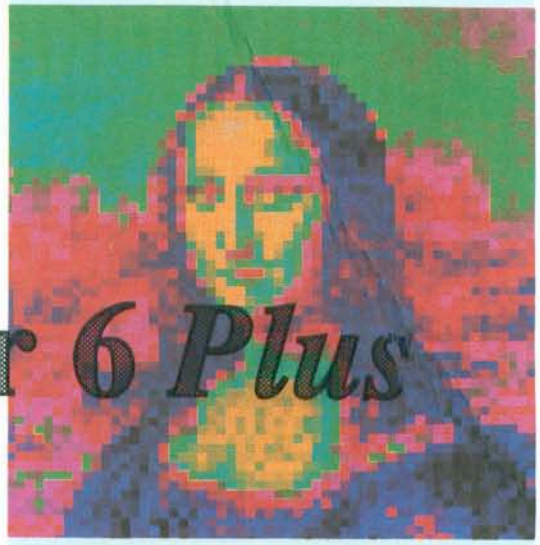
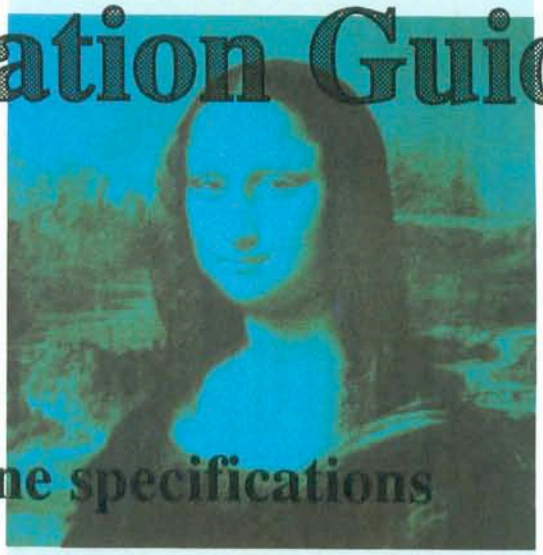


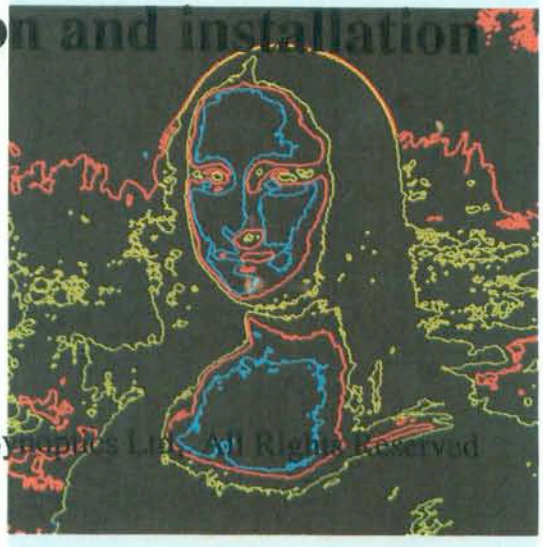
Semper 6 *Plus*

Implementation Guide



Primitive routine specifications

System generation and installation



Synoptics

Synoptics

Introduction: the scope of this document

This guide explains how you *install* Semper on a computer system, and is for most purposes only relevant therefore if you are doing this yourself, though it is possible some of the information may be of more general value. Its main purpose is to explain the concepts behind the interface that must be provided to link Semper to your computer's environment, and give the detailed specification of the routines that exploit this; it also includes information on adjustments that may be needed in the basic system code, and on running the system generation and help library utilities.

When the installation has been completed to the specifications given in this document, you will have a Semper system with standard display facilities. Such a system does not have the facility to input images via the framestore, e.g. camera input. Control of framestore features, such as switching of overlays, specifying overlay colours and camera input, will require additional Semper verbs to be written and are beyond the scope of this document.

VAX/VMS, users are supplied with relatively detailed installation instructions that supplement the general information in this document with a step-by-step guide specific to that environment.

Most of Semper is written in standard Fortran 77. Semper also makes use of the Hollerith data type for the reading and writing of character strings. Holleriths are provided as an extension to the standard by most Fortran 77 compilers. Those operations that need to be machine-dependent, such as character code conversion, display access and efficient disc and tape access, are localised in a small number of *primitive* routines, written afresh as necessary to suit each different environment; these constitute the 'interface' referred to above. You have to write these for your machine, supporting as much as possible of the standard interface Semper expects.

Besides the writing of the primitive routines, a number of minor adjustments also need to be made to the basic code of Semper as part of the installation process; these cover matters such as providing Semper with information about how its environment is configured (e.g. the length of the various Fortran data types, the size of disc blocks, the space to be allocated for various system tables, and the input/output unit numbers to be used), and accommodating variations between Fortran systems (e.g. additional i/o specifiers used in Fortran open statements, and issuing terminal prompts without a carriage return before the user's response).

1. The Primitive Routine Specifications

Unless otherwise stated, the datatypes of all arguments appearing in the specifications below are as Fortran defaults their names; the addition of *4 to an integer name indicates that it is declared integer*4 in the calling program (see section 1.2). The typeface of arguments indicates their mode of use: roman for input usage only, *italic* for output only, and bold for input and output.

1.1 Character access

Semper 6 handles string characters as integer values in the range 32-126, with the following assignments (the standard Ascii assignments), beginning with 'space':

```
 32:     !  "  #  $  %  &  '  (  )  *  +  ,  -  .  /
 48:  0  1  2  3  4  5  6  7  8  9  :  ;  <  =  >  ?
 64:  @  A  B  C  D  E  F  G  H  I  J  K  L  M  N  O
 80:  P  Q  R  S  T  U  V  W  X  Y  Z  [  \  ]  ^  _
 96:  '  a  b  c  d  e  f  g  h  i  j  k  l  m  n  o
112:  p  q  r  s  t  u  v  w  x  y  z  {  |  }  ~
```

These are subsequently referred to as *internal code* (i/c) characters. The file icset contains parameter constants for all the i/c values. A primitive routine is required that converts Hollerith (A1) characters to i/c characters, and two more routines that convert between i/c characters and character*1 data.

A1CONV CALL A1CONV(ibuf,n)
converts the n elements of array ibuf from Hollerith (A1) character form to i/c form.

