University of Edinburgh

Department of Computer Science

The Edwin User's Guide

(Fifth Edition)

by

J. Gordon-Hughes

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James Clerk Maxwell Building,
The King's Buildings,
Mayfield Road,
Edinburgh,
EH9 3JZ.

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THE

EDWIN

USER'S GUIDE

(Fifth Edition)

PRE-PUBLICATION

EDWIN is a set of graphics programs developed in the Edinburgh University Computer Science Department. This document describes how the procedures provided by EDWIN may be used to produce two dimensional line drawings.

The subsequent editions of this guide reflect changes made to EDWIN as a result of user feedback. This edition of the user's guide refers to version 5 of EDWIN.

J. Gordon Hughes

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CONTENTS

A historical and logical overview of EDWIN

'EDWIN' is a graphics package consisting of set of procedures which provide basic facilities for producing two dimensional line drawings. The major design aims when writing EDWIN were :

a) The package should be portable;
b) The package should be small;
c) The package should be independent of the graphics terminal being used.

Before EDWIN was written there existed a number of local graphics packages, mostly based on a Tektronix package called the MacPherson Package [1]. These packages had been implemented on a wide range of machines, but in each case by a different porson, who added new procedures and consequently more incompatibilities. The importance of the first design aim is that a user should have an identical interface on each machine, and this has been achieved in EDWIN. At the time of the first release of EDWIN the following machines were required to support it:

a) DEC PDP-15 (18 bit machines) [2]
b) Interdata series 70 (16 bit machines) [3]
c) ICL system 4-75 (32 bit machines) [4,5]
d) ICL 2900 (32 bit machines) [6]

All of these systems were running the operating systems described in the references mentioned above. During the first year of use EDWIN was also implemented on a VAX-11/780 running the VMS operating system [7]. It has since been implemented on Perkin-Elmer models 7/32 and 3220 under MOUSES [8], and the PDP-11 series of computers under RSX-11/M. More recently it has been moved to a number of systems based on the Motorola 68000 and National Semiconductor 16032 microprocessors.

All of the above mentioned systems support the Imp language [9,10], and for this reason the Imp language was used to write EDWIN. Users of other languages can access the EDWIN library on most machines. Although all the above machines have different word lengths this does not pose a problem as EDWIN does not assume that it has a larger word length than 16 bits. Users can however make use of any 'world space' which the machine will allow, with the knowledge that if they use one greater than ± 32 K, then their programs are no longer portable. In practice the PDP11 implementation is now the only one which has a word length smaller than 32 bits, so this warning is no longer as significant as it was in the mid-late seventies!

Another machine-dependent feature is the length of name which is significant when matching external procedures. Of the original systems, EMAS on the ICL system 4 processors has the lowest limit (8 characters) and all the procedure names were chosen to be distinct in eight characters. On the DECsystem-10 and PDP-11s running RSX-11/M, external names are only matched to six characters. The Imp include statement is used to declare the EDWIN procedures with the system provided file of procedure specs, and these names have been made distinct by the Imp alias mechanism.

The second design aim was to make EDWIN small. This requirement arose because on the PDP-15 there was a limit of 8K words on the size of an Imp program, and on the Interdata 70's and PDP-11's this limit is 64K bytes. There is no significant limit on the 32 bit machines. One of the things which had made previous packages non-standard was the addition of 'frills' on the larger machines. The philosophy taken by EDWIN is to allow the user to make full use of the graphics capabilities of the devices that are being driven, but not to provide facilities which users can easily provide themselves (such as the provision of menus).

The reason for the third design aim is that in the past, local graphics packages have been written for specific devices, and a new set of procedures had to be written for each new device which became available, frequently having the same facilities, but with incompatible procedures. A superior approach is used in GINO [11] and suggested by the ACM in their SIGGraph proposals [12], to have device specific code localised, forming a 'device driver', which is interfaced to the machine and device independent 'core' of the graphics package. The following diagram shows how EDWIN may be thought of in relation to a user's program -

```
                                                                   ______________
                                                                  |              |
                                                                  |   Charles    |
                                                             ---->|   Driver     |
                                                            |     |______________|
                                                            |      ______________
  _______________                ___________________        |     |              |
 |               |              |                   |-----        |  Tektronix   |
 |   U S E R     |---------->|  |                   |             |   Driver     |
 |               | procedure |  |                   |----------->|______________|
 | P R O G R A M |  calls    |  |   E  D  W  I  N   |              ______________
 |               |---------->|  |                   |----------->|              |
 |               |---------->|  |                   |             |   Plotter    |
 |_______________|              |___________________|-----        |   Driver     |
                                                            |     |______________|
 (User shielded from                                        |
  specific device                                            ---->    to other
  idiosyncrasies)                                                  device drivers
```

On the large virtual machines all the device drivers can be included in the version of EDWIN with little overhead, but on the smaller machines the version of EDWIN is normally pruned to include only a small number of device drivers. Device drivers now in existance include

- Tektronix 4000 series storage tubes [13,14,15,16]
- Various Video terminals [17,18,19]
- 'CHARLES', Datatype, Sigma, Westward and Gigi raster displays [20, 21, 22
- Hewlett Packard 2648 terminal [23]
- Hewlett Packard flat bed plotters [24, 25, 26]
- Printronix printers [27]

The facilities provided by EDWIN have been developed from ideas in the existing MacPherson package, with the use of names and other ideas from the ACM SIGGRAPH proposals. Because of the requirement to run EDWIN on the local mini-computers it was not possible to provide the ACM's segmented data structure, although this would have been desirable. EDWIN has provided a low level graphics package which is machine and device independent. If the user wishes to disregard the device independence, virtual coordinate space, ability to produce software characters, and checking of parameters, it would be possible to use the EDWIN device drivers as a 0th level graphics package, or they could be used as drivers for a more complex graphics system. EDWIN has been used in research projects (eg. the ESDL suite [28] and a systems relating to integrated Circuit design [29]), and in undergraduate teaching and projects.

The rest of this guide describes:

i) The user facilities -

Drawing pictures with EDWIN is a matter of writing a program which incorporates the procedure calls which are descibed in this section.

ii) The device drivers -

This section describes the device specific features of the devices which EDWIN can be used to draw pictures on. It should be noted that users should very rarely require to call the device drivers directly as the purpose of EDWIN is to provide a user with a device independant interface.

iii) Some useful utilities -

This section describes a set of geometric drawing routines, and a transformation stack which users may find useful. Utilities for drawing and analysing stored picture descriptions are also described.

iv) Appendices which cover -

The EDWIN error messages
The standard procedures provided
The EDWIN character set
A selection of example programs
A definition of the stored picture format
Acknowledgements and references

Users Guide to the EDWIN procedures

A) Initialisation and Termination routines:

routine INITIALISE FOR (integer DEVICE TYPE)

This is normally always the first EDWIN routine to be called. It initialises EDWIN and selects the device driver to be used. If EDWIN is being used on a system such as VMS or EMAS then the receipt of any asynchronous messages is disabled at this point, and the previous state is restored when the procedure TERMINATE EDWIN (described below) is called. If the device driver selected is not available or if an unidentified device is specified, EDWIN signals error 0 (see appendix A).

The following DEVICE TYPES are valid :-

0	: The 'null' device
52	: DEC VT52 terminals
100	: DEC VT100 terminals
120	: Soroc IQ 120 terminals
200	: Visual 200 terminals
300	: Printronix printers
550	: Perkin Elmer 550 terminal (Bantam)
69 ('E'), 101 ('e')	: Hazeltine Esprit terminal
67 ('C'), 99 ('c')	: CHARLES workstations
70 ('F'), 102 ('f')	: APM Level 1 graphics (Fred's)
73 ('I'), 105 ('i')	: APM Level 2 graphics (Igor's)
71 ('G'), 103 ('g')	: GIGI terminals
16_BBC	: BBC Micro
564, 565, 663, 963	: E.R.C.C. Calcomp plotters
1015, 2015	: Westward monochrome terminals
2014	: Westward colour terminal
2648	: Hewlett Packard terminal
4002, 4010, 4012, 4014	: Tektronix storage tubes
7221, 7220, 7475	: A4/A3 Hewlett Packard plotters
7580, 7585, 7586	: Larger Hewlett Packard plotters
5688, 5982	: Sigma 5688 controller with 5982 display

Further details of these device drivers may be found in the sections following the description of the EDWIN procedures.

integer function DEFAULT DEVICE

On most systems there is an obvious default device which should be used when running a graphics program. Examples of this are where a plotter is connected to a specific terminal line, so that if the user is using that line then the default is likely to be the plotter. On microprocessor workstations the default is to drive that type of workstation. Details of how to set up the default device are given in the section describing the implementation details for each system. On most systems the users can force the result of DEFAULT DEVICE to a user specifed state. If there is no specific graphics device associated with the terminal line, then the terminal model number is used (eg. 52, 100, 550 etc), and if the terminal type is unknown to the system, then the result of the function is zero (the null device).

routine TERMINATE EDWIN

This must always be the last EDWIN routine to be called. It ensures that any pending output is forced out, and the device is left in its normal state.

Examples of what is meant by 'normal' are -

a) Tektronix terminals are set to alpha-numeric mode
b) Roll plotters have all the paper used moved past the pen
c) The HP plotter pen is put away

B) Primitive output routines :

The following routines may be used to generate line drawings. The parameters refer to virtual coordinates (ie. any number in the range -32K to +32K). If storing of the picture is enabled, the procedure calls are noted and the picture may be redrawn by utilities described later. In all cases the vectors are clipped to the current WINDOW setting, and projected to the current VIEWPORT. This is described in more detail in section C. Lines are drawn at the current line style and colour settings if the device has them available. Changing these is described in section D.

routine MOVE ABS (integer X,Y)

This routine moves the current position to the point (X,Y).

routine MOVE REL (integer DX,DY)

This changes the current position (say (CX,CY)) to the point (CX+DX, CY+DY). If the specified point lies outside the current window, then the current screen position remains unaltered.

routine LINE ABS (integer X,Y)

This routine causes a line to be drawn from the current position to the point (X,Y), updating the current position to the point (X,Y).

routine LINE REL (integer DX,DY)

This routine draws a line to (CX+DX, CY+DY), where (CX,CY) is the current position, and updates the current position appropriately.

routine MARKER ABS (integer N,X,Y)
routine MARKER REL (integer N,X,Y)

These routines provide a set of symbols which can be drawn after an implicit call on MOVE ABS or MOVE REL, depending on which routine is used. At present eleven are available; N identifies which symbol is to be drawn

0	Point	(.)
1	Octagon	(O)
2	Square	([])
3	Triangle	(A)
4	Transformation point	(X)
5	Flag point	(one with six)
6	Visual Centroid	(+)
7	Right pointing arrow	
8	Left pointing arrow	
9	Upward pointing arrow	
10	Downward pointing arrow	

The following routines may be used to output text on graphics terminals. The character drawing instructions are recorded if the picture is being stored. Although on some terminals (eg. Tektronix, Cursor Addressable terminals and the HP 2648 terminal) users can mix output produced by the standard I/O routines with output from EDWIN, this practice is not encouraged as problems can arise in the synchronisation of the two outputs. If this must be done the routine UPDATE can be used to ensure that any pending graphics output is forced out.

By default the characters are drawn in a 12 (X) by 20 (Y) box in virtual coordinates. EDWIN supports two types of character. The first of these are 'hardware' characters, which are generated by the device, and are usually of fixed size and orientation. The second type, 'software' characters, may be scaled and rotated by routines described later. Software characters are generated as sequences of lines and moves by EDWIN. There are two types of software character generators. The first of these is a line definition of characters 32 to 127 which may scaled, but rotated only in multiples of 90 degrees, the second type are the Hershey fonts, which are used by the GIMMS package. This provides the user with over 30 fonts, which can be drawn at any size and rotation. Note that if they are drawn at very large sizes, it is possible to see the individual lines which make up the characters.: The routine SET CHAR QUALITY (page 12) selects the mode in which text is to be drawn.

<u>routine</u> CHARACTER (<u>integer</u> CH)

This causes the character CH to be drawn at the current position and the current position is advanced by the character width.

<u>routine</u> TEXT (<u>string</u> (255) ST)

This routine causes sequence of characters making up ST to be output.

Users should note that Imp systems provide procedures for converting integers and reals to strings in various formats. The procedures ItoS, RtoS and FtoS (which mimic the Imp procedures Write, Print and PrintFl) can be used in conjunction with the procedure TEXT for displaying numbers.

