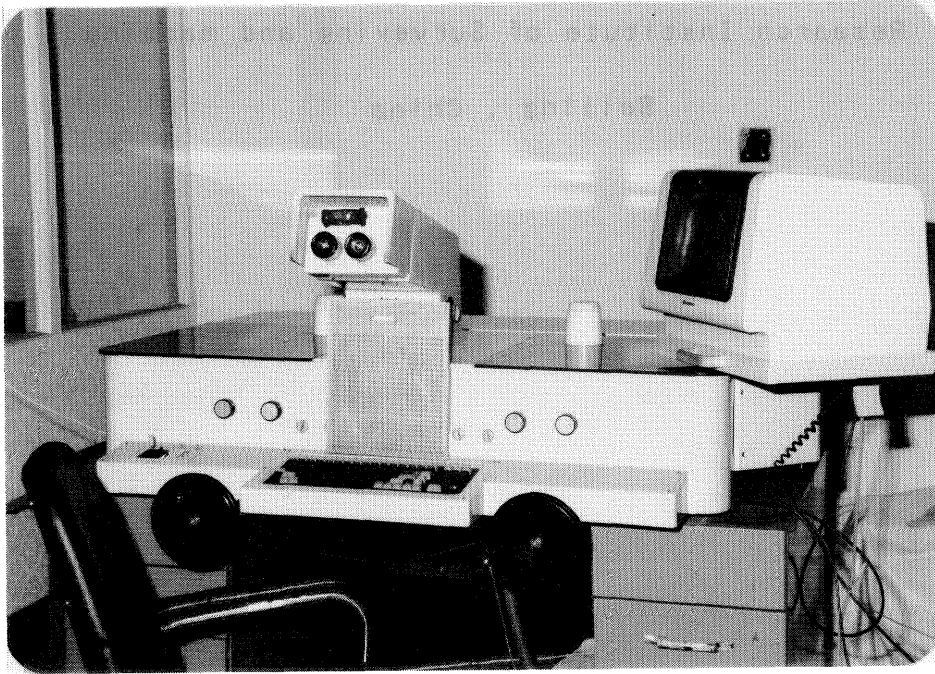


Fig 1

System Structure

A structure block diagram of Analytical Plotter System JX is shown in fig 2. This diagram can be separated to two parts divided by a dash line. Above the dash line is so called a small system, and below it is a host computer. Two parts are connected by a common memory board and a RS-232 communication line.

