

THESIS / THÈSE

MASTER IN COMPUTER SCIENCE

An implementation of 3-graphs : first version

Hewitt, M.

Award date:
1976

Awarding institution:
University of Namur

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

ANNEE ACADEMIQUE 1975-1976

**AN IMPLEMENTATION OF 3-GRAPHS :
FIRST VERSION**

M. HEWITT

**Mémoire présenté en vue de l'obtention
du grade de Licencié et Maître en Informatique.**

I would like to take this opportunity to thank Mr. Claude Cherton for all his help over the past three years, and especially for having taught me how to program a computer. His help and encouragement have been invaluable.

My thanks also to all my friends at the Institut d'Informatique and to Mme Labidi who typed this report.

C O N T E N T S

SECTION 1 :

Introduction	1.
1.1. 3-graphs	1.
1.2. Why implement the model	6.

SECTION 2 :

The internal representation	9.
2.1. Representation of a notion	11.
2.2. Page organisation	11.
2.3. Attribute list organisation	13.
2.4. The statistics cell	15.
2.5. The counter cell	16.
2.6. Empty block indicators	16.
2.7. The special notions	16.
2.8. Simulation of the dynamic aspect	17.
2.9. Identification of actions in the 3-graph	17.
2.10. Choosing the arguments	19.
2.11. Simulation of an action	19.
2.12. Comparison of two notions	20.
2.13. Scan of a root notion	20.
2.14. Scan of a secondary list	21.
2.15. Choice of an attribute at random	21.
2.16. Choice of a value at random	24.
2.17. Creation of a notion	24.
2.18. Addition of an attribute	24.
2.19. Addition of a value	24.
2.20. Suppression of a notion	25.
2.21. Suppression of an attribute	25.
2.22. Suppression of a value	25.
2.23. The successors of an action	26.
2.24. Simulation of parallelism	26.
2.25. Initiation of the simulation	27.

SECTION 3 :

The TGL Representation	28.
3.1. The name of a notion	30.
3.2. Name blocks and the dictionary	31.
3.3. Sections of a 3-graph	31.
3.4. Communication between sections	32.
3.5. The INIT pseudo-operation	33.
3.6. Specification of basic action occurrences	34.
3.7. Specification of other attributes	35.
3.8. Restrictions in TGL imposed by the use of the Macro-assembler	37.
3.9. Transformation of a TGL text into internal representation	38.
3.10. Generation of a basic action occurrence	39.
3.11. Generation of attributes from DEF and DEFS lines	42.
3.12. BEGIN, TGEND, EXT and INIT	46.

SECTION 4 :

The Simulator-Language, Initialisation and Input-Output	47.
4.1. Choice of programming language	47.
4.2. Programming style and documentation of the simulator	50.
4.3. Loading and initialisation of a 3-graph	51.

SECTION 5 :

Future versions of the implementation	57.
5.1. Implementation and theory	57.
5.2. Doubtful choices in the current version of the implementation	58.
5.3. Extensions to the possibilities	59.

SECTION 6 :

Conclusion	61.
------------	-----

BIBLIOGRAPHY	62.
--------------	-----

1. INTRODUCTION

This report describes a first version of a set of programs designed to implement 3-graphs on a Siemens 4004/151 computer. As this set of programs has developed, so has the theoretical side of the work, with the result that the former lags somewhat behind the latter. However, as we hope to show, the necessary modifications should be relatively simple to carry out and localised in their effect, due to the way the programs are organised.

In writing these programs we have exploited certain features of the computer system on which they run. These will be explained where necessary and the alternative in a system not presenting these features outlined.

We will first give a brief description of 3-graphs. For a more complete description see [1].

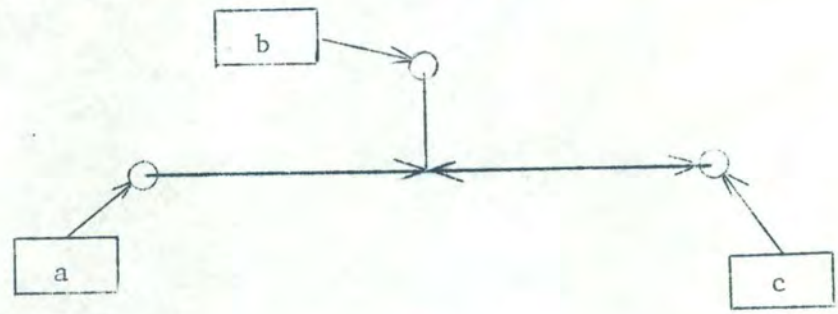
1.1. 3-graphs

3-graphs are an attempt to model the concepts underlying the words and phrases of a language. These concepts are the end results of the processes of filtering and assimilation of all the information reaching an individual. They are modified continually by new information and also by internal transformations.