C) Control Routines :

The following routines may be used to control the drawing of the picture.

routine NEWFRAME

This causes a blank surface to be found for the graphics output to be displayed on. In the case of interactive displays this results in the screen being cleared, in the case of roll plotters the paper is fed to the start of a new plot and in the case of plotters with no paper feed, the user is asked to insert a new sheet of paper. The fact that a new frame has been taken is recorded if the picture is being stored.

routine UPDATE

This routine causes any output buffers to be flushed, so that after a call of UPDATE the picture is guaranteed to be up to date. The routine needs to be used if graphics output is to be mixed with other output to the same device. In the case of a interactive terminals, UPDATE results in the terminal being left in alpha-numeric mode.

routine STORE ON (integer STREAM)

This causes calls of drawing routines to be recorded on output stream STREAM. This representation of the picture, often called the Pseudo Display File or PDF, can then be re-read, or used as input to other EDWIN utility programs described later. The storing of the picture does not alter the currently selected output stream.

routine STORE OFF

This disables the recording of graphics instructions, and is the default.

routine VIEW ON (integer STREAM)

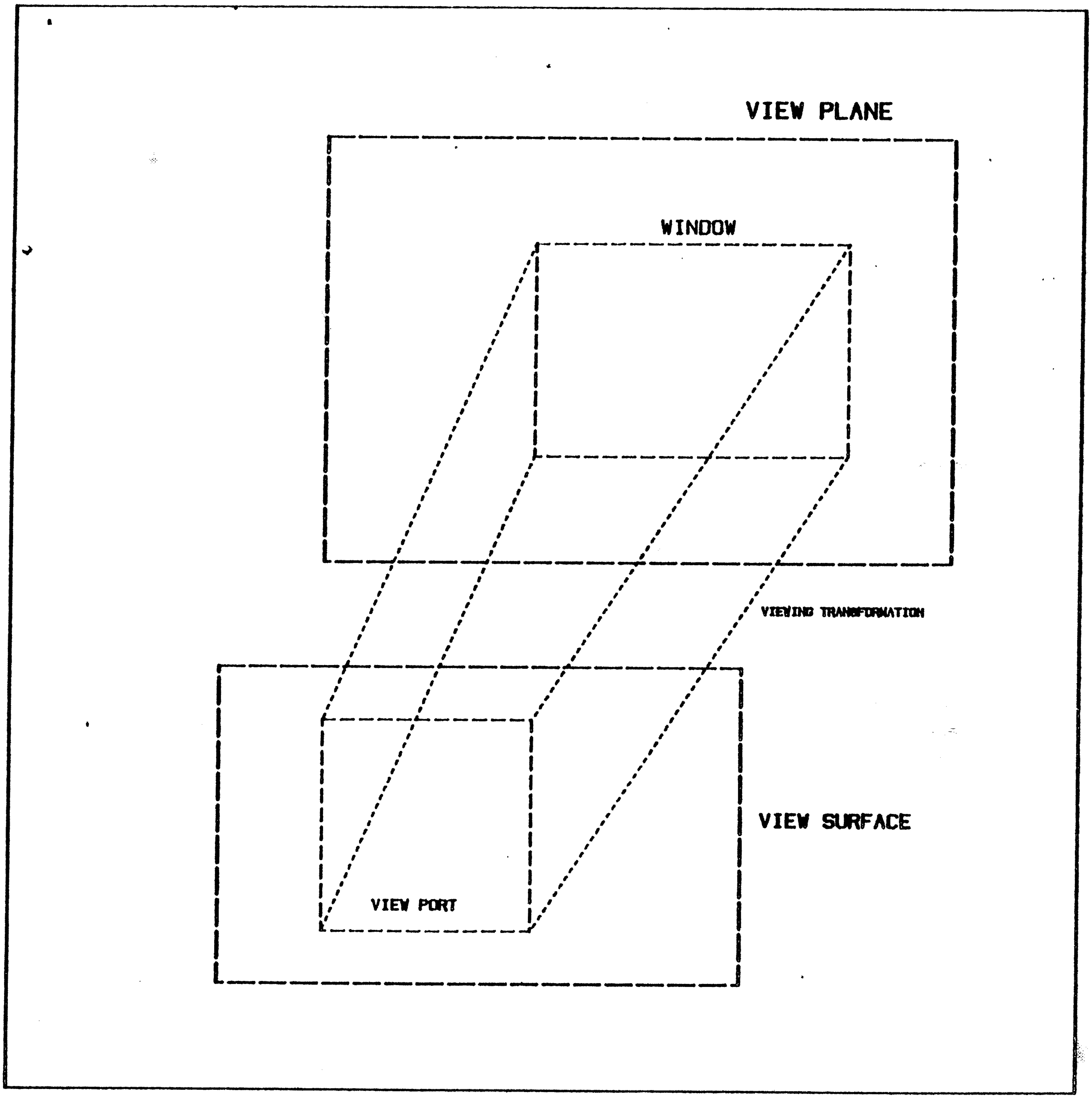
This causes the graphics output to go to the stream specified. By default this is stream number one if the device is not a terminal, and stream zero for terminals. For terminals the graphics output usually reaches the terminal through a different mechanism than the standard I/O routines and trying to view on another stream will have no effect. The default is for viewing to be enabled.

routine VIEW OFF

This disables viewing. Calling any of the routines described in section B will have no visible effect, but the routine calls will be stored if storing is enabled.

<u>routine</u> WINDOW (<u>integer</u> XL, XR, YB, YT)

The picture is built up in a coordinate system which is known as the VIRTUAL SPACE (sometimes called the "WORLD SPACE"). Within this space there is an area known as a WINDOW, and this area is mapped to the user-selected area of the graphics device called the VIEWPORT (see below). The routine WINDOW defines the size of the window in the virtual space. The parameters are the lower and upper X value, and the lower and upper Y values respectively, the default values being (0, 1023, 0, 1023). If a lower window bound exceeds or equals the upper window bound EDWIN signals error 12. The limits of the virtual space are dependent on the machine, but the virtual space must not exceed ± 32K square if the user program and PDF are to be portable. In any particular implementation the maximum size of the virtual space is equal to the largest integer which the machine can hold. The following diagram shows the arrangement for windowing -



<u>routine</u> VIEWPORT (<u>integer</u> XL, XR, YB, YT)

The picture is drawn within an area in the output device's coordinate space which is known as the VIEWPORT. This routine may be used to alter the size of the viewport (the parameters have the same significance as for the routine WINDOW) and they have default values which are device dependent but have been chosen so that if the viewport is unaltered an 'average' size of picture results. For graphics terminals this is the complete screen, and for plotters the default viewport is typically an A4 or A3 area. The descriptions of the individual device drivers give details of the possible and default settings of the viewport.

The package automatically maps the currently specified window onto the current viewport and clips the drawing appropriately.

If the coordinates of the viewport are set greater than the maximum viewport possible on the device, then the largest viewport settings possible are used. If the upper X or Y bound is greater than or equal to the corresponding lower bound then EDWIN error 13 is signaled.

<u>routine</u> ASPECT RATIOING (<u>integer</u> STATE)

If the parameter is 0 then the automatic adjustment of window bounds to keep the picture with the correct aspect ratio is suppressed. A value of 1 (the default) for the parameter causes the window bounds to be enlarged to maintain the correct aspect ratio for the picture. When the routine ASPECT RATIOING or VIEWPORT is called the current window is altered to reflect the current aspect ratio.

When aspect ratioing is enabled; if a square is drawn in the virtual co-ordinate space then a square will be seen on the screen. If aspect ratioing is disabled and if the terminal does not have a aspect ratio of unity then the square which has been drawn in the virtual co-ordinate space will appear as a rectangle on the screen. When aspect ratioing is enabled, EDWIN checks the aspect ratio that a picture will have on the screen, and extends the window in either the X or Y direction to give correct aspect ratio on the screen.

D) Routines for changing Attribute settings :

The following routines are used to set values of attributes, which remain set until they are changed again. Any parameter given outside the specified parameter range causes the default to be used. The information about the attribute change is recorded if the picture is being stored. If the device being used cannot support the attribute change then it is ignored, but the attribute change is still recorded if storing was enabled.

routine SET COLOUR (integer COLOUR)

This allows the colour being used for drawing to be changed. For most devices colour changes are carried out automatically, but on some plotters (eg. the Calcomp 564) this must be done manually by stopping plotting, removing the current pen, and inserting in the new one. It is consequently good practice to draw all the output required in one colour before changing the pen. The following parameters are valid -

1 = Black (default)
2 = Blue
3 = Green
4 = Red
5 = Purple
6 = Orange
7 = Lime Green
8 = Brown

The drivers for a number of devices allow users to specify colours in a larger range. In the case of the Hewlett-Packard plotters the user is asked to replace the pen in a given slot by one of the appropriate colour.

routine SET COLOUR MODE (integer MODE)

In the case of raster displays, this instructs the device how subsequent drawing should interact with the existing picture. In the case of displays which are have no colour or are hard-copy, this procedure is ignored. The following modes are defined, although users should only use Overwrite and Or modes if they wish to ensure that their programs are portable. Consider the case where there is a solid blue box on the screen, and the colour has been changed to red. If a box of the same size is drawn while in 'overwrite mode', then the result is a red box. If the box had been drawn in 'or mode', the result is a purple box.

0 = Overwrite mode : Colour replaces existing colour. (def.)
1 = And mode : Colours is 'and'ed to give new colour
2 = Or mode : Colour is 'or'ed to give new colour.
3 = Invert mode : Colour is inverted with existing colours

routine SET SPEED (integer SPEED)

This can be used to set the speed on a plotter. If the current device is not a plotter, or the plotter cannot change speed then the call is ignored. If the SPEED parameter is zero, then the default speed is chosen.

routine SET LINE STYLE (integer STYLE)

This routine allows the user to make use of the different line styles which are available on the Tektronix 4014, Sigma, Gigi, Westard, and plotters. The driver for Cursor Addressable Terminals uses this routine to choose the symbol which is used to generate lines on the terminal, (see the section on the Cursor Addressable Terminal driver).

The following parameters are significant -

0 = Normal Lines (default)
1 = Dotted lines
2 = Chain Lines (if the hardware permits)
3 = Short Dashed lines
4 = Long dashed lines

routine SET CHAR SIZE (integer SIZE)

This routine may be used to change the size of the characters to be drawn by CHARACTER and TEXT. The size should be a positive integer, representing the size of the character in the X direction. The default size is 12 units wide (which corresponds to 20 units high). If hardware characters are being used then the nearest size of character available is used, but in most cases only size 12 is available. In general nothing about low quality text should be relied on when moving programs to run on other devices. Details of hardware characters available on devices can be found by referring to the sections describing the device drivers. If software characters are used then any size is possible, but choosing factors or multiples of 12 avoids rounding errors in text strings which may otherwise arise.

routine SET CHAR ROT (integer DEGREES)

DEGREES specifies that subsequent characters are to have an anti-clockwise rotation applied to them. If it is not possible to draw the characters at the specified angle, then the nearest angle available is used. The default value for DEGREES is 0.

routine SET CHAR QUALITY (integer QUALITY)

If QUALITY=0 (the default) then hardware characters (that is characters which are generated by the device hardware, or by local device driving software) are used, otherwise software characters set is used. Hardware characters are frequently provided in only a small number of sizes, and with limited or no rotation possible.

routine SET CHAR FONT (integer FONT)

If the device being used has alternative character fonts, then this sets the character font which is used for subsequent hardware characters. If this is used when software characters are selected then this selects which of the available fonts is to be used. EDWIN error 6 is signalled if an attempt is made to draw in a software font which is not defined.

routine SET CHAR SLANT (integer DEGREES)

If the character set which is currently being used can have a slant specifed, this routine can be used to set it. Currently the only two devices which this applies to is the Calcomp and Hewlett Packard plotters. In the case of the HP plotters, DEGREES may be any number in the range -90 to 90, but the Calcomp plotters have only one alternate slant angle which is 15 degrees forward.

routine SET SHADE MODE (integer MODE)

If Procedures such as RECTANGLE, POLYGON, CIRCLE, BOX and WIRE which are decribed in a later section, the user has the option of whether the shapes are shaded or not. If mode is zero then only the outline of the shape is drawn, otherwise it will be shaded (if the device has the hardware ability to do it!). The default is that shading is disabled.

routine SET CHORD STEP (integer NUM)

If the EDWIN procedures ARC, CIRCLE or SECTOR are used, this allows the user to select the step size (in degrees) of the chord which is used when drawing them. The default value of chord step is 15 degrees.

E) Miscellaneous procedures:

routine INQUIRE POSITION (integer name X, Y)

This routine sets X and Y equal to the X and Y coordinates of the current virtual position.

routine INQUIRE WINDOW (integer name XL, XR, YB, YT)

This routine sets the parameters to the current window bounds. The parameters are lower X, upper X, lower Y, upper Y, respectivly.

routine INQUIRE VIEWPORT (integer name XL, XR, YB, YT)

This routine sets the parameters to the current viewport bounds. The order of the parameters is the same as for INQUIRE WINDOW.

routine MAP TO DEVICE COORDS (integer name X, Y)

This routine can be used to ask EDWIN to transform the point specified from the world space to the device space, using the appropriate transformation for the current window and viewport settings. The coordinates have no clipping performed on them.

routine MAP TO VIRTUAL COORDS (integer name X, Y)

This routine performs the inverse operation to the routine above. If converts the coordinates X and Y to the equivalent coordinates in the world space. The coordinates have no clipping performed on them.