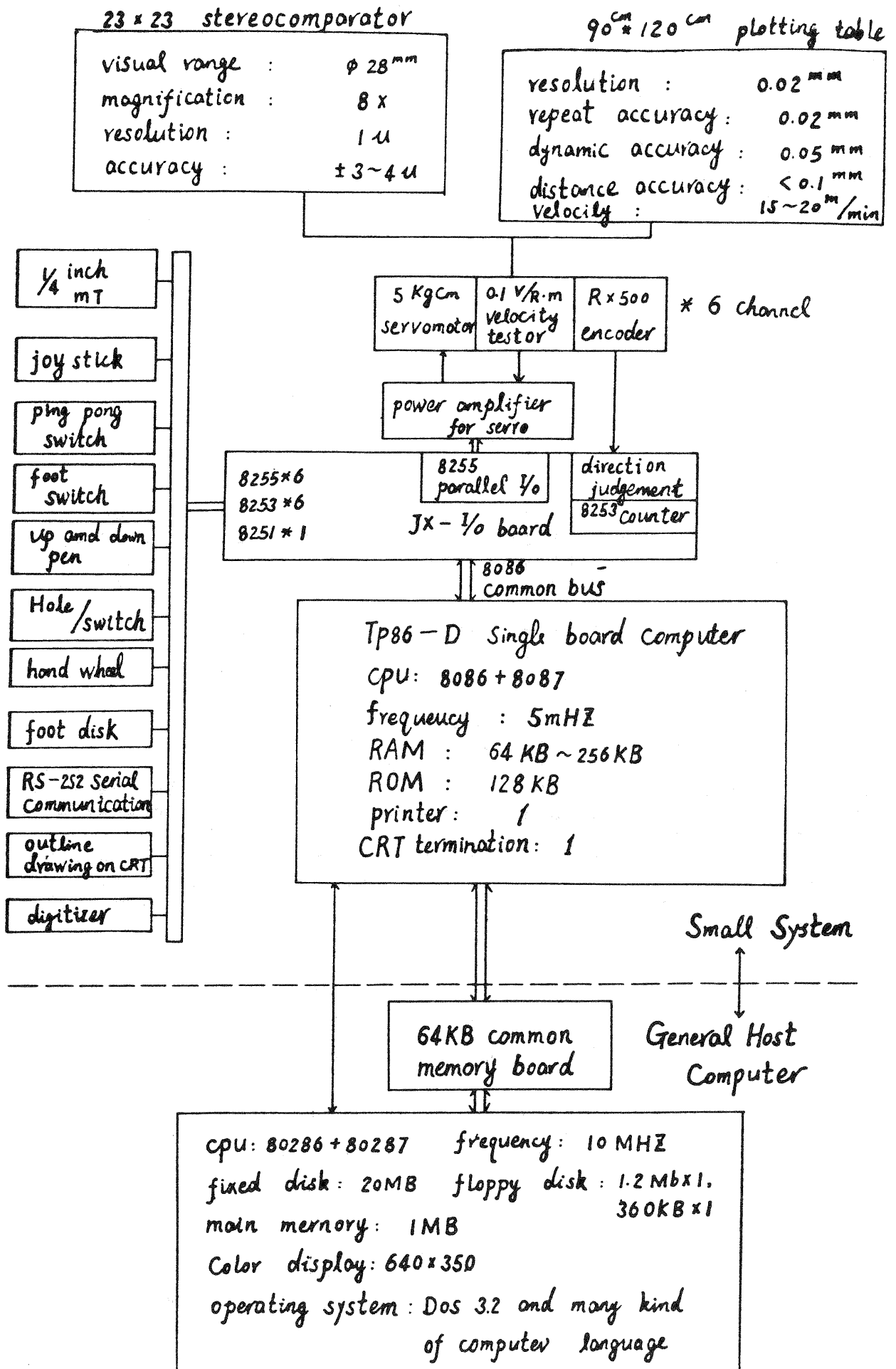


Fig 2 Structure block diagram of JX-Analytical plotter system

Development to Small System

The utilization of CPU's efficiency in previous analytical plotters is not very high, so a foreground terminal must be installed to develop the potentiality of CPU. But the calculation at foreground terminal always disturbs the normal operation of background terminal. As a plotting instrument for one person, the efficiency of a expensive analytical plotter compare with an analog one is only 30% higher. So a cheap airphoto collector is expected for digital mapping in large area and to set up various map data bases. With the development of microelectronics, this expectation becomes realizable. Now we have developed such a small system. Its characteristics are:

- * Specialized single board computer is utilized and one CPU for whole system.
- * Only one I/O interface board of full functions
- * Full solid software, specified object code of high quality nearly 100KB, specified operation system
- * Full loop computation with 8087 instructions
- * Microcomputer aided servo logic

When the system is not connected with a host computer, it can be used not only as a general mapping plotter, but also as a data collector for aerotriangulation, DEM and vector. (except that aerotriangulation calculation, DEM interpolation and video map).

The second method of development to small system is discarding the drawing table, or one drawing table for several collectors, or put the table under the control of workstation.

In this case the system is only used for data collecting, so a video-map function is necessary. With the development of microelectronics, video map function can also be realized at low price. After AST-286 is installed, Small System JX can be operated under video-function and than visual collection can be realized. At that time all of the data and subroutines even loop program will be opened to customers.

By this way, the condition for further enhancement is available. The requirements of users are multi-level. After one or two years, if it is desired, the solid state software could be replaced by single chip processor.

Microcomputer-aided Servo-logic

By use of loop program consisted of 8087's instructions can be much more computer time to handle the servo system, for example coordination-testing program. Neither the logic servoboard hardware nor the specified processor is needed to resolve the servo computation. It means easy manufacturing and high reliability. Since the velocity value to power amplifier and the encoder counts are transmitted directly through BUS, therefore the testing programme can be realized easily: servo power amplifier board is only regarded as hardware interpolator, or say controllable driver of constant velocity. Programmers can calculate out the velocity value in terms of expected coordinates, and present position (8253), and constant value T. By inputting the velocity to the corresponding I/O port, the position feedback loop is formed. By comparison with the servo logic, the position feedback realized by testing program more than 300 times is discontinual "delay" feedback. But it will be unnoticed.