MKCHAR CHARACTER*1=MKCHAR(ic)
returns the character*1 equivalent of the i/c character ic; may be identical to Fortan 77 intrinsic function char if you are lucky in the local collating sequence.

MKICHA INTEGER=MKICHA(cha)
returns the integer i/c equivalent of the first character of the character*(*) string cha; may be identical to Fortran 77 intrinsic function ichar if you are lucky in the local collating sequence.

INKEY LOGICAL=INKEY(*ic,ierror*)
returns in *ic* the i/c equivalent of a single keystroke read from the terminal, by-passing Fortran i/o if possible so as to render the normal terminating carriage return unnecessary. Keystrokes which have no i/c equivalent should be returned with a unique positive integer value that is outside the range 32 to 126. In the file icset you will find parameter constants defined for carriage return, left, right, up and down cursor keys, function keys, character and line delete, cursor to start of line, cursor to end of line, insert and refresh. Other keys may be added from time to time, icset should be taken as the definitive list. Semper currently makes use of carriage return and cursor left and right (parameter constants kbret, kbleft and kbrite) and you must ensure that inkey returns precisely these values. Any keystroke which represents an abandon request (see abandn) must cause inkey to return .TRUE. with *ierror* set to 4.

1.2 Pixel forms

Four distinct *forms* (representations or datatypes) are used for pixels in Semper 6, called byte, integer, fp and complex, and identified by *form numbers* 0, 1, 2 and 3 respectively. The integer, fp and complex forms are identical to the Fortran integer, real and complex datatypes (the last being two real values in succession with the real part before the imaginary part), and pixels in these forms are held and manipulated by Semper in Fortran arrays of the relevant datatype. The byte form is unsigned, allowing values in the range 0-255 (not -128 to 127 like the byte datatype in VAX/VMS Fortran); no Semper code refers to it directly, as few compilers provide the necessary datatype, and a primitive routine is required to convert arrays in this form to and from other forms.

You have to make a decision about your integer datatype. For most purposes, a 16bit (integer*2) pixel is the most suitable, allowing negative as well as positive values with magnitudes up to 32,767 and requiring only twice the space of a byte picture; normally therefore, you should try to arrange that the declaration integer in Semper's Fortran source means integer*2, perhaps via a compiler option. If you positively prefer a 32bit (integer*4) pixel for the sake of the larger magnitude (up to about 2,000,000,000), in spite of the doubled space requirement, you should arrange your compiler options so that integer means integer*4 instead. Of course, it may be that you have no choice, and are obliged to adopt whatever interpretation your compiler applies.

You may like to know, while thinking about this decision, that the Semper source code uses an explicit (and non-standard) integer*4 declaration for any integer variables whose value may exceed the range of an integer*2 datum (e.g. disc block numbers). You will not therefore provoke overflow in other areas by opting for the shorter integer length, provided that this integer*4 declaration is honoured by your compiler; if it is not, *and* the default length is 16bits, you have to edit these to read simply integer instead, and your installation will indeed be restricted in the maximum size that various data structures may have - details are given below as they arise.

In summary: try to make integer mean integer*2, and integer*4 mean just that.

CFORM CALL CFORM(inbuf,*outbuf*,inf,outf,n*4)
converts data with form inf to data with form outf. The data is passed to cform in array inbuf and returned via array outbuf. inbuf and outbuf may point to the same area in memory, so your conversion loop should run backwards through the array when converting to a longer form. There are n data values to convert. If possible, you should provide fast 'block move' code for the cases where inf = outf. In converting from floating point to integer or byte forms you must round to the nearest integer value rather than truncating.

It is worth expending some effort to make this routine efficient, as it is heavily used by Semper for the 'on the fly' form conversions which make it appear capable of processing pictures stored in any of the four forms; all transfers to or from the 'disc cache' buffers, including those where no actual form conversion is required, are made with cform.

1.3 Data storage

Semper 6 needs to store large volumes of data. This data can take the form of pictures, program libraries and help libraries. Semper can make use of three distinct types of storage media: disc, tape and framestore. Random access disc files are used to store pictures, programs and help information. There is also a special disc file called the 'work disc' which is a temporary file created by Semper to hold some of its data structures, those that are too large to be held permanently in memory, e.g. the display partition table, luts, etc. Tape and framestore devices are only used for storing pictures. Any number of disc and tape files, up to a pre-determined maximum, can be assigned during a Semper session. Only one framestore device may be aasigned at any one time.

Semper refers to each storage device by means of a unique integer *device* number. Device 0 is always the work disc and device 1 is always the framestore device. The device number is passed to the disc and tape primitve routines. Therefore disc devices are numbered 0 or 2 upwards and tape devices from 2 upwards. The parameter constant ndvs in the params file determines the upper limit for device numbers. Because the device number for the framestore is fixed, no device number is passed to any of the framstore primitive routines.

1.4 Disc access

Basic picture storage in Semper 6 is in disc files, each of which may hold many pictures, and several of which may be in use at once. All such disc files are seen by Semper as being organised in randomly accessible fixed length blocks (*Semper logical blocks*, or simply *blocks* subsequently). An efficient primitive is needed to read and write these blocks to and from memory buffers; this commonly (though not invariably) needs to make lower level calls to system services than the Fortran read and write statements provide. In most installations, substantial numbers of disc blocks are buffered by Semper in memory areas called *disc cache buffers*, and the primitive reads and writes these buffers as a whole, so that it is only at this level that physically random access is desirable. When this route cannot be adopted (for want of addressable memory), physically random disc access is

desirable at the individual block level.

If you are not *caching*, the Semper logical block size is effectively dictated by the physical sector size on your computer's drives. Otherwise, however, you have to decide the size yourself. It will probably need to be a multiple or sub-multiple of the physical sector size, so that the cache buffers can be read and written efficiently. Too large a size will waste disc space, since many Semper data structures, including picture rows, are stored *block-aligned*, i.e. beginning at the block boundaries; On the other hand, if the integer*4 declarations (see section 1.2) in fact achieve a no better than a 16bit datatype, the maximum block number is only 32,767 and too small a block size limits the size of your disc files. Semper requires a block size of at least 18 integer storage units. A block size of 64 bytes is typical when there is no problem with integer*4 declarations, and 256 bytes or 512 bytes otherwise.