F) Graphical Input

If the graphics device is unable to support graphical input, all of the procedures in this section will fail with EDWIN error 8. Users are refered to the descriptions of the device drivers for full details how device provide graphical input.

<u>routine</u> REQUEST INPUT (<u>integer</u> <u>name</u> STATUS, X, Y)

Many devices have a means of allowing the user to point at the screen, for example the cursor on a Tektronix tube or the BIT PAD on the CHARLES terminal. This routine can be used to allow a limited form of interaction with EDWIN. The contents of STATUS vary between devices; for example it contains the character hit to leave cursor mode on a Tektronix, the value of the buttons on a mouse, or the pen status on the HP plotter. The parameters X and Y are set to the pointer's X and Y coordinates.

<u>routine</u> REQUEST DEVICE (<u>integer</u> <u>name</u> STATUS, X, Y)

This routine is similar to the routine REQUEST INPUT, except that the coordinates are returned in device units, and are not scaled. The value of STATUS is the same as for CURSOR.

<u>routine</u> SAMPLE INPUT (<u>integer</u> <u>name</u> STATUS, X, Y)

This routine is similar to REQUEST INPUT, except that the information about the input devices position is passed back to the applications program without any interaction with the user. This procedure has only been implemented for the APM and Charles device drivers.

<u>routine</u> SAMPLE DEVICE (<u>integer</u> <u>name</u> STATUS, X, Y)

This procedure is similar to SAMPLE INPUT, except that the coordinates are returned in device units, and are not scaled. The value of STATUS is the same as for SAMPLE INPUT.

<u>routine</u> AREA INPUT (<u>intger</u> LX, LY, HX, HY)

This procedure returns an area which has been specified using the input device. It has currently only been implemented on the APM device drivers. The coordinates are returned in virtual coordinates. Note that the order of parameters is different from that of Window & Viewport. It is felt that this is a more intuitive order for the parameters, but in the case of Window and Viewport the order is retained because of backwards compatibility.

<u>routine</u> AREA DEVICE (<u>integer</u> LX, LY, HX, HY)

This procedure is similar to AREA INPUT, except that the coordinates are returned in device units, and are not scaled.

A set of Geometrical Utility routines

The routines described in this section provide the user with a standard set of routines for drawing geometric shapes on any of the EDWIN devices. Because these are higher level primitives, the user can specify if the shapes are to be shaded rather than needing to understand the device driver protocol to implement these facilities themselves. The user determines whether the shapes are shaded by using the procedure SET SHADE MODE described earlier. All the routines clip the resulting polygon, if clipping is enabled. The routines make as much use of device specific features as possible, (eg. using hardware circles on the HP plotter) while retaining the device independence of the picture.

All the routines assume the following record format has been declared -

record format POINTFM (integer X, Y)

The above record format is in a file which can be included on any particular system, along with a separate include file which contains the declarations.

routine POLYGON (integer NUM ELE, record (POINTFM) array name PTS)

This routine draws an arbitrary polygon, on the current device. The polygon is assumed to be defined by the set of points PTS(1) to PTS(NUM ELE). The polygon need not be closed. Pascal users should see the section on cross-calling for details of how to access this routine. The polygon is clipped to the current window by default. Clipping entails a significant expenditure of CPU time, so that if all the polygons to be drawn are known to be inside the current window, and there are a large number to draw, then the routine CLIP OFF may be called to suppress clipping. Clipping is enabled again by calling the routine CLIP ON.

routine RECTANGLE (integer XL, YL, XU, YU)

This routine draws a rectangle. This can often be done faster and more simply than for the general box drawing routine which is described below. The parameters represent the four corners of the rectangle and they are swapped if they have been specified in the wrong order. Note that the order of parameters if different from the procedures VIEWPORT and WINDOW.

routine CIRCLE (integer RAD)

This routine draws a circle with radius RAD centred at the current position. If the device does not have a hardware circle primitive, then the number of sides used can be set by the following routine SET CHORD STEP which was described previously.

routine BOX (integer L, W, record (POINTFM) name C, D)

This routine draws an arbitrary box,'with length L, width W and centre C, with D representing a direction vector. The box is rotated so that side L lies in the direction given by the direction vector. A direction vector of (1,3) would result in the box having an anti-clockwise rotation of 60 degrees applied about its centre before it is drawn. The box is converted to a polygon for clipping and drawing.

routine WIRE (integer W, N, record (POINTFM) array name PTS)

The array PTS is assumed to define a 'wire' from PTS(1) to PTS(N). The strict definition of a wire is the area which is covered by moving a circle of width W along the set of points defined by the array PTS. This results in the wire having a rounded ends, and rounded corners. As this would be time consuming to plot, the mode of drawing wires can be specifed by the procedure SET WIRE MODE which is described below. The wire is converted to a polygon and is then drawn. Pascal users should see the section on cross calling for details of how to access this routine.

routine SET WIRE MODE (integer MODE)

This procedure controls how wires are shown, there are three options:

MODE = 0 : The wire has flat ends flush with end points
MODE = 1 : Wire has round ends, drawn as circles & boxes
MODE = 2 : The wire has flat ends extended half its width

The default is mode 0.

routine ARC (integer OX, OY, RAD, START ANG, END AND)

This procedure draw an arc (line) centred at OX, OY of radius RAD, between the start angle and end angle specified. The relative directions of the angles determines the direction of the arc. The tolerance of the arc can be chosen by SET CHORD STEP procedure.

routine SECTOR (integer OX, OY, RAD, START ANG, END AND)

This procedure is similar to ARC, except the area traced by the arc, and the centre point is treated as a closed polygon, and will be shaded if shade mode is set to be solid.

A Transformation Stack

The following set of routines may be used to provide a graphics program with a transformation stack for a two dimensional coordinate system. The transformation matrices which these routines work on are described in more detail in Newman and Sproull [30].

The following procedures are available to create transformation records -

routine UNITY TRANSFORM (record (TRANSFM) name T)

This procedure creates a unit transformation :

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

routine TRANSLATE TRANSFORM (real X, Y, record (TRANSFM) name T)

This procedure create a translation transformation :

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ X & Y & 1 \end{pmatrix}$$

routine MIRROR X TRANSFORM (record (TRANSFM) name T)

This procedure create a transformation which is a mirroring of the X coordinates, ie. a mirroring of the picture in the Y axis.

$$\begin{pmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

routine MIRROR Y TRANSFORM (record (TRANSFM) name T)

This procedure create a transformation which is a mirroring of the Y coordinates, ie. a mirroring of the picture in the X axis.

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

routine SCALE TRANSFORM (real XS, YS, record (TRANSFM) name T)

This procedure creates a transformation which is a scale factor for the X and Y coordinates.

$$\begin{pmatrix} XS & 0 & 0 \\ 0 & YS & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

routine ROT DV TRANSFORM (real A, B, record (TRANSFM) name T)

This procedure create a transformation which is a rotation specifed by the direction vector (A, B). Note that D = SQRT (A*A+B*B)

$$\begin{pmatrix} A/D & B/D & 0 \\ -B/D & A/D & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

routine ROT ANG TRANSFORM (real ANGL, record (TRANSFM) name T)

This procedure creates a transformation which is an anit-clockwise rotation of the angle specifed.

$$\begin{pmatrix} \text{Cos A} & \text{Sin A} & 0 \\ -\text{Sin A} & \text{Cos A} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

routine COMPOSE TRANSFORM (record (TRANSFM) name A, B, C)

This procedure takes two transformations A and B and uses matrix multiplication to generate the composite matrix C. Remember that the order of the parameters A and B is critical!

The following procedures can be used to manipulate the transformation stack. Note that this is a independent modules from the main part of EDWIN, and if users are using it they must transform any points explicitly before any EDWIN procedures are called to draw the resulting transformed picture.

routine INIT TRANSFORM

This procedure can be used to reset the stack to the 'empty stack'. This intialises the stack by adding a unit matrix as the first element of the stack. It is automatically called of the user does not call it explicitly.

routine PUSH TRANSFORM (record (TRANSFM) name T)

This procedure takes the transformation which is specifed in the parameter, and composes this with the current transformation which is on the top of the transformation stack. This new resulting transformation is added as the top element of the transformation stack. An error is signalled if the stack overflows, (currently 100 elements).

routine SET TRANSFORM (record (TRANSFM) name T)

This procedure is similar to PushTransform, except that the matrix specifed is added to the top of the stack without composing it with the current top transformation on the stack.

routine POP TRANSFORM

This procedure deletes the current top transformation on the transformation stack, (which results in the second top transformation becoming the top one, etc.). An error is signalled if an attempt is made to pop the stack when it is empty.

routine GET TRANSFORM (record (TRANSFM) name T)

This procedure can be used to take a copy of the current top of the stack. Its main use would be to call SetTransform at a later point during the run of the program.

The following procedures can be used to transform points, vectors and boxes with respect to the top of the transformation stack. Note that in the case of transforming a vector there is no need to worry about any resulting translations. The box (typically a bounding Box) is specifed by two points which represent the opposite corners.

routine POINT TRANSFORM (record (POINTFM) name P, NP)

routine VECTOR TRANSFORM (record (POINTFM) name V, NV)

routine BB TRANSFORM (record (POINTFM) name OL, OU, NL, NU)

The following example program shows how the transformation stack can be used to produce a picture consisting of one line drawn at a number of different orientations around one of its end points.

```
! A demonstration program using the EDWIN transformation stack.

include "edwin_dir:types.inc"
include "edwin_dir:specs.inc"
include "edwin_dir:txstack.inc"

begin
   integer I
   record (pointfm) P, NP
   record (transfm) TX

   p_x = 250;   p_y = 0
   initialise for (default device)
   newframe

   init transform
   for I = 0, 15, 360 cycle
        rot ang transform (i, tx)
        push transform (tx)
        point transform (p, np)
        pop transform
        move abs (500, 500)
        line abs (500+np_x, 500+np_y)
   repeat

   terminate edwin
end of program
```

The structure of the EDWIN device drivers.

All the graphics output from EDWIN goes into a module called the "device driver". This can take two forms, either it is a specific device driver, in the case of machines which have a limited version of EDWIN, or it is just a switch which selects the true device driver, after the switch has been initialised. All the device drivers have the following format -

routine DRIVE DEVICE (integer COM, X, Y)

This rigid format makes it easy to produce new device drivers, and it is also easy to configure versions of EDWIN which reflect the devices available. The above named routine may be assumed to be present in any version of EDWIN which supports multiple devices, otherwise the device driver is one of the routines which are described in the following sections.

COM is the command code which instructs the device driver which operation is to be performed, and the parameters X and Y give further information for some of the codes. Codes 1 to 14 are defined for all device drivers, although some sub-codes are accepted by specific device drivers to allow users to make use of device dependent features. These additional codes are described in the descriptions of the device drivers.

The following is the significance of the general codes -

Code	X	Y	Description
0	TYPE	-	Initialise the driver for TYPE.
1	-	-	Terminate
2	-	-	Update
3	-	-	Newframe
4	X	Y	Move Abs to (X,Y)
5	X	Y	Line Abs to (X,Y)
6	CHAR	-	Output character CHAR
7	WHICH	VAL	Change attribute WHICH to VAL
8	XL	YB	Set lower device window bounds
9	XR	YT	Set upper device window bounds
10	MODE	-	Set drawing mode (solid/outline)
12	X	Y	Set lower rectangle bound
13	X	Y	Set upper rectangle bound and draw it
14	RAD	-	Draw a circle of radius RAD

In the case of devices which are interactive, the following procedures which are already been described are required -

routine REQUEST DEVICE (integer name STATUS, X, Y)

routine SAMPLE DEVICE (integer name STATUS, X, Y)

routine AREA DEVICE (integer LX, LY, HX, HY)

The following interface is used within the device drivers to maintain system independence, while providing machine specific input and output.

routine TTPUT (integer SYM)

This places the symbol SYM into an internal buffer. If the buffer gets full then the buffer is sent to the device, otherwise it has no effect.

routine FLUSH OUTPUT

This forces the buffer out to the device. Note that it is not necessary for the buffer to be terminated by an line terminator such as ASCII character 10. This is called automatically when the procdures UPDATE or TERMINATE EDWIN are called.

integer function TTREAD

This procedure reads a character from the device, allowing it to be echoed. The result of the function is the symbol which was read.

integer function TTGET

This procedure reads a character from the device, but not echoing it. The result of the function is the symbol which was read.

routine TTMODE (integer MODE)

This is called at INITIALISE and TERMINATE to select the appropriate terminal characteristics for the duration of the graphics program. If mode is non-zero, then the terminal is assumed to be in graphics mode, otherwise it is assumed to be reverting to normal mode. Depending on how the terminals are interfaced to the system , this procedure is frequently null.

routine SET INPUT (string (255) STR)

If the system allows multiple terminals to be used by the program this selects which terminal line is required for input. If only one terminal line is available, then this procedure is null.

routine SET OUTPUT (string (255) STR)

If the system allows multiple terminals to be used by the program this selects which terminal line is required for output. If only one terminal line is available, then this procedure is null.