To the position feedback realized by software some functions such as over-velocity limitation ,acceleration pre-control can be added (drastical change the moving direction for example).The benefits are:

- * The connecting wires are greatly decreased.
- * A great amount of hardwares logics are saved.
- * More or less smart servo drivers
- * More stability

Besides application of the HOLE components,photocouplera and radi-ate arrangement of cables brought . The system much more advantages

Menus

A menu of tree structure regards the operator as a "passive" dialogist.He(or she) becomes more and more muddle-headed,and would losses interest.The poeration of tree structure menu is trouble-some You would answer n times if you want make selection being at (n+1) level.So as to simplify the operation,to resume the operator's and to easy operations, the menu levels were reduced as possible .The commands are arranged at the same level as possible as it be done.And the same commands would probably occur at the different levels.

For example,all of the commands, provided by computer manufactures can be opened to photogrammetrists in the mapping process,(See Fig 3).The benefits are below:

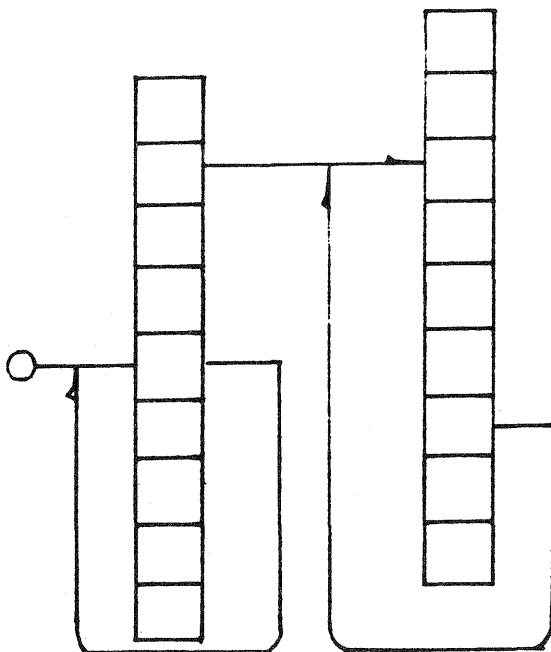


Fig 3

It results in:

- * The combination of command sequences could be unlimited
- * The updation route is shortest
- * Operator's initiative is resumed , and the creation desire is available .

After a failure of inner ,relative and absolute orientations a partial modification and a fast recomputation can be carried . (shown in figure 4 & 5)