Note that Semper starts numbering disc blocks from 1 not from 0.

An alternative version of the Semper system routine disc for use in a non-caching version of Semper is to be found in the file ncdisc.

MCDC61 CALL MCDC61(iop,idev,n*4,num,ibuff,*ierror*)
performs data transfers and disc file assignments and deassignments according to the opcode iop:

iop = 0: initialise disc access (called once at startup), there are num blocks of n bytes in a cache buffer, ibuff is the disc cache array
1: reads blocks n to n+num-1 of device idev to array ibuff
2: writes blocks n to n+num-1 of device idev from array ibuff
3: assigns existing file as device idev for full read/write access
4: assigns existing file as device idev for read-only access
5: creates new file of n blocks; assigns as device idev for full read/write access
6: deassigns device idev
7: deassigns device idev and deletes file
8: as 5, but file is temporary and should be deleted on deassignment

In the event of an input/output error of any kind, mcdc61 sets ierror to 8, and if any error occurs while creating, assigning or deassigning a file, mcdc61 sets ierror to 44. Otherwise, it returns ierror unchanged.

For iop = 3 to 7, the file name is supplied as i/c chars in ibuff(2,3..), with the number of characters in the name in ibuff(1). iop = 4 is intended to allow access to other people's (possibly protected) files as well as to prevent accidental data overwriting: actual read-only enforcement is not in fact required, as Semper remembers the opening mode and prevents any write requests being made. iop = 5 deletes any existing file of the same name if necessary before creating.

Semper uses the temporary file assign (iop = 8) to create the work disc (idev = 0) and any scratch workspace files that are requested by the user. If possible, mcdc61

should create a file that it is automatically deleted on exit from Semper. Semper will usually call mcdc61 to deassign and delete the work disc (iop = 7) when it terminates normally, but this will not happen if an error causes Semper to be aborted. If automatic deletion cannot be arranged, the file should be created as normal. If the worse happens, it can always be deleted manually outside Semper. The filename is generated by Semper and will start with the letters 'ZZ'. Note that this name is intended only as a hint to mcdc61, other names (or no name at all) can be used. If possible, consider making temporary files be areas of dynamic memory, as efficient access to the workspace will noticably improve Semper's performance.

In caching installations, Semper makes read and write calls only with num equal to the cache buffer size, and with n aligned with a cache buffer boundary; file creation in such installations includes any initialisation necessary to allow Semper to *read* the file subsequently, as Semper's first operation on any cache buffer is a read rather than a write.

A typical pattern of access during a Semper session is an initial opcode 0 call followed by several opcode 3, 4, 5 or 8 calls, followed by a more or less arbitrary sequence of opcode 1 and 2 calls (except that no part of a file is written before it has been read), followed by final opcode 6 and 7 calls.

1.5 Tape access

Semper's tape handling reflects the essential differences between tapes and disc; these include the variability of block sizes, the special *tape marks* used as end-of-file markers, and the serial nature of the medium (random access, while possible, is slow; and writing at a given place renders all material further down the tape inaccessible). The primitive routine is required to function at a low level, close to that at which system services commonly operate.

Tapes are identified by device numbers in the same way as for discs except that device numbers 0 and 1 are never assigned to a tape device. The device number assigned, at any given time, to a tape device will not be assigned to a disc device, and vice versa.

MCTP61 CALL MCTP61(iop,idev,n*4,ibuff,*ierror*)
performs data transfers, block and file skipping, end-of-file mark generation or detection, and tape mounting and dismounting, according to the value of iop:

iop = 1: positions tape device idev to the *load point* (beginning of tape); the opcode may be requested when the tape is already positioned there
2: reads a block from device idev, transferring up to n bytes to array ibuff, and resetting n to the number actually transferred if this is less; sets ierror to 2 if the 'block' proves to be an end-of-file mark
3: reserved (unused at present)
4: writes a block of n bytes from array ibuff to device idev
5: writes an end-of-file mark to device idev
6: skips forwards one block, setting ierror to 2 if the 'block' proves to be an end- of-file mark
7: skips backwards one block; the opcode is not requested at the beginning of a file
8: skips forwards one file, stopping beyond the terminating end-of-file mark
9: skips backwards one file, stopping beyond the end-of-file mark terminating the preceding file; the opcode is not requested within the first file on a tape
10: assigns tape as device idev for read/write access, mounting physically if necessary
11: assigns tape as device idev for read-only access, mounting physically if necessary
12: deassigns device idev, dismounting physically if n is zero

In the event of an input/output error of any kind, mctp61 sets ierror to 1 and if there is any assign or deassign failure, mctp61 sets ierror to 44. Otherwise it returns ierror unchanged.

For iop = 10 or 11, the file name is supplied as i/c chars in ibuff(2,3..), with the number of characters in the name in ibuff(1). Ideally, iop = 11 mounts the tape with the write-enable ring removed; however, actual read-only enforcement is not in fact required, as Semper remembers the opening mode and prevents any write requests being made.

If the tape primitive cannot be provided with the above functionality in a given installation, the simplest alternative is to provide a 'dummy' routine which simply returns without doing anything except for setting ierror to 44 on any assign request (iop = 10 or 11); this results in a Semper with no direct tape access, and requires all use of tapes to be made via whatever utilities are available for copying disc files to or from tape.

Where it is only backward tape movement that cannot be provided, Semper can still make a limited use of tapes by rewinding and skipping forward as necessary; in such installations, no requests for opcodes 7 and 9 are made. If rewinding is also impossible, mctp61 sets ierror to 2 before returning when opcode 1 is requested; tape access in such cases is limited to copying pictures to or from

tapes in serial order.

Under operating systems which strive too hard to make tapes appear exactly like a succession of disc files, the ability to move freely between files may be difficult to implement; the effect can sometimes be achieved indirectly by performing a close operation on one file followed immediately by an open with a different file name or sequence number.

A typical pattern of access for a given tape during a Semper session is an initial opcode 10 or 11 call, followed by an opcode 1 call to establish an initial position, and then a more or less arbitrary sequence of opcode 1 to 9 calls, followed by a final opcode 12 call.

1.6 Framestore access

Semper 6 expects a relatively complicated interface with a display device, conceiving it primarily to be of the framestore type. Partial implementation of the specification below is also useful, and leads to an installation with corresponding partial functionality.