Cross calling EDWIN from Fortran and Pascal

On systems such as VAX/VMS, APM, and EMAS where there are a number of compilers for different languages which conform to a standard format of object file, any of these compilers may be used to write graphics programs using the EDWIN library. Users are referred to the system library manuals of the system which they are using for the information which is applicable to their machine, but some details of the use of EDWIN from Fortran and Pascal are given below.

a) Fortran

In Fortran all subroutines are defined to have reference-type parameters, (ie. in IMP terms only integer name parameters can be used). To allow Fortran programs to access EDWIN a number of interface routines have been provided, with the same function as described elsewhere in this guide, but with different names, and parameter passing modes. Subroutines with no parameters, or only name type parameters, may be called directly. The following routines are provided -

Fortran name	IMP name
INIT FOR	INITIALISE FOR
MOVE A	MOVE ABS
MOVE R	MOVE REL
LINE A	LINE ABS
LINE R	LINE REL
MARK A	MARKER ABS
MARK R	MARKER REL
CHAR	CHARACTER
STR ON	STORE ON
V ON	VIEW ON
ASPECT RAT	ASPECT RATIOING
F WINDOW	WINDOW
F VIEW PORT	VIEW PORT

All the attribute routines described in section D have the word SET replaced by the letter S. (eg. SET COLOUR becomes S COLOUR).

Note that the versions of Fortran on VAX and EMAS do not impose a limit of 6 characters in names.

b) Pascal

Each system has a set of files which contain the EDWIN procedure, type and constant specifications in a Pascal format suitable for compiling on that system. In the case of the APM and VAX the %include construct can be used, but on EMAS the procedures should be edited into the users program. The following examples show VMS Pascal programs calling the procedure POLYGON and the transformation stack.

```
PROGRAM Geodemo (input, output);

TYPE

%include 'edwin_dir:types.pas'

      pointa = array [1..10] of pointfm;
      { User must choose max size at compile time }

VAR p : pointa;

%include 'edwin_dir:specs.pas'
%include 'edwin_dir:shapes.pas'

BEGIN
   InitialiseFor (DefaultDevice);
   Newframe;
   p[1].x := 250;   p[1].y := 250;
   p[2].x := 750;   p[2].y := 250;
   p[3].x := 750;   p[3].y := 750;
   p[4].x := 250;   p[4].y := 750;
   Polygon (4, p);
   TerminateEdwin;
END.
```

```
PROGRAM txdemo (input, output);

TYPE

%include 'edwin_dir:types.pas'

VAR      i : integer;
        tx : transfm;
     p, np : pointfm;

%include 'edwin_dir:specs.pas'
%include 'edwin_dir:txstack.pas'

BEGIN
   p.x := 250;   p.y := 0;
   InitialiseFor (DefaultDevice);
   Newframe;
   i := 0;
   InitTransform;
   WHILE i <= 360 DO BEGIN
      RotAngTransform (i, tx);
      PushTransform (tx);
      PointTransform (p, np);
      PopTransform;
      MoveAbs (500, 500);
      LineAbs (500+np.x, 500+np.y);
      i := i + 15;
   END;
   TerminateEdwin;
END.
```

Use of the VIEWPDF program

This utility can be used to view pictures which have been dumped by the storing feature of EDWIN. The form of the command is -

```
VIEWPDF picture/outfile
```

where 'picture' is a picture produced by the use of the EDWIN routine "STORE ON", and 'outfile' is an optional file which is used for output for devices such as the Printronix where files are required.

The program normally views the PDF on the users default device, unless a device is specified by the DEVICE qualifier. If the device is a plotter, the user is also prompted for the size of plot. This can either be the size of paper in 'A' units, or a number in centimeters. If one number is given on the line then a square viewport is set, otherwise if there are two number these specify a rectangle for the paper area, and four numbers can be used to specify the rectangle plus an offset.

```
eg.  Size: A4                     { A4 paper (horisonal) to be used.
     Size: A3                     { A3 paper to be used.
     Size: 10                     { 10cm square of paper to be used.
     Size: 10 5                   { A 10cm x 5cm area to be used.
     Size: 10 5 3 2               { A 10cm x 5cm area to be used offset
                                    by 3cm in X and 2cm in Y.
```

The program then interprets the instructions describing the picture, until either an end of picture instruction (produced by TERMINATE EDWIN) or a NEWFRAME instruction is encountered. The program then prompts "Another?", and if the response "N" or "NO" is received, the program stops, otherwise the program continues hoping to find another picture description on stream one. The program automatically stops if the picture description runs out.

Notes -

a) Each picture is self defined, and any number of pictures can be joined together in one file.

b) This provides a useful method of plotting pictures, without wasting plotter paper and time on unwanted plots.

Use of the PDFDEC program

This utility can be used to decode a PDF into a HEX dump and an IMP program. The form of the command is

```
PDFDEC  pdf/decode
```

If the output parameter is omitted, the decode is done to the users terminal. Although the program is mainly designed for the inspection of PDFs, a number of users have found it useful for recreating programs to draw pictures. The program terminates when the file ends, or if the PDF is found to be corrupt.

Accessing EDWIN under VMS on VAX systems.

On ECSVAX users should add the command SETUP EDWIN to their LOGIN.COM file, and this makes the commands and library available to you.
Other VAX implemenations will have a file which is obeyed to set up EDWIN.

The following files contain declarations which can be included in programs using the Imp and Pascal %include facilities.

```
EDWIN_DIR:CONSTS.INC       EDWIN_DIR:CONSTS.PAS
EDWIN_DIR:SPECS.INC        EDWIN_DIR:SPECS.PAS
EDWIN_DIR:TYPES.INC        EDWIN_DIR:TYPES.PAS
EDWIN_DIR:SHAPES.INC       EDWIN_DIR:SHAPES.PAS
EDWIN_DIR:TXSTACK.INC      EDWIN_DIR:TXSTACK.PAS
```

After the graphics program is compiled, the command LINK (with no special files or options) is used.

The VAX/VMS version of EDWIN is configured for all of the devices described in this document except, the APM graphics drivers.

The following strategy is used to find the result of the default device function on VAX/VMS.

a) If the logical name EDWIN_DEFAULT_DEVICE is defined then this is used as the required device. Ie. the user can say

```
$ Assign 7221 edwin_default_device
```

and then the result of the default device function would be 7221.

b) If the file name "EDWIN_DIR:EDWIN.DAT" exists:

This is assumed to contain lines of the form

```
     terminal line          device

eg.       __TTA5:             7221
```

If the users terminal name matches one of the entries in the file then the associated device is used as the result of default device.

c) If stage b) failed, the users device type is analysed. If it is a terminal of type VT100 or VT52 then the appropriate answer is given.

d) If the terminal type is unknown, the result is zero.

When the user calls INITIALISE FOR for an interacive device the terminal line has its characteristics set to NOBROADCAST, and an exit handler is established. When the program terminates, the terminal state is returned to its previous setting.

Accessing EDWIN on the Edinburgh APM systems.

On the APM, users should add the command SETUP EDWIN to their LOGIN.COM file, and this makes the commands and library available to you.

The following files contain declarations which can be included in programs using the Imp and Pascal %include facilities.

EDWIN:CONSTS.INC	EDWIN:CONSTS.PAS
EDWIN:SPECS.INC	EDWIN:SPECS.PAS
EDWIN:TYPES.INC	EDWIN:TYPES.PAS
EDWIN:SHAPES.INC	EDWIN:SHAPES.PAS
EDWIN:TXSTACK.INC	EDWIN:TXSTACK.PAS

The APM version of EDWIN is configured with drivers for the level 1 and level 2 graphics system, and the driver for cursor addressable terminals.

If default device is called, EDWIN interogates the hardware of the workstation, and as a result decides on the number to use as the result. The function never returns a result of zero on the APM system.

Accessing EDWIN under EMAS on 2900 systems.

On EMAS users should give the command OPTION SEARCHDIR=ECSLIB.EDWINDIR This makes the commands and library available to you and should only be done once.

The following files contain declarations which can be included in programs using the Imp %include facility or edited into Pascal programs.

```
ECSLIB.EDWIN_CONSTS      ECSLIB.EDWIN_PCONSTS
ECSLIB.EDWIN_SPECS       ECSLIB.EDWIN_PSPECS
ECSLIB.EDWIN_TYPES       ECSLIB.EDWIN_PTYPES
ECSLIB.EDWIN_SHAPES      ECSLIB.EDWIN_PSHAPES
ECSLIB.EDWIN_TXSTACK
```

The EMAS version of EDWIN is configured for all of the devices described in this document except, the APM graphics drivers.

The following strategy is used to find the result of the default device function on EMAS.

a) If the logical name EDWIN_DEFAULT_DEVICE is defined then this is used as the required device. Ie. the user can say

```
Command: Assign 7221,edwin_default_device
```

and then the result of the default device function would be 7221.

b) If stage a) failed, the users terminal type is analysed. If it is a type which corresponds to an EDWIN device then the appropriate answer is given, otherwise the result is zero.

When the user calls INITIALISE FOR when using an interactive device, then the command MESSAGES OFF is performed. When TERMINATE EDWIN is called, EDWIN returns the message state to its previous state.

Appendix A : EDWIN error messages

Errors with EDWIN are reported by the IMP signal mechanism. Event 14 is signalled, with the sub event giving which of the following errors occurred. These events may be trapped and then analysed by the IMP event trapping mechanism.

Error number	Description:
0	Initialisation failed - unknown device
1	Initialisation failed - system error
2	Initialise called when a device is active
3	Terminate called when no device is active
4	Device specific error in device driver
5	Corrupt PDF
6	Font not defined
7	Internal error in SHAPES
8	Device does not support interaction
9	Transformation stack not initialised?
10	Transformation stack overflow
11	Transformation stack underflow
12	Invalid parameters to WINDOW
13	Invalid parameters to VIEWPORT
14	Device has no hardware character set
15	Setting an unknown attribute number

In general EDWIN tries to avoid giving up. Examples of this are if a viewport outside the coordinate range is given, the largest one that the device supports is used, and any attempt to draw software control characters is ignored.

If a program wishes to find out what error is meant by a given number then the following function returns a text description of what is meant for each error.

<u>string</u> (63) <u>function</u> EDWIN ERROR (<u>integer</u> NUM)

Appendix B : Listing of the normal EDWIN procedure specs

```
{ EDWIN routine specs added }                                    end of list

! Routines for initialisation and termination
external routine spec INITIALISE FOR     (integer DEVICE TYPE)
external routine spec TERMINATE EDWIN

! Output primitives
external routine spec MOVE ABS           (integer X, Y)
external routine spec MOVE REL           (integer DX, DY)
external routine spec LINE ABS           (integer X, Y)
external routine spec LINE REL           (integer DX, DY)
external routine spec MARKER ABS         (integer N, X, Y)
external routine spec MARKER REL         (integer N, DX, DY)
external routine spec CHARACTER          (integer SYM)

! Text output
external routine spec TEXT               (string (255) ST)
external routine spec TEXT COLOUR ESCAPE (integer CH)
external routine spec TEXT FONT ESCAPE   (integer CH)

! Control
external routine spec NEW FRAME
external routine spec UPDATE
external routine spec CLIP ON
external routine spec CLIP OFF
external routine spec STORE ON           (integer STREAM)
external routine spec STORE OFF
external routine spec VIEW ON            (integer STREAM)
external routine spec VIEW OFF
external routine spec ASPECT RATIOING    (integer MODE)
external routine spec WINDOW             (integer XL, XR, YB, YT)
external routine spec VIEWPORT           (integer XL, XR, YB, YT)

! Attributes
external routine spec SET COLOUR         (integer COLOUR)
external routine spec SET COLOUR MODE    (integer MODE)
external routine spec SET MARKER SIZE    (integer S)
external routine spec SET LINE STYLE     (integer STYLE)
external routine spec SET CHAR SIZE      (integer SIZE)
external routine spec SET CHAR ROT       (integer ROT)
external routine spec SET CHAR QUALITY   (integer WHICH)
external routine spec SET CHAR FONT      (integer WHICH)
external routine spec SET CHAR SLANT     (integer ANGLE)
external routine spec SET SPEED          (integer SPEED)
external routine spec SET CHORD STEP     (integer NUM)
external routine spec SET SHADE MODE     (integer MODE)

! Miscellaneous routines
external routine spec REVIEW
external routine spec INQUIRE POSITION  (integer name X, Y)
external routine spec INQUIRE WINDOW    (integer name XL, XR, YB, YT)
external routine spec INQUIRE VIEWPORT  (integer name XL, XR, YB, YT)
external routine spec MAP TO DEVICE COORDS  (integer name X, Y)
external routine spec MAP TO VIRTUAL COORDS (integer name X, Y)
external string (63) function spec EDWIN ERROR (integer X)
```

```
! Input primitives
external routine spec REQUEST INPUT      (integer name STATE, X, Y)
external routine spec SAMPLE INPUT       (integer name STATE, X, Y)
external routine spec AREA INPUT         (integer name XL, YB, XR, YT)

! Device specifics
external routine spec REQUEST DEVICE     (integer name STATE, X, Y)
external routine spec SAMPLE DEVICE      (integer name STATE, X, Y)
external routine spec AREA DEVICE        (integer name XL, YB, XR, YT)
external routine spec DRIVE DEVICE       (integer COM, X, Y)
external integer function spec DEFAULT DEVICE

record format DEVICE DATA FM (integer DEV NO { logical device number },
   string (31) NAME         { Text name for the device                  },
   integer TYPE             { Model number of the device                },
   integer ARF              { Aspect Rationing Factor as a percentage   },
   integer DVX, DVY         { Default Viewport X and Y                  },
   integer MVX, MVY         { Maximum Viewport X and Y                  },
   short   UNITS PER CM     { Units per Centimeter ( =0 => interacts)   },
   byte    MAX COLOUR       { Maximum number of colours available       },
   byte    MAX STYLES       { Maximum number of line styles available   },
   byte    MAX SPEED        { Maximum speed (cm/s)                      },
   byte    NUM CHAR SIZES   { Number of character sizes (255 => any)    },
   byte    NUM CHAR FONTS   { Number of character fonts available       },
   byte    NUM CHAR SLANTS  { Number of character slant positions 0/*   },
   byte    NUM CHAR ROTS    { Number of rotations of chars 0, 4, 8, *   })

external record (DEVICE DATA FM) map spec DEVICE DATA alias "EDWIN_DEVICE_DATA"

end of file
```

