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SPACS

Graphics Editor

Kenneth Greer
July 17, 1976

Computer Science Department
Carnegie-Mellon University

ABSTRACT

SPACS is an interactive graphics editor for use with a stylus/tablet input device in conjunction with a graphics display terminal. SPACS is well suited for making tables, flow charts, logic diagrams, and other similar schematic diagrams. The user may ultimately obtain a hard copy of her work via the Xerox Graphic Processor (XGP).

SPACS is composed of a large PDP-11 program, where the picture processing is performed, and a SAIL program on the PDP-10, which acts as an I/O link for saving and retrieving files. In addition there is another SAIL program for creating image files for the XGP.

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1. INTRODUCTION

Text editing systems commonly use alphanumeric keyboards with which the user types in commands and enters data (text). For applications other than text, i.e. pictures, the keyboard is either inconvenient or inadequate. For example, the user may wish to place a figure in a certain position on the screen. In this case the command might be "Put figure 3 at coordinates (240,350)"; but this would be both slow and clumsy. It would be much more convenient if the user could point to the figure and position it by moving it about the screen with a stylus of some sort. This is the approach taken by the SPACS graphics editor.

SPACS uses a stylus/tablet arrangement in conjunction with a graphic display terminal for creating and editing picture data. Commands are input by pointing to one of a series of commands displayed on the screen. This is known as the "menu", and it includes. . .

COPY UNIT
ROTATE
DASHES
SAVE FILE

among others. Objects are positioned by moving the stylus about the tablet. An object is rotated, for example, by pointing to the object and touching the appropriate command on the menu; in this case, ROTATE. Lines are drawn by indicating endpoints and can be "stretched" and moved around until they appear satisfactorily placed. There are many more functions which are all described in section 3 on COMMANDS.

Pictures created on the screen can be saved in binary form on disk and read back in at a later date for further editing. The user may further obtain a "hard copy" of the saved file, either directly via the Xerox Graphic Processor (XGP), or by it's inclusion into a PUB (document compiler) file.

Macro-11 programmers may also get a listing of the picture in PDP-11 assembly language format so that it may be included in the users own graphics program.

2. GENERAL INSTRUCTIONS

To run SPACS, type:

R SPACS

In a few moments the screen will clear, and the SPACS PDP-11 program will be loaded. This will take about 20 to 40 seconds. Note that the PDP-11 program will not be loaded if it is already there and running. This is useful if the PDP-10 crashes or if you have exited the PDP-10 program for some reason. You may reestablish the necessary links with the PDP-10 by just typing R SPACS again; your work on the PDP-11 is thus saved.

All commands are entered with either menu "light buttons" or META characters. The "light buttons" are activated by moving the stylus on the tablet so that the cursor is directly over the command, and then pressing down. The cursor will brighten when you press down. The stylus tip may rest on the tablet at all times. (A spring in the stylus puts you in "up mode" unless you are pressing it down.) The command mode name, or an appropriate instruction, will then be displayed on the screen's top right corner. In command mode, instructions with the pen are executed by cursor positioning in conjunction with activating a microswitch in the stylus tip by pressing down and up (or merely releasing the pressure.)

The creation of a picture is accomplished by the creation of individual picture elements (an important concept to remember with SPACS) from which the final display will be composed. Any element in your display can be modified individually with the various modification routines. Similarly, groups of elements, called UNITS, or the whole screen, called the WORLD, may be modified as a whole.

SPACS always has a "current active element" that is being modified and on which all actions occur.

There are four basic groups of commands:

1. Element creation commands
2. Element modification commands
3. Unit (or World) modification commands
4. Utility commands

A description of the individual routines follows in the next section.

All editing of your picture is done inside the grided "work area" box. The box is proportioned to fit evenly on an 8 1/2 by 11 inch page with a half inch border on all sides. You should strive to use the full frame for your picture composition. Any object appearing outside this page frame will not appear in the resulting XGP output. The grid of lines filling the page frame are not only useful for visually alligning objects, but you may also execute commands which will force objects to be positioned on these

lines and increments thereof. Six grid squares equals one inch on the resulting hard copy output.