The framestore *image* memory is considered to be organised as one or more separate *frames* of the same size, (not necessarily square) numbered 1,2.. and addressed individually by an (x,y) coordinate pair in which x counts pixels rightwards across the frame, *y counts pixels downwards*, and 0,0 is the top left. (Note that this is not the usual co-ordinate provided by graphics devices). Typically, each frame is 8 bits deep, allowing 256 distinct grey levels; more can be exploited however, and less can be accommodated. Each image memory pixel is also considered to have a corresponding one-bit *overlay* pixel; the overlay is used for superposing text, graphics etc. on images without corrupting the image data. If a framestore does not have an overlay plane, it is often possible to simulate one by using either the top or the bottom bit of each pixel as the overlay bit. If this approach is not suitable, then any output that would normally go to the overlay will have to overwrite the corresponding parts of the stored image.

You have to make decisions about the division of your framestore memory into frames. Semper allows users to subdivide frames conveniently at run time into smaller display *partitions* that can be used independently for picture storage, so in many cases the division is largely artificial and probably undesirable. With a typical simple framestore device providing a 512 point square memory, there is no reason to do other than treat it as a single frame of this size; a single 1024 square frame is best treated as just that rather than as four independent 512 square frames, as the latter effect can be achieved by partitioning the 1024 frame when needed without prejudicing the ability to store a single image of 1024 pixels square as well.

Frames need to reflect hardware continuity of pixels in two respects: (i) transfers should be possible between host computer memory and rows and columns of pixels extending anywhere across a single frame ; and (ii) the video signal generator should present the complete frame or a subregion of it on a monitor screen. This

may prevent your treating several physically distinct frames as a single larger frame for Semper purposes.

The final factor affecting the decision on frame organisation is *full colour* picture generation, if the hardware has this capability. In the full colour mode (as opposed to *false colour* mode), a series of three pictures, representing the red, green and blue components of an image, must be fed to the three colour inputs of the monitor; Semper 6 chooses to place these pictures in three successively numbered frames (or in corresponding subregions of them). It is necessary therefore to choose an organisation in which whatever different parts of the framestore memory can be combined in a full colour display are presented to Semper as three succesively numbered frames, in the order red, green, blue.

A considerable range of different hardware can be coerced to serve as the Semper display device, mimicking the framestore conception to a greater or lesser extent. Where a *binary* device, offering black and white dots only, is used, grey levels can be simulated within the primitives by allocating a small square block of dots (e.g. 4 square) and setting variable numbers of these according to the brightness required; such blocks are called *grey pixels* below, and the number of addressable pixels along the side of a block is called the *grey pixel size*.

It may help you assimilate the specifications below to know that a typical pattern of framestore access during a Semper session consists of an initial fsas61 call to assign the device, followed by an fsvw61 call to establish viewing conditions; then an arbitrary sequence of fser61, fsro61, fsri61, fsln61, fstx61, fsvw61, fslu61 and fsxw61 calls, with an fsfl61(1) call whenever it is important that the monitor screen is completely up-to-date and an fsfl61(2) call whenever (if ever) a user's close command releases an entire display for output to hard-copy hardware; and a final fsde61 call.

All framestore primitives are coded as logical functions; they return .false. normally and report any kind of error condition by setting ierror to 40 and returning .true..

1.6.1 Assignment, deassignment and data buffer control

FSAS61 LOGICAL=FSAS61(nfrs,nfx,nfy,nmx,nmy,nchx,nchy,ngp,iwo,*ierror*)
assigns the framestore, establishing its configuration, and performs any device initialisation necessary. A particular configuration for the framestore may be requested with non-zero arguments as follows:

nfrs - number of frames
nfx, nfy - horizontal, vertical frame dimensions, in pixels
nmx,nmy - horizontal, vertical monitor signal dimensions, in pixels (the number of pixels in each line of, and the number of lines in, the video signal)
nchx, nchy - horizontal, vertical dimensions of character block, in pixels (see below)
ngp - grey-pixel block size (see above)
iwo - write-only flag (write-only if non-zero)

Where any of these parameters can be adjusted at run time, fsas61 takes the necessary action. It should, in any event, return in all of the arguments values that are applicable to subsequent calls to the framestore primitives until a fsde61 is called to deassign the framestore.

Any initialisation performed by fsas61 need not include establishing monitor viewing conditions (frame, zoom, scroll, look-up table), as these are established by later calls to fsvw61; and it should *not* erase any framestore memory, as this is a convenient route for passing pictures into Semper from other programs. When initialising a framestore that may be shared between several Semper users, fsas61 must not alter the state of the display, as this could interfere with other users already using the framestore. It follows that such a framestore must not be reconfigured by fsas61. On a workstation, a window can be used to simulate a framestore. In this case, fsas61 should try to create a window with a size given by nfx and nfy, adjusting the size if necessary to ensure that the window fits onto the screen.

FSLQ61 LOGICAL=FSLQ61(*lutlen,lutmax*)
returns the number of entries in a framestore lookup table in lutlen and the maximum value for a lookup table entry in lutmax. The function returns .TRUE. if the value of lutlen exceeds the compile time limit LUTSIZ or if there is any sort of problem in determining the values required.

FSDE61 LOGICAL=FSDE61(*ierror*)
deassigns the display device. On a workstaion where a window was created to simulate a framestore, the window should be destroyed, e.g. assigning one of several framestores attached to the system.

All fsas61 and fsde61 calls are made from one Semper module, assfs, which can be easily adapted to accommodate further variations in the assignment or initialisation process to suit particular local requirements.

FSFL61 LOGICAL=FSFL61(iop,*ierror*)
flushes any output display device buffer in one of two ways according to the value of the opcode iop and the type of display hardware in use:

iop=1 : is relevant to installations with framestore hardware which make physical transfers to the framestore only when a relatively large main memory buffer becomes full; fsfl61 *flushes* any such buffer so that any pending material becomes visible on the monitor
2: is relevant to installations with a hard-copy device (e.g. a laser printer), where the entire display is retained in main memory or in some intermediate file until explicitly released by the user; fsfl61 despatches any such buffered display to the hard-copy device

In each environment, fsfl61 ignores requests for the other opcode.