Appendix C : The EDWIN constants

```
{ EDWIN constant definitions }

! Colours
constant byte Video Black = 0, Video White = 1
constant byte Blank       = 0
constant byte Black       = 1
constant byte Blue        = 2
constant byte Green       = 3
constant byte Red         = 4
constant byte Purple      = 5
constant byte Yellow      = 6
constant byte Lime        = 7
constant byte Brown       = 8
constant byte Turquoise   = 9

! Colour Modes
constant byte Replace Mode = 0
constant byte And Mode     = 1
constant byte Or Mode      = 2

! Line styles
constant byte normal       lines = 0
constant byte dotted       lines = 1
constant byte chain        lines = 2
constant byte short dashed lines = 3
constant byte long dashed  lines = 4

! Character quality
constant byte hardware text = 0
constant byte software text = 1

! Modes (Aspect Ratio)
constant byte on  = 1, off = 0

! Constants for shade modes
constant byte OUTLINE = 0
constant byte SOLID   = 1

! Marker types
constant byte point                marker = 0
constant byte octagon              marker = 1
constant byte square               marker = 2
constant byte triangle             marker = 3
constant byte transformation point marker = 4
constant byte flag point           marker = 5
constant byte visual centroid      marker = 6
constant byte right arrow          marker = 7
constant byte left arrow           marker = 8
constant byte up arrow             marker = 9
constant byte down arrow           marker = 10
```

```
! Device numbers (from device data record)
constant byte Tektronix   = 1
constant byte Charles     = 2
constant byte Hp plotter  = 3
constant byte Calcomp     = 4
constant byte Printronix  = 5
constant byte Terminal    = 6
constant byte Hp 2648     = 7
constant byte Westward    = 8
constant byte Sigma       = 9
constant byte GiGi        = 10
constant byte APM Level 1 = 10
constant byte BBC Micro   = 11
constant byte APM Level 2 = 11
constant byte X5A         = 12
constant byte GP300       = 13

end of file
```

Appendix D : The EDWIN types

```
{ TYPE definitions for using EDWIN from Imp }

record format Point Fm (integer X, Y)

end of file
```

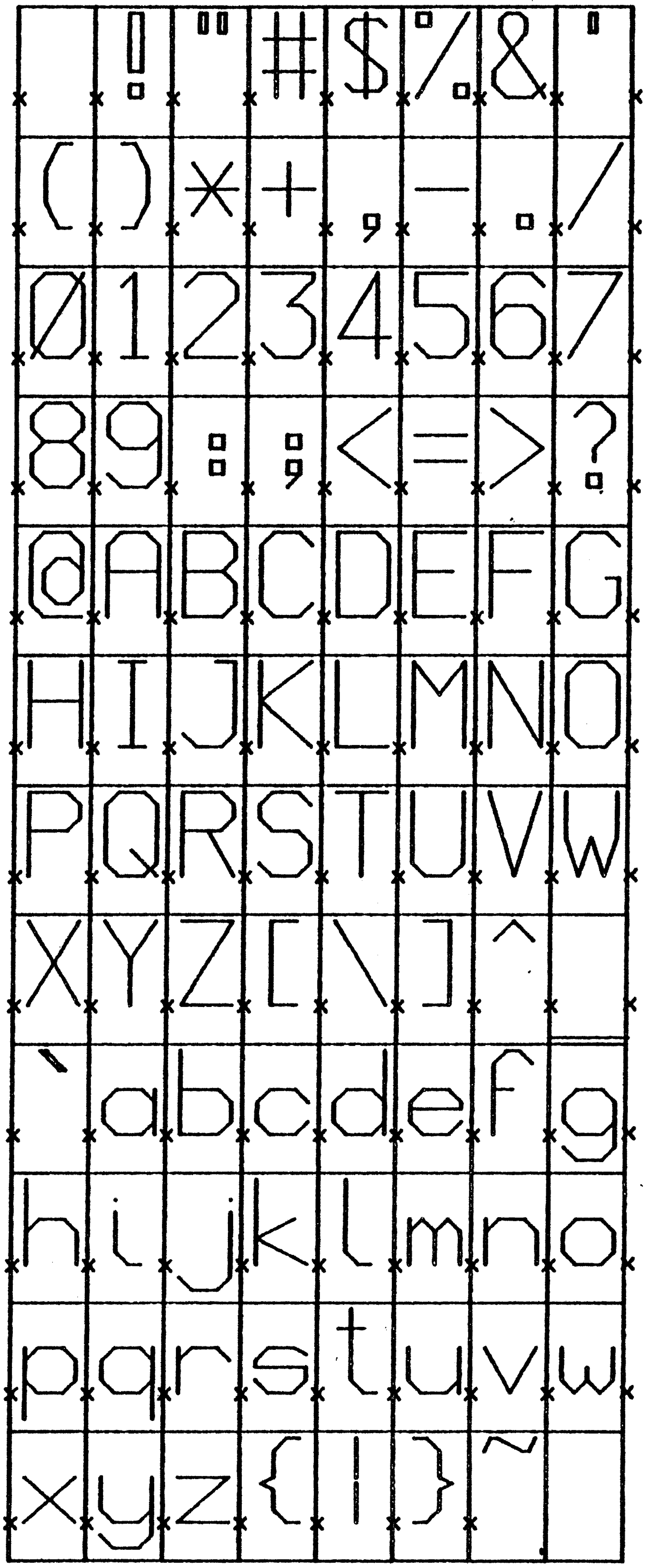
Appendix E : The EDWIN Geometrical Utilities

```
{ EDWIN Geometric utility routines added }                end of list

! Set up routines
external routine spec SET WIRE MODE  (integer MODE)
external routine spec SET COLOUR MAP (integer ADR, RED, BLUE, GREEN)

! Constants for wire modes
constant integer FLAT ENDS = 0
constant integer ROUND ENDS = 1
constant integer EXTENDED ENDS = 2

! Drawing routines
external routine spec ARC         (integer OX, OY, RAD, START ANG, END AND)
external routine spec SECTOR      (integer OX, OY, RAD, START ANG, END AND)
external routine spec CIRCLE      (integer RAD)
external routine spec RECTANGLE   (integer XL, YL, XU, YU)
external routine spec BOX         (integer L, W,
                                   record (POINTFM) name C, D)
external routine spec WIRE        (integer W, NP,
                                   record (POINTFM) array name P)
external routine spec POLYGON     (integer NP,
                                   record (POINTFM) array name P)

end of file
```

Appendix F : The EDWIN Transformation Stack

```
{ EDWIN Transformation stack routines added }          end of list

constant integer TRANSFORM STACK DEPTH = 100

record format TRANS FM (real array A (0:8))

external routine spec UNITY TRANSFORM      (record (TRANSFM) name T)
external routine spec TRANSLATE TRANSFORM  (real X, Y,
                                            record (TRANSFM) name T)
external routine spec MIRROR X TRANSFORM   (record (TRANSFM) name T)
external routine spec MIRROR Y TRANSFORM   (record (TRANSFM) name T)
external routine spec ROT DV TRANSFORM     (real A, B,
                                            record (TRANSFM) name T)
external routine spec ROT ANG TRANSFORM    (real ANGL,
                                            record (TRANSFM) name T)
external routine spec COMPOSE TRANSFORM    (record (TRANSFM) name A, B, C)
external routine spec SCALE TRANSFORM      (real XS, YS,
                                            record (TRANSFM) name T)

external routine spec POP TRANSFORM
external routine spec PUSH TRANSFORM       (record (TRANSFM) name T)
external routine spec INIT TRANSFORM
external routine spec PRINT TRANSFORM      (record (TRANSFM) name T)
external routine spec SET TRANSFORM        (record (TRANSFM) name T)
external routine spec GET TRANSFORM        (record (TRANSFM) name T)

external routine spec POINT  TRANSFORM     (record (POINTFM) name P, NP)
external routine spec VECTOR TRANSFORM     (record (POINTFM) name V, NV)
external routine spec BB     TRANSFORM     (record (POINTFM) name OPL, OPU,
                                                                  NPL, NPU)

end of file
```

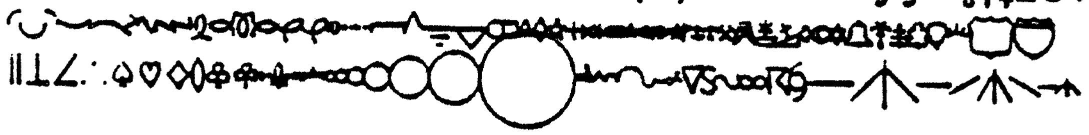
Appendix G : The EDWIN software character sets



	!	"	#	$	%	&	'
(	)	*	+	,	-	.	/
Ø	1	2	3	4	5	6	7
8	9	:	;	<	=	>	?
@	A	B	C	D	E	F	G
H	I	J	K	L	M	N	O
P	Q	R	S	T	U	V	W
X	Y	Z	[	\	]	^	_
`	a	b	c	d	e	f	g
h	i	j	k	l	m	n	o
p	q	r	s	t	u	v	w
x	y	z	{	|	}	~	

```
Set 32 :  '≠√÷'x·°ĩĨ⃗ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[]abcdefghijklmnopqrstuvwxyz{|}~⌑
Set 31 :
Set 30 :
Set 29 :
Set 28 :
Set 27 :
Set 26 :  "°ĩĨ !"$&'()*+,-./0123456789:;=?ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
Set 25 :
Set 24 :  '≠÷'x·°∏ĩĨ⃗ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[]~abcdefghijklmnopqrstuvwxyz{|}~
Set 23 :  '≠√÷'x·°∏ĩĨ⃗ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[]~abcdefghijklmnopqrstuvwxyz{|}~
Set 22 :
Set 21 :
Set 20 :
Set 19 :
Set 18 :
Set 17 :  $ !"#$%&'()*+,-./0123456789:;<=>?ABCDEFGHIJKLMNOPQRSTUVWXYZ
Set 16 :  "°ĩĨ !"$&'()*+,-./0123456789:;=?ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
Set 15 :  "°ĩĨ, !"$&'()*+,-./0123456789:;=?ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
Set 14 :  '≠÷'x·°∏ĩĨ⃗ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[]~abcdefghijklmnopqrstuvwxyz
Set 13 :  '≠√÷'x·°∏ĩĨ⃗ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[]~abcdefghijklmnopqrstuvwxyz{|}~
Set 12 :  '≠√÷'x·°ĩĨ⃗ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[]abcdefghijklmnopqrstuvwxyz{|}~⌑
Set 11 :  "x·° !"#$&'()*+,-./0123456789:;=?ABCDEFGHIJKLMNOPQRSTUVWXYZ|⌑
Set 10 :
Set  9 :
Set  8 :
Set  7 :  ﬀﬁﬂﬃﬄıȷ()∏∑[]{}⌠⌡≤≥√∫
Set  6 :  ﬀﬁﬂﬃﬄıϵθϕς‖±∓∝⁀ˆ˘˙˚¨⊂∪⊃∩∈⟨≡⟩→↑↔↓∂∇√∫∮∞§†‡∃⊙☿♀⊕♂♃♄♅♆☾♇∗Ω℧
Set  5 :  ﬀﬁﬂﬃﬄıȷ()∏∑[]{}⌠⌡ˏˎ∘∘∘•≦≧♯♮♭−√∫ -×𝄞@:‖ρ♈♉♊♋♌♍♎♏♐♑♒♓⋇♯♮♭−-𝄽𝄞𝄢:𝄡
Set  4 :  ﬀﬁﬂﬃﬄıϵθϕς‖±∓⁀ˆ˘˙˚¨⊂∪⊃∩∈⟨≡⟩→↑↔↓∂∇√∫∮∞§†‡∃⊙☿♀⊕♂♃♄♅♆☾♇∗Ω℧
```