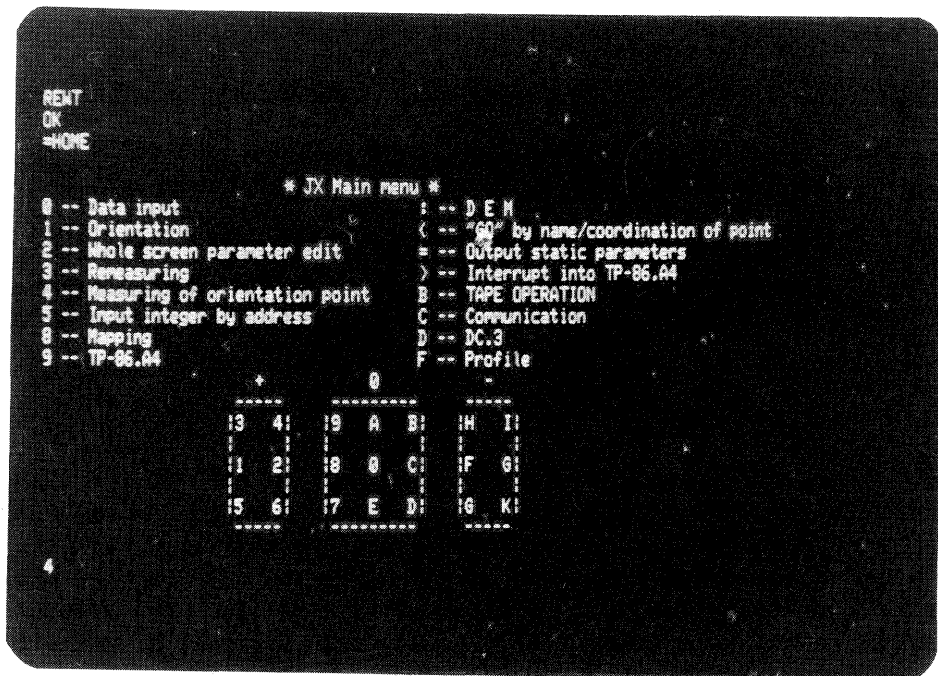


Fig 4 Main menu of the analytical plotter system

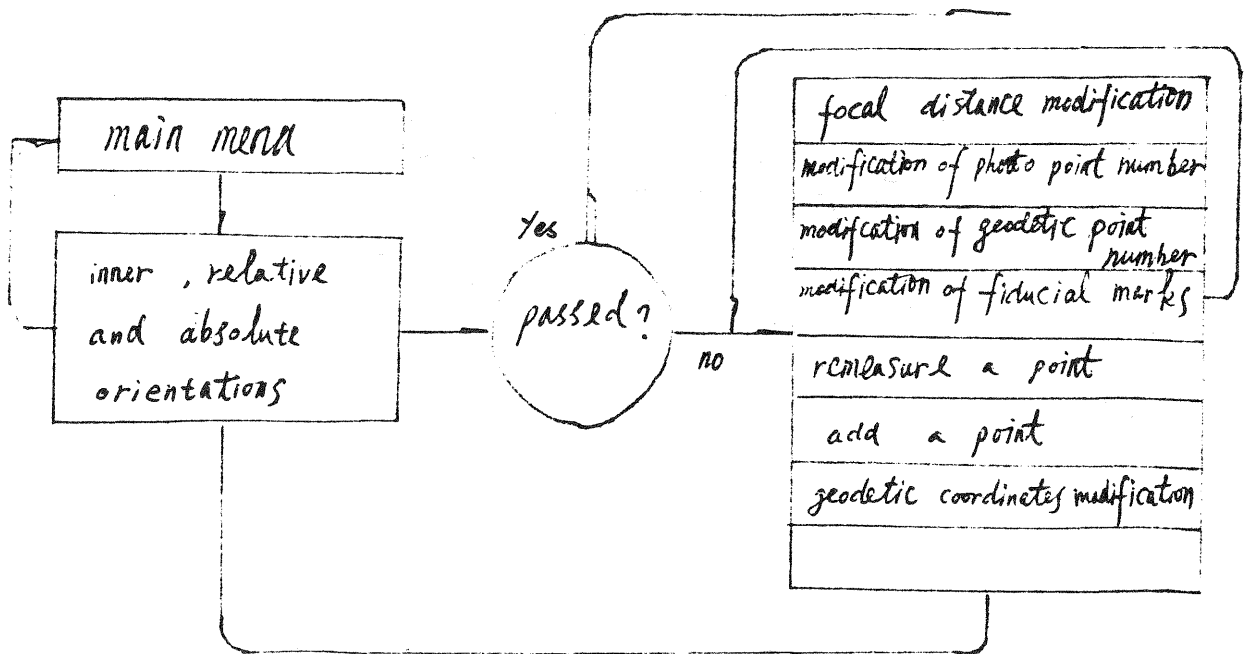


Fig 5 Model set-up

Distinctive Software

Beside the traditional softwares, the some softwares of the Analytical Plotter system JX has it's own characteristics as follows:

- * Preliminary intellegence
- * Chinese characters
- * Full-screen data editingd & parameters I/O forms. See Fig 5 & 6
- * House program: rectangular house program, eaves correction
automatical close of multi-angle house, area calculation
house information table
- * Precise area calculation
- * Handy, key-directed automatical movement
- * Personal difference adjustment (horizontal & vertical
parallaxes)
- * Inner orientation by measuring principal points only.

POINT	+57583.96	Others	LDC coordination X	+93428.77
Y0	+4882.67		Y	+4882.67
X(0)	+38998.48		LTC coordination X	+4882.67
Y(0)	+4913.33		Y	+4882.67
a(grid rotation)	+6783.88		RTC coordination X	+4882.67
B(0)	+100.00		Y	+4882.67
B	60		RDC coordination X	+4882.67
B	30		Y	+4882.67
B(increment n)	0	Grid interval		+4882.67
Velocity	3	dx(n)		+1.00
DBI's scanning	6	Area		+32367.88
By stick	9	Volume		+32367.88
Hand wheel	3	Length		+44.00
Foot wheel	4	Width		+38.00
Turning	7	Length*Width(strip area)		+3673.66
writing	3	Y exchange Z?		1
Signal	40	Altitude systematic error		40
Hard number	39	Oblique view		39
d(equivalent/100)	25	Scale 1:		200
Normal dir. interval	1	L/R		12
Horizontal dir. interval	100	D(Z3-1)		100
Recording?/Playback?	+200.00	Spare 3		0.00
Machine line interval	+45.00	Spare T14		0.00
Machine line rotation	0.00			+3673.66
Hard rotation				
Hard affine coefficient				