After the picture is complete you may want to save it. The command SAVE FILE performs this function. The file saved has the extension ".SPX" appended. This file can be read back in directly at a later date with READIN FILE. (This file is in binary format. Always use the "/B" switch in PIP whenever transfering your .SPX files.) To obtain an image file (hard copy) the program SPXIMG is run with this .SPX file as input. SPXIMG creates another file, of image format, which may be shipped directly to the XGP with LOOK, or may be included in a PUB file.

Also available to those who write their own graphics programs is the SAIL program SPXP11. This program will translate the ".SPX" file into an ASCII file of PDP-11 assembly language format using all the standard graphics mnemonics. The user may include this file in a graphics program to display the picture.

3. COMMANDS

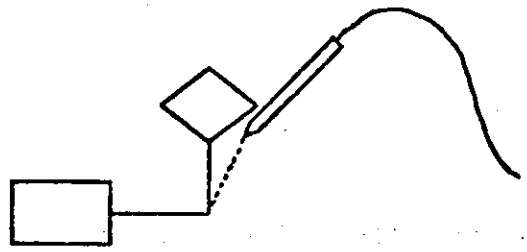
3.1 ELEMENT CREATION

LINE By hitting points on the tablet, a straight line is drawn between each successive point. While the pen is down, the line will be drawn and appear "stuck" to the stylus tip, as if it were an elastic band, and can be "stretched" about the screen. Lifting the pen "fixes" the line. The next line will be drawn from this point. To enter a new starting point hit LINE again - i.e. create a new element.

There is a "positioning" mode with the routine which will force perfectly straight horizontal, vertical, and 45 degree lines. Positioning is selected with the Meta command **Meta-P** (see Meta table, section 3.4). Each hit of **Meta-P** moves you to the next of five states. You will initially be in **SELF POSITIONING** mode. The states are...

HORIZONTAL lines will be horizontal
VERTICAL lines will be vertical
FORTY FIVE lines will be 45 degrees extended to the X-coordinate value.
SELF POSITIONING lines will position themselves to one of the above, whichever is closest. Very useful for flow charts and schematics. This is the default mode.
OFF lines will connect to the cursor at any angle

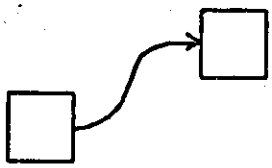
There is also a "gravity field". As the line is drawn, the display is searched to see if this line's endpoint is close to an element vertex. If it is close enough (about 1/2 grid unit) the line will be drawn exactly to the vertex point (you'll see it "snap" on as the line is "stretched" towards the point). The gravity field may be turned on and off by typing **Meta-G**. The state (on or off) is displayed on the screen's top right corner. When composing large pictures, the gravity will tend to slow down line drawing because it must search the entire display for points. You may want to toggle the gravity on and off with these larger pictures. The default is ON. You may also find grid positioning useful. See the Meta Table commands **Meta-X** and **Meta-Y** for a description.



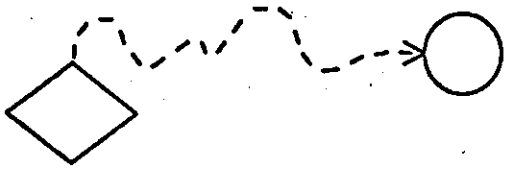
DASHES Like the line routine, touch endpoints and a dashed line will be drawn between these points. Dashed lines are limited in length to about twelve inches unscaled. There is no "Positioning" or gravity but it is "elastic".

CHARACTER Hit a point on the screen where you want the starting character, then enter characters from the keyboard. A cursor will be displayed at the selected point. Each new point hit with the stylus will create a new element at that selected point. Backspace and carriage return both work. The carriage return creates a new character element one line below the last string and aligned with the beginning of the string. If you would like to use the GDP's intraline editor, you may call it by typing Meta-I. If you do use it, the function of the carriage return is changed to simply exiting CHARACTER mode.

FREE FORM A smooth line can be drawn with the stylus. Each continuous line, with pen down, is a single element. Free form lines are limited in length to about 12 inches.



FREE FORM DASHES This is similar to FREE FORM except that instead of a solid line following the cursor a dashed line will follow the cursor as you draw. Drawing at a moderate to slow speed will usually give you better results than drawing fast.