Set 3 :
Set 2 :



Set 1 :

Set 64 : '£'"!"$%&'(),-./0123456789;<=>?ABCDEFGHIJKLMNOPQRSTUVWXYZ\^_`abcdefghijklmnopqrstuvwxyz~

Set 63 : '£'°!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz[\]^_

Set 62 : '£'"!"$%&'(),-./0123456789;<=>?ABCDEFGHIJKLMNOPQRSTUVWXYZ_`abcdefghijklmnopqrstuvwxyz\-

Set 61 : '£'"!"$&'(),-./0123456789:;?ABCDEFGHIJKLMNOPQRSTUVWXYZ\^_`abcdefghijklmnopqrstuvwxyz-

Set 60 : '£'"!"$&'[],-./0123456789;<=>?ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz|-·

Set 59 :

Set 58 :

Set 57 :

Set 56 :

Set 55 :

Set 54 :

Set 53 : ''°ſßß !"$&'()*+,-./0123456789:;=?ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz

Set 52 : ''°ſßß !"$&'()*+,-./0123456789:;=?ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz

Set 51 : ''°ſßß !"$&'()*+,-./0123456789:;=?ABCDEFGHIJKLMNOPQRSTÜVWXYZabcdefghijklmnopqrſtuvwxyz

Set 50 :

Set 49 :

Set 48 : '≠√÷'×·°∏ĭĬ⇄ !"#еъяьцыЕЪЯЬЦЫ0123456789:;<=>?@АБЭДЙФГЖИЧКЛМНОПШРСТЮВЩХУЗ[]~абэдйфгжичклмнопшрстювщхуз{|}~

Set 47 :

Set 46 :

Set 45 :

Set 44 : '≠÷'×·°∏ϑς⇄ !"#$%&'()*+,-./0123456789:;<=>?@ABHΔEΦΓXIJKΛMNOΠΘPΣTΥVΩΞΨZ[]~αβηδεφγχιεκλμνοπθρστυφωξψς{|}~

Set 43 : '≠√÷'×·°∏ϑς⇄ !"#$%&'()*+,-./0123456789:;<=>?@ABHΔEΦΓXIJKΛMNOΠΘPΣTΥVΩΞΨZ[]~αβηδεφγχιεκλμνοπθρστυφωξψζ{|}~

Set 42 : '≠√÷'×·°ϑς⇄ !"#$%&'()*+,-./0123456789:;<=>?@ABHΔEΦΓXIJKΛMNOΠΘPΣTΥVΩΞΨZ[]αβηδεφγχιεκλμνοπθρστυφωξψζ{|}~□

Set 41 : ''×·° !"#$&'()*+,-./0123456789:;=?ABHΔEΦΓXIJKΛMNOΠΘPΣTΥVΩΞΨZ|□

Set 40 :

Set 39 :

Set 38 :

Set 37 :

Set 36 :

Set 35 :

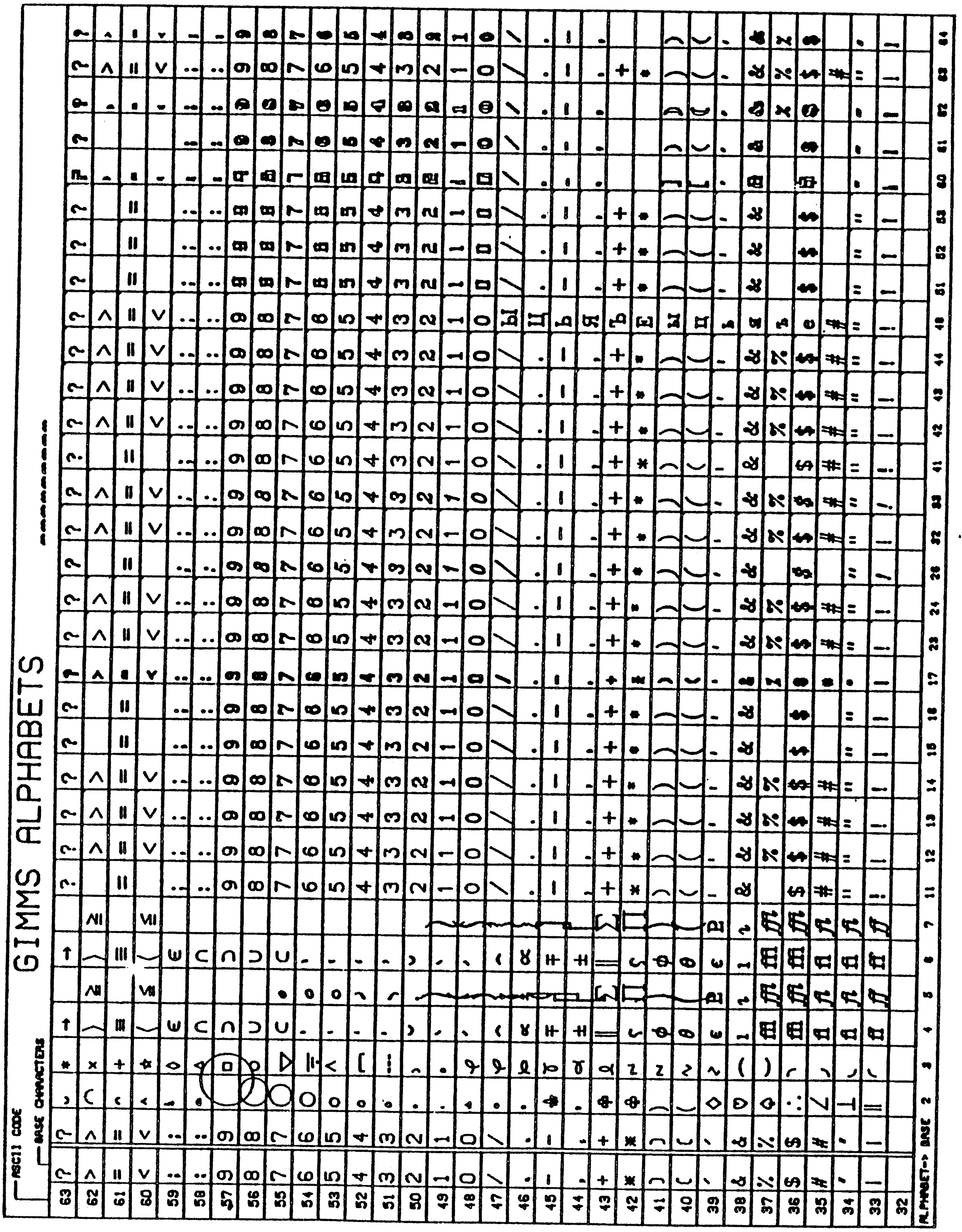
Set 34 :

Set 33 : '≠√÷'×·°∏ϑ⇄ !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[]~abcdefghijklmnopqrstuvwxyz{|}~

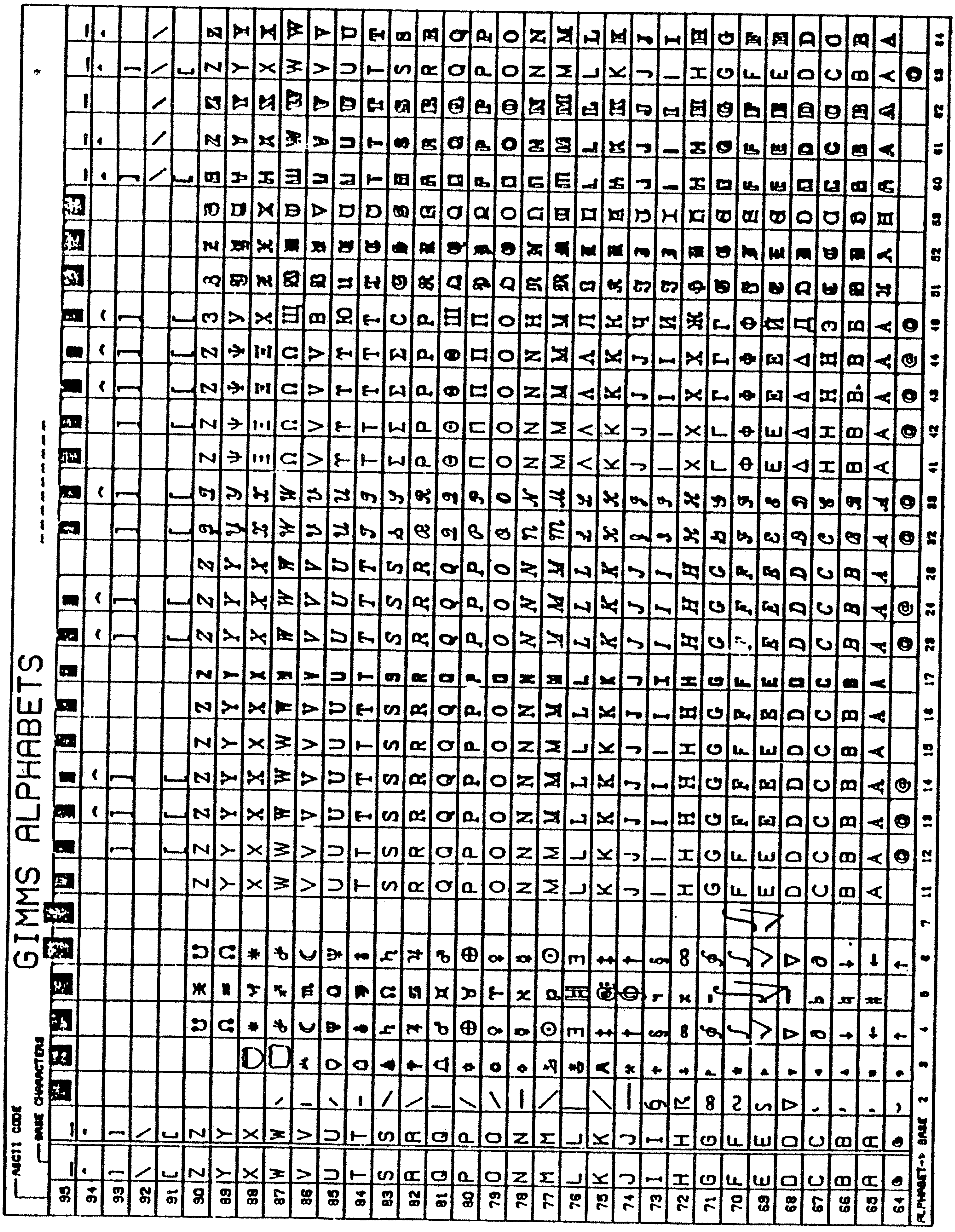
GIMMS ALPHABETS

ASCII CODE	BASE CHARACTERS																																
31	?_•	–								→	→	→				→	→		→	→		→	→	→	→								
30	>°~	–								·			·						·			·							·	·	·	·	·
29	=|)	–								·		·	·				·		·			·		·					·	·	·	·	·
28	<\\|	–																											·	·	·	·	·
27	;{(	–																											·	·	·	·	·
26	:Zz	–								·	·	·	·	·		·	·		·	·		·	·	·	·				·	·	·	·	·
25	9Yy	–								·	·	·	·	·		·	·		·	·		·	·	·	·				·	·	·	·	·
24	8Xx	–								·	·	·	·	·		·	·		·	·		·	·	·	·				·	·	·	^	·
23	7Ww	–								·	·	·	·	·		·	·		·	·		·	·	·	·				·	·	·	^	·
22	6Vv	–								·	·	·	·	·		·	·		·	·		·	·	·	·				·	·	·	\	·
21	5Uu	–								·	·	·	·	·		·	·		·	·		·	·	·	·				·	·	·	\	·
20	4Tt	–								·	·	·	·	·		·	·		·	·		·	·	·	·				·	·	·	/	·
19	3Ss	–								·	·	·	·	·		·	·		·	·		·	·	·	·				·	·	·	/	·
18	2Rr	–								Ī	Ī	Ī	Ī	Ī		ſ	ſ	ſ	ĵ	ĵ		ʕ	ʕ	ʕ	Ī	ɧ	ɧ	ɧ					
17	1Qq	–								Ī	Ī	Ī	Ī	Ī		ɩ	ɩ	ɩ	ɨ	ɨ		ϑ	ϑ	ϑ	Ī	ɓ	ɓ	ɓ					
16	0Pp	–									∏	∏				∏	∏			∏			∏	∏	∏	ʂ	ʂ	ʂ					
15	. 'o	–							o	o	o	•	•	•		o	•	•	o	o	o	•	o	•	o	•	•	•				•	
14	.Nn	–							.	.	.	.				.	.		.	.	.	.	.	.	.								
13	-Mm																																
12	,Ll	–																															
11	+Kk	–							×	×	×	×				×	×		×	×	×	×	×	×	×								
10	*Jj			•																													
9	)Ii	–																															
8	(Hh																																
7	'Gg	–							‘	‘	‘	‘	‘	‘		‘	‘	‘	‘	‘	‘	‘	‘	‘	‘	‘	‘	‘	‘	‘	‘	‘	‘
6	&Ff	–																															
5	%Ee	–								÷	÷	÷				÷	÷		÷	÷		÷	÷	÷	÷								
4	$Dd	–								√	√				●	√			√	√		√	√		√				£	£	£	£	£
3	#Cc	–								≠	≠	≠				≠	≠		≠	≠		≠	≠	≠	≠								
2	"Bb	–							’	’	’	’	’	’		’	’	’	’	’	’	’	’	’	’	’	’	’	’	’	’	’	’
1	!Aa	–																															
ALPHABET->		BASE	2	3	4	5	6	7	11	12	13	14	15	16	17	23	24	28	32	33	41	42	43	44	48	51	52	53	60	61	62	63	64