1.6.2 Memory access

References to memory positions off the display frames are possible, given the user's freedom to write code of his own with direct calls to the primitives. Therefore the framstore primitive routines should clip all information that is passed through. Standard Semper code truncates pictures, lines and text as necessary.

FSER61 LOGICAL=FSER61(iop,nx,ny,ix,iy,ifr,*ierror*)
erases (resets to zero / black) a region of frame ifr, nx pixels across by ny down, with the top left at ix,iy, according to iop:

iop = 1: erases image memory only
2: erases overlay memory only
3: erases both memories

FSRO61 LOGICAL=FSRO61(row,n1,n2,isam,iform,ix,iy,ifr,black,white,icol,*ierror*)
outputs pixels n1 to n2, in steps of isam, from array row as a picture row rightwards across image frame ifr beginning at ix,iy; accepts pixels in row in any of the four Semper forms according to the form number iform. If the data form is complex, the real part of each pixel should be displayed. The values should be scaled so that a value equal to black maps onto the minimum pixel value (zero) and a value equal to white maps onto the maximum pixel value, allowing for the possibility black > white (reversed contrast). Any values outside the range black to white should be set to the corresponding extreme pixel value. This scaling facility means that Semper does not need to know the range of values actually supported within the framestore image memory.

If icol is non-zero, fsro61 outputs the pixels as a picture column downwards from ix,iy. This opcode is not currently used but it will be used in the next version of Semper.

FSRI61 LOGICAL=FSRI61(*row*,n,iform,ix,iy,ifr,black,white,icol,*ierror*)
recovers a picture row of n pixels rightwards across image frame ifr beginning at ix,iy to array row. Returns pixel values in any of the four Semper forms according to the value of iform. The pixel values should be scaled so that the minimum pixel value maps to black and the maximum pixel value maps to white, allowing for the possibility that black > white.

If icol is non-zero, the pixels are accessed downwards from the position ix,iy. This opcode is not currently used but it will be used in the next version of Semper.

FSOI61 LOGICAL=FSOI61(*row*,n,ix,iy,ifr,icol,*ierror*)
recovers a picture row of n overlay pixels rightwards across the overlay of image frame ifr beginning at ix,iy to array row. Returns integer pixel values that should be zero if the overlay pixel is blank and non-zero otherwise.

If icol is non-zero, the pixels are accessed downwards from the position ix,iy. This opcode is not currently used but it will be used in the next version of Semper.

FSLN61 LOGICAL=FSLN61(ix2,iy2,ix1,iy1,ifr,*ierror*)
draws a line from ix1,iy1 to ix2,iy2 in the overlay of frame ifr; the direction matters only when the hardware is of the pen plotter type.

FSTX61 LOGICAL=FSTX61(ibuf,n,ix,iy,ifr,*ierror*)
writes a string of text, defined by the n i/c characters in array ibuf, to the overlay of frame ifr, centred at ix,iy.

Semper expects characters to be generated with a fixed (i.e. non-proportional) font; each character is allocated a block of pixels which allows one blank column at the right and one blank row at the bottom, and the blanks are included in the dimensions reported by fsas61 (see above). A string is assembled by abutting these character blocks. The position in the string to align with ix,iy is the string centre rounded to the nearest pixel to the right and down.

1.6.3 Viewing conditions

Semper provides for simple integer zoom and scroll control of its framestore; and also for relatively sophisticated control of the output look-up tables (*luts*) and colour presentation modes. No standard interface is however defined at present for controlling how the overlay memory is presented; this is generally assumed to be visible on the monitor at all times in some form or other, and you may need to combine overlay presentation control with your management of luts, which are assumed by Semper to be applied only for displaying the contents of the image memory. There is no facility provided in Semper for managing input luts.

Semper envisages in general the ability to hold several luts in the hardware, to write or read any [illegible]hese, and to select any one of them for *active* use in controlling the mon[illegible] signal generated, independently of which frame is being

viewed (i.e. luts are *not* associated with particular display frames.

A *mode* (value 1, 2 or 3) is associated with each lut, which may be monochrome, false colour or full colour; in the monochrome mode, a single intensity transformation table is used to map pixel values from a single image frame to all three monitor colours (or a single monochrome monitor input); in the false colour mode, the lut consists of three separate tables which are used to map pixels from a single image frame to the three monitor colours; and in the full colour mode, the same three tables are used to map pixels from three distinct (but consecutively numbered) frames to the three monitor colours. In making a given lut active, the corresponding mode must also be correctly established.

A given table consists of an array of integers with a length determined by the number of possible pixel values supported within an image memory frame, giving replacement intensity values, in the range 0 to whatever local maximum is appropriate, for each stored pixel value. You must set the parameter constants lutlen and lutmax in the file params to specify the lut size and maximum lut value.

Luts are numbered from 1 up to a maximum number you chose. This will usually exceed the number of luts the hardware supports. The parameter constant lutnum in the file params determines the maximum number of luts that Semper can maintain. fsvw61 and fslu61 manage the details of which luts are actually held in the hardware. fslu61 is called whenever a change is made to one of the luts. If the lut is currently held in the hardware, fslu61 can overwrite its contents with the new data. A different lut is activated with a call to fsvw61. If the lut is already stored in the hardware, fsvw61 can activate it more rapidly than a lut that must be loaded from the host. For a simple framestore with a single lut, only the active lut can be held in the hardware. New data will have to be loaded from the host when fsvw61 activates a different lut, and when fslu61 is called to alter the contents of the active lut. For a more sophisticated framestore with n luts, you might maintain copies of the luts numbered from 1 to n-1 in the hardware and use the remaining space to hold the last activated lut numbered from n upwards.

FSVW61 LOGICAL=FSVW61(lutn,izoom,iblank,nx,ny,ix,iy,mx,my,ifr,*ierror*) establishes monitor viewing conditions that present a region of frame ifr (or frames ifr, ifr+1, ifr+2 in the full colour mode) at zoom factor izoom, with pixel mx,my at the centre of the monitor screen; if iblank is non-zero, the screen is blanked outside the nx,ny pixels whose top left is (frame position) ix,iy. The present version does not call fsvw61 with a non-zero value for iblank. Requests for unsupported functions are simply ignored.

