

ROBO 1000

BIT-STIK GRAPHICS SYSTEM

Preliminary information

This document is a preliminary version of Sections 1 and 2 of the User's Manual. We have supplied the information in this form to allow the earliest possible delivery of your Robographics System. To obtain your copy of the complete manual, please fill in and return this page to:

Robocom Ltd.
CIL Buildings
Goodwin Street
LONDON N4 3HQ.

Your Name: _____

Company: _____

Address: _____

Post Code: _____

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Please complete and return the LICENSE REGISTRATION FORM. This will enable us to provide you with the following important services:

Technical help

Your local dealer will be able to help you, especially with hardware-related questions. Also, as a registered user, you can call Robocom Ltd. direct during normal business hours on 01-263-3388. Please refer to your software and interface serial numbers when you call.

Software updates

As a licensed user you will be notified if the Robo 1000 software is significantly modified, or if additions to the system become available.

Replacement copies of system software

Robo 1000 software is protected to prevent unauthorized duplication. A back-up copy of the system software is provided in case the original disk becomes damaged. The back-up disk should be stored carefully in a clean, dry environment clear of strong magnetic fields. If the software fails to load (boot) properly at start-up please do not check the system disk by substituting the back-up copy. Check first with your dealer; the most likely cause of difficulty is an improperly installed disk or a disk drive malfunction which could damage the back-up disk also.

If the system disk is found to be defective, return it to Robocom Ltd. with dated proof of purchase. Provided the disk has not been damaged by improper use, it will be replaced free of charge within the warranty period of 90 days from the date of purchase.

PLEASE USE CARD STIFFENERS TO AVOID SHIPPING DAMAGE!

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The Type 1 Interface supplied is an essential part of the Robo 1000 system. If the system fails to function properly, and if the computer hardware (especially disk drive No. 1) is in good order, the fault may be in the Type 1 Interface. Please return it with dated proof of purchase to Robocom Ltd., packed to avoid damage to the connector pins. Provided the Interface has not been damaged by improper use, it will be replaced free of charge within the warranty period of 90 days from the date of purchase.

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Repair service

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Please pack the product in a protective shipping container. In-transit damage is not covered by the warranty.

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- (3) you do not transfer the software electronically to another computer over a network;
- (4) you do not make copies of the software and its related documentation for distribution or sale to others;
- (5) you do not modify, translate or augment the software and its related documentation without the prior written consent of Robocom

This license shall be governed in its interpretation and enforcement by the laws of the United Kingdom.

M A I L T H I S T O D A Y !
= = = = =

LICENSE REGISTRATION FORM

Robo 1000 Bit-Stik Graphics System

Serial numbers: S xxxx
 I xxxx

Your name

Address

.....
.....

Date of license purchase

Dealer from whom you purchased license []
 []
 []
 []
 []

Signature

((Reverse))

Robocom Ltd.
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Goodwin Street
London N4 3HQ

WARRANTY

Warranty period

Robocom Ltd. warrants its Robographics computer products against defects in materials and workmanship for a period of ninety (90) days. During the warranty period, Robocom Ltd. will repair or replace products which prove to be defective.

Limitation of warranty

The foregoing warranty shall not apply to defects resulting from improper maintenance by the user, user-supplied software, hardware or interfacing, unauthorized modification or misuse.

Robocom Ltd. does not warrant that the operation of the software, firmware or hardware shall be uninterrupted or error free.

The warranty set forth above is exclusive and no other warranty, whether written or oral, is expressed or implied. Robocom specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

Exclusive remedies

The remedies provided herein are the buyer's sole and exclusive remedies. In no event shall Robocom Ltd. be liable for direct, indirect, special, incidental or consequential damages (including loss of profits) whether based on contract, tort or any other legal theory.

ROBOGRAPHICS

ROBO 1000

Bit-Stik Graphics System

Software serial number: S
Interface serial number: I

USER'S MANUAL

Section 1	<u>The Robo 1000 System</u> Connecting and checking the system components; loading the system software
Section 2	<u>Quickdraw Tutorial</u> Introduction to the main drafting, filing, text and image handling functions of Robo 1000; paper copies us- ing a dot matrix printer
Section 3	<u>Precision Drafting</u> Using scale, lock and grid functions for accurate tech- nical work; isometric and scale drawings; artwork us- ing a drafting plotter
Section 4	<u>Alphabetical reference</u>

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SECTION 1

The Robo 1000 System

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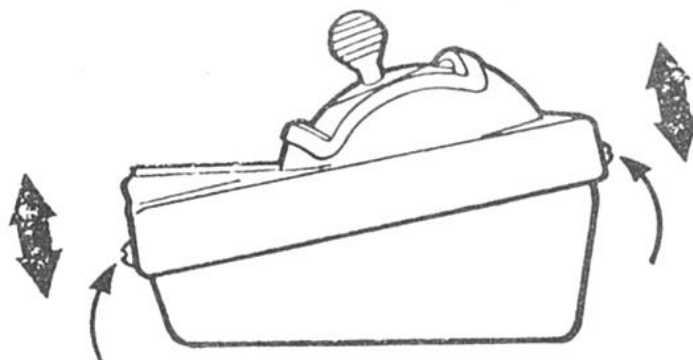
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TOUCH CONTROL ADJUSTMENT (U.K. only)

The Robographics Controller is capable of precise and almost inertia-less motion about any axis, and yet can be 'parked' positively at any desired position. Although the touch control has been factory pre-set, you may prefer to adjust it to your preference. For this purpose you can adjust the height of the top casing, which in turn alters the pressure of a felt pad against the moving hemisphere.

Four adjustment screws are provided so that the drag on the hemisphere can be adjusted in all quadrants. Normally the height is adjusted to provide a light drag. Should you wish to alter this, take a medium cross-head screw-driver and do the following:

- * Unclip the screw covers as shown.
- * Loosen, but do not remove all four screws.
- * Adjust the height of the case while moving the XY control over the entire 'window' area, checking for even pressure.
- * When the feel of the control is satisfactory in all positions, hold the case firmly and tighten the screws, checking the XY control as you proceed.
- * Replace the screw covers.



SECTION 3: PRECISION DRAFTING

ROBOGRAPHICS CAD-1 System

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SECTION 3: PRECISION DRAFTING

ROBOGRAPHICS CAD-1 System

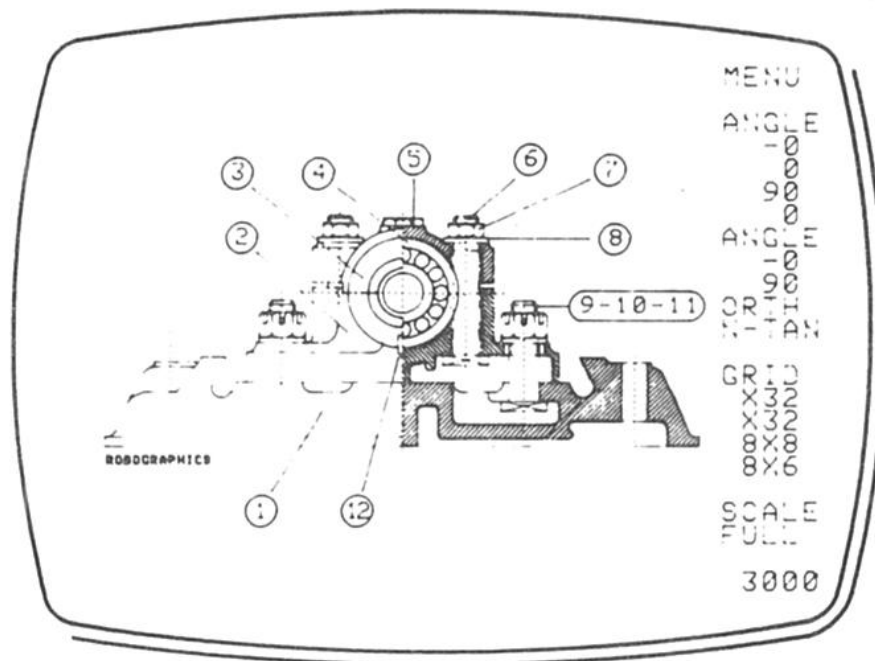
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PRECISION DRAFTING AIDS

We assume here that you have the Robographics system set up and functioning, and that you have tried using the freehand drawing functions outlined in Section 2.

You've seen in Section 2 how Robographics can be used as a powerful sketching, or freehand drawing tool. But that's really only the beginning; you have at your disposal a range of precision aids which can be used with the same effect as the traditional graph paper, scales, protractors, and other drawing instruments.

These precision aids are available through Menu 2. You will find them essential if you intend to plot your drawings to a high technical standard. End-points will be accurately defined, lines will meet where they are supposed to, curves will blend smoothly, parallel lines will be just that, and text will be consistent in size and position. With the precision aids on Menu 2, you'll find that your drafting jobs go faster, with less repetition than before.



Precision drafting aids on Menu 2
Menu 2 provides all the aids needed for accurate artwork suitable for reproduction on a drafting plotter.

LOCK FUNCTIONS

Menu 2 provides lock functions which control movements of the drawing cursor in specific ways depending on the type of lock you've selected. For example, you can position the cursor precisely at any chosen point on the work page, or you can make the cursor move only along a particular line, at any chosen angle.

LOCK FUNCTIONS (continued)

There are two general types of lock: angle and grid. Each has a wide range of possible settings. The two locks can be used separately, or in combination, to set a skewed grid (e.g. an isometric grid). Additionally, there is a scale mode which can be used to assign a 'real' dimension to the grid, e.g. 100 mm/division.

With Menu 2 on the screen, you can access all the palette functions you used in freehand drawing, Section 2. However, if you've engaged a lock function from Menu 2, you cannot change a menu or palette selection without first suppressing the lock condition. Why tell you this before you've even seen a lock? Because, literally, you can lock yourself into a condition where you can't do anything else!

Suppressing a lock to select menu/palette functions

If any lock function is in effect, the cursor cannot move freely outside the work page to make menu and palette selections. To free the cursor, you must first press and hold down the right button on the controller (P/hold R). Now you can XY to the desired function on menu or palette, then release the button (Rel R). Releasing R has the effect of 'arming' the lock system; if you move the cursor away from your menu or palette selection, you'll find that the lock is re-engaged. This is why for menu selections, only, you arm by Rel R, then confirm in the usual way by pressing and releasing the left button (P/rel L). Here's a reminder:

<u>LOCK SUPPRESS/ FUNCTION SELECT</u>	<u>Unlock</u>	P/hold <u>R</u>
	<u>Select</u>	<u>XY</u> to menu/palette
	<u>Arm</u>	Rel <u>R</u>
	<u>Confirm</u>	P/rel <u>L</u>

WIPE in the lock condition

The above procedure works for WIPE, too, the only difference being that to confirm WIPE you P/rel L and RED together. The lock is automatically cancelled by WIPE, which is in effect a general system reset.

Cancelling a lock condition

Lock cancellation is similar to suppression, with one difference: to 'select' you return the cursor to the lock flag which is already engaged, arm by releasing R, then switch off the lock by pressing L:

<u>LOCK CANCEL</u>	<u>Unlock</u>	P/hold <u>R</u>
	<u>Return</u>	<u>XY</u> to lock flag
	<u>Arm</u>	Rel <u>R</u>
	<u>Cancel</u>	P/rel <u>L</u>

ANGLE LOCKS

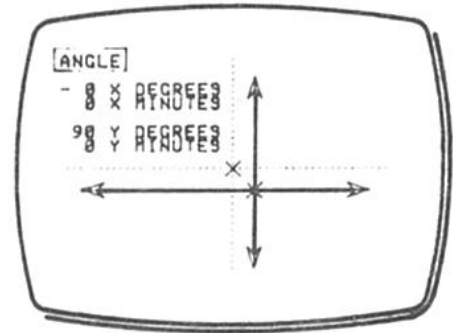
(1) Vernier angle lock

This lock constrains the cursors to move only in two fixed 'grooves' originating at the x cursor.

<<<< DO THIS >>>>

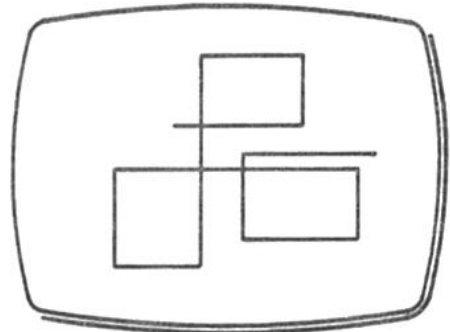
- * Clear the screen using WIPE
- * Select Menu 2
- * XY and P/rel L to switch on the top ANGLE flag
- * Try moving XY; the cursor can move only along two axes passing through the x cursor

The angle of each axis, referred to the horizontal axis, is displayed on the menu. In the 'default' state (which is what you selected above) the X (East-West) axis is at 0 degrees, 0 minutes, and the Y (North-South) axis is at 90 degrees, 0 minutes. Later you will change these angles, but first try drawing with the lock engaged in the default state:



<<<< DO THIS >>>>

- * Move the + cursor away from x, then P/rel L to shift the lock origin (i.e. the x)
- * Draw a number of lines and boxes, all perfectly right angled, which is a very useful feature; don't worry if you can't make a perfect box - there is another lock function for this
- * P/hold R to unlock the cursor; then XY to move the cursor freely



So long as R is held down, the cursor can be moved anywhere on the screen, including the menu and palette.

Freehand drawing with the lock engaged

You can draw 'unlocked' with any of the lock functions engaged. It's a little complicated:

- (1) Free the cursor by P/hold R
 - (2) Shift the cursor by P/hold L, or draw by P/hold RED (but notice that nothing happens yet)
 - (3) Rel R, then Rel L or RED to execute
-

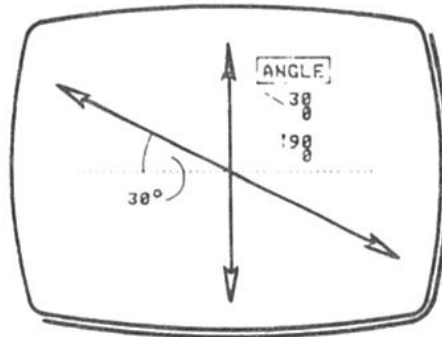
ANGLE LOCKS (continued)

Now you can try setting the axes at different angles:

<<<< DO THIS >>>>

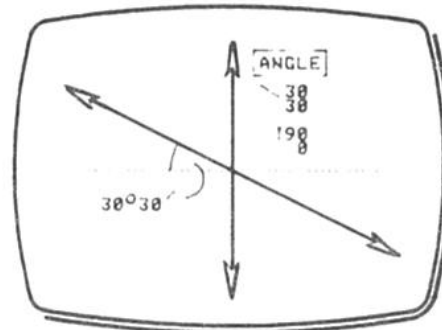
Change degrees of the X axis:

- * Clear the screen using WIPE
- * P/hold R, XY to the X degrees flag, then Rel R
- * Keeping the flag lit, P/hold L, then 0 to alter the slope about the horizontal axis from $\backslash 45$ degrees (fully clockwise) through $\nearrow 45$ degrees (fully counter clockwise); select $\backslash 30$ degrees, then Rel L
- * Try drawing a few lines along the locked axes, which are now at $\backslash 30$ and 90 degrees



Change minutes of the X axis:

- * P/hold R, XY to the X minutes flag, then Rel R
- * Keeping the flag lit, P/hold L, then 0 to fine tune the slope from 0 to 60 minutes; leave the setting at 30 minutes (1/2 degree), then Rel L
- * The locked axes, are now at $30 \frac{1}{2}$ degrees and 90 degrees



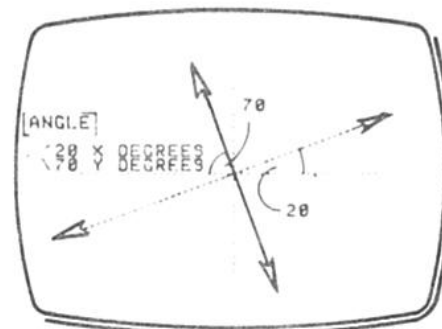
The Y axis lock acts in a similar way, with a range of $\backslash 45$ to $\nearrow 45$ degrees about the vertical.

(2) Coarse angle lock

The vernier lock is used whenever your drawing requires degrees-and-minutes precision. The second angle group down on the menu is a coarse lock for less critical applications:

<<<< DO THIS >>>>

- * Switch off the vernier angle lock
- * Set the angles of the coarse lock to X = $\nearrow 20$ degrees and Y = $\backslash 70$ degrees
- * Switch on the coarse ANGLE flag; try drawing with this new pair of locked axes
- * Now switch back to the vernier lock; the coarse lock is automatically switched off when the vernier lock is re-engaged



ANGLE LOCKS (continued)

Four-axis lock

Because you can alternate between coarse and vernier locks anytime, there are effectively four presettable lock axes - two in degrees and minutes and two more in degrees only.

Orthogonal lock (ORTH)

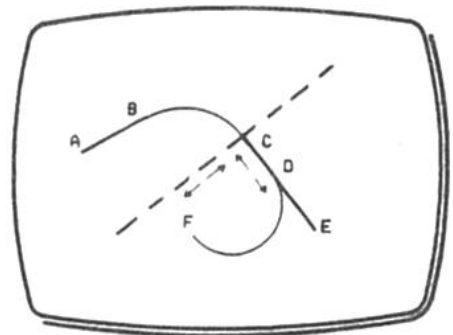
This lock works just like the coarse or vernier angle locks, with one difference - it is not adjustable. ORTH provides convenient one-shot selection of 0 and 90 degree lock axes, and is routinely used for outlining rectangular structures.