Resolutions There are four resolutions available for FREE FORM and FREE FORM DASHES. The resolution state defines the lengths of the small line segments which make up FREE FORM and FREE FORM DASHES. The higher the resolution, the shorter the line segments will be. The resolution may be selected by typing Meta-R. Each hit of Meta-R moves you to the next state. The states are:

LOW RESOLUTION	no good for tight curves, but nice for relatively straight sections. This resolution will give you the longest line segments.
MEDIUM RESOLUTION	for smaller curve sections. This is the default state.
HIGH RESOLUTION	uses lots of really short vectors (expensive!!) for very small tight curves.
SUPER RESOLUTION	dashes appear as closely spaced dots.

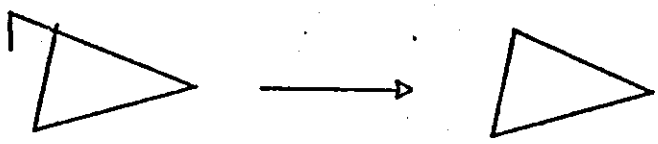
Element Menu Touch an element from this menu, lift the pen, press it down on the screen area, and the element will be displayed about the stylus on the screen. You are then automatically placed in MOVE ELEM mode so that the element may be easily positioned where you want it. There are currently four menus; three pre-stored, and one user-definable (See STORE ELEM, section 3.2). One menu consists of circles and ellipses which are "character defined" (and thus cannot be rotated.)

3.2 ELEMENT MODIFICATION

FIND ELEM Allows modification of any element previously drawn by selecting one as the new "current element." Find the element by touching an element vertex, or any where on a curve, or the bottom of the first character in a string. When the element is "found" it will blink on and off to verify that it has been found. The blinking will be turned off when the next command is executed.

ERASE ELEM Erases the active element. The new active element will be blinked until the next command is executed. (The active element after an ERASE will be the previous element created providing you have not done a FIND ELEM in between. If a FIND ELEM has been done, then the current active element is chosen rather randomly).

BACKUP VEC Erase last vector drawn. Very useful with the LINE routine as not only will it erase the vector but will allow you to continue the line from the backed-up position.



You can also erase sections of semi-circles, provided in the menu, to get curve segments.

BACKUP VEC will also erase one character at a time in a character string, and small bits in a FREE FORM line.

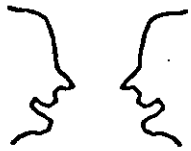
SIZE + Increases the size of the element by 20% increments. In most cases, you may increase the size of the element created by 16 increments. This brings it's size to a maximum of 3 1/2 times it's original size.

SIZE - Decreases the size of the element by 20% decrements. There is no limit on the number of decrements in this direction.

A word to the wise -- You should be careful with these scaling routines, do not go back and forth, increasing and decreasing the figure size because round-off error may begin to distort the object. You should have no problems, though, if you only scale in one direction.

MOVE ELEM This lets you move the active element to any place on the screen. Place the stylus down and the element will move as the stylus moves. You may find the Meta commands Meta-X, Meta-Y useful for aligning objects.

MIRROR ELEM The element will be inverted (mirrored) across the Y-axis. All elements except characters can be mirrored.



STORE ELEM Users may define an element and store it in the third element menu. There is space for 10 user defined elements. They are marked "0" through "9" on the screen. To store an element. . . .

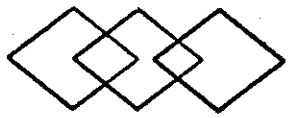
First	create an element (or FIND an element)
Second	select a number (0-9) from the number menu
Third	press STORE ELEM

The command confirms the storage by moving to the 3rd menu and placing the element there. Elements may be erased from the menu with the Meta command Meta-M (See section 3.5). Note that the command CLEAR ALL will not clear the menu.

ROTATE Any element, except characters, can be rotated. Select a number in degrees from the number menu. Hit ROTATE and the element will be rotated that many degrees. Positive degrees rotate clockwise, and negative counter-clockwise. (Round off error begins to mess up things, especially curves, after a few rotates, so use SPIN if you're not sure of the angle.)

SPIN This will continually rotate the element around 360 degrees, slowly, so that you may visually decide on the best angle. Type Meta-BREAK to stop/continue the spinning. Also, if the BREAK is preceded by a number from the keyboard, then that value in decimal degrees will be used for the rotation increments instead of the default 1 degree. A positive number will spin clockwise, a negative number, counter-clockwise. The next menu hit will stop the spinning and fix the element. Note that this routine saves a "virgin" copy of the element and works from that so as to minimize round-off errors.

