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Siliconpaint User Manual

Jerry Stewart

The Mitsubishi XT-1000 is a flat visual terminal which has a transparent touch tablet with a 640x400 dot liquid crystal display (LCD). The XT-1000 is touch-sensitive, having the capability of selecting a single pixel through any blunt, pointed object. SiliconPaint is a graphics program for the XT-1000. Many of its features are similar to the features of MacPaint for Macintosh. These features include drawing figures, manipulating files, editing, entering text, and filling shapes with patterns. Many operations are executed using a pen on the surface of the XT-1000, though some, such as manipulating files and entering text, require a... **Read complete abstract on page 2.**

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SILICONPAINT
User Manual

Jerry Stewart

WUCS-89-40

August 1989

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XT-1000 on loan from Mitsubishi Electronics America, Inc.

Abstract

The Mitsubishi XT-1000 is a flat visual terminal which has a transparent touch tablet with a 640x400 dot liquid crystal display (LCD). The XT-1000 is touch-sensitive, having the capability of selecting a single pixel through any blunt, pointed object. SiliconPaint is a graphics program for the XT-1000. Many of its features are similar to the features of MacPaint for Macintosh. These features include drawing figures, manipulating files, editing, entering text, and filling shapes with patterns. Many operations are executed using a pen on the surface of the XT-1000, though some, such as manipulating files and entering text, require a keyboard. SiliconPaint is compatible with MacPaint in that files created on the XT-1000 can be accessed through MacPaint and vice versa. The purpose of SiliconPaint is to demonstrate how a device like the XT-1000 can be used as a viable alternative user-interface to the mouse, CRT, and keyboard.

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INTRODUCTION

The XT-1000 is a flat visual terminal which has a transparent touch tablet with a 640x400 dot liquid crystal display (LCD). The XT-1000 is touch-sensitive, having the capability of selecting a single pixel through any blunt, pointed object. In addition, the XT-1000 has a switch which is similar to the button on a mouse. The XT-1000 is also capable of receiving and executing commands through an asynchronous line, as well as returning requested information to the host system. Forty-eight (48) commands are available for drawing, text printing, ringing a bell, as well as reading and writing bit-map images on the XT-1000.

The purpose of SiliconPaint is to demonstrate how a device like the XT-1000 can be used as a viable alternative user-interface to the mouse, CRT, and keyboard.

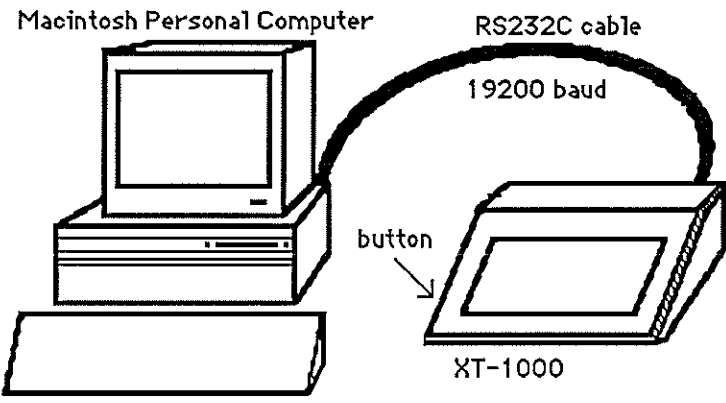
SiliconPaint is a graphics program for the XT-1000. Many of its features are similar to the features of MacPaint for Macintosh. These features include drawing figures, manipulating files, editing, entering text, and filling shapes with patterns. Many operations are executed using a pen on the surface of the XT-1000, though some, such as manipulating files and entering text, require a keyboard. SiliconPaint is compatible with MacPaint in that files created on the XT-1000 can be accessed through MacPaint and vice versa.

SiliconPaint is implemented as a Macintosh Programmers Workshop (MPW) tool on the Macintosh personal computer and is written in the language C.