Normal-tangent lock (N-TAN)

This function automatically senses the slope of the last line drawn, then sets an orthogonal axis lock at the end of the line. With this lock engaged, you can draw either a smooth continuation of the previous line, or a line normal (i.e. at right angle) to it. N-TAN is especially useful for smoothly blending curves into straight lines. (Compare this with the TAN ARC, which works the other way, i.e. TAN ARC blends a straight line into an arc.)

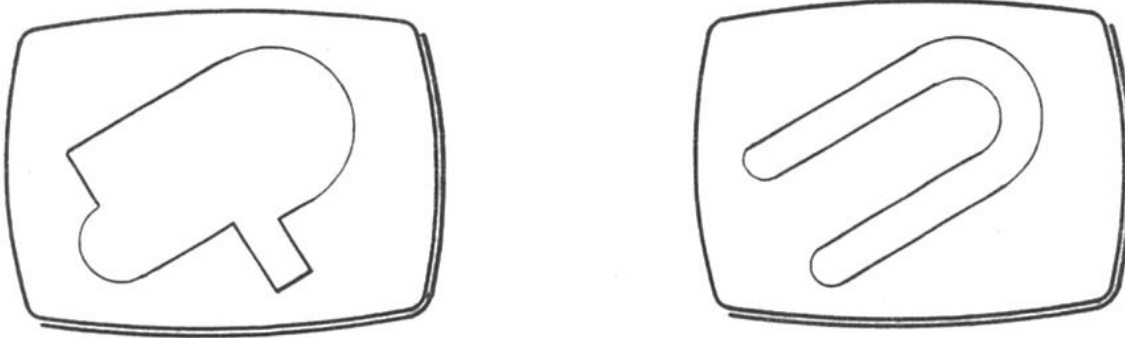
<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Draw a short straight line AB at any angle
- * Select TAN ARC from the palette
- * Draw an arc BC blending with the line
- * Select Menu 2, then select N-TAN; notice how the cursor now moves along the tangent to the arc (giving a straight line), or at right angle to the tangent (giving a perfect semicircle)
- * P/rel RED to draw the straight line CD
- * The N-TAN lock now operates from its new origin, i.e. the end of the line you just drew, allowing you to draw a straight continuation DE, or the semicircle DF



N-TAN is a very powerful function, used in many of Robo-graphics' more advanced drawing routines. Try constructing the examples shown on the following page.

ANGLE LOCKS (continued)



Drawing with N-TAN and TAN ARC

LOCKED GRIDS

A variety of grids can be displayed on the screen as aids to precision drafting, just as you would use a transparent ruled overlay or graph paper. The grid appears as a matrix of 'lock points' on the work page. When a grid is engaged, the cursor can no longer move freely about the screen. Instead it jumps from lock point to lock point, and can't go anywhere else. This makes it very easy to draw with zero error to and from the accurately defined nodes of the grid - something you will appreciate when you plot precision drawings, and see that lines supposed to meet at a point do exactly that!

A few words on the display ...

The screen display is itself a grid - a fine mesh to be sure, but a grid just the same. If you draw a vertical straight line you'll see that it isn't continuous, but instead is a column of individual points, called pixels. On the Apple display there are 280 columns of pixels, and 192 rows. However, 24 of these columns are needed for the Robographics menu, so the active work page is 256 across (the X dimension) by 192 down (Y).

Grid divisions

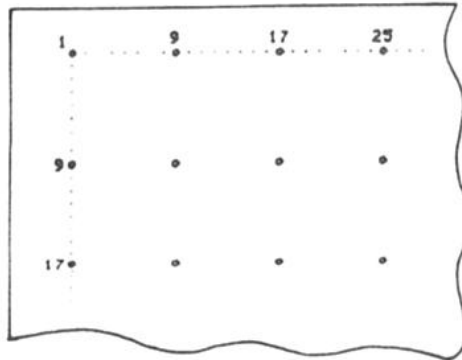
When you draw freehand, the cursor can be moved freely to any pixel on the work page. With a grid in place, however, the cursor can move only to those pixels coinciding with lock points of the grid. Because the grid divisions in the X and Y directions can be set independently, the grid cells can be made square, or rectangular in any proportion. You can choose any value for the X and Y divisions from 4 through 32 pixels.

Grid size

How many divisions can you have across the work page? This depends on the grid value you choose, but it's one less than you might think! For illustration assume an X value of 32 pixels, with the first lock point in the top left corner. Counting 32 pixels to the right, you come to the second lock

LOCKED GRIDS (continued)

point, after 32 more the third, and so on. However, because your starting point is marked by the first pixel, the second point is actually on the 33rd pixel, and the eighth point would be on the 257th pixel, outside the work page boundary. This means you cannot have more than 7 divisions across the page with the grid value 32; the same math applies down the page - 192 pixels, 5 divisions.



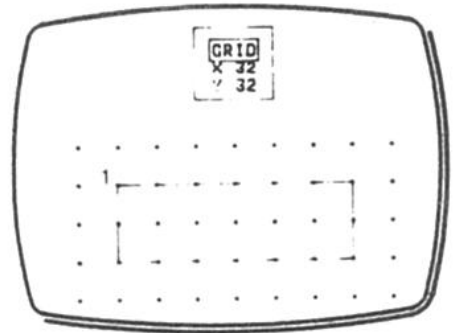
Lock points on the 8 pixel grid

Using the grid

Because the X and Y axes can be assigned different values, there is a wide choice of orthogonal grids. Additionally, the X and Y axes can be set at different angles, so the possibilities are practically infinite! These variations are explored later, but here you start with an orthogonal 32 pixel grid:

<<<< DO THIS >>>>

- * Clear the screen using WIPE; notice that the x cursor comes up in the center of the work page
- * Select Menu 2
- * XY to illuminate the GRID flag and P/rel L to switch it on; a locked 32 x 32 grid appears on the work page in register with the origin (the x cursor)
- * XY and P/rel L to position the x cursor at (1), then draw a rectangle by XY and P/rel RED in the usual way



LOCKED GRIDS (continued)

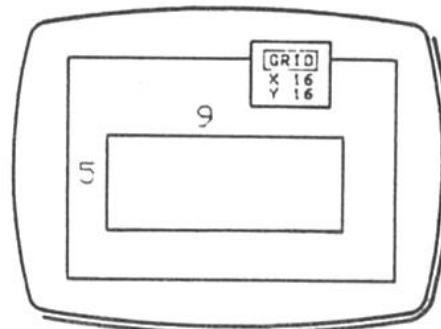
- * Draw other lines between lock points for practice
- * P/hold R to unlock the cursor, then XY to the GRID flag; switch off the GRID flag by Rel R, then P/rel L (the grid disappears, leaving small holes in your drawing where the lock points were)
- * Select Menu 1, then select PAGE to replay the drawing without holes

Changing the grid spacing

The X and Y grid values can be altered independently anytime you wish. You can choose any number between 4 and 32, but note that 4, 8, 16 and 32 are preferred values because they allow magnified views to be displayed without requiring the grid origin to be shifted.

<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Select Menu 2
- * XY to light the X 32 flag; holding XY there, P/hold L, then turn 0 to change the X value to 16
- * Rel L, then move XY away to confirm the new setting
- * XY to light the Y 32 flag; holding XY there, P/rel L; the value should change automatically to 16 (if a different number is displayed, P/hold L, turn 0 to set 16, then Rel L, and move XY away to confirm)
- * XY to light the GRID flag, then P/rel L to confirm; a 16 x 16 grid then appears on the work page
- * Draw a rectangle 9 x 5 units



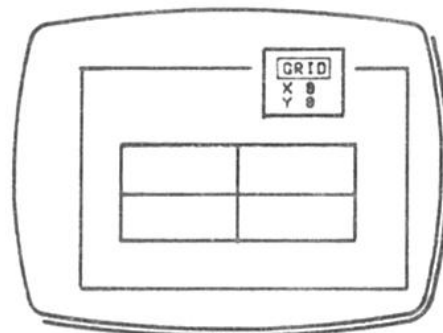
LOCKED GRIDS (continued)

Changing the grid spacing (continued)

You can now set a smaller grid, allowing you to halve exactly the rectangle (which you cannot do with the 16 x 16 grid):

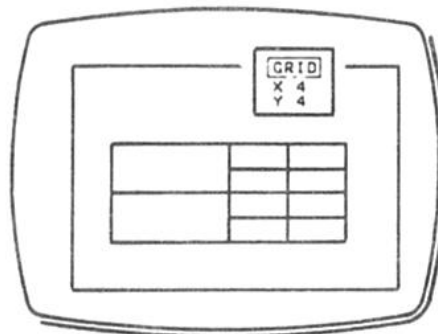
<<<< DO THIS >>>>

- * P/hold R to unlock the cursor, then XY to light the X 16 flag; Rel R, P/hold L, turn 0 to display the value 8, then Rel L
- * To set the Y value to 8, XY to the Y flag, then P/rel L; the value should change automatically to 8 (if not, P/hold L, then 0 to set 8)
- * To set the new grid, P/hold R, XY to the GRID flag, Rel R, then P/rel L
- * Now, with the GRID flag still flashing, P/rel L to switch it on again; the grid then appears at the new 8 x 8 spacing
- * Draw in the center lines



Now try a 4 X 4 grid, the smallest available:

- * Reset the X and Y values to 4 and halve the rectangles again
- * To cancel the grid, P/hold R, XY to the GRID flag, Rel R, then P/rel L
- * Select Menu 1, then select PAGE to replay the drawing without holes



Before changing grid size in the above procedure, make sure the x cursor is at one of the rectangle corners. If you've shifted the x cursor accidentally, the grid will be shifted to a new origin, probably out of register with the rectangle. If this happens you can re-locate the origin of the rectangle using FIND (page 3-11).

LOCKED GRIDS (continued)

Two ways of changing the grid position

You can alter the position of the grid by first planting the x cursor at the point you want the grid to originate from, then switching on the GRID flag. One of the grid's lock points will coincide with the x. The x cursor can be planted in one of two ways: (1) manually, anywhere on the work page, or (2) by using FIND to locate the end of a line or an intersection.

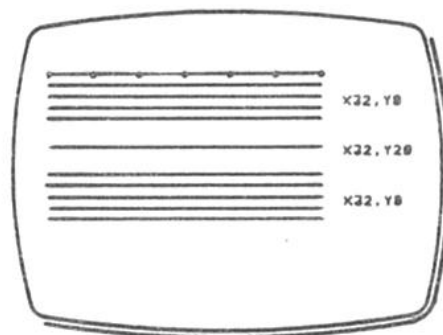
(1) Manual positioning

The example below uses manual shifting of the x cursor, together with grids of different spacings to produce ruled lines at any desired position:

<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Select Menu 2; set the Y grid value to 8, leaving the X value at 32
- * Switch on the GRID flag
- * Draw five equally spaced lines near the top of the work page

- * Reset the Y grid value to 20
- * Switch off the GRID flag, then switch it on again; one lock point of the 32 x 20 grid which now appears coincides with the last position of the x cursor
- * Draw a line 20 pixels down from the last line
- * Draw a second line 20 pixels further down
- * Reset the Y grid value to 8
- * Switch off the GRID flag, then switch it on again to re-display the 32 x 8 grid
- * Draw a further four lines 8 pixels apart



In this example the X value remains at 32 throughout, but you can change this anytime. You can also try setting a grid to a point not related to a previously drawn line: switch off the grid, plant the x cursor anywhere you wish, then switch on the grid again.

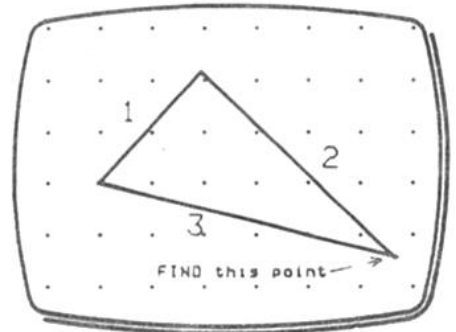
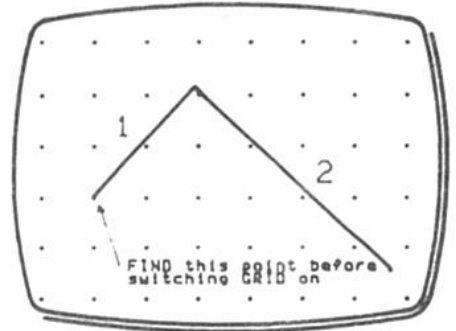
LOCKED GRIDS (continued)

(2) Automatic positioning using FIND

This second technique ('SHIFT-GRID') is very often used to make precise joins to any previously drawn end points. You will find it a most useful procedure to memorize.

<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Draw two lines, (1) and (2)
- * Select FIND and P/rel L to locate the start of line (1), then P/rel RED to plant the x cursor at this point
- * Select Menu 2
- * Switch on the GRID flag; notice that one of the lock points of the grid now displayed coincides with the end of line (1)
- * P/hold R, select Menu 1, select FIND, Rel R, then P/rel L
- * The FIND cursor now marks the end of line (2); P/rel RED to plant the x cursor
- * XY to position the + cursor at the free end of line (1), a lock point
- * P/rel RED to draw line (3); all corners of the triangle are now perfectly joined



REMEMBER!

'FIND and SHIFT-GRID'
is a key technique in
precision drafting.

LOCKED GRIDS (continued)

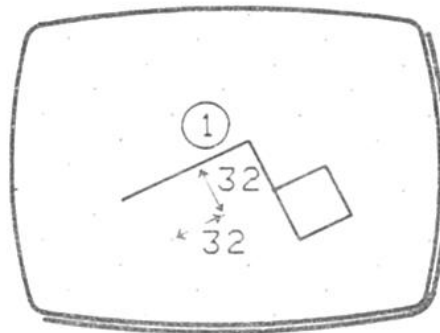
Rotating the grid using N-TAN

Here you use the N-TAN lock (page 3-5) to rotate the grid, and align it with a previously drawn line.

Note that the lock points on the rotated grid are spaced by an amount equal to the indicated values (e.g. X32 x Y32) only along the axes of the grid, not the horizontal or vertical. This means that you can use the grid as a scale to measure the length of lines at any angle - a very useful feature with many applications.

<<<< DO THIS >>>>

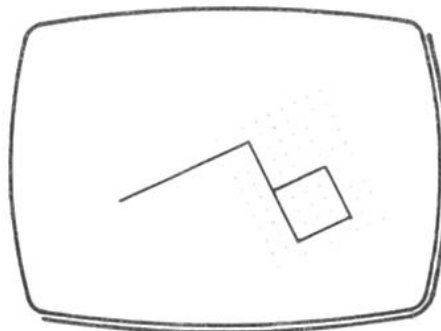
- * Clear the screen using WIPE
- * Draw a line at random as (1)
- * Select Menu 2
- * Select N-TAN; the cursor now locks onto two axes, in line with (1), and at right angle to it
- * Switch on the GRID flag; a 32 X 32 grid appears at the angles set by the N-TAN lock; the cursor is still locked to the angle axes, not the grid lock points
- * Switch off N-TAN; the cursor is now locked to the grid
- * Draw lines on the grid; they will all be parallel or at right angle to the first line



You can use this procedure anytime to set a grid to a line you have just drawn. Provided you re-engage N-TAN before turning off the first grid, you can quickly set another grid at the same angle but with different spacing:

<<<< DO THIS >>>>

- * Switch on N-TAN again
- * Switch off the GRID flag, reset the X and Y values to 8, then switch on the GRID flag again; an 8 X 8 grid is now displayed at same angle as the former 32 X 32 grid
- * Switch off N-TAN to lock the cursor to the grid
- * Draw several lines using the new grid
- * Switch off the GRID, but don't clear the screen



You have now 'lost' the grid angle, but you can recover it anytime using the ZOOM and FIND procedure on the next page.