Fig 6 Full-screen data editing data of object space

8 -- Mapping		D -- DC.3						
9 -- TP-86.04		F -- Profile						
Write the file name, please!								
Map :	MH	Q type	3	4				
Photo :	MH	Fiducial type	0	0				
SL / SR :	SL	Fiducial coordinate	X :	-10.000	Y :	+10.000		
Date :	88.1.7			+10.000		+10.000		
Operator :	Z			+10.000		-10.000		
Focus(L) :	153.86			-10.000		-10.000		
Focus(R) :	153.86	Astronomical refraction-E:		0.00				
Scale 1:	2000	Measured value of n.s.e. :		+0.50				
No	x	y	p	q	N	E	h	
1	-100.000	+100.000	0.000	0.000				
2	+100.000	+100.000	0.000	0.000				
3	+100.000	-100.000	0.000	0.000	0.00	0.00	0.00	
4	-100.000	-100.000	0.000	0.000	0.00	0.00	0.00	
11	-0.787	-0.398	+97.467	+4.346				
22	+105.473	+4.997	+106.772	+11.114				
1422	-9.847	+74.243	+96.383	+3.337	+50640.95	+673.46	+887.85	
1323	-2.518	-17.499	+98.194	+4.365	+49403.82	+1261.63	+618.95	
1328	+64.828	-23.496	+100.033	+9.760	+49788.66	+2395.29	+1064.58	
3427	+51.336	+69.980	+99.194	+7.598	+50867.20	+1518.75	+976.33	
33	-5.683	-61.178	+100.739	+4.473				
DO YOU INPUT COORDINATS OF CONTROL POINTS(Y,N)█								

Fig 7 Full-screen data editing of image space

Some software are developed for chinese convention (see figure8). The general symbols at the scale of 1:500-1:10,000 are all stored in the symbol library. The movement control is peculiar too. Floating mark can be directed by joy-stick, handwheels, footdisk, the Digitizing Board, and the velocity parameter can be pre-set by operator on CRT. Compound movement occurs when different controls are applied on it at same time.

Operation without Redundancy

After statistic analyses of operator's key operation, one can found that 'telex' transmitted has a high redundancy. This isn't the mistake of operator, but it increases the intensity of operation. Here, a new specification for Analytical plotters even proposed: Operational redundance level. For the reduction of redundant operations redundancy. We have made a plenty of work. First, many single key commands are designed. This is a sort modification after a series of operations on CRT, and enables users to put a sequence of commands under the defination of a expanded function key. Besides this, a futher statistic of all human's handling operations has shown, there is also redundancy. A lot of work has been done on it. For instance, in process of deawing a enclosed contour line or a irregular curved line, when floating mark approaches the original point, the instrument would automatically do:

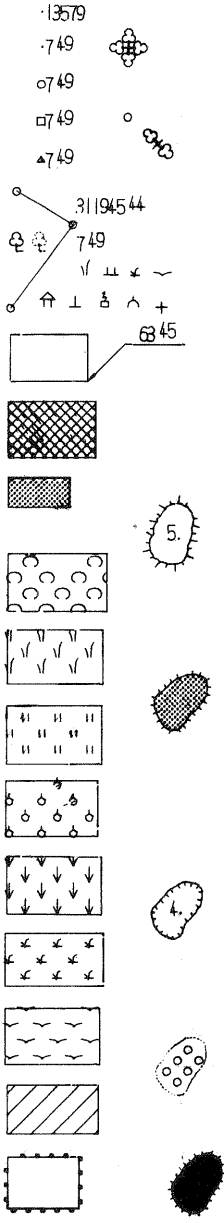
- * Output an absolute vector returning to original point to the digital map data area.
 - * Release pen-up command and close the combined pen-down
 - * Close time-interval sampling.
 - * Close distance-interval sampling or curvature fitting
- all of above four functions are carried out automatically, non key strike is needed. This is so-called operation without redundancy, witch is welcomed by operators.

Preliminary Intelligence

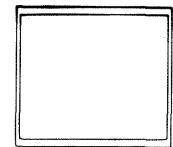
An interchange should exist between operator and programmers, and the programmers should know what the operators want for. A part of work has been completed by computer so the labour intensity was certainly decreased. Shown in Fig 9 (Mapping menu)

- * Point-by-point DEM scanning without key operation
- * Automatic return to original point without key operation
- * Floating mark goes up and down automatically in DEM scanning forecasting.
- * Footdisk release when measure contouring
- * Automatical footdisk release when it is necessary
- * Search the mapping window automatically by a single key
- * Go up and down a contour-interval by a single key
- Pen head moves away and back.
- * There are about 30 standard points in the image space can be approached automatically

These so called intelligence functions are preliminary or say a kind of test. The intelligence functions of the instrument are not in a linear relation with amount of programs, but in a exponent relation.