If the hardware is incapable of blanking outside arbitrary regions, as described above, there is little loss of functionality in simply ignoring this feature. Blanking outside the memory frame however should be implemented if possible, so as to avoid displaying spurious data when the monitor viewing window is scrolled beyond the limits of the memory frame. If blanking is not possible, an alternative is to limit scrolling to keep the monitor window always within the memory frame. Some hardware will wrap round the display when pan and scroll exceed the limits of the frame memory; for these systems it is acceptable not to limit scrolling.

The lut number lutn is also activated by fsvw61, together with the associated mode. No action is necessary of course if this lut is already active; if the lut is inactive but held within the hardware, fsvw61 takes whatever action is necessary to activate it. If it is not held within the hardware either, then fsvw61 asks Semper to supply the lut data and mode as follows:

```
INTEGER LUTBUF(enough)
...
IF (SEMLUT (1, LUTN, MODE, LUTBUF)) THEN
   FSVW61=.TRUE.
   RETURN
ENDIF
```

Note that ierror is *not* set to 40 in this case. The data is then transfered to the hardware by fsvw61 and activated (perhaps with a call to fslu61). False and full colour luts are passed in lutbuf as three consecutive sets of values in the order red, green, blue.

FSLU61 LOGICAL=FSLU61(iop,lutn,mode,lutbuf,*ierror*)
transfers data to or from hardware luts according to the opcode requested:

iop = 1: reads lut from hardware lut number lutn to array lutbuf, returning in mode the corresponding lut mode, When it is not possible to obtain the lut mode from the hardware, the user has the option to specify a mode on the command line. This is passed to fslu61 in mode as a non-zero value and this mode should be assumed for the purposes of reading the lut data from the hardware. If, however, mode is set to zero, a fault should be reported. A fault is also reported if the requested lut is not buffered in the hardware.

iop = 2:copies lut data from array lutbuf to the hardware. mode specifies the lut mode. If lut lutn is not currently held in the hardware, fslu61 does nothing.

Fslu61 is called whenever the contents of a lut change.

FSXW61 LOGICAL=FSXW61(ix,iy,*ierror*)
activates a display cursor, with an initial position ix,iy (on whichever frame is currently being viewed; see below), allows the user to move the cursor with a mouse, trackball or terminal keys, and returns in ix,iy the coordinates of the position finally selected (by a mouse 'read' button, a terminal carriage return etc. as you choose). The cursor should preferably be displayed in such a way as not to destroy any of the information stored in the framestore, e.g. by displaying it in a separate overla

1.7 Miscellaneous

Semper users can normally issue some form of *abandon request*, such as striking a control-C at the terminal; this allows them to interrupt indefinite loops, abandon lengthy procedures or correct mistakes as soon as they are noticed. A primitive is required to sense these requests.

ABANDN LOGICAL=ABANDN(*ierror*)
returns .true., and sets ierror to 4, if an abandon request has been made since the last time abandn was called, emptying any terminal type-ahead buffer if possible. Otherwise abandn returns .false. without changing ierror. An abandon request is any special keystroke or break signal which can be trapped by the operating system and detected by abandn. Semper calls abandn at regular intervals, for example, whenever a picture row is accessed, and always after any call to inkey. Systems which use the Event Queue mechanism are supplied with a standard version of abandn.

MCTIME CALL MCTIME(*ibuf*)
sets the seven elements of array ibuf to the current year (e.g. 1986), month (1-12), day (1-31), hour (0-23), min (0-59) sec (0-59), and centisec (0-99), supplying zero for any information not available. If possible attempt to provide the first six items, as Semper uses the time to generate temporary file names.

WAITS CALL WAITS(secs)
suspends or otherwise delays Semper for secs seconds of real (not central processor) time; limited or approximate functionality is still useful.

Three routines for bit manipulation are defined in a way commonly provided by Fortran compiler extensions:

IBTNOT INTEGER=IBTNOT(i)
returns the bit-wise not of the argument.

IBTOR INTEGER=IBTOR(i1,i2)
returns the bit-wise or of the two arguments.

IBTAND INTEGER=IBTAND(i1,i2)
returns the bit-wise and of the two arguments.

1.8 Event Queues and their implementation

In order to interface to the Semper 6 *plus* user interface, and to provide improved interactive facilities, it is worth implementing the Semper Event Queue mechanism. Systems with the Event Queue mechanism can make use of standard versions of the routines inkey and abandn and will also be supplied with the command line buffer and editor.

1.8.1 Overview

The Event Queues are four independent circular queues of data from the standard interactive input devices: the keyboard, the pointing device, the button or switch device and the break key or switch. The queues are ordered internally, but there is no attempt to synchronise them temporally e.g. it is not possible to determine whether a key press preceded a pointer movement, but the order of key presses is recorded. The queue interface routines allow the queues to be initialised, have their status changed or examined and have their entries examined (in any order), read (first in, first out).

The queues have an explicit priority relative to each other. This is to ensure that the status routine used to inquire for a non-empty running queue (eqnext) will return a predictable result. The queues and their relative priorities are as follows:

1.8.1.1 The BREAK queue

This queue has the highest priority. It handles the signal that is normally attached to the Semper primitive abandn, and a version of abandn that uses the queue is supplied as standard for Event Queue versions. In most systems the signal will be a special keystroke (e.g. Control-C, Control-Break etc.), although it could also be a front panel switch or some other external signal.

The queue always has a maximum length of one, and simply returns the number of BREAKs since the queue was last read or initialised.

1.8.1.2 The KEYBOARD queue

The keyboard queue accepts direct keyboard input. If possible it will bypass normal Fortran I/O and read key presses without echo and without the need to press return (in fact return should be readable as the special character KBRET). Any special sequences will be handled by the keyboard read routine; the entries placed in the queue are Semper internal characters (see Section 1.1). Event Queue versions are supplied with a standard version of inkey that uses this queue.

1.8.1.3 The POINTER queue

The pointer queue tracks movement of the pointing device (as used by fsxw61). The co-ordinate system used has the same sense as the framestore system i.e. x inreases from left to right and y increase from top to bottom. Absolute pointer positions are not reported, instead the relative changes in pointer position are reported.

1.8.1.4 The BUTTON queue

The button queue records changes in the state of the buttons associated with the pointing device. The buttons are numbering convention used is that the buttons are numbered from 1 upwards from left to right.