This evolution of concepts over time implies that an individual will attach different "meanings" to the same word or phrase at different periods, and that two individuals with different backgrounds will also attach different "meanings" to the same word or phrase. Despite this, the underlying structures are sufficiently similar for them to be expressed using the same word or phrase and thus to allow communication to take place between individuals. We believe that it is possible to abstract such structures from the words or phrase used to express them, and thus to model semantics. The 3-graph model is an attempt to do this in order to study the structures and the processes of modification that cause them to evolve.

A 3-graph is a set of "notions" structured by a ternary relation. The structure represents the semantics of the concepts modelled. If we represent the relation between three notions (represented by a, b and c respectively) by the triplet $\langle a, b, c \rangle$ we say that the notion represented by a is the "root", the notion represented by b is the "nature", and the notion represented by c is the "value", of an "attribute". Any notion can potentially play any one of the three roles in different attributes (or even in the same attribute e.g. $\langle a, b, c \rangle$, $\langle a, a, a \rangle$ etc are not excluded). We also say that an attribute whose root is the notion represented by a is an "attribute of the notion a". The semantics of the notion is then described by the whole structure in which it is embedded, by all the attributes to which it is directly or indirectly connected via other attributes.

The attribute $\langle a, b, c \rangle$ can also be represented graphically, as follows



The boxes containing the letters designating the notions are used for convenience of identification only and do not belong to the structure.



Any static structure can be represented using one of the above conventions, but a characteristic of such structures is their ability to evolve in time, an ability which is built-in. In the 3-graph model this dynamic aspect is provided by distinguishing a certain number of notions having intrinsic semantics and thus an existence independent of their relations with other notions (that is, their role as root, nature or value in attributes) in the 3-graph. These notions are a set of "basic actions" plus certain notions used to specify any particular instance of one of these.

The basic actions are :

- COMP - comparison of two notions
- CREN - creation of a notion and an attribute where the new notion is a value
- CRER - creation of an attribute
- LAT - "load an attribute"
- SUP - suppression of an attribute specified by root and nature
- SUPR - suppression of an attribute specified by root, nature and value
- TMV - a value of an attribute is "transmitted" to another attribute
- REP - a value of an attribute is "replaced" by a value of another attribute.

The other "special" notions are :

- OCCDE - specifies which action the notion is an occurrence of.
- SUC1 } - designate the possible successors of a notion
- SUC2 }
- ARG1 } - designate the arguments of an occurrence of an
- ARG2 } action
- ARG3 }
- ARG4 }