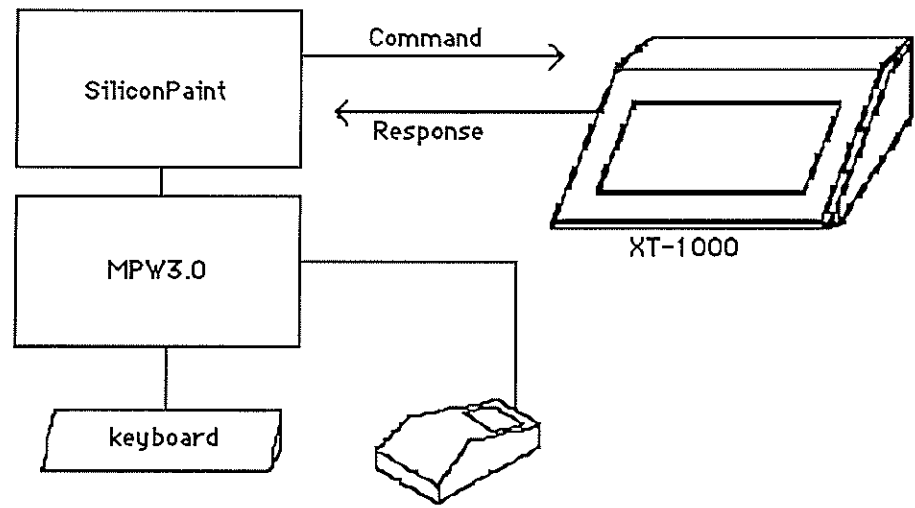
It is assumed that the reader is familiar with the Macintosh and has some knowledge of MPW.

Hardware and software configurations are found on the next page.

XT-1000™ is a trademark of Mitsubishi Electronics America, Inc.,
Torrance, CA
MacPaint™ is a trademark of Apple Computer, Inc., Cupertino, CA
Macintosh™ is a trademark licensed to Apple Computer, Inc.



HARDWARE CONFIGURATION



SOFTWARE CONFIGURATION

GETTING STARTED

INSTALLING

To install SiliconPaint:

1. Insert the SiliconPaint disk into the drive.
2. Copy SiliconPaint into a folder on your hard disk.

STARTING

To start SiliconPaint:

1. Start up MPW3.0.
2. Set the directory to the folder containing SiliconPaint.
3. Type "SiliconPaint", then enter.

WARNING: Until the screen has completely set up, do not touch the screen or switch the button. Doing so may cause an error which requires a rebooting of the entire system.

QUITTING

To quit SiliconPaint:

1. Touch the Quit icon in the upper right-hand corner of the SiliconPaint screen.
2. Click the button.

You will know SiliconPaint has quit when the Quit icon looks like this:



USING

When you run SiliconPaint, you'll see five tool boxes, a pattern box, a quit box, and the document area, which are laid out as shown on page 7. There are three tool boxes, each of which contains related features: **editing**, **file manipulation**, and **figure drawing**. A fourth tool box contains miscellaneous features: **erasing**, **drawing**, **painting**, **text**, and **inversion**. Finally, the fifth tool box contains the **crosshair** feature which can be used with operations in other tool boxes.

Getting started in SiliconPaint is simple. This section will take you through the development of some simple figures.



First, try drawing with the pen. All you have to do is touch the Pencil in the miscellaneous tool box with the pen. The box surrounding the Pencil will disappear when you activate the drawing function. Now you can draw with the pen.



When you've finished experimenting with the pen, touch the Eraser. You will notice that the box around the Pencil is back on, while the box around the Eraser has disappeared. This is true with most operations. Whenever you touch a new feature, the one that was previously on goes off. Erase some of the markings you made with the pen using the Eraser. Touch somewhere inside the document and drag the square around, clicking wherever you want to erase. Holding the click switch in will allow you to erase continuously.



Now draw a few rectangles. Touch the Rectangle, place the pen on location where you wish one corner of the rectangle to be, then drag the rectangle, lifting the pen when the opposite corner is where you want it to be. Draw a few rectangles, then draw a few ellipses.



You draw ellipses the same way you draw rectangles, and you even see a rectangle while you are deciding where you want the ellipse. The difference is that this rectangle is dotted, and when you lift the pen, an ellipse is drawn inside the final rectangle, which disappears.