SET LINE WIDTH You may set the line width (thickness) of any element, except for character strings. There are three settings -- 1,2 and 3. Select the number from the number menu and press the command to set the line width of the active element. The default setting for all lines and elements is 2. You may change the actual hard-copy line widths to any value in SPXIMG if you desire. (This is explained in section 5.)

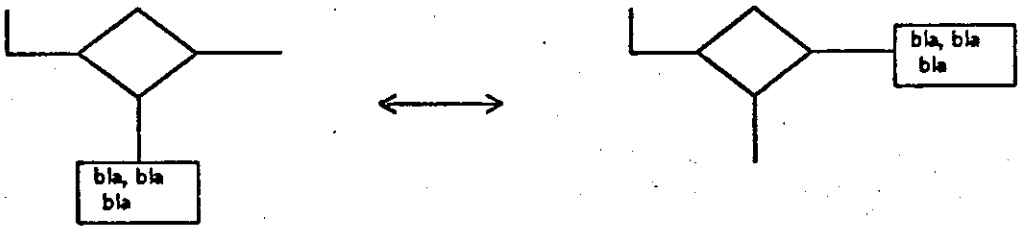


1 2 3

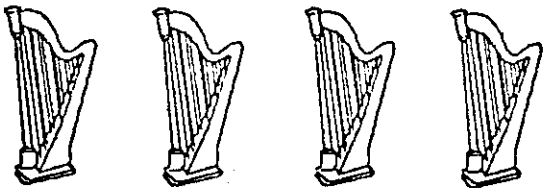
3.3 UNIT COMMANDS

The following commands work on UNITS rather than ELEMENTS. A unit is defined as the collection of elements that are enclosed by the "current" element. You may define a unit by drawing a line around the group (with LINE or FREE FORM) or by FINDing the element which encloses the unit. "Enclosing" here means anything within the high and low X and Y coordinate boundaries of the element (if the element is an irregular shape, imagine an invisible rectangle on the four outermost edges). Unit definitions are dynamic, rather than permanent, so that the elements comprising the Unit are determined each time a Unit command is executed. The currently active element completely specifies the unit, and the element will remain active throughout any unit command executions. When you are done, you may simply hit ERASE ELEM to get rid of the surrounding line, if desired.

MOVE UNIT Lets you move a set of elements as one unit. To do this, FIND the box or other element surrounding the group or draw a line around the group with either LINE or FREE FORM. Then touch MOVE UNIT. The whole group will move as a unit as the stylus is moved across the screen.

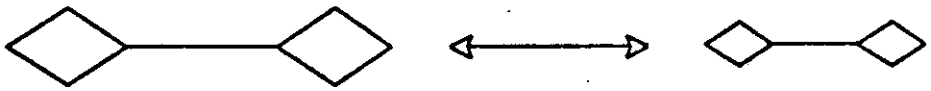


COPY UNIT This duplicates the UNIT. The UNIT is copied directly over the old unit (it will appear brighter). You are then placed in MOVE UNIT mode, automatically, so that you may place the UNIT where you want it.



EXPAND UNIT This will increase the size of the whole unit. Note! This will only work perfectly for units whose elements are all of the same scale or if you execute this command four times in sequence, and, thus, bring the unit to twice the previous size. You will have to reposition some elements (with MOVE ELEM) in most other cases.

SHRINK UNIT This will decrease the size of the unit. The same problem holds true with this as with the above.



ERASE UNIT This one is located near the bottom of the menu next to CLEAR ALL so that you don't hit this by accident. This will erase the entire unit. I suggest you do a MOVE UNIT first to be sure of what you have before you erase it.

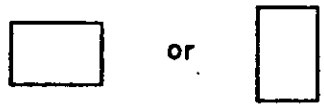
SET CHAR SCALE This will enforce a specified scale (size) on all the characters in the unit. The scale is chosen from the Number menu. A "0" is normal scale. Scales -3 through +3 are legal.

SET LINE WIDTH This command is the same as the corresponding element command, but will work on the active unit rather than the active element.