GIMMS ALPHABETS



GIMMS ALPHABETS


ASCII CODE
BASE CHARACTERS
ALPHABET-> BASE

GIMMS ALPHABETS

ASCII CODE

BASE CHARACTERS

ALPHABET->		BASE	2	3	4	5	6	7	11	12	13	14	15	16	17	23	24	26	32	33	41	42	43	44	45	51	52	53	60	61	62	63	64
127	_	◇							⌶	⌶									⌶		⌶	⌶							•			_	
126	^	~								~	~	~				~	~		~	~		~	~	~	~				-	-	-	ˆ	-
125	]	}								}	}	}				}	}		}	}		}	}	}	}							]	
124	\	|							|	|	|	|				|	|		|	|	|	|	|	|	|				|	|	\	\	|
123	[	{								{	{	{				{	{		{	{		{	{	{	{							[	
122	Z	z								z	z	z	z	z		z	z	z	z	z		ζ	ζ	ζ	з	z	z	z	z	z	z	z	z
121	Y	y								y	y	y	y	y		y	y	y	y	y		ψ	ψ	ψ	у	y	y	y	y	y	y	y	y
120	X	x								x	x	x	x	x		x	x	x	x	x		ξ	ξ	ξ	х	x	x	x	x	x	x	x	x
119	W	w								w	w	w	w	w		w	w	w	w	w		ω	ω	ω	щ	w	w	w	w	w	w	w	w
118	V	v								v	v	v	v	v		v	v	v	v	v		ϕ	ϕ	ϕ	в	v	v	v	v	v	v	v	v
117	U	u								u	u	u	u	u		u	u	u	u	u		υ	υ	υ	ю	u	u	u	u	u	u	u	u
116	T	t								t	t	t	t	t		t	t	t	t	t		τ	τ	τ	т	t	t	t	t	t	t	t	t
115	S	s								s	s	s	s	s		s	s	s	s	s		σ	σ	σ	с	ſ	s	s	s	s	s	s	s
114	R	r								r	r	r	r	r		r	r	r	r	r		ρ	ρ	ρ	р	r	r	r	r	r	r	r	r
113	Q	q								q	q	q	q	q		q	q	q	q	q		θ	θ	θ	ш	q	q	q	q	q	q	q	q
112	P	p								p	p	p	p	p		p	p	p	p	p		π	π	π	п	p	p	p	p	p	p	p	p
111	O	o								o	o	o	o	o		o	o	o	o	o		ο	ο	ο	о	o	o	o	o	o	o	o	o
110	N	n								n	n	n	n	n		n	n	n	n	n		ν	ν	ν	н	n	n	n	n	n	n	n	n
109	M	m								m	m	m	m	m		m	m	m	m	m		μ	μ	μ	м	m	m	m	m	m	m	m	m
108	L	l				𝄡				l	l	l	l	l		l	l	l	l	l		λ	λ	λ	л	l	l	l	l	l	l	l	l
107	K	k				𝄢				k	k	k	k	k		k	k	k	k	k		κ	κ	κ	к	k	k	k	k	k	k	k	k
106	J	j				𝄞				j	j	j	ȷ	j		j	j	j	j	j		ϵ	ϵ	ϵ	ч	j	j	j	j	j	j	j	j
105	I	i				𝄾				i	i	i	ı	i		i	i	i	i	i		ι	ι	ι	и	i	i	i	i	i	i	i	i
104	H	h				𝄽				h	h	h	h	h		h	h	h	h	h		χ	χ	χ	ж	h	h	h	h	h	h	h	h
103	G	g				𝄻				g	g	g	g	g		g	g	g	g	g		γ	γ	γ	г	g	g	g	g	g	g	g	g
102	F	f								f	f	f	f	f		f	f	f	f	f		φ	φ	φ	ф	f	f	f	f	f	f	f	f
101	E	e								e	e	e	e	e		e	e	e	e	e		ε	ε	ε	ё	e	e	e	e	e	e	e	e
100	D	d				𝄼				d	d	d	d	d		d	d	d	d	d		δ	δ	δ	д	d	d	d	d	d	d	d	d
99	C	c				♭				c	c	c	c	c		c	c	c	c	c		η	η	η	э	c	c	c	c	c	c	c	c
98	B	b				♮				b	b	b	b	b		b	b	b	b	b		β	β	β	б	b	b	b	b	b	b	b	b
97	A	a				♯				a	a	a	a	a		a	a	a	a	a		α	α	α	а	a	a	a	a	a	a	a	a
96	@	`																											`	`	`	`	`

Appendix H : Some Example programs

Note that the IMP %include statement causes some lines to appear in the listing which are NOT part of the source file.

```
          ERCC. Imp80 Compiler Release 1 Version 27 May 81

 255  765
   1      include "ECSLIB.EDWIN_SPECS"
   2      { EDWIN routine specs added }                   end of list
  57      external routine spec PROMPT (string (15) S)
  58      begin
  59
  60      ! EDWIN test program 1
  61      ! This program tests the ability to draw lines and to read the cursor.
  62      ! The program reads four cursor locations, and then joins these by
  63      ! a mesh of lines.
  64      ! This is repeated until 'S' is the key hit in response to the cursor.
  65
  66      const integer NUM = 10
  67      integer I,CVAL,TYPE
  68      integer array X,Y (1:4)
  69
  70      PROMPT ("Device Type:")
  71      READ (TYPE)
  72      INITIALISE FOR (TYPE)
  73
  74      NEW FRAME;     ! This clears the screen
  75
  76      cycle
  77         for I=1,1,4 cycle
  78            ! This cycle reads the 4 points defining the two primary lines.
  79            REQUEST INPUT (CVAL, X(I) , Y(I))
  80            exit if CVAL = 'S' or CVAL = 's'   ;! This stops the program.
  81            if I&1=1 then MOVE ABS(X(I),Y(I)) else LINE ABS (X(I),Y(I))
  82         repeat
  83
  84         exit if CVAL = 'S' or CVAL = 's'
  85
  86         ! Now the points on these lines are joined up.
  87
  88         for I=0,1,NUM cycle
  89            MOVEABS (X(1) + I*(X(2)-X(1))//NUM, Y(1) + I*(Y(2)-Y(1))//NUM)
  90            LINEABS (X(3) + I*(X(4)-X(3))//NUM, Y(3) + I*(Y(4)-Y(3))//NUM)
  91         repeat
  92      repeat
  93
  94      TERMINATE EDWIN
  95
  96      end of program

   96 LINES ANALYSED IN    458 MSECS  -  SIZE=  2288

CODE   1096 BYTES      GLAP 376+ 0 BYTES      DIAG TABLES 104 BYTES
TOTAL  1576 BYTES
     80 STATEMENTS COMPILED IN  1047 MSECS
   Computer Science IMP-77 Compiler.  Version 4.17

include "EDWIN:EDWIN.SPECS"
{ EDWIN routine specs added }                          end of list
begin

   ! EDWIN test program 2
   ! This tests some of the attribute commands, for altering colour,
   ! line style, and character size.
   ! The picture is designed to show how windowing in EDWIN operates.
   ! It is best run on a 4014 or VT15 to get the correct attributes set,
   ! because the other devices can't support the attributes.

   const integer BLACK = 1, BLUE = 2, RED = 4
   const integer NORMAL = 0, DOTTED = 1, SDASH = 3, LDASH = 4
   integer TYPE

   routine PRINT TEXT (string (255) S, integer X, Y)
      MOVE ABS (X,Y)
      TEXT (S)
   end

   routine JOIN (integer X1, Y1, X2, Y2)
      MOVE ABS (X1,Y1)
      LINE ABS (X2,Y2)
   end

   routine RECT (integer X, Y, H, V)
      MOVE ABS (X,Y)
      LINE REL (H,0); LINE REL (0,-V)
      LINE REL (-H,0); LINE REL (0,V)
   end

   PROMPT ("Device Type:")
   READ (TYPE)
   INITIALISE FOR (TYPE)

   NEW FRAME

   STORE ON (2)
   ! A copy of the picture will be made on stream 2.

```

```
         ! Now that everything is set up the picture can be drawn.


         RECT (0,1023,1023,1023)

         SET CHAR SIZE (14)
         SET LINE STYLE (LDASH)
         RECT (300,900,600,400)
         PRINT TEXT ("VIEW PLANE, 700, 920)

         SET CHAR SIZE (12)
         RECT (200,400,500,300)
         PRINT TEXT ("VIEW SURFACE", 720, 250)

         SET COLOUR (BLUE)
         SET LINE STYLE (SDASH)
         RECT (500,800,300,200)
         PRINT TEXT ("WINDOW", 620,810)

         RECT (300,350,200,200)
         SET CHAR SIZE (9)
         PRINT TEXT ("VIEW PORT", 350,170)

         SET LINE STYLE (DOTTED)
         SET COLOUR (RED)
         JOIN (500, 800, 300, 350)
         JOIN (800, 800, 500, 350)
         JOIN (500, 600, 300, 150)
         JOIN (800, 600, 500, 150)

         SET CHAR SIZE (7)
         PRINT TEXT ("VIEWING TRANSFORMATION", 720,450)

         TERMINATE EDWIN

     end of program
? NORMAL unused
? BLACK unused

   90 Statements compiled
```

```
          Computer Science IMP77 Compiler.  Version 6.02

             Compiled on 10-JUN-1981 at 16:24:19

    Source file: _DRA0:[GRAFIX.EDWIN]TEST3.IMP;1

    1  include "EDWIN_DIR:SPECS.INC"
    &  { EDWIN routine specs added }                   end of list
    2  begin
    3
    4     ! EDWIN ›test program 3
    5     ! Program to check software characters,
    6     ! It checks both the size and rotation of the characters.
    7
    8     const integer GOOD = 1
    9     const integer PDF STREAM = 1
   10     integer I
   11
   12     PROMPT ("Device: ")
   13     READ (I)
   14     INITIALISE FOR (I)
   15     NEW FRAME
   16
   17     OPEN OUTPUT (PDF STREAM, "TEST3.PDF")
   18     STORE ON (PDF STREAM)
   19
   20     SET CHAR QUALITY (GOOD)
   21
   22     for I = 0,1,3 cycle
   23          MOVE ABS (511, 500)
   24          SET CHAR ROT (I*90)
   25          SET CHAR SIZE (12)
   26          TEXT ("CHAR at 12 OK")
   27          SET CHAR SIZE (24)
   28          TEXT ("CHAR at 24 OK")
   29     repeat
   30
   31  TERMINATE EDWIN
   32
   33  end of program

Code 292 bytes  Glap 88 bytes  Diags 138 bytes   Total size 518 bytes
   62 statements compiled in  3.10 seconds.  (1200 statements/minute)
```

```
      Computer Science VAX-11 IMP77 Compiler.  Version 8.01

            Compiled on 10-JUN-1981 at 16:24:26

   Source file: _DRA0:[GRAFIX.EDWIN]TEST4.IMP;1

      1  include "EDWIN_DIR:SPECS.INC"
  &   1  { EDWIN routine specs added }                    end of list
      2  begin
      3     ! EDWIN test program 4
      4     ! Program to draw the EDWIN character set on a plotter to check for
      5     ! consistancy of letters, and also demonstrate the character set.
      6
      7     const integer PDF STREAM = 2, GOOD = 1
      8     integer I, X, Y
      9
     10  PROMPT ("Device:")  ;  READ (I)  ;  INITIALISE FOR (I)
     11
     12  NEW FRAME
     13  STORE ON (PDF STREAM)
     14
     15  MOVE ABS (400, 20)  ;  ! Bottom right corner
     16
     17  ! The boxes are now drawn to minimise moves.
     18  MOVE REL (-36, 0) and LINE REL (-36, 0) for I = 1, 1, 4
     19  LINE REL (0, 720)
     20  MOVE REL (36, 0) and LINE REL (36, 0) for I = 1, 1, 4
     21  for I = 1, 1, 4 cycle
     22     LINE REL (0, -720 )  ;  LINE REL (-36, 0)
     23     LINE REL (0, 720)  ;  LINE REL (-36, 0)
     24  repeat
     25  for I = 1, 1, 6 cycle
     26     MOVE REL (0, -60)  ;  LINE REL (288, 0)
     27     MOVE REL (0, -60)  ;  LINE REL (-288, 0)
     28  repeat
     29
     30  X = 112  ;  Y = 697  ;  MOVE ABS (X, Y)  ;  I = 32
     31
     32  SET CHAR SIZE (36)
     33  SET CHAR QUALITY (GOOD)
     34
     35  cycle; ! To draw the characters
     36     MARKER REL (4, 0, 0)
     37     CHARACTER (I)
     38     I = I + 1  ;  exit if I=127
     39     if X = 364 start; ! The end of a row
     40         MARKER REL (4, 0, 0)
     41         Y = Y - 60
     42         X = 112
     43     finish else X = X + 36
     44     MOVE ABS (X, Y)
     45  repeat
     46
     47  TERMINATE EDWIN
     48  end of program
Code 732 bytes  Glap 48 bytes  Diags 232 bytes   Total size 1012 bytes
    85 statements compiled in  2.96 seconds.  (1722 statements/minute)
```

```
Source file: test5      compiled on 10-JUN-81 at 19.04.00
Object file: TEST5.EXE

         Edinburgh IMP77 Compiler - Version 8.1

      1  include "edwin_dir:specs.inc"
  &   1  [ EDWIN routine specs added ]                      end of list
      2  begin
      3     ! EDWIN test program 5
      4     ! A demonstration program for the EDWIN CATs driver.
      5
      6     const integer GOOD=1, LOW=0
      7     integer SYM,TYPE
      8
      9     routine BOX (integer XL,YL,XR,YR)
     10        MOVE ABS (XL,YL)
     11        LINE REL (0,YR-YL)
     12        LINE REL (XR-XL,0)
     13        LINE REL (0,-(YR-YL))
     14        LINE REL (-(XR-XL),0)
     15     end
     16
     17     routine PAGE 1
     18        NEWFRAME
     19        MOVE ABS (12,21)
     20        TEXT ("This introduces a new version of")
     21        MOVE ABS (10,6)
     22        SET CHAR QUALITY (GOOD)
     23        TEXT ("EDWIN")
     24        MOVE ABS (41,4)
     25        SET CHAR QUALITY (LOW)
     26        TEXT ("for the ")
     27        TEXT ("Visual 200") if TYPE=200
     28        TEXT ("Bantam 550") if TYPE=550
     29        TEXT (" terminals")
     30        BOX (5,3,74,22)
     31        MOVE ABS (0,1)
     32        UPDATE
     33     end
     34
     35     routine PAGE2
     36        routine CROSS
     37           LINE REL (20,20)
     38           MOVE REL (-20,0)
     39           LINE REL (20,-20)
     40        end
     41
     42        NEW FRAME
     43        MOVE ABS (0,2)
     44        CROSS
     45        MOVE ABS (55,2)
     46        CROSS
     47        MOVE ABS (31,12)
     48        TEXT ("When things go wrong")
     49        MOVE ABS (32,10)
     50        TEXT ("Don't get cross!!")
     51        UPDATE
```

```

    Prompt ("Terminal type: ")
    Read (TYPE)
    Initialise for (TYPE)
    Aspect ratioing (0); ! Off
    Window (0, 79, 0, 23)

    Print string ("Enter line style required as a number between 0 and 4")
    Newline
    Prompt ("Number: ")
    Read (SYM) until 0<=SYM<=7
    Set line style (SYM)
    Read symbol (SYM) until SYM=NL

    Prompt ("Hit RETURN key")

    Page1
    Read symbol (SYM) until SYM = NL
    Page2

    Terminate edwin
end of program
```