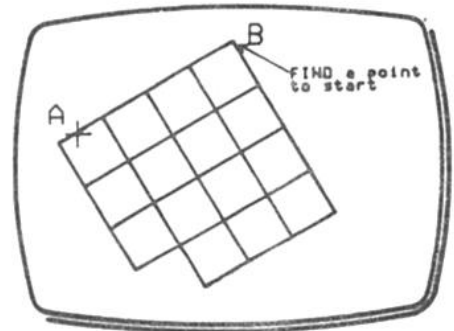
LOCKED GRIDS (continued)

Rotating the grid to an unknown angle

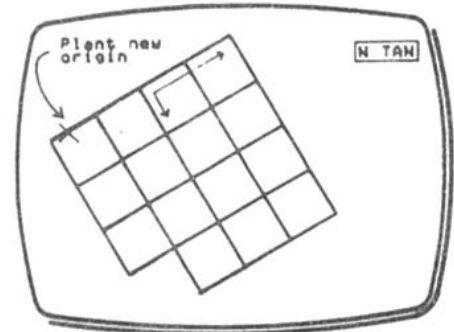
You can set an angled grid to any previously drawn line, using ZOOM and FIND to fix the angle. Use the drawing you have on the screen from the previous page:

<<<< DO THIS >>>>

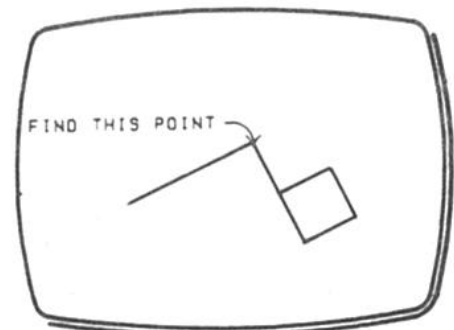
- * Select ZOOM, then enlarge a portion of line (AB) including the end-point B
- * Exit ZOOM
- * Select FIND, locate B, then P/rel RED to plant the origin



- * XY to move the + cursor back along the line as far as it will go, superimposing the cursor line on line AB (the two lines cancel each other)
- * P/rel L to replant the origin and so fix the angle
- * Select Menu 2, then switch on N-TAN



- * Select Menu 1, then PAGE to replay the drawing at the original size
- * Select FIND, then choose a point to be the origin of the grid
- * P/rel RED to fix the origin at that point
- * Select Menu 2, set the grid to 32 x 32, then switch on the GRID flag; the 32 x 32 grid is now aligned with AB
- * Switch off N-TAN to lock the cursor to the grid



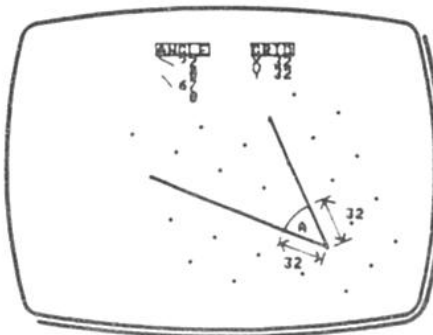
LOCKED GRIDS (continued)

Setting a skewed grid with X and Y axes at chosen angles

You've seen how to rotate an orthogonal grid to any angle with N-TAN. Now, with the other angle locks, you can skew the grid, i.e. set the X and Y axes independently to specific angles:

<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Select Menu 2
- * Set the X ANGLE vernier lock to $\setminus 22$ degrees, and the Y angle to $\setminus 67$ degrees, then switch on the vernier ANGLE
- * Switch on the GRID
- * Switch off the vernier ANGLE
- * Draw two lines as shown; angle A is 45 degrees



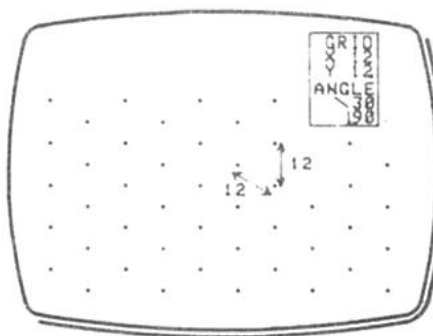
Values X and Y32 apply only along the axes you define

Isometric grids

You can generate perfect isometric drawings using a skewed grid set to X = 30 degrees and Y = 90 degrees, at any spacing of your choice:

<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Select Menu 2
- * Leaving the Y angle at the default setting of 90 degrees, set the X coarse ANGLE to $\setminus 30$ degrees
- * Set both X and Y grid spacings to 12
- * Switch on the ANGLE flag
- * Switch on the GRID flag
- * Switch off the ANGLE flag



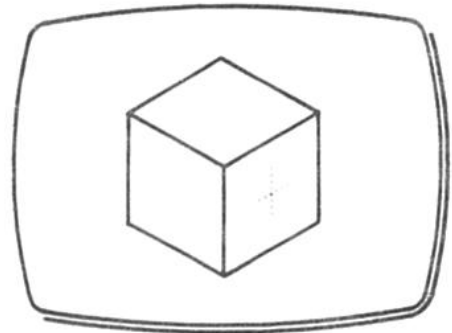
You now have an isometric grid. True measurements can be made along both of the 30 degree axes and the vertical axis. For practice with the isometric grid, start with a cube as described on the next page.

LOCKED GRIDS (continued)

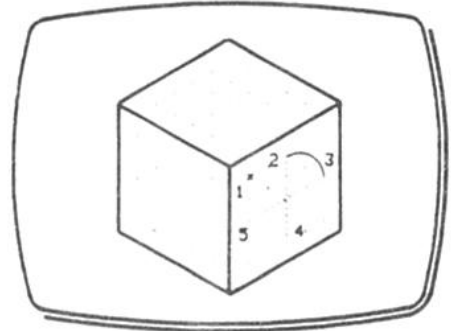
Isometric grids (continued)

<<<< DO THIS >>>>

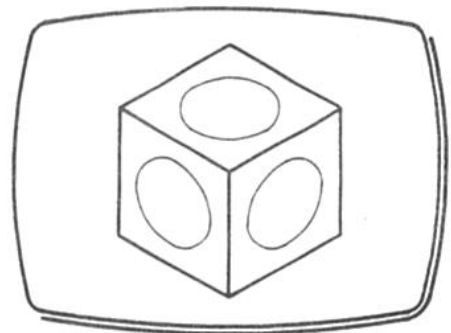
- * Draw the cube shown with 6 unit sides
- * Select DOT 1 from the palette
- * Draw a cross centered on the right face of the cube; the arms of the cross must all be equal (use 2 or 4 units)



- * Select continuous line
- * XY to position the + cursor at (1), then P/rel L to plant the origin there
- * XY to position the + cursor at (2), then P/rel L to re-plant the origin (this sets the direction for the arc which follows)
- * Select TAN ARC
- * Position the + cursor at (3), then P/rel RED to draw the arc
- * Repeat at (4), (5) and (2) to complete the ellipse



- * Draw ellipses on the other visible faces of the cube
- * Remove the dotted construction lines using ERASE, then select PAGE to replay the drawing



This method draws an approximation of the ellipse, adequate for most purposes. You can also generate mathematically perfect ellipses by 'squeezing circles', page 2-18.

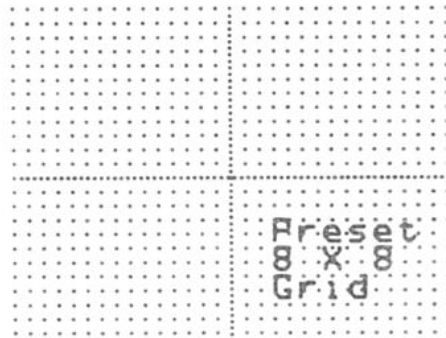
LOCKED GRIDS (continued)

Preset grids

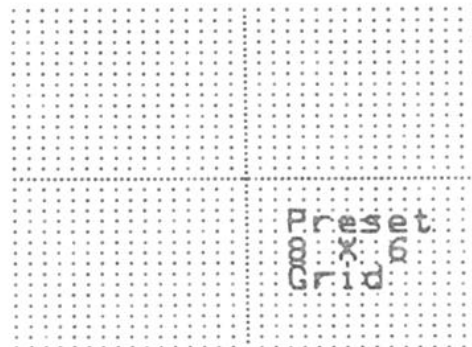
In addition to the grids with variable X and Y spacings, there are two preset 'convenience' grids on Menu 2 designated '8 x 8' and '8 x 6'. Both of these grids automatically originate at the center of the screen, no matter where the x cursor happens to be when the grid is selected. This feature can be used to find the center of the screen. It also provides a register grid which always appears in the same position on the work page.

The spacings of the two preset grids are chosen for two reasons: first, they are very convenient for general drawing assignments, and second, they divide exactly into the 256 x 192 pixel dimensions of the work page.

The preset grids are fixed at 0 and 90 degrees, and cannot be skewed or rotated.



Preset 8 x 8 grid



Preset 8 x 6 grid

When either of the preset grids is displayed, the column of lock points on the extreme right is hidden by the menu, and the two rows along the bottom are hidden by the palette. Although they are not displayed, these lock points are effective, and can be used in the normal way. The palette (but not the menu) can be removed by selecting FULL (re-display the palette by switching off FULL).

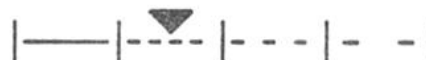
LOCKED GRIDS (continued)

Registration marks using the preset grids

Preset grids are frequently used to generate registration lines and points or drawing symbols, furniture units, etc., to a common datum position. A very useful registration point is the center of the work page, which you can mark as follows:

<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Select DOT 1 from the palette
- * Select Menu 2
- * Select 8 X 8; a grid with dotted cross-hairs will appear
- * Position the + cursor at top center of the screen
- * P/rel L to plant the cursor there
- * Position the + cursor at bottom center of the screen
- * P/rel RED to draw a vertical line
- * Repeat the above sequence to draw the horizontal center line
- * Re-select 8 X 8, then Rel R; the grid disappears, leaving the center lines as you drew them
- * For future use, FILE the center lines in an empty library box



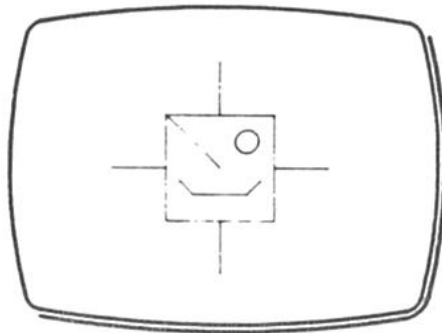
LOCKED GRIDS (continued)

Drawing schematics with the preset grid

Here use the 8 x 8 grid as a finder for the center of the screen, then set a larger grid at the same origin. On the larger grid draw a figure which you will use as a 'dummy symbol' to illustrate the principles of drawing schematics.

<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Select Menu 2
- * Select 8 x 8; a grid with crossed center lines will appear
- * Position the x cursor at the center of the cross
-
- * Switch on the GRID flag; a 32 x 32 grid will now appear at the same center origin
- * Draw a square as shown, centered on the screen, 4 units each side
-
- * Re-select 8 x 8
- * Draw the 'dummy symbol' as shown
- * Add vertical and horizontal 'connecting' wires 4 units long (for the vertical lines this is the limit of the grid)
-
- * Select Menu 1, then select FILE
- * FILE the drawing in an empty library box
- * Skip the label request
- * When the work page returns, clear the screen using WIPE



You can assemble clones of the 'dummy symbol' into a schematic on the 8 x 8 grid, using COPY and ZOOM functions, which act in a special way on this particular grid. To see just how easily a schematic can be assembled, try the exercise on the following page.

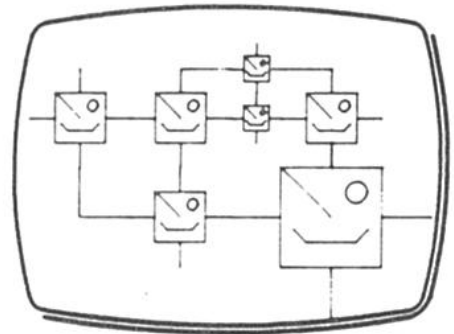
LOCKED GRIDS (continued)

Copying onto the preset grid

When using COPY on a preset grid, the scale of the copy cursor can only be altered in quantized steps. This ensures perfect registration and consistent size of symbols.

<<<< DO THIS >>>>

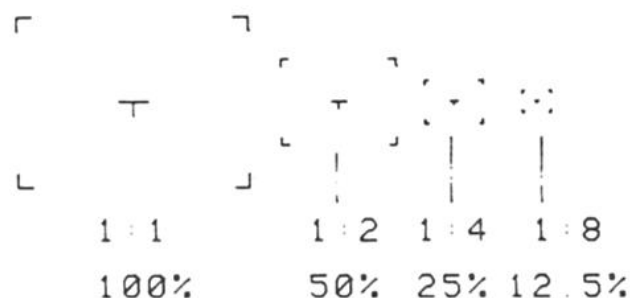
- * Clear the screen using WIPE
- * Select Menu 2, then select 8 X 8
- * Select Menu 1
- * Select COPY, then acquire the shape you just filed
- * When the work page returns, try turning θ to adjust the size of the cursor frame; you'll see that it jumps from one size to the next in fixed steps (watch the SCL value) instead of the usual smooth progression
- * Now try shifting XY to move the cursor frame about the work page; notice that the center of the frame always homes onto a lock point
- * P/rel RED to plant different size copies of the symbol at various positions on the grid; notice how the 'connecting wires' align perfectly
- * Exit COPY



LOCKED GRIDS (continued)

Quantized COPY ratios

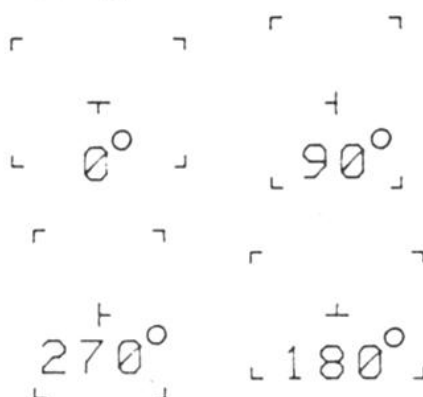
You have seen how the COPY cursor frame has only a limited number of settings when a grid is in effect. These settings define the ratio of the picture unit's original size, and its size as copied onto the screen. The four ratios available are 1:1, 1:2, 1:4 and 1:8.



Four sizes

Here are the other COPY functions with the preset grid:

ROT The COPY cursor frame can be rotated through only four fixed settings when used with the preset grid: 0, 90, 180 and 270 degrees. To rotate the cursor frame, P/hold L, then turn 0.



Four rotations

STR This is not available with preset grid.

FLIP This operates in the usual way. To activate FLIP, P/hold R, then select X and Y using the COPY cursor frame.

LOCKED GRIDS (continued)

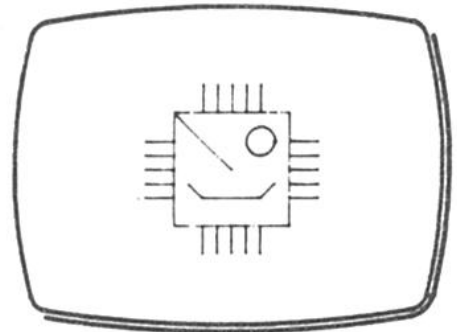
Zooming with the preset grid

As with COPY, the size of the ZOOM cursor (and therefore, the magnifications available) is limited to four quantized settings, i.e. 1:1, 1:2, 1:4, and 1:8. (You can, of course, ZOOM repeatedly for higher magnifications, 1:16, 1:32, etc.) This is helpful in two ways: first, it ensures perfect registration of the drawing on the grid, and second, it gives a 'nested' structure of locked grids within the preset grid on the base page allowing you to draw to precisely determined intermediate points.

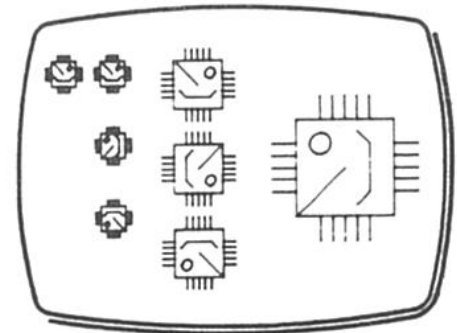
You could try zooming on the schematic you drew in the previous exercise, but try another drawing, this time using a dummy symbol with more than one connecting line on each side. This will show how useful it can be to ZOOM repeatedly to display successively finer grids.

<<<< DO THIS >>>>

- * Using the 8 X 8 grid, draw a symbol like the one on page 3-XX, but with 5 connecting lines at each side; make the lines 2 units long, with 1 unit spacing
- * FILE the completed symbol



- * Plant different sizes of the symbol at various positions as shown (those at top left are at 12.5%)

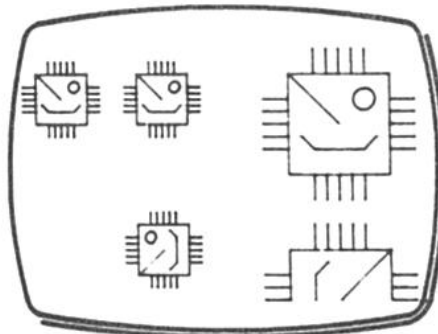


LOCKED GRIDS (continued)

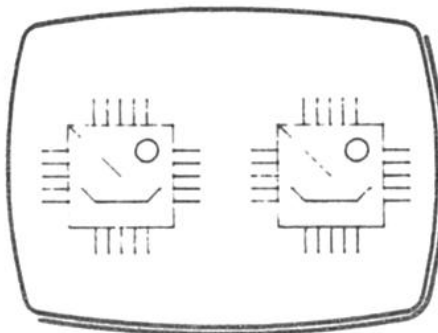
Zooming with the preset grid (continued)

Now ZOOM on the smaller symbols:

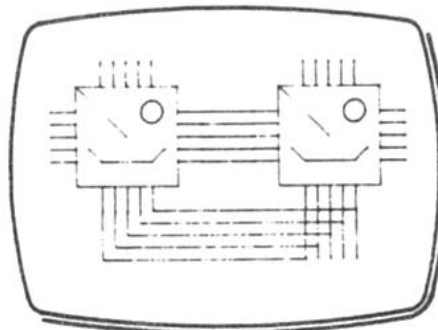
- * P/hold R, then select ZOOM
- * Try turning Ø to adjust the zoom cursor frame; just like the COPY cursor, it jumps from one size to the next (with a preset grid, the sizes available are the same for both ZOOM and COPY cursor frames)



- * Frame an area containing two or more of the smaller symbols, then P/rel RED to enlarge it
- * Some of the connecting lines will be on lock points, some won't; try ZOOM again to display a smaller grid with lock points on all the connecting lines
- * Exit ZOOM by P/rel L and R together



- * Using the grid lock points, try making connections between the symbols
- * P/hold R, then select PAGE to display the complete drawing, including the lines you just added



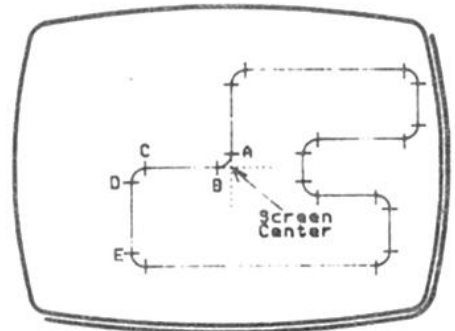
LOCKED GRIDS (continued)

Blending arcs with the locked grid

A locked grid can be used to generate precise, repeatable blending arcs and fillets. Note that the following applies to any orthogonal axis (square) grid, either preset or variable.