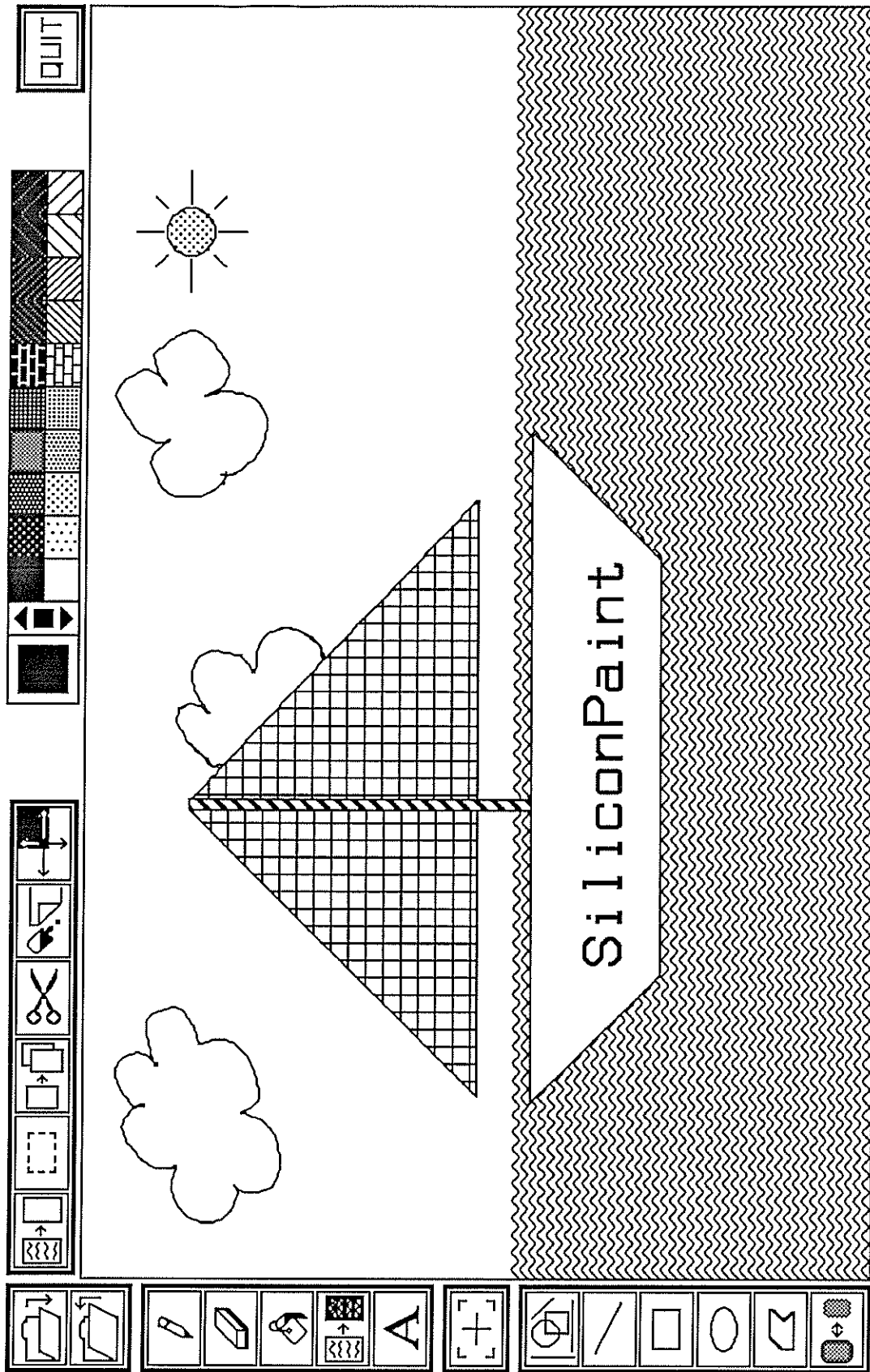


Now select a pattern from the Paint Palette in the upper right-hand corner of the screen and touch the Paint Bucket. Now touch in one of the figures you have drawn. Repeat this process choosing different patterns.



Now save what you have created by touching Save and entering a name for the file via the Macintosh monitor. When it is done saving, the rectangle around Save will reappear.

WARNING: Do not touch the screen or click the button while the file is being saved. Doing so may cause an error which requires rebooting the entire system.