DO WORLD After pressing this, the whole screen will become the active unit. You will stay in "World Mode" until you execute the next non-unit command.

3.4 UTILITY COMMANDS

FLIP TABLET You may want your picture lengthwise or up and down. This routine will flip the work area 90 degrees. The XGP output will be formated accordingly.



NEXT MENU Each hit of this selects the next element menu stored in SPACS. There are currently four menus; three pre-stored, and one user-definable (initially empty).

SAVE FILE This saves your display on a PDP-10 file, so that you may get a hard copy of it and/or read the file back at a later date for further editing. The pen is turned off while saving and turned back on when done. The dialogue is displayed on the screen's top left corner: An output file name is requested. Don't give an extension, it will be ignored. The extension appended is ".SPX". If a file of the same name already exists, then you will be asked "REPLACE OLD FILE?(Y or N):". An "N" response prompts you for another name. Note that this file created is an intermediate file. You must run SPXIMG to get an image file suitable for LOOK. SPXIMG is explained in section 5.

Saving is somewhat slow because of the slow link (300 baud) back to the PDP-10. If you discover a mistake in your picture while saving, you may stop the save by typing the single character "A", for ABORT. This will immediately abort transmission and give you back control. Note that if you were superseding a file (you said "Y" to the "REPLACE OLD FILE?"), and aborted the save, then the old copy of the file will still remain. The new, partly written, file is thrown away.

If the PDP-10 happens to crash in the middle of a SAVE or READIN, you may get control back by typing Meta-T. When the PDP-10 comes back up, you may merely type Meta-RETURN or "R SPACS" and the links will be reset, thus permitting you to save the file again.

READIN FILE A previously saved .SPX file can be: 1) Read back onto the blank screen for further editing. 2) Appended to the picture currently being displayed to merge the two scenes. The dialogue is similar to the SAVE FILE routine above. The pen is turned off during transmission and turned back on when it is complete.

CLEAR ALL Erase entire screen to start over and reset all defaults. This does not clear the user defined element menu. You may use the command Meta-minus-1-M to clear the user menu.

QUIT This exits the program (without saving your display, so save it first.) It will ask "KEEP SPACS RUNNING ON PDP-11?". If you respond with "Y", you will

return to the PDP-10 monitor with SPACS still running on the PDP-11. You can continue to edit your picture in this state (you can even logoff) until you want to save it. Typing Meta-RETURN will bring back the SPACS monitor on the PDP-10. A response of "N" to the query will clear the PDP-11 and reload the standard fixed-width character set (takes about 10 seconds).

Number Menu Decimal numbers are input to various routines via this menu. To select a number, say 45 degrees, first touch 4, then 5. An over-flow will zero the register. To enter a negative number, first enter the positive number, then negate. The two right-most buttons, N and C, are:

N - negate number in register
C - clear (zero) the register
The register contents will be displayed to the left of the menu.

3.5 META TABLE

The meta table is a table of commands which either parallel the menu commands, or are better located on the keyboard. They are activated by typing meta characters. A meta character is much like a control character except that the character is passed to the PDP-11 rather than the PDP-10. Meta characters are entered by holding down the META key and typing the character(s). Thus,

M(P) means hold down the META key and type "P"
M(1 S) means hold down the META key and type "1", "S"

The meta table is initialized by typing Meta-Control-M. I type it for you (by magic) at startup. In order to enter any of the meta commands which are the same as menu commands, the pen must be in the up position. These meta commands are very useful because they enable you to use two hands for controlling frequently paired operations (i.e. Finding and Moving.)

COMMANDS:

M(L) Meta lock. Rather than hold the META key down for each meta command you may "lock" it on with this command. Typing M(1 L) turns the Meta lock on, M(0 L) (or just M(L)) turns it off. With the Meta lock on, the META key will be assumed to be on for all keyboard input. The Meta lock will be temporarily turned off when it needs to be -- in the routines. . . SAVE FILE, READIN FILE, QUIT, CHARACTERS, and during intra-line edit (META I).

M(Z) Zero the number input. If you type an incorrect number for a meta command, you may type M(Z) to zero the number buffer.

M(G) Turns the gravity field (in LINE routine) on and off. Often, with large pictures, the gravity makes line drawing very slow. You may want to turn it off in these cases. The state of the gravity field is diplayed in the screen's top right corner.