Z	Z	53	□	8A	⊕				
Y	Y	49	—	88	▲				
X	X	41	○	87	⊔				
W	W	40	○	86	⊥				
V	V	39	○						
U	U	38	+						
T	T	37	○	85	⊥				
S	S	35	∨	84	▲				
R	R	34	×	83	⊕				
R	Q	36	+	82	□				
Q	Q	33	⊔	81	⊗				
P	P	32	∨	80	⊗				
O	O	31	○	79	▽				
И	И	30	и	78	△				
M	M	29	∨	77	⊔				
L	L	28	⊕	76	⊗				
K	K	27	○	75	☆				
J	J	26	□	73	⊥				
I	I	25	∨	72	○				
H	H	24	.	71	⊕				
G	G	23	.	70	⊕				
F	F	22	○	69	⊗				
E	E	21	∨	68	⊗				
D	D	20	.	67	⊕				
C	C	19	□	66	×				
B	B	18	.	65	×				
A	A	17	∧	64	⊗				
0	0	16	.	63	⊗				
9	9	15	∨	62	⊗				
8	8	14	⊔						
7	7	13	⊔	61	⊗				
6	6	12	∨	59	■				
5	5			58	○				
4	4		○	57	⊕				
3	3		△	56	⊕				
2	2		□	55	⊕				
1	1		.	54	⊕				



- AC. ⊔
- AB. ⊔
- A9. ●
- A8. ●
- A7. ▲
- A6. ⊥
- A5. ⊗
- A4. ⊕
- A2. ▲
- A1. ⊔
- A0. |||
- 8K. ⊔
- 8J. ⊔
- 8I. ⊔
- 8H. ⊔
- 8G. ⊔
- 8F. ⊔
- 8E. ⊔
- 8D. ⊔
- 8C. ⊕
- 8B. ⊕
- 8A. ⊕

- 9K. 瓦
- 9J. 沙
- 9I. 石
- 9H. 铜
- 9G. 铁
- 9F. 风
- 9E. 气
- 9D. 煤
- 9C. 视
- 9B. 电
- 9A. 油
- 99. 台
- 98. 姓
- 97. 花
- 96. 菜
- 95. 温
- 94. 厕
- 93. 木
- 92. 土
- 91. 竖
- 9I. 竖