FEATURES

This section provides a brief overview of the features available in SiliconPaint. There are two types of features: operations and selectors. To use an operation, touch the icon. The surrounding rectangle will disappear indicating that the operation is on. The surrounding rectangle will reappear once the operation is complete or has been turned off. In general, selectors change the way certain operations are performed. How they are used varies from selector to selector. Selectors are indicated by an asterisk (*). All features will be discussed at greater length in the appropriate section under "Tools."

Editing Tools

In relation to the editing tools, there is an **editing buffer** which stores the contents of areas which are copied or cut and which can only be changed by a copy or cut.



The **Selection Rectangle*** selects a rectangular area for copy, cut, or clear.



Clear removes a selection from the document without placing it in the editing buffer, or clears the entire screen if no selection has been made.



Copy places a copy of the selection into the editing buffer.



Cut removes a selection from the document and places it into the editing buffer.



Paste pastes the editing buffer onto the document.



The **Paste Direction*** selects the direction from the pen that pasting will be done.

File Manipulation Tools



Open opens a previously-created MacPaint file.



Save saves the document as a MacPaint file under a given name.

Figure Drawing Tools



The **Line** draws lines.



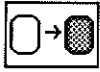
The **Rectangle** draws rectangles.



The **Ellipse** draws ellipses.



The **Polygon** draws polygons.



The **Fill Selector*** selects whether figures will be drawn with a simple border, with the current pattern and a border, or with the current pattern and no border.



The **Symmetric Selector*** selects whether or not to constrain lines to vertical, horizontal and 45° angles; rectangles to squares; ellipses to circles; and polygons to lines drawn with vertical, horizontal and 45° angles.

Miscellaneous Tools



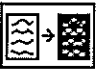
The **Pencil** makes a line a single-pixel thick.



The **Eraser** erases black areas.



The **Paint Bucket** pours the current fill pattern into an enclosed area.

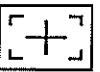


Inversion inverts the color of all pixels selected (i.e. all black pixels become white and all white pixels become black.).



Text enters keyboard text.

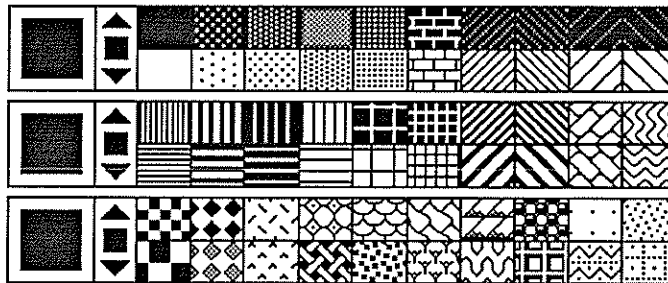
Crosshair Tool



The **Crosshair*** selects exact placement of the Line, Rectangle, Ellipse, Polygon, Selection Rectangle, Inversion Rectangle and Text.

Paint Palette

The **Paint Palette*** selects the current pattern for use with the Paint Bucket as well as filled figures. There are three different sets of patterns in the palette:



EDITING

The editing operations in SiliconPaint include clearing, copying, cutting, and pasting. These operations let you transfer images within a document and between MacPaint files, and also allow for the deletion of unwanted areas. These operations automatically turn off as soon as they are performed once.



The **Selection Rectangle** selects an area to be cleared, cut, or copied. To use it, touch Selection Rectangle. You will know it is on if the surrounding rectangle disappears. Now touch at one corner of the area you want to select, drag to the opposite corner, then click the button. Now clear, copy, or cut.

Since the Selection Rectangle is not set until you click, you may pick up the pen at any time during the selection. If you decide not to select before you touch inside the document area, touch anywhere outside the document. If you decide not to select after you have begun to select an area, drag the Selection Rectangle anywhere outside the document and click. This will terminate the selection process since you must select an area which is entirely within the document. If you decide you do not wish to Cut, Copy, or Clear the area you have selected after you click, touch anywhere except Cut, Copy, or Clear.



Clear is used to clear the entire document or a selected area. To clear the entire document, touch Clear. To clear a selected area, touch Clear after you have used the Selection Rectangle.



Copy places a copy of the selected area into the editing buffer. First, use the Selection Rectangle to select an area, then touch Copy.



Cut places a copy of the selected area into the editing buffer and clears the selected area. First, use the Selection Rectangle to select an area, then touch Cut.