<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Select Menu 2, then select 8 X 8
- * P/hold R, then select TAN ARC from the palette
- * XY to position the + cursor on the lock point 1 unit to the left of the x cursor at B
- * P/rel L to re-position the x cursor, so defining the arc's direction
- * XY to position the x cursor 5 units to the left at C (notice that the 'arc' is a straight line because the lock points are perfectly aligned)
- * P/rel RED to draw the line
- * XY to position the cursor 1 unit down and 1 unit to the left at D, forming a perfect 90 degree corner radius
- * P/rel RED to draw the arc
- * Move the + cursor down 5 units to E, then P/rel RED to draw another straight line
- * Continue drawing arcs and lines to complete the shape as shown



LOCKED GRIDS (continued)

COMPASS ARC

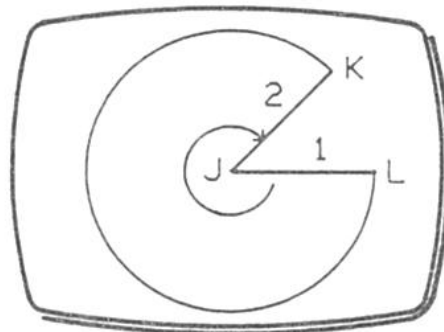
When COMPASS ARC is selected with a locked grid engaged, the 'free end' of the radius, which moves with XY, automatically attaches itself to the nearest lock point. However, once the radius has been set (P/rel L), the end of the radius marker as it steps around isn't always coincident with a lock point. Instead, the radius marker aims at the nearest point in line with the free end.

To illustrate this, try rotating a compass arc of radius 10 units on the 8 x 8 grid. You'll see that the only angles at which the free end truly coincides with the grid are 0, 90, 180 and 360 degrees.

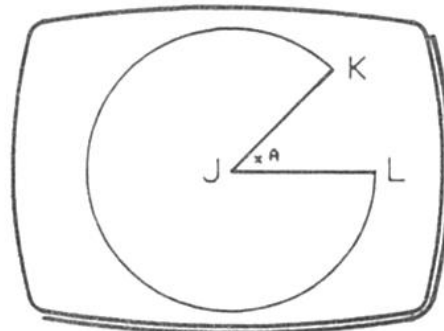
Among other things, compass arcs are used for drawing precise concentric arcs, and for demonstrating geometrical constructions such as angle bisection, etc. For practice with compass arcs, try constructing a pie chart:

<<<< DO THIS >>>>

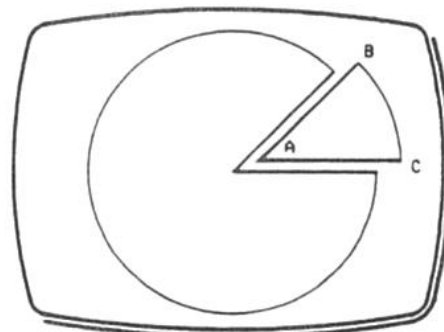
- * Clear the screen using WIPE
- * Select COMPASS ARC
- * XY to place the radius at a chosen angle and length, as (1)
- * P/rel L to fix the radius
- * XY to sweep the radius marker to (2)
- * P/rel RED to draw the arc



- * Select straight line
- * Set the 8 x 8 grid from Menu 2
- * Draw the line KJ to the center
- * From Menu 1, FIND L, then draw LJ
- * Switch off the 8 x 8 grid
- * ZOOM on the missing sector of the pie (do this for better resolution)
- * Judging by eye, plant the origin cursor at a point A, bisecting the angle



- * P/rel L to reverse the arc, then draw the arc CB
- * Select straight line
- * FIND point A, then switch on the 32 x 32 grid (with a lock point at A)
- * FIND point B, then draw BA
- * FIND point C, then draw CA
- * Switch off the grid
- * PAGE the drawing



**SCALE DRAWING
IN ENGLISH UNITS**
(FEET AND INCHES)

Robographics scale drawing system is based on metric units (millimeters, meters and kilometers). However, these units are only labels, and you can draw in English units simply by thinking of meters as feet, or meters as inches. When your drawings are plotted, they can be scaled in the conventional way, e.g. $1/16'' = 1' - 0''$.

Refer to Appendix 8, page 3-60.

SCALE DRAWING

Introduction

The SCALE function on Menu 2 allows you to set a locked grid of specific metric dimensions, and to draw on this grid using all the techniques previously described. The full base page size can be set to any value in the range 1 mm to 1000 km. It's as simple as this; set the base page to the exact overall length (e.g. 357 mm) of the subject you wish to draw, and the computer will display the nearest, larger base page that gives a convenient grid spacing.

Typically, the next step is to draw the subject outline at 1:1 scale, i.e. the subject's 'real' dimensions are transferred directly onto the screen using the grid as a measuring scale.

The ZOOM function, which is used to magnify selected areas of the drawing, automatically re-scales the screen grid, with progressively finer divisions as the degree of magnification is increased. This allows you to draw to any desired level of detail and precision. You can then use the PAGE function to display the base page, with all the detail added in true scale.

True scale is maintained when a picture unit is filed from the screen to the library, and also when COPY is used to assemble picture units into another structure, whatever its base page dimensions may be.

Skewed scale grids

You can set a SCALE grid at any angle in the same way as for a regular locked grid, i.e. set the required angle, set the scale, then switch off the ANGLE flag (page 3-14). This allows you to draw isometric projections in true scale, and to draw angled lines and arcs to exact real dimensions.

Plotting scale drawings

Robographics plotter software allows a drawing produced in the SCALE mode to be plotted on paper to any scale ratio of your choice from 1:1 up to 1:9999. You can also plot larger than life (e.g. for microcircuits) in the range 9999:1 down to 1:1.

Space layout

For an understanding of the SCALE mode's interesting possibilities, we suggest you work through a typical real life example, such as the kitchen layout described on the following pages.

SCALE DRAWING (continued)

Space layout (continued)

In this example you will do the following:

- (1) Use SCALE to draw a unit of furniture to absolute dimensions
- (2) FILE and label the furniture on the library disk
- (3) Draw a floor plan to absolute dimensions
- (4) FILE the floor plan on the library disk
- (5) COPY the floor plan onto the work page at a reduced size
- 6) Assemble the furniture onto the floor plan with various trial layouts
- 7) FILE the finished plan on the library disk

First you need to format the library (page 3-46). For this application you might use the following arrangement:

Volume = 1, Index A = 16, Index B = 16, Index C = 4

This gives you 32 compartments for your furniture and construction outlines, and 4 (larger) boxes for finished plans.

Getting started with scale drawing

There are three important points to consider before you begin any scale drawing:

- (1) Positioning the scale grid on the work page
- (2) Selecting the size of base page, i.e. choosing the base-scale grid
- (3) Positioning the drawing on the grid

(1) Positioning the scale grid

Just like any other locked grid, the scale grid comes up on the screen with one of its lock points coincident with the last position of the x cursor. For many purposes, you will want the grid to be centered, and there are two ways of doing this:

- * Clear the screen using WIPE; this is a system reset which returns the x cursor to the center of the work page.
- * If there is material on the screen you don't wish to erase, select the 8 X 8 grid from Menu ?, then XY and P/rel L to plant the x at the center of the grid. Now switch off the 8 X 8 grid.

SCALE DRAWING (continued)

(2) Selecting the size of base page

- * Center the x cursor as above
- * Select SCALE from Menu 2;
you will be asked to enter a value
- * For the furniture example which follows, enter '4' from the keyboard, then press RETURN
- * Enter M (meters), then press RETURN (you may have to use SHIFT to enter M)

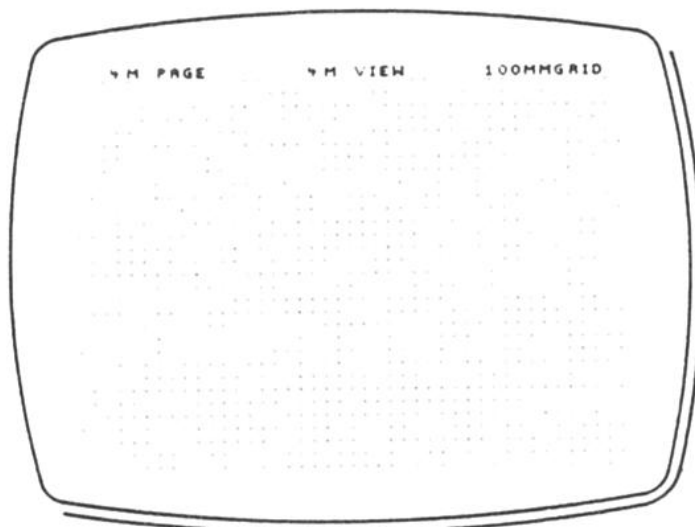
```
SET PAGE SCALE
-----
ENTER VALUE (1-999)
ENTER UNITS (MM/M/KM)
-----
PRESS (ESC)          TO CANCEL
```

A locked scale grid now appears on the work page. Dimensions of the grid are shown by the scale palette at the top of the screen:

PAGE Indicates your chosen size of base page, in millimeters (MM), meters (M), or kilometers (KM).

VIEW Indicates the size of the view displayed on the screen. This is the same as the PAGE dimension until you use ZOOM.

GRID Indicates the spacing of the grid divisions. This establishes the absolute dimensions of anything drawn on the work page, at an 'image scale' of 1:1, e.g. a bookcase 1 meter long would be drawn 10 divisions wide with your chosen 100 MM/division grid.



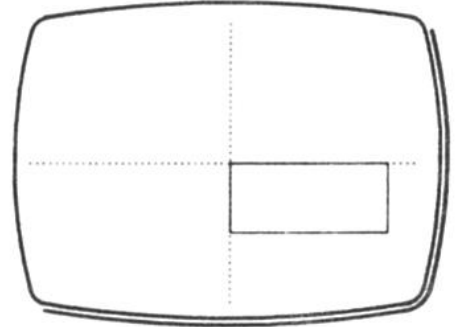
4 meter page with 100 millimeter grid

avec

SCALE DRAWING (continued)

(3) Positioning the drawing

When originating picture units of furniture, machinery, vegetation, or other items to be used in preparing a space layout, you will find it useful to position the drawing to the right of and below the work page center lines. This way, when you copy a unit from the library, the 'T' in the center of the cursor frame marks the top left corner of the unit - a most useful aid to accurate positioning.



Drawing a sink unit

This introduces the technique of dotting in construction lines, then erasing them when the drawing is completed. As an extension of this you can always FILE any outline you think you will use later, then bring it back to the screen using UTILS/LOAD FROM LIBRARY. The dimensions we chose for the sink unit are 1200 mm x 600 mm:

<<<< DO THIS >>>>

- * Starting from the center of the work page draw a rectangle 12 divisions across by 6 divisions down; each division represents 100 mm, so this rectangle is 1200 x 600 mm
- * Select DOT 1 from the palette, then outline the sink (4 x 4) and drainage (5 x 4) areas

4M 4M 100MM GRID

SINK DRAIN

- * Select ZOOM, then size and position the cursor frame to enclose only the area outlined for the sink itself; as you turn 0 to alter the frame size, the GRID value also changes, indicating the scale of the new grid (20MM) which will appear after you execute this particular ZOOM
- * P/rel RED to ZOOM, then exit ZOOM

4M 731MM 20MM GRID

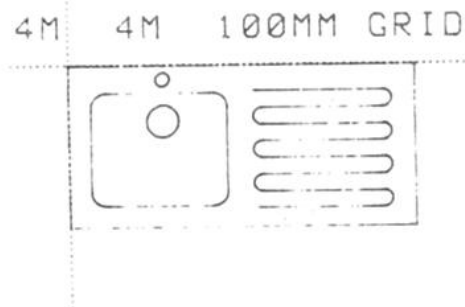
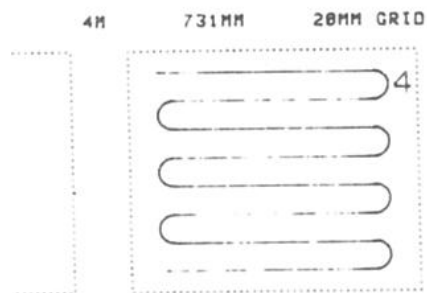
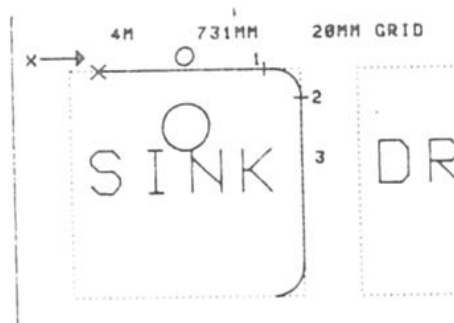
SINK

DR

SCALE DRAWING (continued)

Drawing a sink unit (continued)

- * Select continuous straight line
- * Select TAN ARC, then direct the arc to draw a straight line (1); draw the radiused corner (2), followed by straight line (3), and so on, until the sink outline is completed
- * Select CIRCLES, then draw small circles to depict the drain and faucet holes
- * Select PAN, shift the view to the drainage area (you'll need to PAN twice), then exit PAN
- * Re-select TAN ARC, then draw alternate straight and curved lines as (4) to depict the drainage area
- * When completed, select PAGE to redraw the entire unit
- * Select ERASE, then erase all construction lines
- * Select FILE, then store the complete unit in an empty library location, labeling it 1200 X 600 (you might call it 'SINK', or anything else you wish, but the unit's dimensions often turn out to be the most convenient reference)



SCALE DRAWING (continued)

Drawing a range

This is a more complex project. It introduces a two-part method of drawing precisely to chosen points between lock points of the base page scale. The two parts of the method we call ZOOM-AND-ADD (below) and SHIFT-GRID (page 3-11); these are frequently used in precision drafting, and you'll find it helpful to memorize them. For scale drawings intended to be plotted, there is an important refinement to the ZOOM-AND-ADD procedure. This is described in Appendix 7.

ZOOM-AND-ADD procedure

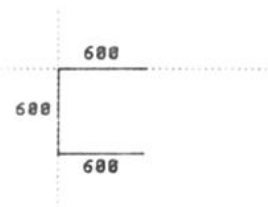
- * Select ZOOM, size and position the cursor frame in the desired location on the drawing
- * Exit ZOOM
- * Add detail to the zoomed portion of the drawing
- * If needed, select ZOOM again to add further detail, repeating the above procedure
- * Select PAGE; all detail added in the ZOOM levels appears on the base page drawing

A drawing may have a number of ZOOM levels depending on the magnification required.

For practice with 'intermediate' dimensions, we will make the range 655 wide x 600 mm deep.