M(H) Turns the grid display on and off. This merely makes the grid visible or invisible; it has no effect on the M(X) or M(Y) settings.

M(P) Positioning switch for LINE routine. See description in the LINE command.

M(C) Set character scale. Typing M(n C), where "n" is the scale in the range -3 to +3, will make this the creation scale for all future charater elements created. The default value is 0. A CLEAR ALL will reset the default scale to 0.

M(R) Change resolution for FREE FORM routine. See description after the FREE FORM command.

M(F) FIND ELEM

M(D) MOVE ELEM

M(E) ERASE ELEM

M(S) MOVE UNIT

M(A) COPY UNIT

M(ALT) This will select the alternate element menus stored in SPACS in the same manner as NEXT MENU.

M(M) To erase elements from the user defined menu. Preceding the command with a number from 0 through 9 will erase the corresponding element. A negative number (-1 will do) will erase the entire menu. E.g. M(0 M) will erase element number 0.

M(I) Calls the graphics intra-line editor to edit the active character element. Please refer to the Graphics Monitor manual for the full command set available to the editor. When the return key is typed you will exit the editor.

M(T) Turns the pen back on. Use this if the PDP-10 crashes in the middle of a SAVE or READ and you want to continue editing while the PDP-10 is down.

M(BREAK) Stops/continues spin of element in SPIN routine. If the BREAK is preceded by a number, then this number, in decimal degrees, will be used as the rotation increments instead of the default 1 degree. A positive number will spin clockwise, a negative number spins counter-clockwise.

M(X) and M(Y) These two commands set an invisible incremental grid along the X and Y axis. What they do is force elements to be positioned along set increments on either axis, for example every half grid unit. They are enforced with the routines. . . LINE, DASHES, CHARACTERS, start point in FREE FORM, and in the MOVE routines. These commands, or switch settings, allow you to position easily by bringing vertices to a common point. This allows you to perfectly line up objects along the X or Y axis. The grid you see on the screen is placed along the axis at a Meta X and Meta Y setting of 4; that is, if you set M(X) and M(Y) both equal to 4 then all lines drawn will be brought to the grid line's intersections. The full range of settings and corresponding placements are. . .

Setting	Grid Units	Setting	Grid Units
0	0 (Free placement)	4	1
1	1/8	5	2
2	1/4 (default)	6	4
3	1/2	7	8

The increments are set by typing a number from 0 thru 7 with the META key down, and then either M(X) or M(Y). The X and Y may be set to any value independent of each other. The default is setting 2, and is reset to this whenever you do a CLEAR ALL. A value of 0 will not force any grid. There are about 6 grid squares to the inch.

M(RETURN) Return to SPACS. If you do a QUIT with the response "Y" (thus keeping SPACS running on the PDP-11) you may type M(RETURN) to bring back the SPACS monitor on the PDP-10. The Meta lock will be turned back on if it was on prior to the QUIT.

M(CLEAR) Clear the graphic display. Use this if you do a QUIT with a "Y" response (keep SPACS running on the PDP-11) and you want a clear screen to converse with the PDP-10 (running SPXIMG, for example, to check your work). Typing a **Meta-RETURN** will bring the SPACS monitor back and put back the display. Typing another M(CLEAR) will also put the display back.

M(B) Infrequent hardware problems have prompted me to include this command. You may on occasion get a Check-sum (CKS) or other error from the graphics monitor, at which time the screen will be blanked out. When the user is editing a rather complex picture, this state has been known to cause near heart failure,. . . or at least a frustrated scream. Fear not, user! In most cases the entire program state may be retrieved by typing the sequence. . . **Meta-**, **Meta-Control-M**, Meta-B. If the screen comes back and you have a moving cursor, then you're in luck.

4. CHARACTER SETS

There are 7 different scales for character string elements. The scales are selected whenever you do a SIZE +, a SIZE -, or a SET CHAR SCALE. The different sized characters are formed on the XGP not by altering the vector list, as they are on the GDP, but rather by choosing a different character set among a set of 7 (These are the NGR characters). So, when you select a different size for your character string, you are actually selecting a different character set.

You can use this to your advantage!