For example : < a, OCCDE, SUP>

< a, SUC1, b>

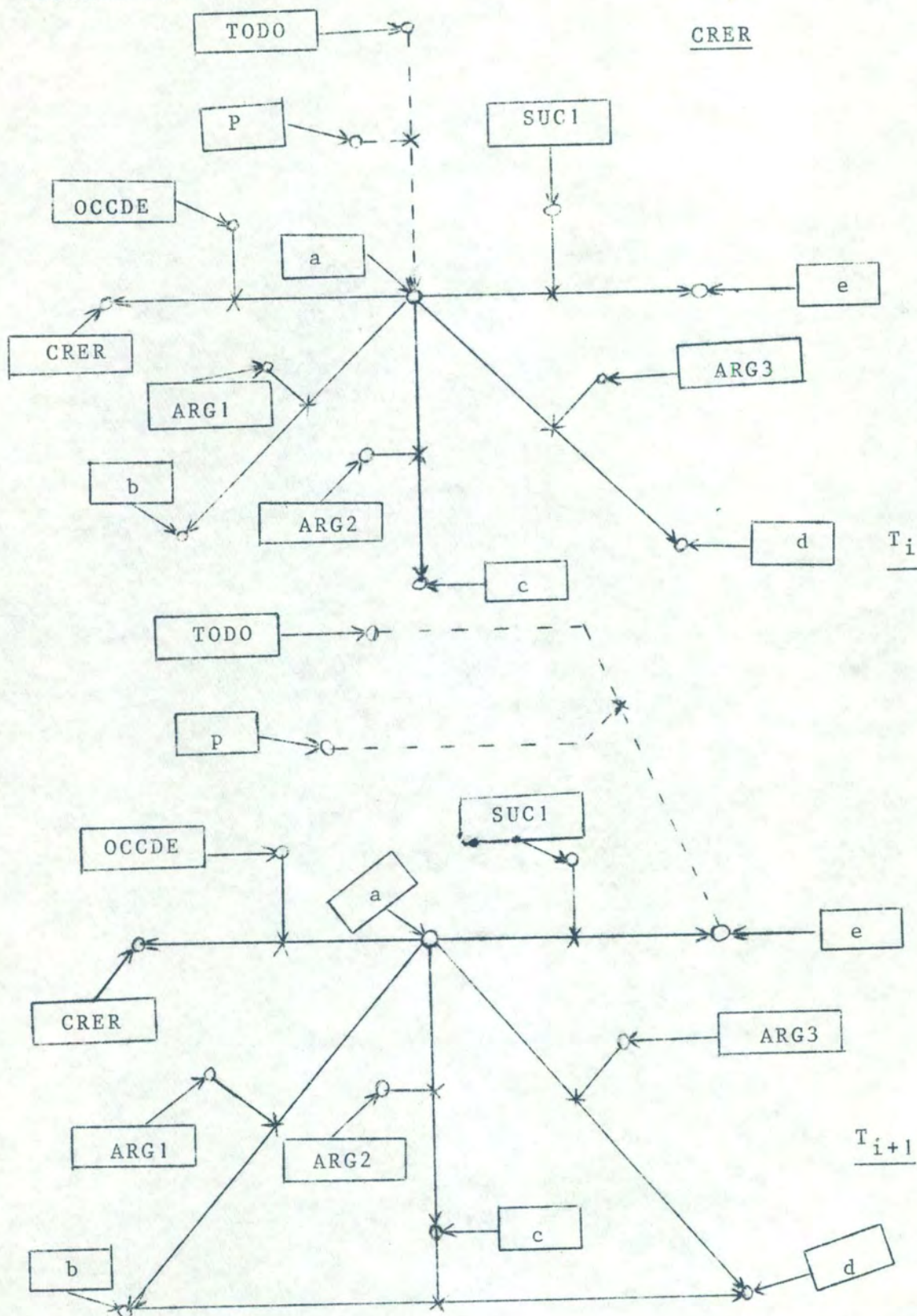
< a, ARG1, c>

< a, ARG2, d>

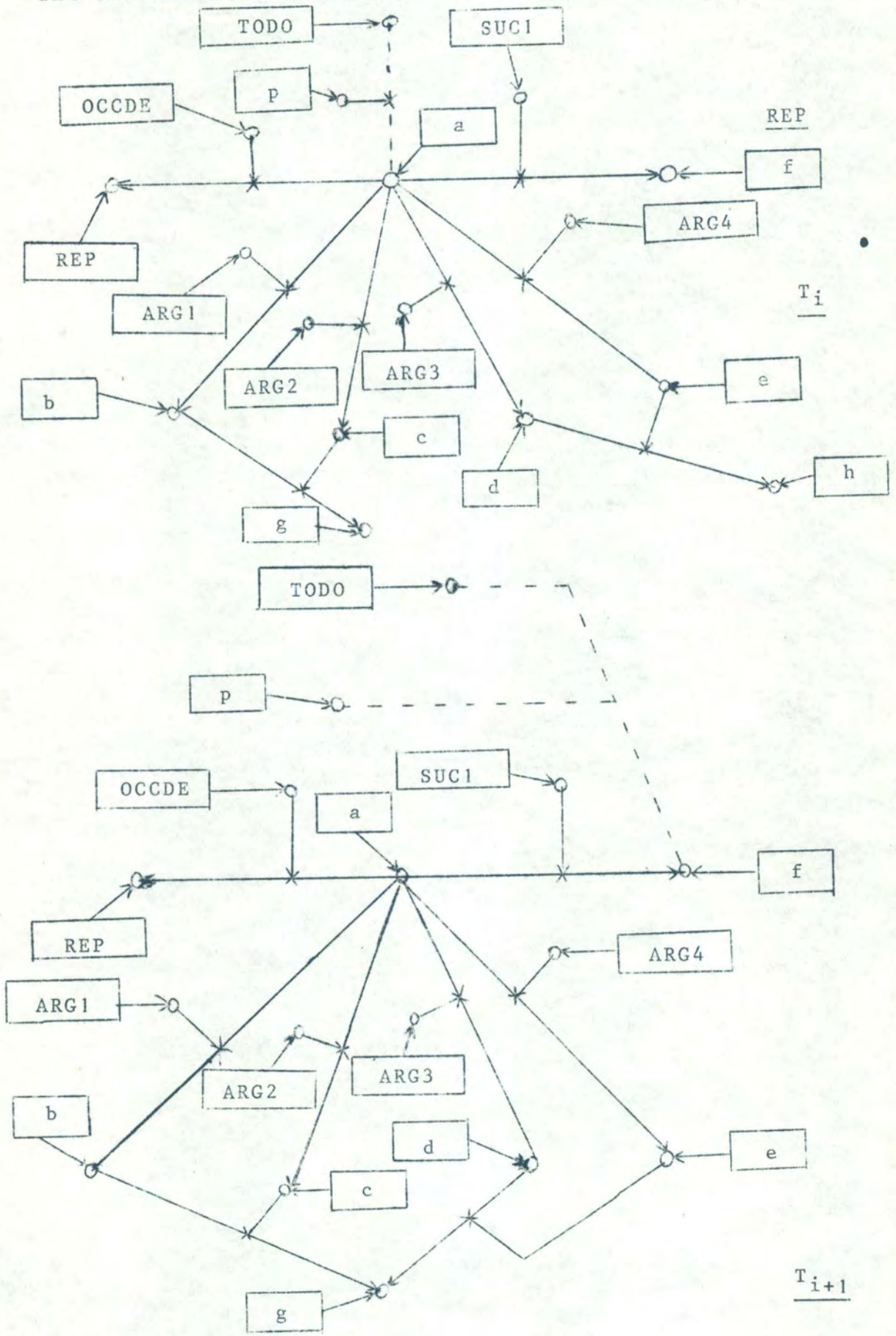
specify the notion a as an occurrence of the basic action SUP.