<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Select SCALE, then enter 4M base page
- * Draw a line representing the left edge of the range 6 units down from the center
- * Add lines for the front and back of the unit, also 6 units long (this is as near as you can get with the 100 mm grid to the 655 mm required width)



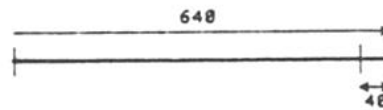
ZOOM-AND-ADD

- * Select ZOOM, then size and position the cursor frame over the right end of the upper 600 mm line, with the GRID indicating 20MM
- * P/rel RED to ZOOM, then exit ZOOM

SCALE DRAWING (continued)

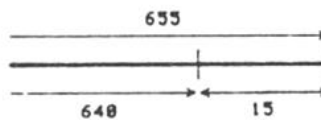
Drawing a range (continued)

- * Extend the 600 mm line by 2 units, giving a total length of 640 mm

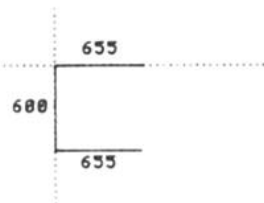


More ZOOM-AND-ADD:

- * Select ZOOM again on the end of the 640 mm line to give a 5MM grid, then exit ZOOM
- * Extend the line by 3 units, giving a total line length of 655 mm
- * Select PAGE to redisplay the figure

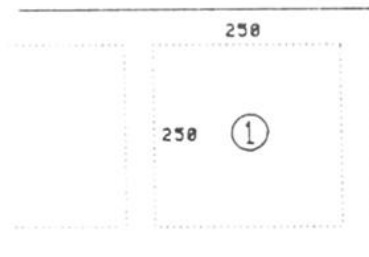


- * Repeat the above procedure to draw the bottom 655 mm line
- * Select PAGE



Now use SHIFT-GRID:

- * Select FIND, then plant the origin cursor at the right end of either 655 mm line
 - * Exit SCALE, then re-select SCALE; the 100MM grid is now shifted so that one of its lock points coincides with the 'found' origin
 - * Draw in the right edge to complete the 655 x 600 mm outline
-
- * ZOOM on the outline to give a 50MM grid enclosing the whole outline, then exit ZOOM
 - * Select DOT 1, then dot-in a 5 x 5 unit construction square (1) placed 1 unit inside the range outline in the upper right corner

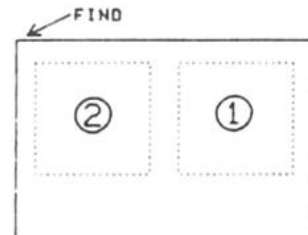


SCALE DRAWING (continued)

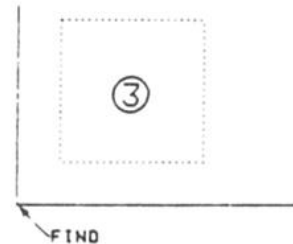
Drawing a range (continued)

More SHIFT-GRID:

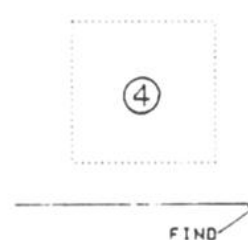
- * Select FIND and plant the origin at the left end of the 655 mm line
- * Exit SCALE, then re-select SCALE; the 50MM grid is now displayed from the 'found' origin
- * Dot-in another similar square (2) at top left



- * Select ZOOM, then enlarge the lower half of the drawn outline to give a 20MM grid
- * FIND the bottom left corner of the outline, shift the grid, then dot-in an 8 x 8 unit construction square (3) with a 4 unit clearance



- * FIND the bottom right corner of the outline, shift the grid, then dot-in a similar square (4) at right; this completes a symmetrical layout for the range's heating elements
- * FILE the completed drawing



Use the grid as a measuring scale

ZOOM and SHIFT-GRID can also be used to measure a line. To do this, plant the scale grid on one end of the line, then count the units to other end, zooming as needed for finer resolution.

SCALE DRAWING (continued)

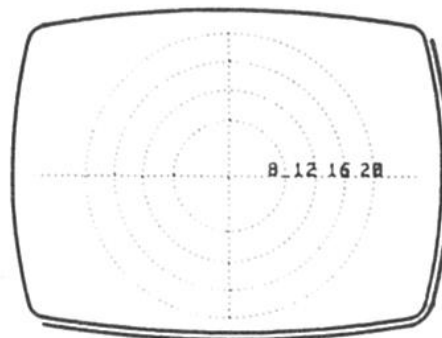
Drawing a range (continued)

Here's an interesting part: drawing spirals for the heating elements. There are many ways of doing this with Robographics, but first try the following approximate method (this is adequate for most space layout work, where detail is added only for visual cues). To illustrate the method, the spiral drawn here has three and one half turns, which is probably more than you will need in practice; you can modify it to suit your application.

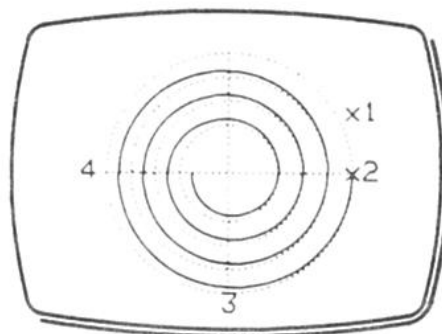
<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Set a 4 X 4 grid
- * Select DOT 1, then draw four concentric circles with radii 8, 12, 16 and 20 units
- * Also with DOT 1, add horizontal and vertical center lines

All of the above constructions will be erased later.



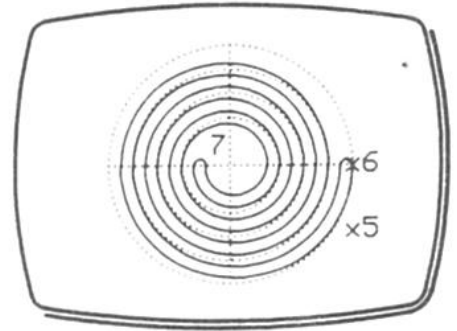
- * Select continuous white line
- * Select TAN ARC, then plant the x cursor at (1), above the horizontal, and 20 units to the right of the vertical center line
- * Replant the x cursor at (2) on the horizontal center line, 20 units from the center
- * Place the free end of the arc at (3) on the vertical center line, 19 units from the center
- * Draw the arc to (3)
- * Draw the arc to (4), 18 units from the center
- * Complete the outer track of the spiral, reducing the radius by 1 unit every 90 degrees



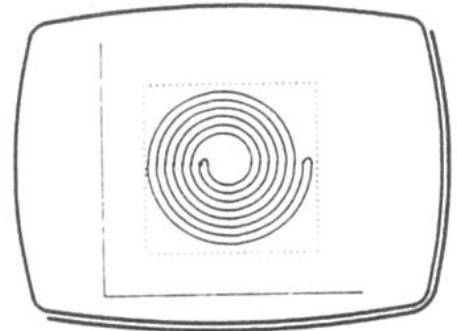
SCALE DRAWING (continued)

Drawing a range (continued)

- * Plant the x cursor at (5), exactly opposite (1)
- * Replant the x cursor at (6), on the horizontal center line
- * Draw the semicircle at (6), 2 units in diameter
- * Draw the inner track of the spiral in 90 degree increments, maintaining a 2 unit separation between the two tracks
- * Complete the outer end of the element with a semicircle, as (6)
- * Switch off the grid, then ERASE all construction lines
- * PAGE to check the drawing, then FILE



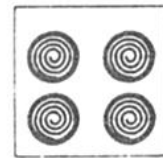
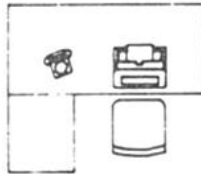
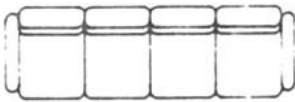
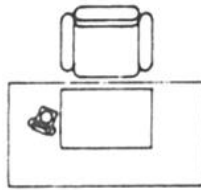
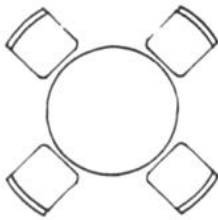
- * Using UTILS/LOAD FROM LIBRARY the outline of the range onto the work page, then ZOOM on one of the dotted square outlines
- * COPY the spiral heating element onto the square outline
- * Repeat for the other three elements
- * ERASE the dotted squares
- * FILE the completed drawing



SCALE DRAWING (continued)

Draw some more furniture

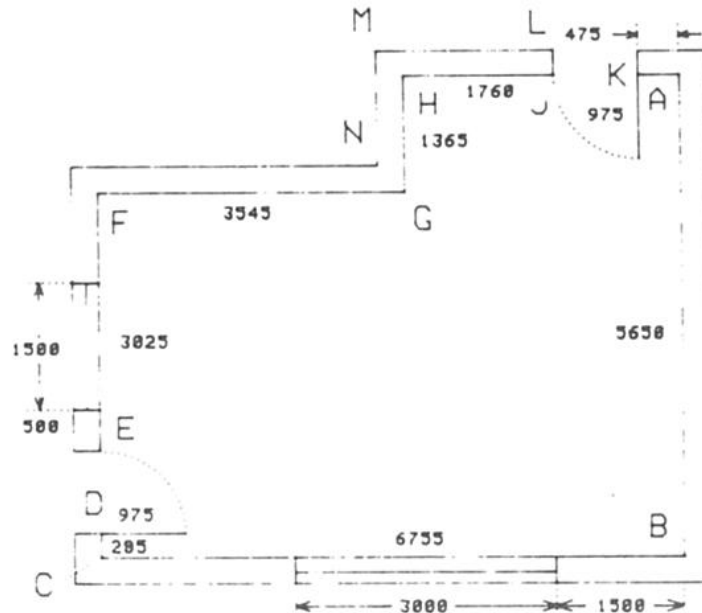
Before you move on to the practice floor plan, you will need some more furniture elements. You can copy those shown, or reproduce your own office or home furniture.



SCALE DRAWING (continued)

Drawing the floor plan

The same techniques you learned while drawing furniture units can be used for drawing accurate plans on the SCALE page. Start with a dimensioned sketch on paper such as the one shown, or a design of your own. Again, you will be using two main procedures: ZOOM-AND-ADD and SHIFT-GRID.



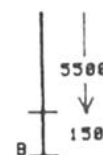
The smallest unit of measure used in this example is 5 mm. (If the application requires it, you can draw with a finer resolution (down to 0.1 mm) using repeated ZOOM-AND-ADD.) Starting at point 'A' on the plan, we first draw the inside walls:

<<<< DO THIS >>>>

- * Clear the screen using WIPE
- * Select SCALE, then enter 10M as the base page scale; this gives a 500MM grid unit
- * Draw a line 11 units, 5500 mm down from A

ZOOM-AND-ADD

- * Select ZOOM, XY to center the frame at the end of the line, then 0 to give the GRID value 50MM; P/rel RED, then exit ZOOM
- * Extend the line 3 units, 150 mm down, to B



SCALE DRAWING (continued)

Drawing the floor plan (continued)

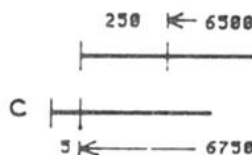
SHIFT-GRID

- * Select PAGE, then FIND
- * Plant the origin cursor (x) at the end of the line
- * Exit SCALE, then re-select SCALE; the grid is now shifted so that one of its lock points coincides with the 'found' origin
- * Draw a line 13 units, 6500 mm to the left



ZOOM-AND-ADD

- * Repeat the ZOOM-AND-ADD procedure, to 50MM grid, this time adding 5 units, 250 mm to the left
- * Repeat ZOOM-AND-ADD, to 5MM grid, adding 1 unit, 5 mm to the left, to C
- * Select PAGE to display the two completed walls of the ground plan



- * SHIFT-GRID to point C
- * ZOOM to 50MM grid; add 5 units (250 mm), up
- * ZOOM to 10MM grid; add 3 units (30 mm)
- * ZOOM to 5MM grid; add 1 unit to complete CD



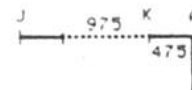
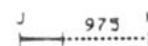
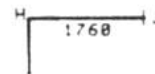
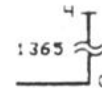
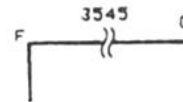
- * Select PAGE, then ZOOM to 100MM grid
- * SHIFT-GRID to point D
- * Select DOT 1, then draw a dotted line 9 units (900 mm), up
- * ZOOM to 10MM grid; add 7 units (70 mm)
- * ZOOM to 5MM grid; add 1 unit to complete the 975 mm construction DE for the door opening



SCALE DRAWING (continued)

Drawing the floor plan (continued)

- * Select PAGE, then continuous line
- * SHIFT-GRID to point E
- * Draw 6 units (3000 mm), up
- * ZOOM (twice) to 5MM grid; add 5 units (25 mm) complete the line EF
- * SHIFT-GRID to point F
- * Draw 7 units (3500 mm), right
- * ZOOM (twice) to 5MM grid; add 9 units (45 mm) to complete the line FG
- * SHIFT-GRID to point G
- * Draw 2 units (1000 mm), up
- * ZOOM to 100MM grid; add 3 units (300 mm)
- * ZOOM to 10MM grid; add 6 units (60 mm)
- * ZOOM to 5MM grid; add 1 unit to complete GH
- * SHIFT-GRID to point H
- * Draw 3 units (1500 mm), right
- * ZOOM-AND-ADD to complete the line HJ (1760 mm)
- * Select DOT 1 from the palette
- * Draw the 975 mm door opening construction JK
- * Select continuous line, then draw KA to complete the inside wall diagram
- * Select PAGE
- * Select ERASE
- * Stepping back through the drawing sequence, erase the dotted door markers
- * FILE the drawing in an empty location in a large library box



SCALE DRAWING (continued)

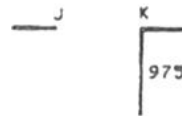
Detailing the floor plan

(1) Adding the doors

With the outline floor plan still on the work page:

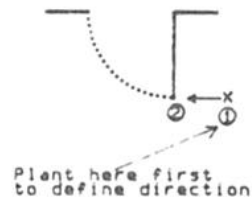
<<<< DO THIS >>>>

- * ZOOM to 100MM grid, then position the cursor frame to enclose the door opening at right
- * Exit ZOOM, then use FIND to position the x cursor at the hinge end of the door opening
- * Using ZOOM-AND-ADD, draw a continuous line 975 mm down from the hinge
- * Select PAGE, then repeat this procedure for the other door



(2) Adding the door swings

- * Select PAGE, then switch off SCALE
- * Select ZOOM, then enlarge an area to include a complete door and its opening
- * Use FIND to position the x cursor on the free end of the door
- * Set a 4 X 4 grid
- * Select DOT 1, then TAN ARC
- * Plant the + cursor a few units right of the free end of the door (1)
- * Replant the + cursor at the free end of the door (2), then draw the dotted arc representing the door swing
- * Repeat this procedure for the other door



SCALE DRAWING (continued)

Detailing the floor plan (continued)

(3) Adding wall thickness

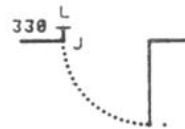
There are at least three ways of doing this, depending on the quality and accuracy desired in the finished plot:

- (1) Judge the thickness by eye, then use the orthogonal lock to ensure squareness.
- (2) Plant the points at a measured separation from the inner wall, then use FIND and SHIFT-GRID to connect the points together.
- (3) Copy pre-drawn wall sections, including cross-hatching and other details from the library.

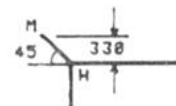
Here we use a combination of (1) and (2) which you will probably find adequate for most purposes. The wall thickness used in this example is 13 inches (330 mm).

<<<< DO THIS >>>>

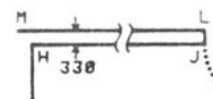
- * Select PAGE, then SHIFT-GRID to the door opening J
- * ZOOM to 100MM grid, center the frame on J, P/rel RED, then exit ZOOM
- * Draw a line 3 units (300 mm) up from J
- * With 10MM grid, ZOOM-AND-ADD 3 units (30 mm) to complete the wall thickness JL (330 mm)



- * PAGE, then SHIFT-GRID to corner H
- * ZOOM on H with 100MM grid, then draw a miter line 3 units out and 3 units up from H
- * ZOOM to 10MM grid on the free end of the miter line, then place a single point at M, 3 units out and 3 units up



- * Select PAGE, then ERASE the miter line leaving the single point M in space
- * Select FIND, then plant the x cursor at M
- * SHIFT-GRID to M
- * Select FIND, then plant the x cursor at L
- * Draw the line ML, 330 mm from the inner wall

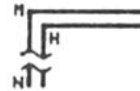


SCALE DRAWING (continued)

Detailing the floor plan (continued)

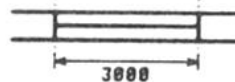
Adding wall thickness (continued)

- * Switch off SCALE, then select ORTH
- * Starting with line MN, draw in the other walls by eye, using the measured wall thickness as a gauge
- * Re-select SCALE



(4) Adding windows

- * Select PAGE, then DOT 1
- * Draw guidelines perpendicular to the wall to mark window openings (use the SCALE grid with ZOOM-AND-ADD to achieve the exact dimensions)
- * Switch off SCALE, then ZOOM to enlarge an area to include one of the window openings
- * Select continuous line, then draw in the window symbol as shown, gauging by eye
- * ERASE the construction lines



(Where a number of similar windows are required, you may wish to FILE and COPY to save time.)

- * FILE the completed floor plan

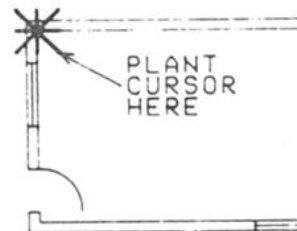
SCALE DRAWING (continued)

Adding furniture to the floor plan

All units drawn in the SCALE mode will automatically remain in true scale when copied from the library onto the work page provided that, too, has been assigned a size. This applies even though the current work page size may differ from that used originally to create the drawing. To illustrate this try setting up a new scale drawing session with a larger base page:

<<<< DO THIS >>>>

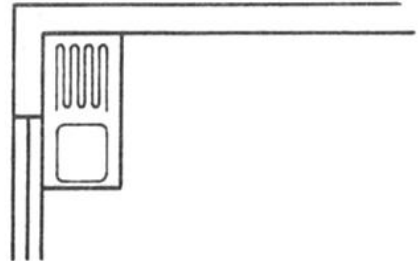
- * Clear the screen using WIPE
- * Select SCALE, then enter 20M as the base page size (twice the original)
- * COPY your completed floor plan from the library, planting it anywhere on the work page; you will see that the floor plan image is half of its original size, but its real dimensions are exactly the same, as measured against the 1M grid
- * Select ZOOM, then enlarge a portion of the floor plan
- * Exit ZOOM, then switch off SCALE
- * Decide in which corner you wish to start arranging the furniture
- * Position the + cursor in this corner, then P/rel L to plant the x cursor there
- * Switch on SCALE to display a grid coincident with your chosen corner



SCALE DRAWING (continued)

Adding furniture to the floor plan (continued)

- * Select COPY, then acquire the sink unit (Page 3-29) from the library
- * Position the unit against the wall, remembering that the top left corner of the unit is at the exact center of the cursor frame (you can rotate the frame by P/hold L and Ø)
- * P/rel RED to plant the sink unit
- * Repeat this procedure for other units of furniture



You can use MOVE anytime to reposition any of the copied furniture units. In this way you can produce any number of alternative layouts, filing them as required.