If you would like to use something other than the handsome NGR characters, or want to use several character sets in your picture, you indeed may. In the program SPXIMG (the XGP output module) I give you the option of defining what character sets go with each of the seven scales. So if you want to make some of your characters italic, for example, just make those characters on the screen a certain size (lets say normal+1). Then when you run SPXIMG define the normal+1 scale (that would be 0+1=+1) as NGI25.

When you run SPXIMG respond to "DEFAULT CHAR SET?" with "N". You will get a brief message and a request for a character set assignment for each scale . . .

```
CHAR SET  -3 :      ; <car ret> defaults NGR13
CHAR SET  -2 :      ; <car ret> defaults NGR17 *
CHAR SET  -1 :      ; <car ret> defaults NGR20
CHAR SET   0 :      ; <car ret> defaults NGR25
CHAR SET  +1 :      ; <car ret> defaults NGR30
CHAR SET  +2 :      ; <car ret> defaults NGR36 *
CHAR SET  +3 :      ; <car ret> defaults NGR40
```

You may leave out the ".KST". If no PPN is mentioned, then your account will be searched for the character set. If it is not found there, then the character set account [A730KS00] will be searched. It will request again if it isn't on either area. A carriage return will default the appropriate NGR character set (indicated above) for that scale.

* These character sets are on [A640KG0K].

5. GETTING AN IMAGE FILE

The file saved, <file>.SPX, must first be translated into the proper format required by the XGP to get the hard copy. The SAIL program SPXIMG performs this tedium.

Type:

```
R SPXIMG                          ; the mnemonic is SPX to IMG format
DEFAULT LINE WIDTH?(N or <CR>):   ; <CR> defaults Y
DEFAULT CHAR SET?(N or <CR>):     ; <CR> defaults Y
PUB FORMAT?(N or <CR>):           ; <CR> defaults Y
SPX INPUT FILE(S):                ; your file(s)
```

1) The LINE WIDTH sets the line thickness on the XGP output. There are three settings -- 1,2,3. The default line width value of each setting is . . . LINE WIDTH 1=1 unit, LINE WIDTH 2=2 units, LINE WIDTH 3=3 units. You may substitute a different value for any or each of the three settings. (The default for all elements created in SPACS is width 2.)

2) See previous section for information on using different CHARACTER SETS.

3) If you want to include the picture into a PUB file respond with "Y" or a carriage return. This response will not fill the page with blank lines or include a paper cut. The number of scan lines (and text lines) is given on completion. A macro for requiring image files into PUB may be found in XCRIBL.DFS[A700PU00]. The PUB command ".SOURCE!L(KSETS)" will get you this and other XGP macros. The macro is simply . . .

.XIMAGE("<file.img>", <number of text lines>)

In non-PUB format, the picture will be centered on an 8 1/2 by 11 inch page with a paper cut at the bottom. Either of these forms may be run off directly on the XGP. For the PUB form you will have to dash out to the XGP and cut it manually, of course.

4) The output image file will have the same name as the .SPX file only with the .IMG extension. If a sequence of files is given (separated by commas) then each one will be processed with the settings just selected. When SPXIMG is finished creating the image files it will repeat the loop and prompt you for another file set. All defaults will again be in effect (any change to the default settings for the last file set will be forgotten.) When you're finished just Control-C to exit. Then, run LOOK in image mode to get the hard copy. I.e.:

```
.R LOOK
*←MODE=IMAGE                      ; set to image mode
*FOOBAZ.IMG                       ; your file
DONE

*<↑C to exit>
```

6. GETTING A MACRO-11 FILE

The picture you've created can be translated into a PDP-11 assembly language source file. The purpose being that you may include this in your own graphics program which will display the picture.

The file outputed is in ASCII format and may be listed on the line printer or terminal. All the standard mnemonics are used for easy understandability.

Type. . .

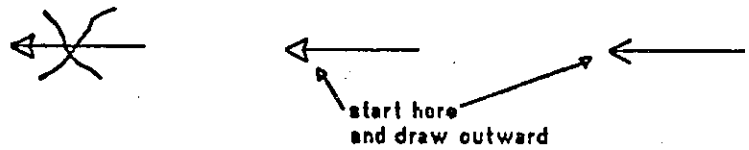
```
RU SPXP11[A640KG0K]          ; the mnemonic is .SPX to .P11 format
SPX INPUT FILE: FOO.SPX      ; your file
ONE DISPLAY OR MANY?:        ; Type "O" or "M"
```

The output file will have the same file name, only with the extension ".P11". "One display" means the display list will be created with a single SETXY at the beginning and all others removed. This is usefull for picture animation. "Many" means that the file will be created in the same format as the .SPX file with each picture element seperate but the Terminate words commented out.