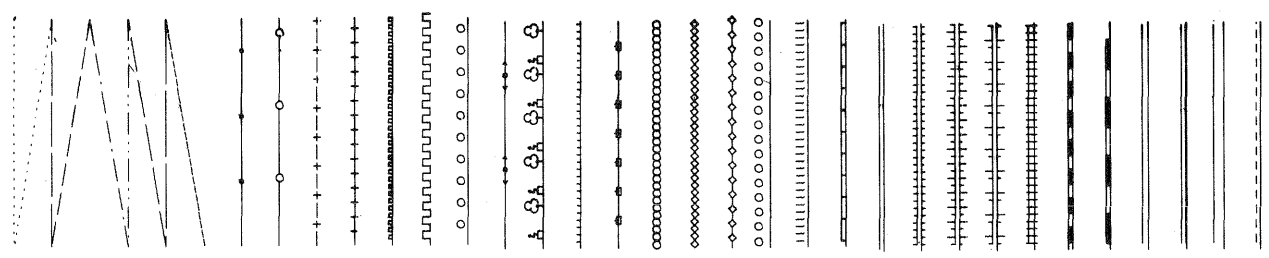


Fig 3 Symbols Library of JX-system

```

# Mapping menu #
*CR -- Back to main menu          D -- Pen down
*SP -- Show & print coordinates   U -- Pen up / end a element
A -- Dz up & FD lock              J -- Joy stick velocity adjustment
IV -- Dz down & FD lock           S -- HM & FD velocity adjustment
Z -- Set altitude & FD lock       P -- Off-line

*
# Digital menu # (Can be used under off-line only)
*
-> -- Pen "GO"                    AP -- Point menu
<- -- Pen "BACK"                 AH -- Drawing hachure line
K -- Set plotting window RTC      AS -- Symbol menu
V -- Set plotting window LBC      AD -- Up & down programmed pen
1 -- Show mapping & digital menu  AF -- Fillin symbols menu
2 -- Whole screen parameter edit  AE -- Area calculation
6 -- Input real by addresses      A*SP- Altitude annotation
7 -- Output real by addresses     AM -- Line with symbols
N/E -- Enter / Quit pen moving    O -- Forced recording
C -- Auto-track along plot window G -- Off-line "GO" by coordinates
I -- Interrupt into TP-86.U4.4    M -- Margin formation & Km grid drawing
L-Y -- Curve fitting              N -- Rectangle house auto-closing( )
R-U -- Sampling by distance interval X -- Eaves correction (after O/M)
T-B -- Sampling by time interval  H -- On-line
D/F -- Start a element (real/false)  @ -- Closing to the point defined by D/F

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Fig 9 mapping menu

Redundancy-free digital map format

During vector digitizing process, the digital map data must be compressed and discarded the redundancy. In other case, the map digital mapping is impossible. A compressed map data can be reduced to 1M bytes. This kind of map format is:

- * Every absolute vector takes 14 bytes
- * Every relative vector takes 2 bytes
- * Every pen code takes 2 bytes and follows-up in force continually.
- * Every ASCII code interpret words and attribution code takes 14 bytes, and serves as the the futher interpretation of basic line.

Graphics Software and Intillegent drawing Machine

The drawingtable can be separated as a independent product, which is a real CPU-controlled intelligent drawing machine. Beside the functions of normal straight line interpolation, curved line fitting, there are some graphic softwares which could be invoked directly by the system computer:

- * P command: Decorate a point with several graphics, ant set up in English, Chinese characters, or Arabic numerals in any place of its surrounding. Coordinates X Y Z, and letter sizes can be changed at will.
- * D command: complex pen-down command. D command consist of D and followed by six ASCII codes, which define the lengths of three intervals. AD command gives many kind of complex lines
- * H command: mark hachures with 0.01-9.9mm intervals at any directions in closed or ooen polygon.

- * F command: mark in a closed or open polygon with 0.01-9.99mm intervals at any direction, including Chinese, English characters and Arabic numerals.
- * S command: mark any symbol existed in library at any position in three sizes.
- * WFF: a time -saved double line (widening) command
- * W: a three-fold symbol cycles along a polygon in 1-9mm interval, and mark any symbol existed in library along a normal line .