TEXT can be added as required, using any ZOOM level.

APPENDIX 1

HOW SCREEN IMAGES RELATE TO PHYSICAL DRAWINGS

When you draw a line with the Robographics system, the start and end-points of the line are remembered by the computer as coordinates, i.e. horizontal and vertical distances from the bottom left corner of the work page. The work page is potentially of enormous size, and you can access any part of it using ZOOM. However, the screen view of the work page, no matter what the zoom level, is limited to a fixed number of points, or pixels, known as the resolution of the screen. With the Apple computer the resolution is 280 across by 192 down. The Robographics system uses the right 24 columns for menus, giving a work page of 256 x 192. The screen image always appears at this resolution (which accounts for irregularities in the display), but the resolution of your drawing on the work page, as it resides in the computer's memory, is practically unlimited.

*Schematic at base page level
with screen view of transistor
symbol inset*

The screen is just a window on the work page!
Although the screen view has limited resolution, ZOOM increases the coordinate resolution allowing any level of detail to be added.

How much resolution do you need? The Robographics system allows you to draw with very high resolution, but experience will show you how far to ZOOM to produce drawings of the desired accuracy. For practical purposes, it is rarely necessary to zoom more than x20 linear magnification to produce highly detailed A0 (metric) or D-size (U.S.A.) plots.

APPENDIX 2

THE LIBRARY SYSTEM

How your drawing is stored

One of Robographics' most powerful features is its library system for data storage and retrieval.

The key to the library, both for you and the computer, is the graphic index. This gives the user a visual catalog of the library contents, and it also provides the means for the computer to identify any picture element simply by its location on the page. (Remember that to FILE a drawing on the disk, you need only position the cursor frame on the chosen index box, then press a button.)

The drawing you create on the screen is handled by the computer as a set of instructions based on coordinate points rather than as a shape, or mosaic of pixels. This set of instructions is used by the computer both to re-generate the drawing on the screen or plotter, and also to effect COPY transformations such as position, scale, rotation, etc.

When you FILE a drawing, the set of instructions relating to that drawing is identified by the computer by its location code in the library, not by its visual appearance. This code is generated automatically by the computer when the picture unit is filed. (It is not the same as the 'personal' label, such as a dimension or drawing number, which you may assign to a picture unit; the personal label appears on the index page as a visual reminder only, and has no meaning to the computer.)

The code contains three elements:

- * Index page identifier (A, B or C)
- * Box location number (1 through 64)
- * Library volume number (1 through 254)

The coding system allows the computer to recognize almost 50,000 unique, individual library locations, so long as each of the library disks is assigned a unique volume number.

Capacity of the library disk

In the Robographics system, drawings are stored in a highly compressed form. Exactly how many drawings you can store on a single disk depends on the complexity of the subject, i.e. the number of lines used. A single library disk can store approximately 12,000 straight lines of any length, and slightly less for curves and text. Although unlikely, this limit could be reached with only one or two very detailed drawings. In this case the disk would be full, but there would be many empty boxes on the index pages. Typically, however, most of the index boxes will be used before the disk is filled (provided you format the disk in an appropriate way - large boxes for large drawings, small boxes for small drawings, etc.).

APPENDIX 2 (continued)

Using library disks

As you use the Robographics system, you will very quickly build up in the library a large number of drawings, at various stages of completion, as well as other symbols, sketches, grids and blocks of text. An organized approach from the start will save you a lot of time, and also help avoid the grief of accidental erasure.

The library system can be used in the same way as the physical plan file found in the conventional design office. But more than that, the library disk is a pictorial catalog (i.e. a bill of materials) of all the component parts or stages leading to a finished drawing. A library disk can in fact be the single data source for all the information pertaining to a particular project.

Although all Robographics library disks are organized in a similar way, they fall into three distinct categories:

- * User disks, volumes 1 through 229 (for your own source material)
- * Robo disks, volumes 230 through 253 (pre-drawn source material)
- * Archive disks, volume 254 (a generic number for an unlimited category of disks used for finished work)

Formatting your own User library disks

In the Robographics system all drawings are saved on library disks. This allows you to create your own disks of source material such as symbols, frequently used components and blocks of text, custom typefaces, etc.

'Format' means the arrangement of the empty index pages on the disk. Before a standard off-the-shelf 5 1/4 inch floppy disk can be used as a library disk, it must first be formatted. This is provided for on the Systems Menu of the master software.

CAUTION!

Before starting a drawing session, make sure you have enough formatted User library disks.

APPENDIX 2 (continued)

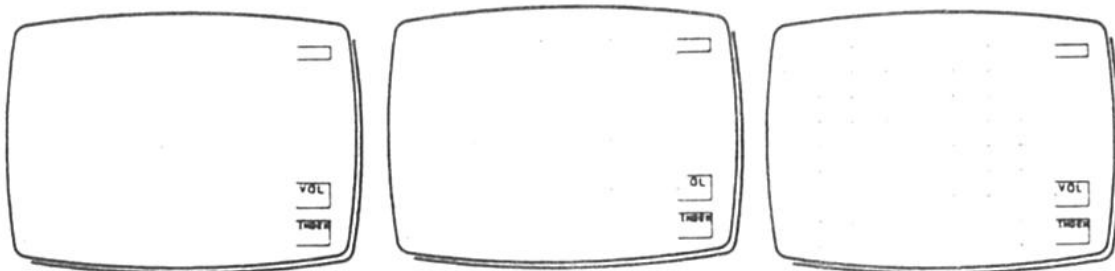
Formatting your own User library disks (continued)

<<<< DO THIS >>>>

- * Switch off the computer
- * Insert the Systems Master disk in Drive 1
- * Switch on the computer; the Systems Menu will appear
- * Select Option 2 from the keyboard; you will be asked to insert the disk to be formatted into Drive 2
- * Make sure there is no write-protect tab on the disk; insert it into the drive, then press RETURN

(Although the library-disk-co-be can be any new or used 5 1/4 inch floppy disk, new disks are preferred.)

- * You will be asked to give the disk a volume number; type in the desired number, then press RETURN
- * You will then be asked to define the number of boxes on INDEX A; type in your choice (64, 16, or 4), then press RETURN
- * Repeat for INDEX B and C
- * When the disk has been formatted, the System Menu reappears



User index page layout

Each of the three index pages, A, B and C, can be laid out to one of these formats. P/rel L or R as required to step through the page sequence.

APPENDIX 2 (continued)

Choosing the number of index boxes

You should tailor the index pages to suit your application, i.e. large boxes, 4 to the page, for large drawings, small boxes, 64 to the page, for small symbols and letters. (There is, of course, the medium size, 16 to the page, for material that falls in between. It's a good idea to have at least one 16-box page on each library disk.)

Choosing the volume number

Your numbering system for disks is very personal! Here are some factors to consider:

- * The numbers available, i.e. recognized by the computer, for User library disks range from 1 through 229.
- * There is no limit to the number of sets, each of 229 disks, so long as two volumes of the same number from different sets are not used in the one drawing session. (The computer cannot distinguish one set from another, e.g. it cannot differentiate between two picture units both coded Volume 5, Index A, Location 6.)
- * If you have an application where there's no need to catalog, or structure the stored material, you can use any numbering system you like, provided you bear in the mind the above.
- * If you know in advance the extent of your pictorial data base, you may wish to pre-allocate volume numbers for future work, e.g. Volumes 1 through 10 for electrical symbols, 11 through 20 for sub-assemblies, 21 through 25 for standard text blocks, and so on.

APPENDIX 2 (continued)

Formatting your own Archive library disks

User library disks are intended both for active source material and finished work. The Archive disk is different; it is intended mainly as a store for a completed drawing, perhaps together with related amended versions, which you wish to preserve (and possibly, plot), but will not use as part of another drawing.

All archive disks have the same volume number, 254, automatically assigned by the computer. Therefore, you should not use more than one archive disk in a single drawing session. Also, you should not attempt to combine picture units from different archive disks on the same work page.

Because archive disks are intended for completed work, the index pages can only be formatted for 4 or 16 boxes:

<<<< DO THIS >>>>

- * From the System Menu select Option 3
- * Insert new disk in Drive 2, then press RETURN
- * Choose the number of boxes, 4 or 16, for INDEX A, then press RETURN
- * Repeat for INDEX B and C
- * When the disk has been formatted, the System Menu reappears

Using the archive disk

Drawings can be filed onto an archive disk in two ways:

- (1) Direct from the screen: When the drawing is completed on the screen, replace the user library disk in Drive 1 with the archive disk, then FILE the drawing in the normal way.
- (2) From another library disk: If the completed drawing has already been filed on a user library disk, transfer it to screen using LOAD FROM LIBRARY on the UTILS menu, then proceed as (1).

For editing purposes, you can recover a drawing from the archive disk (LOAD FROM LIBRARY), amend it, then return it to the disk. You can either overwrite the old drawing, or place the amended version in a new box.

APPENDIX 2 (continued)

Using the archive disk (continued)



Archive index page layout

Each of the three index pages, A, B and C, can be laid out to one of these two formats. P/rel L or R as required to step through the page sequence.

Pre-drawn Robo library disks

Pre-drawn Robo library disks, based on commonly used standards, are available for many applications including architecture, electronics, fluid power, process engineering, business presentations, and display typesetting with various typefaces. The graphic components on Robo disks can be used as they come from the disk, or with your own modifications.

To avoid confusion with User volumes, Robo disks are assigned numbers from 230 through 253. Each disk is supplied with a user guide.

Hard copy of library index pages

You may find it helpful to make a print ('hard copy') of material stored on your library disks. The print can be filed separately, or together with the disk itself; either way you won't have to load the disk to find out what it contains. You will need a dot matrix printer with graphics dump facilities (Section 1):

<<<< DO THIS >>>>

- * Switch on the printer; set it ON-LINE; load it with paper
- * Select UTILS from Menu 1
- * Select SCREEN IMAGES - CATALOG, then P/rel L to confirm; a list of all named screen images on the library disk will appear, and you will see that the first three are library index pages A, B and C
- * P/rel L and R together to return to the UTILS list
- * Select SCREEN IMAGES - LOAD, then P/rel L to confirm
- * Type A, B or C as required, then press RETURN
- * Select SCREEN IMAGES - PRINT, then P/rel L to confirm

APPENDIX 2 (continued)

Buffer disks

Buffer disks are formatted by following directions on the start-up menu which is displayed when the System Master disk is loaded. Like other disks, it should be stored properly when not in use (don't leave it in the drive for long periods!). You should replace, or at least re-format, the buffer disk every 100 hours or so of system use.

In the Robographics system, the buffer disk is used only as an overflow memory. The buffer disk, together with Disk Drive 2, can be replaced by a 128K RAM card configured as a disk emulator. This functions much faster than a disk drive, eliminating almost completely delays in data transfer to and from the buffer.

APPENDIX 3

Constructing a line with given angle and length

This example shows how the SCALE grid can be rotated to construct lines of specific length at any chosen angle.

IMPORTANT

No Pythagoras here! Lock points on a skewed grid are the same distance apart as they are on a square grid.

<<<< DO THIS >>>>

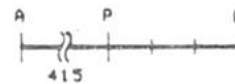
Draw a horizontal 419 mm line

- * Clear the screen using WIPE
- * Select SCALE, then enter a 1 meter (1 M) as the base page size, with 50 MM grid
- * Draw the line AP, 8 units = 400 mm long (this is the closest to the desired length possible with a 50MM grid)



ZOOM-AND-ADD

- * Select ZOOM, XY to center the frame on P, then 0 to give a 5MM grid; exit ZOOM
- * Plant the x cursor at P, then draw PQ, 3 units = 15 mm long
- * ZOOM-AND ADD again, this time adding 4 units = 4 mm to complete the line AB
- * Select PAGE to display the complete line AB (400 + 15 + 4 = 419 mm long)



FIND and SHIFT-GRID

- * Select FIND, then P/rel RED to plant the origin at B
- * Switch off SCALE to cancel the grid
- * Set the Y coarse angle (P/hold L and 0) to $\angle 63$ degrees
- * Switch on the coarse ANGLE flag
- * Select SCALE; a skewed grid with one of its lock points coincident with B now appears



ANGLE
/ 63 ° DEGREES

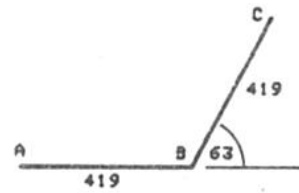
CAUTION

The cursor is now trapped in one of the two 'grooves' set by the angle lock; it is not locked to the scale grid.

APPENDIX 3 (continued)

Draw a joining line at an angle

- * Switch off ANGLE to return the cursor to the locked-grid condition
- * Now construct the 419 mm line BC, using the same ZOOM-AND-ADD procedure as before



Summarizing Use ZOOM-AND ADD to draw a line precisely to length; use FIND and ANGLE lock together to draw at any angle through any point.

APPENDIX 4

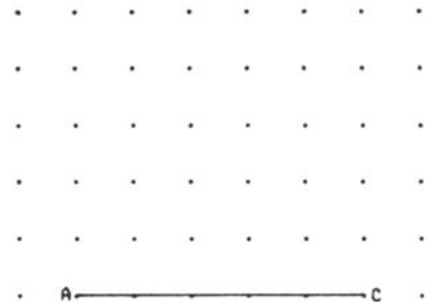
Drawing to points defined by intersections

In traditional drafting practice, intersections of lines are often used as datum points for the development of drawings. Similar techniques can be applied with Robographics.

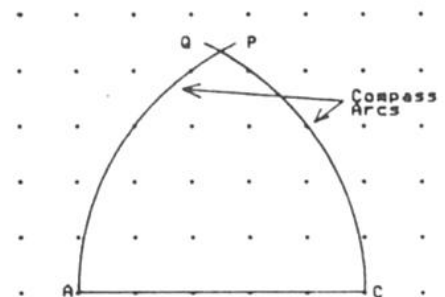
The following illustrates the basic idea using the standard geometrical construction for an equilateral triangle:

<<<< DO THIS >>>>

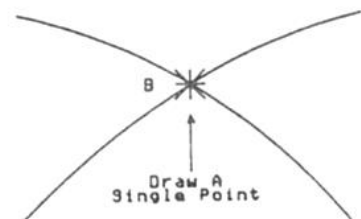
- * Clear the screen using WIPE
- * Set a 32 X 32 grid by switching on the GRID flag
- * Draw the baseline AC 5 units long (an odd number is used to show how the grid can be replanted using FIND)



- * Select COMPASS ARC; make the radius of the arc coincident with AC (P/rel L), then XY to describe the arc CQ, and P/rel RED to confirm
- * Re-select straight line, then plant the origin at A
- * Re-select COMPASS ARC, then draw the arc AP



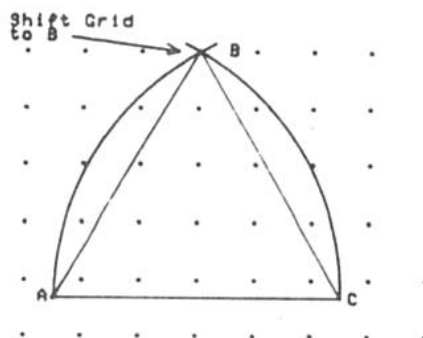
- * Re-select straight line, then switch off the GRID flag
- * Select ZOOM, then enlarge the intersection of the two arcs as far as you can go in one step (this means shrinking the ZOOM cursor frame to about 1/4 inch wide on the screen)
- * Exit ZOOM, then position the + cursor at the intersection of the arcs
- * P/rel L to plant the x cursor there; then, without moving XY, P/rel RED to draw a single point at the intersection (you can't see it on the screen, but watch for the change in the memory count at bottom right)



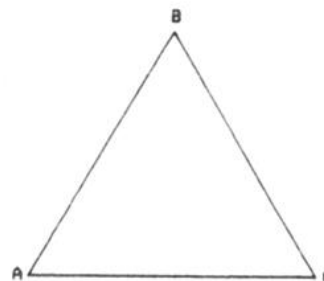
APPENDIX 4 (continued)

Drawing to points defined by intersections (continued)

- * Select PAGE to re-display the whole drawing
- * Select FIND, mark (P/rel R) the single point you drew at the origin, then P/rel RED to fix the x cursor there
- * Switch on the GRID flag
- * Re-select FIND, then plant the x cursor at A
- * Position the + cursor at the arc intersection (now a lock point), then draw line AB
- * Re-select FIND, then repeat for line BC
- * Switch off the GRID flag



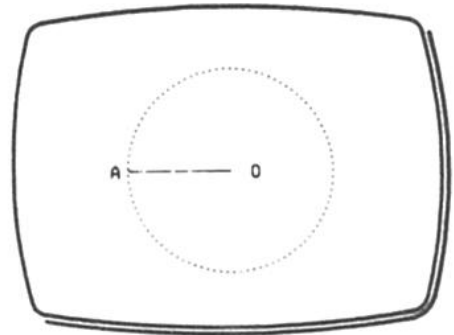
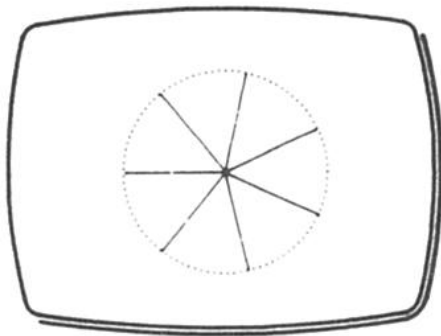
- * ERASE the two arcs
- * ERASE the intersect point to eliminate this from the plotting process



APPENDIX 5

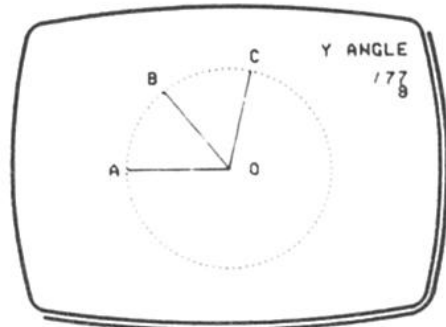
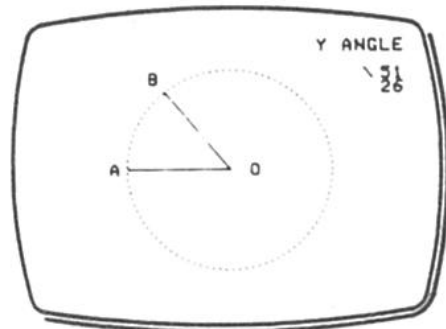
Radial lines

Many two-dimensional drawings (wheel spokes, pipe flanges, etc.) are based on a structure of radial lines having a specific angle between them. This example draws a construction outline with 7 equally spaced radials, which can be filed in the library, and then used as often as you wish. The angle between the radials is $360/7$ degrees, which approximates to 51 degrees, 26 minutes.