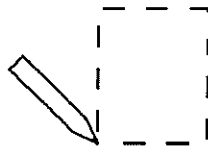
WARNING: Do not touch the screen or click the button during a copy or cut. Doing so may cause an error which requires rebooting the entire system.



Paste pastes the contents of the editing buffer onto the document in an area specified by the Paste Rectangle after a cut or copy. First, touch Paste, then touch anywhere within the document. A Paste Rectangle will appear. Move the Paste Rectangle around until it is exactly where you wish the paste to occur, then click. If the Paste Rectangle is not entirely within the document area when you click, the contents of the editing buffer will be clipped so that pasting is done only within the document, though the actual contents of the editing buffer will not be affected. Initially, the Paste Rectangle will be to the upper-right of where your pen is. To change the direction of the Paste Rectangle from the pen, use Paste Direction described below. If you decide not to paste before you click, just touch anywhere outside the document area.



The **Paste Direction** selects the direction from the pen that the Paste Rectangle will appear during a paste. You may change it by touching the desired direction in Paste Direction at any time. Initially, the direction is to the upper-right of the pen, and the Paste Rectangle will look like this in relation to the pen:



If you decide you want the direction to be to the lower-left of the pen, touch the Paste Direction in the lower left-hand corner. The Paste Direction icon and the Paste Rectangle in relation to the pen will look like this:



Do likewise for upper-left and lower-right directions.

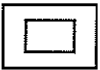
WARNING: Do not touch the screen or click the button during a paste. Doing so may cause an error which requires rebooting the entire system.

DRAWING FIGURES

The drawing operations in SiliconPaint include lines, rectangles, ellipses, and polygons. When you have turned on a drawing operation, you can continue to draw with that operation until another feature is touched.



The **Line** draws lines. To use it, touch Line. Now touch the location where you wish the line to begin, drag to where you want the line to end, and lift the pen. As you drag the line, it is drawn from the starting point to wherever the pen is; the line moves around like an elastic string with one end anchored down. Any line ending outside of the document area will not be drawn.



The **Rectangle** draws rectangles. To use it, touch Rectangle. Now touch the location where you wish one corner of the rectangle to be, drag to where you want the opposite corner to be, and lift the pen. As you drag the rectangle, it is drawn with the initially-touched location as one corner and the pen location as the opposite corner; the rectangle changes size with one corner anchored down. Any rectangle outside of the document will not be drawn.



The **Ellipse** draws ellipses. To use it, touch Ellipse. Now you must draw a rectangle within which the ellipse will be drawn. This is done exactly the same way Rectangle is, except that when you lift the pen, the rectangle will disappear and an ellipse will be drawn in its place. Any rectangle drawn outside of the document will result in no ellipse drawn, as will trying to draw an ellipse which is too thin for its length or height.



The **Polygon** draws polygons. To use it, touch Polygon. Now touch the location where you wish one corner of the polygon to be, drag the line to where you want the next corner to be, and lift the pen. The line is drawn in exactly the same fashion as with Line. The location of the beginning for the next line is the end of the previous line. So, put your pen down anywhere and draw the next line as you did the first. When you are finished, click.



The **Fill Selector** selects how figures are to be drawn: with a simple border, with a border and the inside painted with the current pattern, or with the current pattern and no border. Initially, the Fill Selector and figure icons will look like this:



In this mode, figures will be drawn only with a border, not disturbing anything underneath them except where the border is drawn. You may now change to figures drawn with the current pattern and a border by touching the left side of the icon or drawn with the current pattern and no border by touching the right. If you touch on the left, the Fill Selector and the figures will look like this:



In this mode, figures will be drawn with the current pattern and a border, replacing anything underneath them. You may now change to figures drawn only with a border by touching the left side of the icon or drawn with the current pattern and no border by touching right. If you touch on the left, the Fill Selector and figure icons will be as they were initially. If you touch on the right, the Fill Selector and the figures will look like this:



In this mode, figures will be drawn with the current pattern and no border, replacing anything underneath them. You may now change either to figures which are drawn only with a border by touching the left side of the icon or which are drawn with the current pattern and a border by touching the right.