All of these commands can be used repeatedly and compoundly. So a great amount of new commands can be created, among which only a few of them are really needed .Plotting files are drastically reduced due to the advantage of these intelligence.

Outline "plotting"-Display

The editing at a workstation and the collecting process demand a display-outline indicating of digital map. Blind collection can't be acceptable. High speed processor is needed when a realtime display of compressed digital map is required. About 640k memory space is needed for storing a map at 500mm x 500mm size digital map at 0.2mm resolution. This resolution of digital map corresponds to 40 on photo (5x magnification) It is also acceptable for image superimposition. Under a 8 time magnification, the line width is 0.3mm. During collecting the information of "bit" map enters into semiconductor memory from a port of drawing table. (a drawing table is not really needed in this case). The information of old map enters into the "bit" map by communication after its digitizing.

Certainly, "bit" map also can show graphics of image space, but transformation (only one time) is needed in this case.

A vector display made by raster scanning has a lower performance of realtime. But this lower performance has no effect on use. When "bit" map developed to "byte" map, the colors can be added to it.

User's Interface

In order to accommodate the various personal characters, a user's affects its commercial value. So this point must be hold in great account from beginning to the end. At first there are some problems in connection with application of human engineering. The next is to model the cartographer's actions- change the "free hand" to "free finger"-Digitizing Board to direct the movement of measuring mark. In the design of graphic language and menu, the creating initiative has been considered. The monotonous mapping become interesting. Different efficiency would be achieved by different operators. While the capable operator demand more higher transparency. to the user's interface.

Thus, all mapping data will be open to users in coupling of the PC-AT/XT/286/386 by serial port and common data memory. That means PC users can get all mapping data in his own programmes. Besides , the sub-programmes can be invoked by PC users. At last, it allows the user to develop their own LOOP programme on PC. This is very useful In some particular mappings, but it should be fast enough.

The powerful CPU discards the multi-CPU method, as the integration is the development direction of integrated circuits, small in size, less connection and more reliability. Analytical Plotter JX System adopts a single board, computation and control being all concentrated, solid software (EPROM), parallel menu, full screen editing I/O, full format storage of bit map. (See fig 10 & 11) The purpose is for reducing the circuit boards, the connections, the circuit levels, the CPU, the keying times. All of these makes the system smaller, cheaper, convenient and more reliable. With the development of microelectronics, what an advanced Analytical Plotter will occur in the future.

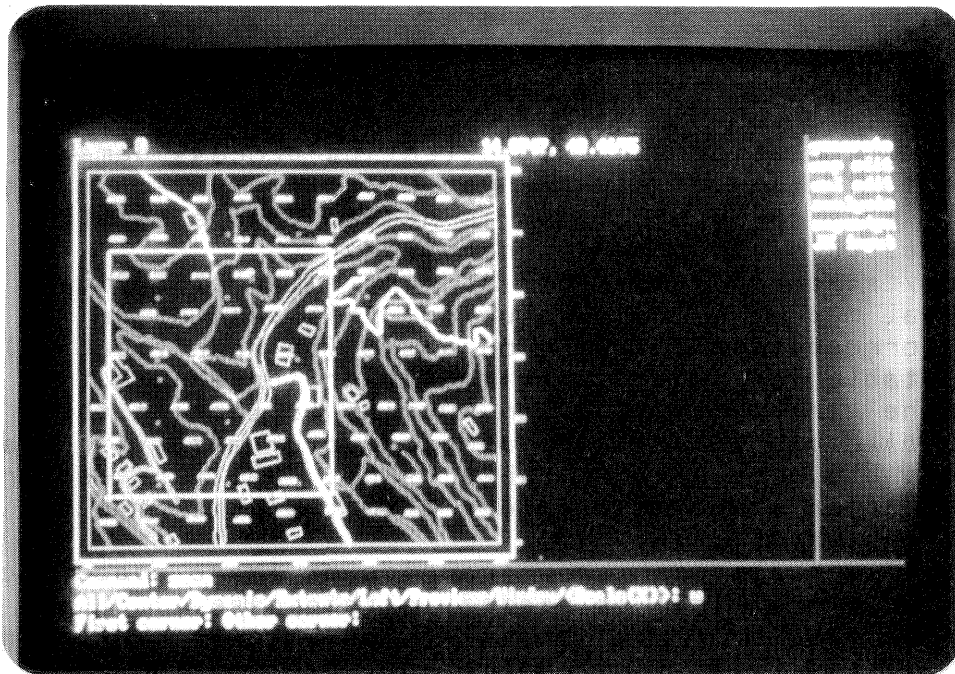


Fig 10 Full map displaying of JX-CAM

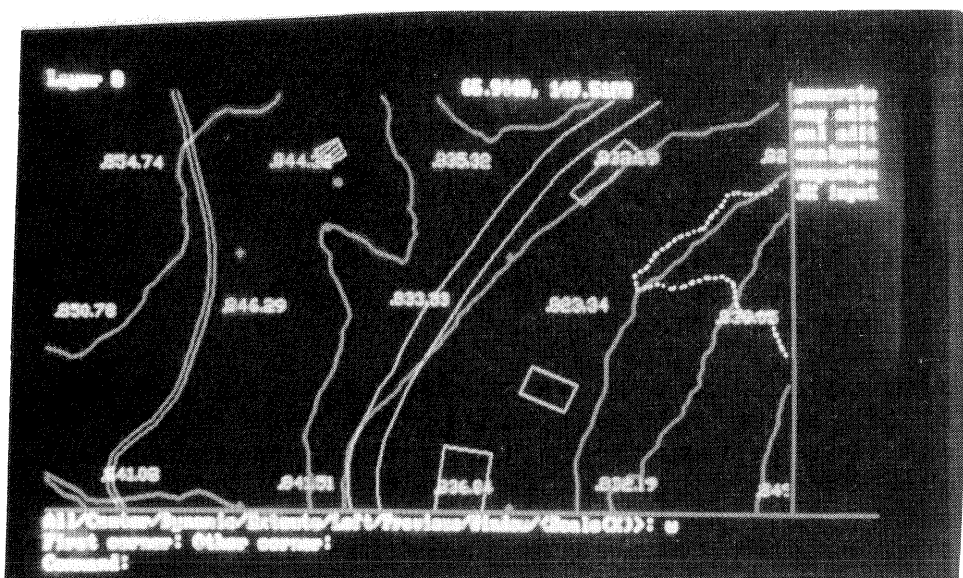


Fig 11 Part map editing of JX-CAM