<<<< DO THIS >>>>

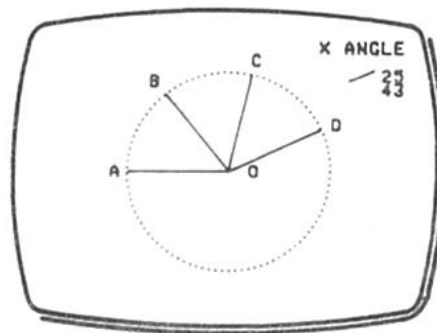
- * Clear the screen using WIPE
- * Select the 8 X 8 grid (this is used to center the construction)
- * Draw a circle of radius 10 units, centered on the grid
- * Draw the radial OA
- * Switch off the GRID flag
- * Set the Y vernier angle to $\setminus 51$ degrees 26 minutes, then switch on the ANGLE flag
- * Draw the radial OB, then switch off ANGLE
- * Select FIND, then locate the center
- * Set the Y vernier angle to $\setminus 77$ degrees, 8 minutes, then switch on the ANGLE flag
- * Draw the radial OC, then switch off ANGLE



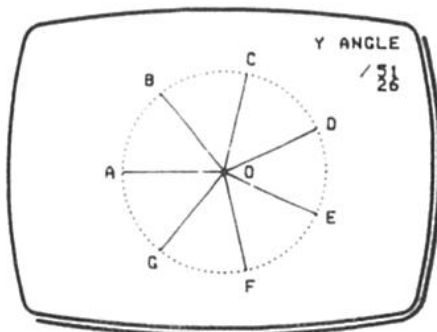
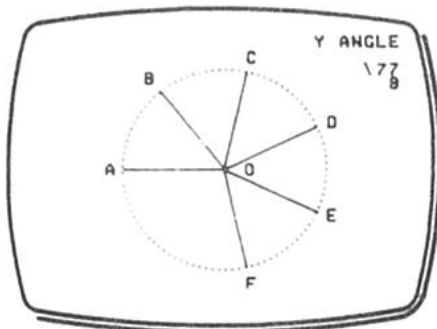
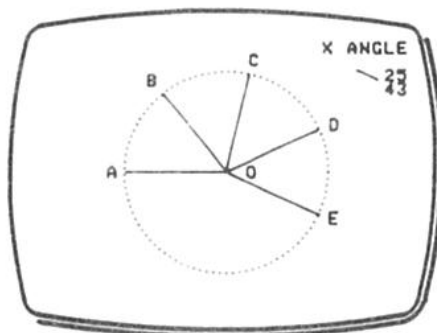
APPENDIX 5 (continued)

Radial lines (continued)

- * Select FIND, then locate the center
- * Set the X vernier angle to $\angle 25$ degrees 42 minutes, then switch on the ANGLE flag
- * Draw the radial OD, then switch off ANGLE



- * Repeat for OE, OF and OG (use X vernier for OE, and Y vernier for OF, OG)
- * ERASE the circle if you wish
- * FILE the drawing in the library



The same basic technique can be used to produce radial constructions with any required angular spacing.

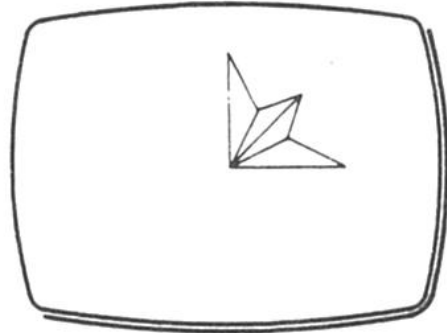
APPENDIX 6

Symmetry

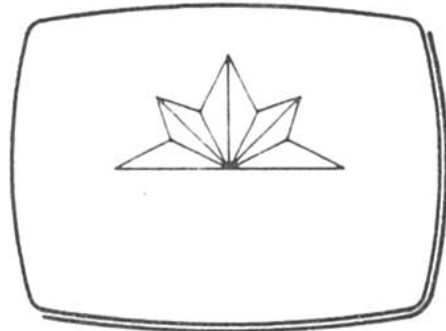
Symmetrical structures can be drawn very quickly by reproducing a single cell in different orientations.

<<<< DO THIS >>>>

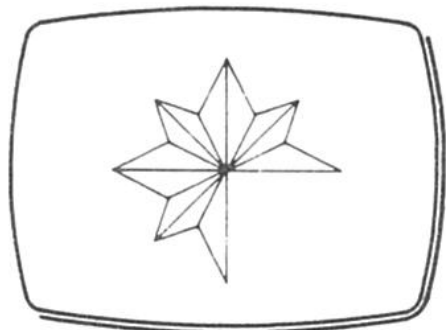
- * Clear the screen using WIPE
- * Select the 8 X 8 grid
- * Draw the figure shown
- * FILE the figure in the library



- * COPY the figure from the library
- * Before planting the figure, P/hold R, then select X FLIP
- * XY to center the cursor frame, then P/rel RED to fill the top left quadrant
(Why X FLIP? This transforms the X coordinates of the original figure into negative numbers, while leaving the Y coordinates as they were.)



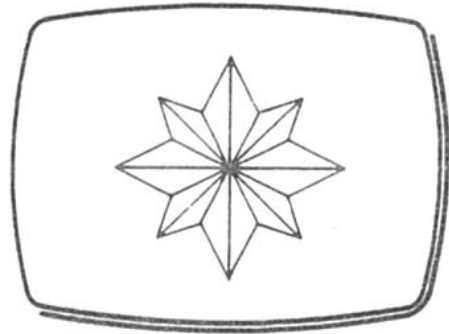
- * P/hold R, then select Y FLIP (leave on the X FLIP)
- * XY to center the cursor frame, then P/rel RED to fill the bottom left quadrant



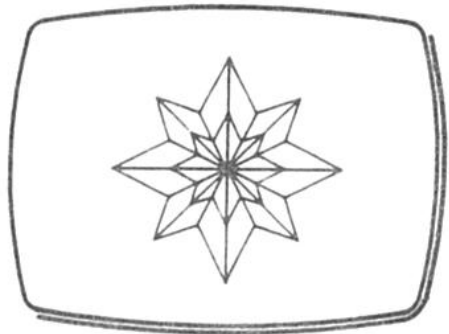
APPENDIX 6 (continued)

Symmetry (continued)

- * P/hold R, then switch off X FLIP, leaving on Y FLIP
- * XY to center the cursor frame, then P/rel RED to complete the symmetrical figure



- * FILE the complete shape
- * COPY the complete shape, then plant it center screen at various scales
- * Try painting the drawing, if you wish



APPENDIX 7

ZOOM-AND-ADD refinements

A drafting plotter used with the Robographics system reproduces not only the shapes and dimensions of your drawing; it also follows the exact sequence by which the drawing was created. This means that a line you have extended by small ZOOM-AND-ADD increments will be plotted in a series of small steps, a procedure which is time consuming and can lead to cumulative error. There's an easy solution to this:

- * Use dotted line for the entire ZOOM-AND-ADD line development, from the start right through to the last, smallest segment
- * FIND and set a grid at the end of the last segment added
- * PAGE and FIND the start of the line
- * DRAW the complete line in one movement
- * ERASE the dotted construction lines

APPENDIX 8

PLOTTING CAD-1 DRAWINGS

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INTRODUCTION TO PLOTTING

Drawings generated in the CAD-1 system can be converted into hard copy, i.e. ink on paper, using either a dot matrix printer or a precision drafting plotter. The two methods have nothing in common. A dot matrix copy is simply a one-shot 'dump' of whatever is on the screen when the PRINT utility is selected from the CAD-1 menu. Unfortunately, display effects such as jagged lines appear also in the printed image. A plotted drawing is quite different. It is generated, line by line, from the list of instructions compiled by the computer when you created and filed the drawing. Plotted drawings appear line-perfect, showing none of the irregularities caused by limited display resolution.

Drafting plotters emulate hand drawing. They draw smooth, straight lines and curves in a variety of colors and weights, using many different types of pens and drafting media (paper, vellum, polyester film). Today's plotters usually have a single pen carriage which traverses the paper along a fixed track from left to right - the X axis. Movement along the Y axis is achieved by driving the paper, not the pen. Many plotters have magazines which allow the active pen to be changed automatically as the plot proceeds. However, by plotting each color in sequence, and changing the pen manually, the same result can be achieved with a single pen plotter (page 1-4). This takes a little longer, but costs less!

To drive a drafting plotter from your Apple computer, you need an RS232 interface card and cable (page 1-12). You also need special Robographics software to link the CAD-1 system to your choice of plotter. Like the system master software, the plotter software is supplied on a single floppy disk. When you've completed a drawing session with CAD-1, you load this disk to 'tell' the Apple that it is now to act as a plotter driver instead of a drawing generator.

Using a drafting plotter with CAD-1

The outline on the following pages applies to all plotters for which Robographics software is available. For information specific to your plotter and interface card (e.g. baud switch settings), refer to the operating instructions supplied with the hardware, or consult your local dealer.

Which plotter?

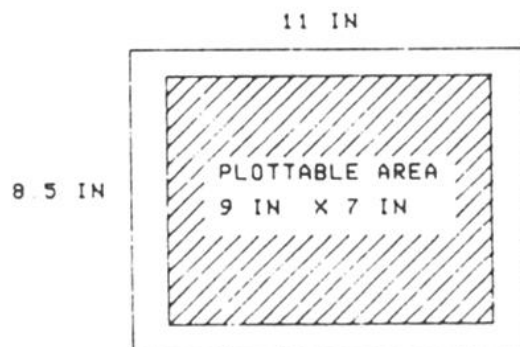
Two plotters are available from Robographics (page 1-12). These plotters come complete with all hardware interfacing and dedicated software. Additionally, Robographics software is available (July 1983) for the plotters listed on the following page. Software is being developed for other plotters. Please ask.

Which plotter? (continued)

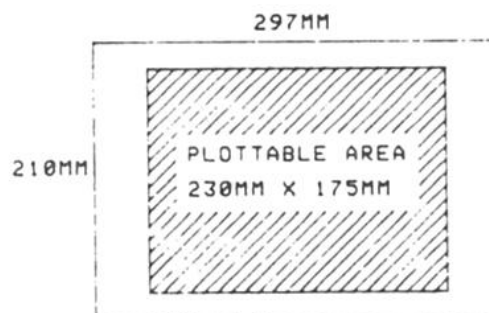
Bausch & Lomb (Houston Instrument) All DMP models
Calcomp Models 81, 84
Gould Bryans Colorwriter
Hewlett-Packard Models 7470A, 7580A/B, 7585A
Watanabe Digiplot All B or A3 sizes

How large can the plot be?

The size of the plot has to do with mechanical limitations of the plotter itself, not the relationship of plotted lines to real-life dimensions (this is covered in the next section). Most plotters cannot draw over the entire surface of the paper. For example, the active plottable area of most A size (American) or A4 (European) plotters is approximately 9 x 7 inches (230 x 175 mm). Check the operating instructions for the active area available with your plotter.



American (ANSI) A-size sheet



Metric (ISO) A4 sheet

Robographics software limits the active area to slightly less than the absolute area defined by the plotter's mechanics. This ensures that everything within the screen's active area of 256 x 192 pixels (page 3-7) is reproducible by the plotter.

The aspect ratio (length to height) of the plottable area with CAD-1 is always 4:3, regardless of plotter type. This equates to the screen's 256:192 pixels.

Plotting in English or metric scale

Robographics CAD-1 software in the scale mode is based on the metric system, the units of measure being millimeters (mm), meters (m), or kilometers (km). However, these units are really only labels. They have no physical meaning until the drawing is plotted. It's at this time you want the size of the drawing to relate in a specific way to the drawn object's 'real' dimensions. For instance, one millimeter on the drawing could represent an actual dimension of one millimeter, a scale of 1:1. Or it could represent 25 mm (1:25), 1/20 mm (1:0.05), 3 m (1:3000), or any other plot scale you choose.

There's virtually no limit to the choice of plot scale. The plot can be either smaller or larger than real-life by any amount you wish. Because of this, it's just as simple to plot in English units as it is in metric. This is the procedure:

- (1) When you draw in the scale mode with CAD-1, think of meters ('M') on the screen grid as feet or inches, whichever is appropriate for the object to be drawn.
- (2) When you plot the drawing, modify the nominal English scale (e.g. 1/8":1'-0" = 1:96) by a conversion factor for either meters to feet or meters to inches, whichever was the notional unit used for the drawing. Here are two illustrations:

For M read feet

Nominal scale 1:96
Meters to feet conversion 3.281
Modified plot scale 1:(96 x 3.281) = 1:314.96

For M read inches

Nominal scale 1:10
Meters to inches conversion 39.372
Modified plot scale 1:(10 x 39.372) = 1:393.72

It's as simple as that! Often you won't even have to do the conversions yourself. Plot scales commonly used by architects and engineers are listed on page 3-74.

With CAD-1 you can't have both feet and inches on the one drawing. It's one or the other. Also, you can only draw in decimal, not fractional quantities. The range of measurement is one million feet (almost 190 miles!), or one million inches, with a resolution of 0.00001 inches.

PLOTTER SOFTWARE DISKS

Two copies of the plotter software are provided. One is intended for immediate use and the other is a back-up. The back-up copy should be stored carefully in a clean, dry environment clear of strong magnetic fields and other hazards.

PLOTTER SOFTWARE DISKS (continued)

It is not possible to copy the plotter software using the disk duplication utilities on the Apple DOS System Master. If a copy is accidentally damaged, return it to Robographics for replacement at a nominal charge.

LOADING THE PLOTTER SOFTWARE

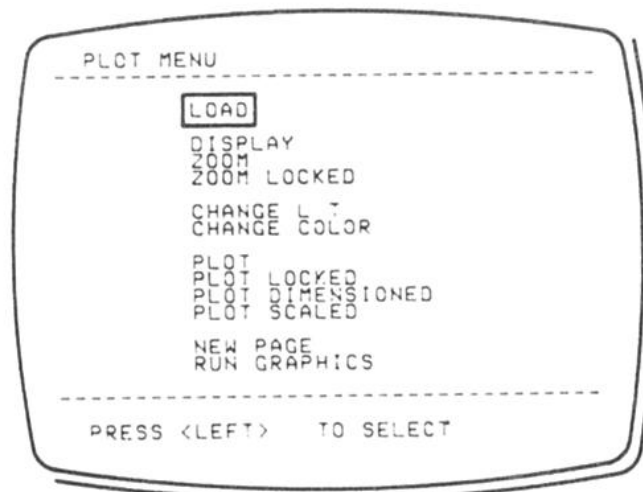
If you're in a drawing session with CAD-1 and wish to move on to plotting, you should first FILE the current drawing. Then you can select PLOT from the UTILS menu and follow the screen prompts.

The other way of loading the plotter software is to switch off the computer, then remove the library disk from drive 1. Insert the plotter software disk in drive 1, then switch on the computer again. (Always pause for a few seconds between switching off and on.) Follow the screen prompts as before.

The buffer disk you are asked to insert in Drive 2 is the one that's already there if you've just been drawing with CAD-1.