1.8.2 Specification of the top level routines

This specification can be used as a definition for the implementer of the Event Queues on a new host machine, it can also be used by experienced programmers who wish to interface to the keyboard, pointer etc. directly. Any programmer wishing to change the state of a queue (using eqsets) should save the current state of the queue (using eqnqre) and restore it (always) when the local routine has finished.

1.8.2.1 Standard parameters

The file events should be included in all files that wish to access the Event Queues. This file contains parameter declarations for the standard arguments to the queue handlers. These are as follows:

Queue sources:

MANYS	Any source - used in read and status calls
MBREAK	The break queue
MKEY	The keyboard queue
MPOINT	The pointer queue
MBUT	The button/switch queue

Queue request/action states:

QRUN	Allow events to be read and new events to be inserted
QOPEN	Flush queue then as QRUN
QWAIT	Disable event reads, but insert new events
QCLOSE	Disable event reads, ignore new events

QOPEN is a request state only, and will read back as QRUN when accessed by the status read routines.

Queue access methods:

QTAKE	Read and remove queue head entry
QLOOK	Read and keep queue entry, advance peek pointer
QSNAP	Ignore queue and read device immediately (only sensible for MPOINT and MBUT)

Queue modifiers:

OSETL	Set pointing device lock state
OSETG	Set pointer gearing ratio
OSETS	Set pointer sensitivity

Pointer track states:

ECHNON	no hardware echo of pointer position (the normal case)
ECHDSP	pointer echoed on framestore
ECHHST	pointer echoed on host monitor
ECHALL	pointer echoed on both framestore and monitor

1.8.2.2 Standard routines called from Semper

EQINIT CALL EQINIT

Initialise all queue manager routines and set all queues to the QCLOSE state. All physical sources are checked to see if they are present, and any internal flags and variables are set.

EQSETS LOGICAL=EQSETS(iqueue,istate)

Change the action state of the event queue specified by iqueue. The function returns .TRUE. if either iqueue or istate is invalid or if an internal error occurs during processing. If the source of the queue is not physically present, the queue is always be set to QCLOSE. If the queue is already in the required state no action is taken.

EQNQRE LOGICAL=EQNQRE(iqueue,*state*,*lqueue*,*nqueue*)

Return the current action state of the event queue specified by iqueue in istate. istate may not be the same as the last state set with eqsets; QOPEN is never returned and if the source of the queue is not physically present, iqueue will always be returned as QCLOSE. The function returns .TRUE. if either iqueue or istate is invalid or if an internal error occurs during processing. The maximum length of the queue is returned in lqueue (this will be zero if the source is not physically present) and the current length of the queue is returned in nqueue.
If lqueue and nqueue are identical (and non-zero), it is possible that some data

will have been lost due to queue overflow.

EQSETD LOGICAL=EQSETD(iqueue,modify,i1,i2,i3)

This function sets information about the event queue specified by iqueue. modify selects the required operation and i1,i2,i3 contain the information to set. The function returns .TRUE. if any argument is invalid or if some unexpected internal error occurs during processing. The queues affected by this function and the acceptable operations are as follows:

Pointer queue:

modify = OSETG set the pointer X and Y gearing to i1 and i2
OSETS set the pointer X and Y sensitivity to i1 and i2

Sensitivity is the number of internal pointer units by which the pointing device must move before the move is considered *significant*. Such a *significant* move is then scaled by dividing by the pointer gearing; if the absolute value of the scaled move is then non-zero in either co-ordinate, the move is queued.

OSETL set the pointer lock on (i1=1) or off (i1=0)

The pointer lock is used to ensure that it is possible to read pointer moves and button state changes. This is mainly for use on workstations where, for instance, a mouse button may cause a menu to appear rather than a button change to be reported. Since locking the pointer may prevent use of workstation facilities, it should be held only when necessary, and released in all circumstances (including when an error has occured).

Break, keyboard and buttons:

No valid operations at present.

EQGETD LOGICAL=EQGETD(iqueue,*i1*,*i2*,*i3*)

This function returns information about the physical source of the event queue specified by iqueue. The function returns .TRUE. if any iqueue is invalid or if some unexpected internal error occurs during processing. i1,i2 and i3 are used to return information about the physical sources of the queues as follows:

Break queue:

i1 contains zero if BREAK can not be detected

Keyboard queue:

i1 contains the minimum detectable function key number
i2 contains the maximum detectable function key number
i3 contains zero if there are no detectable cursor keys

(if you do not have function keys return i1 and i2 as zero)

Pointer queue:

i1 contains the pointer echoing state:
i1 = ECHNON if there is no echo
ECHDSP if the pointer position is echoed on the framestore
ECHHST if the pointer position is echoed on the host monitor
ECHALL if the pointer position is echoed on both

Buttons queue:

i1 contains the number of buttons or switches
i2 is zero if button closure can not be detected
i3 is zero if button open can not be detected
(if i2 and i3 are both zero only 'clicks' are detected)

EQNEXT LOGICAL=EQNEXT(*iqueue*)

This function returns the next source of events (in priority order) in iqueue. The next event may not be the next one temporally as the queues are examined in priority order until a non-empty running queue is found. If all queues are empty the function returns .TRUE., but will initiate polling on passive devices (e.g. demand mice, etc.) ready for the next call. The priority order in which the queues are examined is as follows:

Break queue
Keyboard queue
Pointer queue
Buttons queue

EQREAD LOGICAL=EQREAD(*iqueue*,method,*entry*,*i1*,*i2*,*i3*)

This function is used to examine and read information from one or any event queues. iqueue specifies the specific queue to use or if set to MANYS the first queue (in priority order) to contain information is used and iqueue returns the actual queue. i1, i2 and i3 return information according to the specific queue used (see below). method specifies the queue access method to use:

method = QTAKE reads and removes the first entry from the appropriate queue. entry is returned non-zero if an entry was successfully read, or zero if there is nothing to return (the queue is empty).

QLOOK reads the next queue entry. entry is used to indicate which queue entry to read (zero is the first entry). entry returns the position of the next entry or zero if the queue is exhausted.

QSNAP looks at the actual physical source if possible.
(If QSNAP is used with MANYS and the break and keyboard queues are empty, then if either of the pointer or button queues are in state QRUN a snapshot of their respective physical source will be made.)