The **Symmetric Selector** selects whether or not to constrain lines to vertical, horizontal and 45° angles; rectangles to squares; ellipses to circles; and polygons to lines drawn with vertical, horizontal and 45° angles. Initially the Symmetric Selector is off and figures are drawn without constraint. To turn the Symmetric Selector on, touch it. The icon will look like this:



Figures drawn in this mode will be constrained as listed above. The Symmetric Selector will remain on, constraining figures until you turn it off by touching it.

TEXT

SiliconPaint lets you enter text via the keyboard. The text operation allows you to select the size of the text and the spacing between the letters. When you have turned on the Text operation, you can continue to use the operation until another feature is touched. There is a copy of the pre-defined character set in Appendix A.



Text allows you to enter text into the document from the keyboard and change the font size. To do this, touch Text. A Size icon will appear next to Text. If you wish to enter text at the size displayed in the Size icon, simply lift your pen from the Text icon and the Size icon will disappear. If you wish to change the size, follow the instructions below for Size.

Now touch the lower left-hand location in the document area where you wish the text to begin. A cursor will appear which represents the height of a capital letter. You may now enter characters from the keyboard. The arrows allow you to move in any direction and a return will move the cursor to the beginning of the next line. Character printing is restricted to the document area. The tail on letters like "j" will actually be printed below the cursor, so the actual height of the string is longer than the cursor. When you are finished, type the "esc" key. You may continue entering text by once again touching the lower-left hand location where you wish the text to begin. Or, you may wish to change the size first by touching Text and using the Size feature described below. To exit the text function, make sure you have escaped from the keyboard, then touch anywhere outside of the document window and Text.



Size selects the size and spacing of the text. First, drag the pen to the Size icon after you touch Text, then lift the pen. If you decide you wish to use the current size, simply enter "return" on the keyboard. Otherwise, enter a number between 8 and 239 inclusively. If you try to enter characters other than numbers you will hear a beep. Return when you are finished, and Size will disappear. If the number you have entered is not inside the indicated range, you will hear a double beep, and you must enter a new number.

The actual size of the characters increases in multiples of 8, with the numbers in between representing the number of pixels between each character. For example, 16 through 23 are all the same size, but 17 has one more pixel between each character than 16 does and so on. The number of pixels between each character can be found by dividing the size by 8 and adding the remainder. Therefore, if the size 43 is used, 8 pixels will be between each character since $43/8 = 5 \text{ R}3$ and $5+3 = 8$.

CROSSHAIR



The **Crosshair** selects the exact location to start a line, a rectangle, an ellipse, a polygon, text, the Inversion Rectangle or the editing Selection Rectangle. Initially the Crosshair is off and figures are drawn without its use. To turn the Crosshair on, touch it. The icon will look like this:



Now whenever you draw a figure, use the Selection Rectangle, use the Inversion Rectangle or write text, instead of the first place you touch being the initial point, the Crosshair will appear. Move the Crosshair around the screen until you have pinpointed the exact location where you want the figure, Inversion Rectangle, Selection Rectangle, or text to begin, then click. The Crosshair will disappear when you click. The Crosshair will remain on, appearing whenever you draw a figure, use the Inversion Rectangle or Selection Rectangle, or begin text, until you turn it off by touching it.

PENCIL & ERASER

The pencil and eraser functions do just what their names imply: draw and erase. They do have a few special functions, however, which this section will explain. When you have turned on the Pencil or Eraser operation, you can continue to use that operation until another feature is touched.



The **Pencil** makes a free-hand line one-pixel thick. To use it, touch the Pencil. Now you may draw inside the document. Be careful not to touch outside the document before you are finished drawing, since this will turn the Pencil off. If this happens, just touch the Pencil again and continue drawing.

An interesting feature of the Pencil is the ability to draw in both colors. To draw white, touch the Pencil again after it has been turned on. The Pencil will now look like this:



To switch back and forth between colors just touch the Pencil.



The **Eraser** erases a 16x16 square of black pixels. First, touch the Eraser. Now touch anywhere in the document and you will see the eraser:



You can drag it anywhere on the document, but it will only erase whenever you click. If you hold the button in while you drag the eraser around, you can erase continuously.

Whenever you get to the side of the document, the eraser will shrink until the pen leaves the document area, which turns the Eraser off. This "shrinking" allows you to erase in hard-to-reach areas around the sides.