The library or archive disk you are asked to insert in Drive 1 is the one that holds the picture units you wish to plot.

Software loading is completed when the PLOT MENU is displayed.



The plot menu

Use XY on the Robographics controller to move the selector up and down the menu. Position the selector over the desired option, then P/rel L. 'LOAD' here means loading a selected picture unit from the library disk into the main memory of the computer.

PLOT MENU SELECTIONS

LOAD

This is similar to the COPY function. When the selector flag is moved to LOAD with XY, and confirmed with P/rel L, one of the three library index pages is displayed. If the picture unit you wish to plot is on another page, P/rel L or R as required.

The picture unit itself is selected with the cursor frame, which is moved by XY in the usual way. When the selection is confirmed by P/rel RED, the picture unit is loaded into the computer memory and the plot menu is re-displayed.

DISPLAY

When selected (XY and P/rel L), this function displays the chosen picture unit at base scale, i.e. its size as originally drawn.

You can terminate the display process anytime by pressing the space bar on the keyboard.

If you find you've chosen the wrong picture, select another one with LOAD.

Exit from DISPLAY to the plot menu by P/rel L and R together.

ZOOM

When ZOOM is selected, the chosen picture unit is displayed (at base scale) together with a zoom cursor frame. This can be positioned by XY and adjusted in size by rotating 0, allowing you to select any detail of the picture unit to be plotted at full page size. P/rel RED to confirm the desired zoom view.

You can terminate the display process anytime by pressing the space bar on the keyboard.

To replay the picture unit at base scale, select DISPLAY.

Exit from ZOOM to the plot menu by P/rel L and R together.

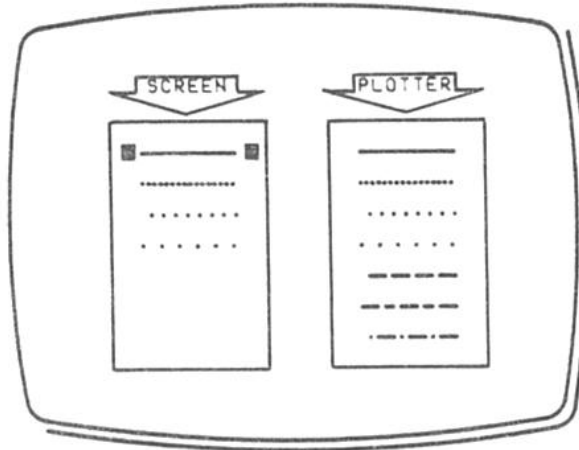
ZOOM LOCKED

This is similar to the regular ZOOM function, except that it provides a choice of three preset magnifications: x 64, x 16 and x 4. This is useful for assembling on one plot several details at the same magnification.

PLOT MENU SELECTIONS (continued)

CHANGE L.T. (LINE TYPE)

Robographics provides a choice of four line types for drawing. If you don't do anything to change it, the plotter will reproduce those line types exactly as you drew them. However, the plotter software provides seven types of plotted line, any of which can be assigned to the four kinds of line on the screen. To do this, select CHANGE L.T. from the plot menu.



CHANGE L.T. display

The left column represents the four types of line as drawn on the screen. The seven types line available on the plotter are shown at right.

To change a line-type assignment, use XY and P/rel L to select one of the four lines from the left column. The right column then becomes active, and you can choose any of the seven lines with the cursors. Now P/rel L to confirm the chosen type of plotter line as the substitute for the screen line at left.

Repeat the procedure to change other line assignments if you wish.

Exit from CHANGE L.T. to the plot menu by P/rel L and R together.

CHANGE COLOR

Multi pen plotters

If your plotter has six pens or more (e.g. Hewlett-Packard Model 7580), the six screen colors used for line drawing with Robographics will usually be assigned automatically as follows:

<u>Color</u>	<u>Pen No.</u>	<u>Color</u>	<u>Pen No.</u>	<u>Color</u>	<u>Pen No.</u>
GREEN	1	WHITE	3	RED	5
MAGENTA	2	BLACK	4	BLUE	6

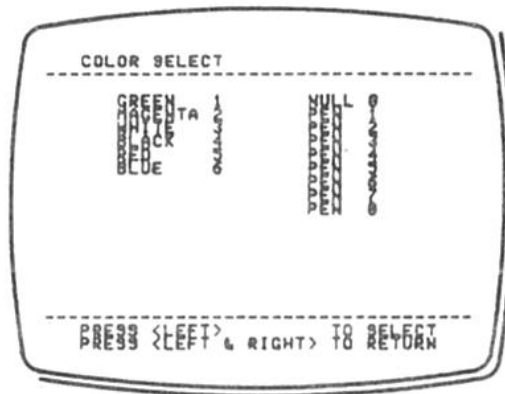
PLOT MENU SELECTIONS (continued)

CHANGE COLOR (continued)

This assignment of colors to pens is the default state, and that's how your drawing will be plotted unless you do something to change it. Note that BLACK lines, although you can't see them on the screen, are handled like any other color.

Changing color/pen assignments

To change the assignment of line color to pen number, select CHANGE COLOR from the plot menu. This displays the COLOR SELECT page which lists the default state for your plotter.



Default color assignments for an eight pen plotter

Select the a color from the left column with XY, then P/rel L to confirm. The right column then becomes active, allowing you to select a pen number with XY. When you P/rel L to confirm, the default state is modified by your new pen assignment.

Repeat the procedure to change other screen color to pen assignments if you wish.

Null is the 'no plot' option. If you assign '0' to a color, that color will be skipped in the plotting sequence, i.e. the plotter simply ignores it, and moves onto the next color without delay.

Loading the pen magazine

It's up to you what pens you actually load into the numbered magazine slots. You don't have to put a green pen in slot 1. For instance, you might want white lines on the screen to be plotted in 0.3 mm black, and blue lines to be plotted in black also, but in a heavier weight (e.g. 0.7 mm) for contrast. You can also select an alternative style of pen (fiber tip, roller ball, etc.). The ability to choose which

PLOT MENU SELECTIONS (continued)

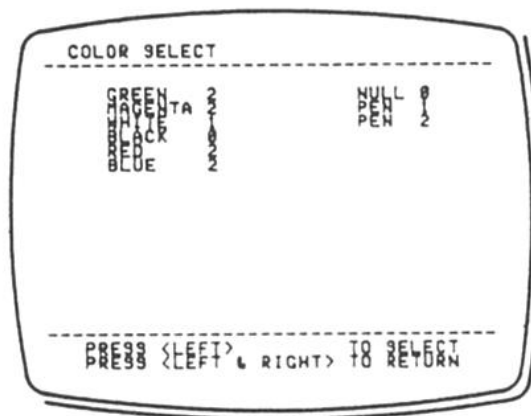
CHANGE COLOR (continued)

pen goes where, coupled with the system's ability to reassign line color to pen number in software, gives you great flexibility in configuring the plotter. So much so that an organized approach is essential!

A convention often adopted is to put a standard-weight black pen in slot 3, corresponding to the screen color WHITE in the default state.

Two pen plotters

In the default state for a two pen plotter (e.g. Hewlett-Packard Model 7470), WHITE lines on the screen are plotted by pen 1, and all colors other than BLACK by pen 2 (BLACK is assigned '0', and is ignored).



Default color assignments for a two pen plotter

Single pen plotters

In the default state for a single pen plotter, only WHITE lines are plotted. All others are assigned '0', and are ignored.

Multi-color plots with single and two pen plotters

Easy! A multi-color (or multi-weight) plot is built up from several passes of the one drawing, changing the pen at each pass. With a single pen unit the procedure is first to plot the default color, WHITE, then to choose a second line color by changing its assignment from '0' to '1'. Change the pen and then, without altering the registration of the paper in the plotter, make the second pass. Repeat the procedure as needed for completion.

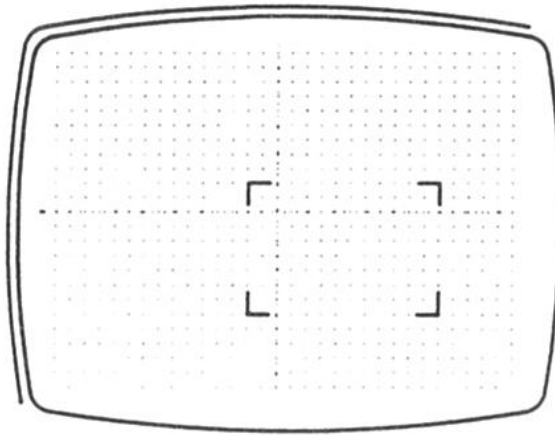
With a two pen plotter be careful to assign pen 2 to only one screen color (in the default state pen 2 plots all colors other than BLACK and WHITE).

PLOT MENU SELECTIONS (continued)

PLOT

Remember to load paper and switch on the plotter!

The PLOT function initiates the plotting process. It also allows you to define, before plotting, the size and position of the drawing within the plotter's active area. Here, drawing means either (1) the base scale version of your selected picture unit as it came from the library, or (2) the magnified portion you selected with ZOOM.



Plot map with plot cursor

The cursor frame carries, invisibly, the drawing to be plotted. Position it with XY, and size it with 0.

When PLOT is selected, a grid map of the plotter's active area is displayed together with a cursor frame representing the entire active area of the screen as it appeared in the DISPLAY mode or ZOOM mode (page 3-65).

With the cursor frame at the desired location and size, initiate the plot by P/rel RED. When the plot is completed, the cursor frame - now inactive - is redisplayed on the plot map. This helps in compiling multi-part plots. Clear the plot map by selecting NEW PAGE.

Terminate the plot anytime by pressing the space bar.

Halt the plot temporarily by P/hold R.

Exit the PLOT function, before you initiate the plot, by P/rel L and R together.

PLOT MENU SELECTIONS (continued)

PLOT LOCKED

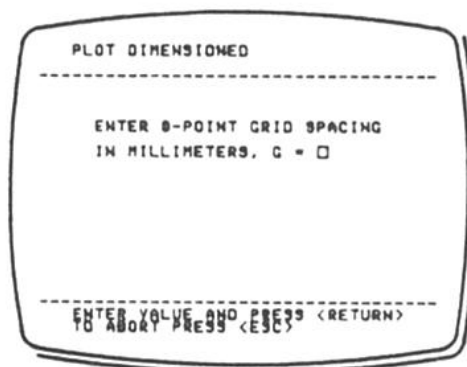
Remember to load paper and switch on the plotter!

PLOT LOCKED is similar to PLOT (page 3-69) except that the plot cursor is limited to four fixed sizes in relation to the plotter's active area. These sizes are 1/64, 1/16, 1/4 and 1/1.

PLOT DIMENSIONED

Remember to load paper and switch on the plotter!

This function allows you to set a specific numerical relationship between dimensions of the plot, in millimeters, and the screen display, as measured in pixels.



PLOT DIMENSIONED display

You are asked to assign a plot dimension to the screen measure of 8 points (i.e. 8 pixels)

As prompted by the screen, type in the dimension you wish to equate to 8 pixels on your drawing, as displayed in either the DISPLAY mode or ZOOM mode (page 3-65). The dimension doesn't have to be whole number of millimeters; you can make it as precise as your application requires, e.g. 3.245 mm. This gives you complete control over your finished artwork dimensions, allowing you to size book illustrations, for example, without the time and expense of photostatting.

Why 8 pixels? Because that's the X axis spacing of both Robographics preset grids (page 3-16). The full screen width is 32 times the 8 pixel dimension. When you've typed in the grid dimension, position the plot cursor as required on the plot map, then initiate the plot by P/rel RED.

If you've chosen a number that would make the 256 pixel dimension wider than the plottable area, the plot cursor will be locked in the center of the plot map, and some of your drawing may be 'clipped', i.e. rejected by the plotter, if it comes too close to the full page boundary.

PLOT MENU SELECTIONS (continued)

PLOT DIMENSIONED (continued)

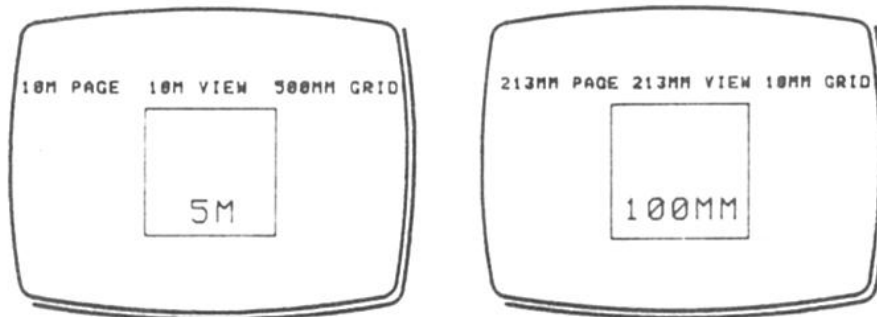
Terminate the plot anytime by pressing the space bar.

Halt the plot temporarily by P/hold R.

Exit the PLOT DIMENSIONED function, before you enter the dimension, by pressing the ESC key. You can also exit before before you P/rel RED to initiate the plot, by P/rel L and R together.

PLOT SCALED

This plot function is valid only if the picture unit loaded from the library was drawn in the SCALE mode (page 3-25). For practice with scale plotting, load the Robographics System Master (page 2-2), select SCALE from Menu 2, then draw the two squares shown below.



Trial figures for scale plotting

Using these two figures you can experiment with several kinds of scale plot. Before filing, add the text labels '5M' and '100MM' for reference.

Macro scale

Now load the plotter software (page 3-64), load the 5 meter square you drew earlier, then select PLOT SCALED from the menu.



PLOT SCALED display

PLOT MENU SELECTIONS (continued)

PLOT SCALED (continued)

The macro scale referred to on the display is the overall width of the base page, which turns out to be slightly larger (by 0.67 meters) than the 10 meter page scale you entered to draw the 5 meter square. This is because the active area of the screen extends beyond the 10 meter grid, as will always occur unless the chosen page scale happens to divide neatly into the screen's 256 pixels.

It is the macro scale, not the page scale, that the computer regards as full page width. If you choose a plot scale that would make the macro area larger than the plottable area, the plot cursor will be locked in the center of the plot map, and some of your drawing may be 'clipped', i.e. rejected by the plotter, if it comes too close to the full page boundary.

Trial plot - metric

Remember to load paper and switch on the plotter!

Enter the plot scale 1:100, position the plot cursor as required on the plot map, then initiate the plot by P/rel RED. The plotter should draw a square with 50 mm sides. Now load the 100 mm square from the library, and plot this at 1:1 scale. The plotted square should measure 100 mm.

Terminate the plot anytime by pressing the space bar.

Halt the plot temporarily by P/hold R.

Exit the PLOT SCALED function, before you enter the plot scale, by pressing the ESC key. You can also exit before you P/rel RED to initiate the plot, by pressing P/rel L and R together).

Trial plot - English

Remember to load paper and switch on the plotter!

Refer to page 3-63. Load the 5 meter square from the library. Then, using the 'M read feet' rule, plot the square at the scale 1:314.96. This is equivalent to 1/8":1'-0", a nominal scale of 1:96, so the square should measure 5/8 ins. You might try the plot again at 1:52.5, a nominal scale of 1:16, to give a 3 3/4 in square.

For practice with the 'M read inches' rule, try the plot at 1:39.372, a nominal scale of 1:1, to give a 5 in square.

Terminate the plot anytime by pressing the space bar.

Halt the plot temporarily by P/hold R.

PLOT MENU SELECTIONS (continued)

PLOT SCALED (continued)

Trial plot - English (continued)

Exit the PLØT SCALED function, before you enter the plot scale, by pressing the ESC key. You can also exit before you P/rel RED to initiate the plot, by pressing P/rel L and R together.

NEW PAGE

This function clears the plot map of the markers representing previous plots.

RUN GRAPHICS

This is the exit plot function, which prompts you to remove the library disk from Drive 1, and insert the Robographics System Master.

ENGLISH PLOT SCALES

M read feet		M read inches	
Nominal scale	Plot scale	Nominal scale	Plot scale
1/32":1'-0"	1260	1:100	3937.2
3/64":1'-0"	839.9	1:50	1968.6
1/16":1'-0"	630	1:20	787.44
3/32":1'-0"	420	1:10	393.72
1/8":1'-0"	314.96	1:5	196.86
1/4":1'-0"	157.5	1:2	78.744
3/8":1'-0"	105	1:1	39.372
1/2":1'-0"	78.74	2:1	19.686
3/4":1'-0"	52.5	5:1	7.8744
1":1'-0"	39.37	10:1	3.9372
2":1'-0"	19.69		
3":1'-0"	13.12		
4":1'-0"	9.843		
6":1'-0"	6.562		

STANDARD PAGE SIZES

American (ANSI)			Metric (ISO)		
	inches	mm		mm	inches
A	8.5 x 11	216 x 280	A6	105 x 148	4.1 x 5.8
B	11 x 17	280 x 432	A5	148 x 210	5.8 x 8.3
C	17 x 22	432 x 559	A4	210 x 297	8.3 x 11.7
D	22 x 34	559 x 864	A3	297 x 420	11.7 x 16.5
E	34 x 44	864 x 1118	A2	420 x 594	16.5 x 23.4
			A1	594 x 841	23.4 x 33.1
			A0	841 x 1189	33.1 x 46.8