IMP77 Compiler for PDP-11

File: _DRA0:[GRAFIX.EDWIN]TEST6.IMP;1   16:24:54   10-JUN-1981

Edinburgh IMP77 Compiler - Version 8.1a

```
include "edwin_dir:specs.inc"
{ EDWIN routine specs added }                           end of list
begin
   ! EDWIN test program 6
   ! Acknowledgements to PSR and ADC for this program.
   ! Something to do with a fast video

   own string (40) array pic(1:8) =
      "  ~\",
      "    \   /~~~~~~~~~\",
      "    /  /           ~\     /~\",
      "   /  /              ~\   |  |",
      "  (  /   ___           ~\_\  /_",
      "  (  |      \                  \",
      "   \_|       \___       |     o \",
      "     \___________\_______\_______\"
   byte integer name eye == charno(pic(7),31)
   const integer  open = 'o', closed = '*'
   integer j, left

   initialise for (default device)
   aspect ratioing (0)
   viewport(2,66,1,8)
   window(2,66,1,8)
   newframe

   left = 2
   cycle
      moveabs(left,9-j) and text(pic(j)) for j = 1,1,8
      left = left + 2
      eye = open + closed - eye
   repeat until left = 74

   terminate edwin

end of program
```

```
EUCSD IMP Compiler for M68000.  APM Version  1.9d

 CHARDEMO  compiled on 03/10/84  at  00.38

! Demonstration program to draw all of the Hershy fonts

include "edwin:consts.inc"
include "edwin:specs.inc"

begin
   own integer init = 0
   const integer split = 32
   integer alphabet, char, set, y, dev

   on 14 start
       ! Event 14,6 signaled if alphabet doesn't exist.
       alphabet = alphabet + 1
   finish

   if init=0 start
       dev = default device
       initialise for (dev)
       viewport (0, 85*400, 0, 60*400) if  dev=7580
       viewport (0, 40*400, 0, 28*400) if  dev=7221
       window (0, 7200, 0, 4000)
       new frame
       prompt ("Page 1 or Page 2: ")
       read symbol (set) until set='1' or set='2'
       set char quality (software text)
       set char size (60)
       if set='1' start
           alphabet = 1
           set = split
       else
           set = 64
           alphabet = split+1
       finish
       init = 1
   finish

   cycle
      y = 120 * alphabet
      if set = 64 then y = y - 120*(split-1)
      move abs (0, y)
      set char font (26)
      text ("Set".ItoS(alphabet,2)." : ")
      set char font (alphabet)
      for char = 1, 1, 127 cycle
           character (char)
      repeat
      alphabet = alphabet + 1
   repeat until alphabet>set

   terminate edwin

end of program

153 statements compiled (+ 32 comments)
```

Appendix I : The Structure of the EDWIN PDF

The EDWIN Pseudo Display File (PDF) consists of a number of coded graphics instructions, one per line, which can be dumped into a file. These instructions contain all the information to re-generate the picture. The file can be redrawn by the use of -

<u>routine</u> REVIEW

which reads the current input and uses it to redraw the picture which it represents. This appendix describes the instruction formats of in the PDF.

Drawing Instruction Formats

These are of two types :

1) Normal Form-

This consists of one integer for the code giving the instruction type, this is stored in the first half byte, and the other three half bytes are zero. The next integer contains the X co-ordinate which the instruction uses, and the final integer contains the Y co-ordinate.

eg. | 0 0 0 code | | X value | | Y value |

2) Short Form -

This consists of the code integer, with the instruction code having had 16 added to it, the X and Y co-ordinates are packed into two eight bit fields inside the second integer. This means that for any drawing instruction where both co-ordinates are in the range -128 to 127, the shorter form may be used. This is frequently the case.

eg. | 0 0 1 code | | X value , Y value|

The codes for the drawing instructions are -

0	-	Line Abs
1	-	Move Abs
2	-	Marker Abs
3	-	Line Rel
4	-	Move Rel
5	-	Marker Rel

The top byte of the first number is used to specify marker selection for codes 2 and 5.

Other Instruction Formats

Window

If the EDWIN routine WINDOW is called, the parameters are stored in the PDF in the following form. The window is automatically altered if the PDF is being reviewed.

```
eg.   | 0 0 0 8 |   | XL |   | XR |   | 0 0 0 8 |   | YB |   | YT |
```

Characters

This requires one integer. The code dumped is -

```
                    | 0 , char val , 9 |
```

CHAR VAL is a byte, containing the ASCII value of the character to be drawn, and this is drawn at the current settings of character size, rotation, and quality as set by change attribute value commands.

Change of attribute value.

This has code 10. The centre two half bytes contain the value of the attribute, and the top half byte is one of the following codes :-

```
| 0 value A | => Colour Change
| 1 value A | => Line Type Change
| 2 value A | => Char Size Change
| 3 value A | => Char Orientation Change
| 4 value A | => Char Quality Change
| 5 value A | => Char Font Change
| 6 value A | => Char Slant Change
| 7 value A | => Marker Size Change
| 8 value A | => Speed Change
| 9 value A | => Colour mode Change
| A value A | => Shade mode Change
| B value A | => Chord step Change
| F value A | => Aspect ratioing
```

Newframe and End

These require one integer of value eleven or twelve respectively. If either are encountered when interpreting a PDF it causes control to return to the point where the interpreting routine was called from.

Appendix K : Acknowledgements

If everyone who had contributed to EDWIN was mentioned the list would go on for pages. The following people deserve special thanks for their contributions -

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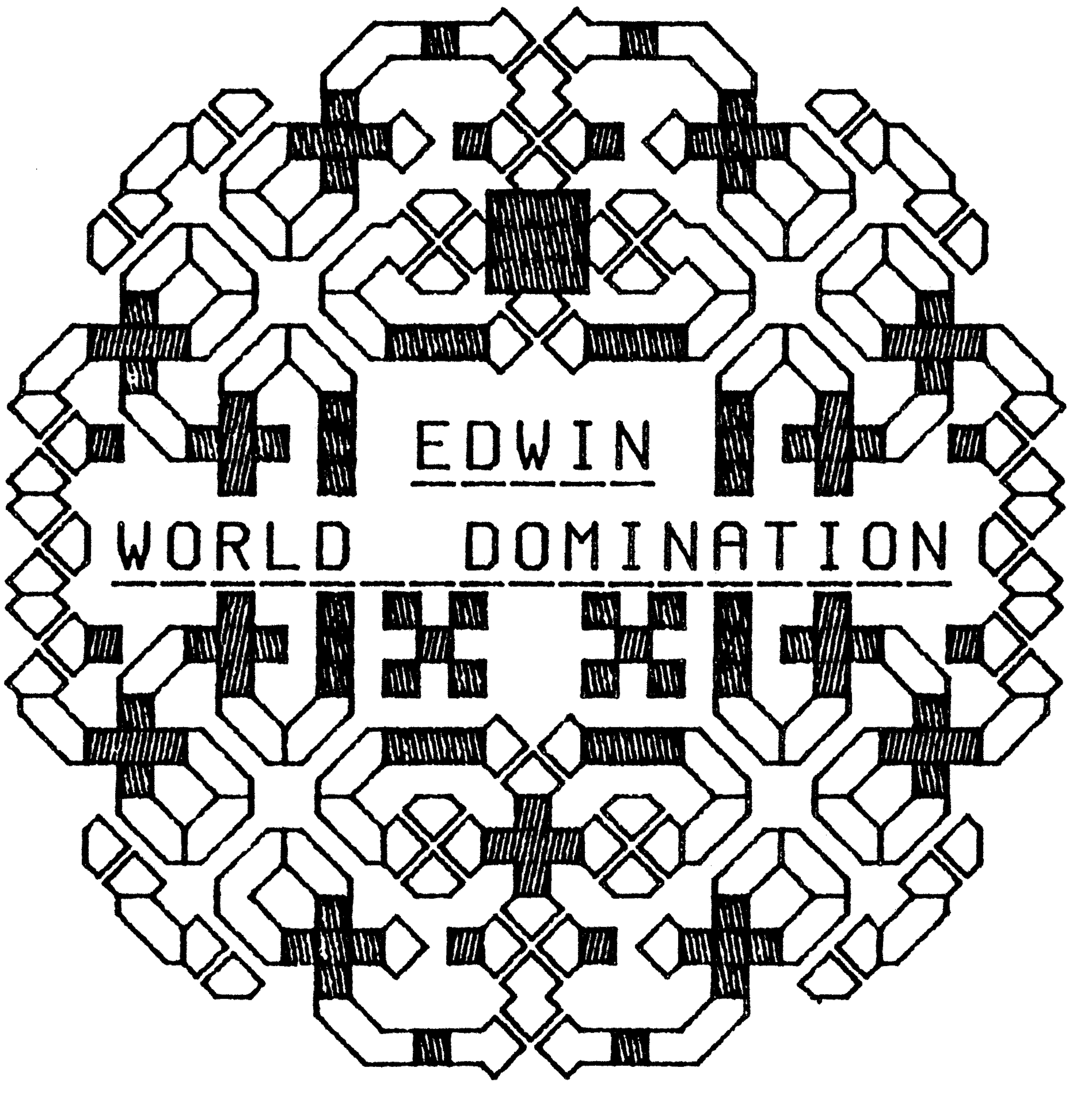
Special thanks to Nick Rothwell, whose interactive design program (which uses EDWIN) was used to design the cover picture. For technical reasons the cover picture appears below!



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