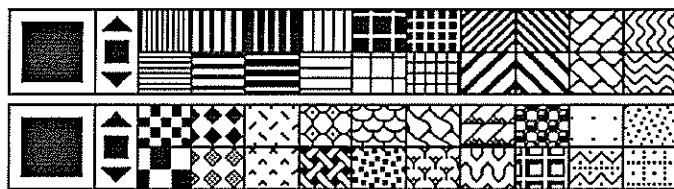
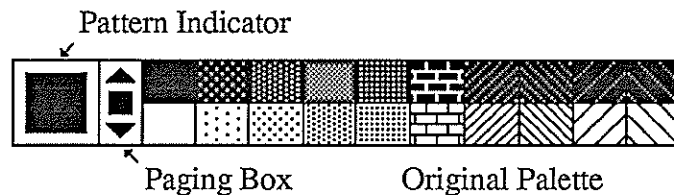
PAINTING

SiliconPaint has a painting operation which allows you to fill in a closed object with any of the available patterns. When you have turned on the painting operation, you can continue to fill closed areas until another feature, such as the Paint Palette, is touched.



The **Paint Bucket** pours the current fill pattern into an enclosed area. To use it, touch the Paint Bucket. Now touch the area you want filled. The touched area will immediately fill with the current pattern. Be careful to use the Paint Bucket only on figures which are entirely closed. If the area you are painting has even the smallest hole, the paint will "leak" outside of the area. You can continue to fill areas until another feature is activated.

The available patterns for use with the Paint Bucket as well as for filled figures are found in the **Paint Palette**. There are three different sets of patterns in the palette which can be accessed by simply touching an arrow or the home box in the Paging Box: the "up" arrow pages forward, the "down" arrow pages backwards, and the "home" box will return to the original palette. The current pattern is indicated by the Pattern Indicator at the far left of the palette. Initially, the pattern is solid black. To change the current pattern, simply touch the pattern you desire in the palette.



Other Palettes

WARNING: Do not touch the screen or click the button while an area is being painted, and do not paint an area more than once. Doing so may cause an error which requires rebooting the entire system.

INVERSION



Inversion color-inverts rectangular areas. To use it, touch Inversion. Now touch at one corner of the area you want to invert, drag to the opposite corner, and click the button. Since the Inversion Rectangle is not set until you click, you may pick up the pen any time before you click and still reshape the Inversion Rectangle. As soon as you click, the Inversion Rectangle will disappear and all white pixels inside will become black while all black pixels will become white. If you decide not to invert before you touch inside the document area, simply touch anywhere outside the document. If you decide not to invert after you have begun to select an area, simply touch anywhere outside the document and click. This will terminate the inversion process since you can only invert an area which is entirely within the document.

FILE MANIPULATION

SiliconPaint lets you display a MacPaint file onto the screen and also save a screen as a MacPaint file.



Open opens a previously-created document. To use it, touch Open. You will know it is on if the surrounding rectangle disappears. Now go to your Macintosh monitor and select a MacPaint file to open. As soon as the file has been transferred to the XT-1000, the rectangle surrounding Open will reappear.



Save saves the current document. To use it, touch Save. You will know it is on if the surrounding rectangle disappears. Now go to your Macintosh monitor and choose a name for the file. SiliconPaint will not save a previously opened file under the same name unless you use that name in the prompt on the Macintosh monitor. As soon as the file has been saved, the rectangle surrounding Save will reappear.

WARNING: Do not touch the screen or click the button during Open or Save. Doing so may cause an error which requires rebooting the entire system.

CONCLUSIONS

Status of System

There are 5332 lines of source code, 105 functions and 19 modules. The size of the object code is 57K.

Future Work

Hardware should be light-sensitive, have higher resolution, and be able to allow the user to select a pixel more precisely. This equipment has very high potential, but will only reach its fullest capabilities when the display reaches current CRT resolution and pixel selection becomes very precise.

Software should be used to determine if the concept of silicon paper is a good alternative to the CRT/mouse user-interface. Also, software should be developed in the educational field since children can much more readily use an interface which is based on the pencil/paper paradigm than one which uses the mouse.

Appendix A

Predefined character font (00h-7Fh)

Hex	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
2	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
3	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
4	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
5	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
6	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
7	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

Predefined character font (80h-FFh)

H/L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
8																
9																
A																
B																
C																
D																
E																
F																