7. HINTS

1) If you find you run out of space (i.e. SPACS will no longer allow you to create new elements) you can still probably reclaim a good deal of "garbage space". Although there is a "garbage collector" in SPACS the most efficient data reorganization can be accomplished by -- SAVEing the picture, CLEARing the screen, READing it back in again.

2) There are two arrow heads in the element menu -- one closed, one open. The closed arrow head looks best if the arrow head is first placed and the line is drawn from the rear of it. The gravity field will attach the line's start-point exactly at the arrow heads rear center.



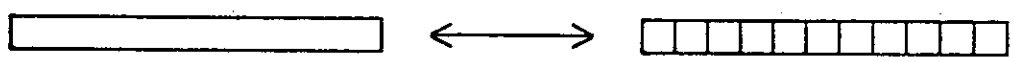
3) SPXIMG will automatically center your picture, left and right, on the page. If you don't want the picture centered in this way, put two small periods on either side of the diagram, and the picture will be centered using these periods. You may also put the two periods just outside the work area box.

4) Before you ERASE UNIT - check to see what you really have first with MOVE UNIT!

5) Free-form objects (curves) are actually best made by drawing them LARGE with LOW-RESOLUTION and then shrinking them down with SIZE -.

6) Use SET CHAR SCALE command for units or world to make sure all the text in the unit is the same size (when you want them the same size, of course.) It's not always obvious when looking at the screen when two strings are of different, but close, sizes.

7) You may often want to segment a rectangle as below. . .



You can make the dividing line segments exactly the right length by drawing a line from two of the rectangle's vertices. The gravity field will bring the line's endpoints to the rectangle's vertices and thus make the segment the exact length you want. Then MOVE the element. You can STORE it if you want duplicates.

8) SPX files are in binary format. If you transfer them to a DECtape, **remember to include the "/B" switch** in PIP, otherwise the file may be garbaged.

9) If your PUB file contains many required image files, you will have to change the BREAK setting in LOOK. The BREAK variable says how many pages to load onto the PDP-11 disk before printing out the file. If BREAK is too high, the disk will run out of space and you will lose the remainder of your file. This document was output with BREAK set to 10; the default is 50.

APPENDIX A

SPX FILE FORMAT

FORMAT - BINARY format, mode '14. 16 bit words not sign extended in 36 bit words.
WORD 1 - Information on tablet direction and file version number.

BIT 15	1 for up/down direction (as this page) 0 for on side
BITS 14-0	Version number Exception -- A negative number around -100 is version 2. A 0 is version 2.

WORD 2 to M - Standard element descriptions. See Appendix B.

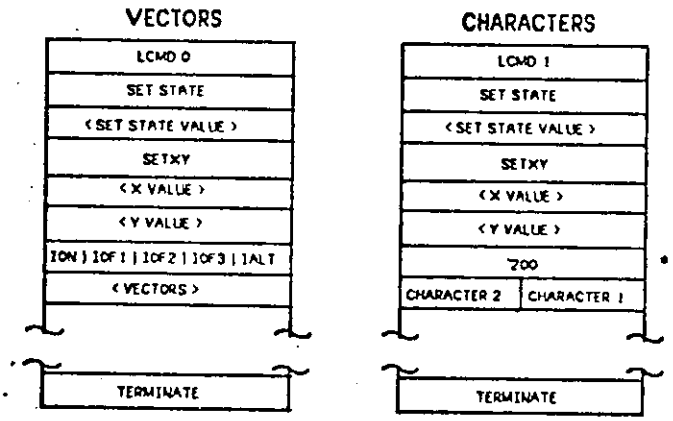
WORD M - '100360 Signals beginning of element menu.

WORD M+1 to N - Standard element descriptions. See Appendix B.

WORD N - An EOF signals end of file.

APPENDIX B

ELEMENT FORMAT



* This word will be 0 for characters from character element menu.

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