The function returns .TRUE. if any argument is invalid or if any unexpected errors occur during processing.

The actual data returned is as follows:

Break queue:

i1 contains the number of BREAKs detected

Keyboard queue:

i1 contains the internal Semper ASCII character code of the key pressed or one of the following special values (defined in icset):

KBRET - return/enter key
KBTAB - TAB key

KBDEL - delete character left of cursor (e.g. DEL)
KBKILL - delete line (e.g. Control-U, Escape)

KBINS - insert/overstrike toggle (e.g. Control-A)
KBHOME - cursor to start of line (e.g. Control-H)
KBEND - cursor to end of line (e.g. Control-E)

KBREFL - refresh line (e.g. Control-R)

KBUP - cursor up
KBDOWN - cursor down
KBLEFT - cursor left
KBRITE - cursor right

KBFUNC+n - function key n

Any other single key strokes with values less than 255 and any unrecognised escape sequences are passed straight through, any other keystrokes are ignored.

Pointer queue:

i1 contains the change in X co-ordinate
i2 contains the change in Y co-ordinate

Buttons queue:

i1 contains the number of the button that closed, or zero
i2 contains the number of the button that opened, or zero
i3 contains a bit-packed closure set (least significant bit is button 1)

EQFLUS LOGICAL=EQFLUS(*iqueue*)

This function flushes (empties) the given queue.

1.8.3 Proforma event queues

The source distribution set contains some proforma Fortran source code for the Event Queues in the file equeue and using the include files eqcom and eqxcom. Dummy routines are supplied for the low level access to physical devices, examine and modify the routines from EQXBIN onwards, to suit your local devices.

1.9 Primitive testing programs

A set of (relatively) simple test programs is provided for verifying the behaviour of most of the primitive routines; these cannot of course test their functionality exhaustively, and may in any case have to be adapted slightly to accommodate significant departures from the full interface defined above. They are for most purposes however very helpful while you are writing the primitives, and examining their source may also help clarify points that are not explained clearly above.

3. Adjustments to the Fortran code

Three things must be considered before you actually compile the main bulk of the system source code. The first is the values assigned to a set of parameter constants that control maximum array sizes, inform Semper about the details of your particular environment etc.. These are defined in a document called params, which you should examine carefully. Within the section bracketed by comments of the form:

```
C ****** CHANGE ******
...
C ******  ******  ******
```

many of the crucial system configuration details are established, and you will need to alter many of the values assigned here in the light of your own requirements and capabilities. This document is included in the source of almost all Semper modules compiled, via an include statement. Since this statement itself is not in fact provided for within the Fortran 77 Standard, you may need to adjust its syntax, or at worst insert the text in full wherever necessary. As supplied, three include files are involved: common, which includes params, which includes icset. Most Semper modules include common, but a few only include one of the two shorter files.

The second matter is the interpretation of integer and integer*4 declarations, discussed in section 1.2 above. If the latter are unacceptable to your compiler, you will have to edit all the integer*4 declarations back to integer, and accept slightly restricted functionality in a few respects. The standard code, incidentally, avoids the difficulties sometimes arising over the interpretation of constant actual arguments in subroutine or function calls (are they integer*2 or integer*4?), by using integer*4 parameter constants where necessary.

Thirdly, you must examine all of the source code with an editor, searching for sections bracketed by change comments of the form given above; these are called change sections, and draw attention to points which may require action to accommodate your particular environment. Appropriate instructions are given in comments within each such section.

These matters attended to, you can compile all the supplied code (except for the independent system generation and help library management modules) into an object code library for subsequent linking with a main program.

4. System Generation

No main program source is provided with Semper, as this is machine generated at the time of installation (and subsequently, whenever additional commands are added to the system by local users), together with a subroutine semvds which it calls, by the system generation program semgen. This reads a supplied *verb descriptor* document semper.vds on one Fortran unit, and writes the main program and semvds to another. Accordingly, you must now compile and link semgen itself; its source contains some change sections, which you should consider in the usual way; it calls the primitive routine a1conv, but is otherwise entirely self-contained. If possible, store semgen in a linked form ready for immediate use whenever necessary later.

Normal termination of semgen is confirmed by a terminal message *System generation complete*, together with some statistics on the processing commands defined. The programs output should be compiled and linked together with the other modules in the object library (and the standard Fortran run time support library, of course) to complete the process of generating a working Semper load module. The System Users' Guide gives general information on the various Fortran input/output units used by a Semper session, which you may like to consider when establishing this load module; session initialisation code for Semper is localised in the subroutine semini.

5. Help Library Management

A second independent utility helpman provides a utility for generating and managing *help libraries* in the standard form supported by Semper. This reads supplied (or locally generated) files of on-line *help* text interleaved with keyword directives, and creates or alters a disc file containing the information in a suitably indexed and cross-referenced form. You must compile and link helpman now, examining its source for change sections in the usual way. Note that helpman refers to a number of Semper routines which should be linked in from Semper's object code library. If possible, store helpman linked ready for immediate use whenever necessary later.

You use helpman interactively in the first instance; it prompts at the terminal for the name of the help library (disc file) to be used, and if this does not already exist, suggests that you use the initialise command to create it - typing help produces a list of all the commands recognised, and a brief explanation of their function. Initialise requires you to guess the size of file you will need: don't worry about guessing badly, as you can easily repeat the process later in the light of experience.

Initially you will want to type a command such as run semper, which diverts terminal input temporarily to the file semper.shl, and loads the information from it into the help library. Type ? (or type full ?) lists all entry points currently defined; type name (or type full name) types the text stored for entry name etc.; status types information on the amount of space used, free etc.

Later, you may try the log command, which outputs a given entry in text form to a *log file* attached to a helpman session; this allows you later to edit the text to a file which you then make the subject of a run command so as to reload the revised text into the library. The delete command is used to get rid of entries you do not want; old versions of an entry are implicitly deleted whenever you reload them via run (or enter them directly via add). Space is not reclaimed immediately when entries are deleted, and from time to time you need to use the compress command to recover this.

You can choose which of the supplied help files to include; you may add additional entries of your own (an entry installation is particularly recommended to note details peculiar to your own environment); and you may delete entries selectively. You might like to create more than one help library, so that supplementary material is not automatically made available to all Semper users, and so on.