For detailed descriptions of the basic actions COMP, CREN, LAT, SUP, SUPR and TMV see [1]. The action CRER creates a new attribute with three existing notions as root, nature and value respectively. REP replaces a value of an attribute specified by root and nature by a value of another attribute also specified by root and nature (effectively suppressing an attribute and creating a new one with same root and nature).

Using the same conventions as in [1], CRER and REP are defined as follows :



At time T_{i+1} the attribute $\langle b, c, d \rangle$ has been created and the notion e is the next action to be executed.



At time t_{i+1} , the attribute
< d, e, h >
has been replaced by the attribute
< d, e, g >

If the notion h is no longer root, nature or value of any attribute it is removed from the 3-graph. The notion f is the next action to be executed.

As in [1] the notion 'NIL' signifies " nothing" and may be considered to be root, nature or value of any attribute not otherwise defined (non-significant relations). The notion 'TODO' does not exist in the implemented version of 3-graphs described here, therefore the set of actions to be performed at any time t_i is not explicitly shown. (For consistency in the descriptions it has been shown dotted).

The actions REP and CRER were added to the set of basic actions for convenience in describing the processes transforming 3-graphs. They are useful in practice but do not add to the power of the model, that is, to the set of processes that can be described with these actions.

1.2. Why implement the model

Two ways of representing 3-graphs on paper have been used so far in this report. Both methods are, however, far too cumbersome to be of much practical use in studying semantic structures by means of 3-graphs. Even simple structures quickly become very difficult to represent clearly by either notation when considering only the static aspect. It becomes even more difficult to represent the dynamic aspect, not only because of the difficulty in presenting the structures clearly but also because of the conventions required to represent a transition in a static medium.

The storage capacity of modern computers permits the description of extremely complex structures that it would be impossible to contemplate attempting with pen and paper only.

For the study of the dynamic aspect the computer is an ideal tool, providing :

- a) both the static and dynamic aspects can be represented in a way comprehensible to the computer, and;
- b) the computer has been instructed how to effect the transformations corresponding to the dynamic aspect.

It is evident that we need two new ways of representing 3-graphs :

- the representation in a computer;
- a representation for input to the computer.

Ways must be provided for the computer to translate the latter into the former and for it to interpret those parts relating to the dynamic aspect and execute them. (After this, the computer can be used as a tool for the study of semantic structures) The implementation described here aims to provide those ways.

- Two points concerning the implementation should be noted :
- the theory of 3-graphs continued to evolve while the implementation was being developed. In order to keep abreast of changes in the theory, both actual and future, it must be highly adaptable. This necessity has conditioned the implementation from the start, in particular, the programming style and the method of documentation, both intended to simplify maintenance and updating;
 - the structure of present day computers does not lend itself to the representation of a ternary relation. This can only be represented indirectly and this fact has also conditioned the representation.

XXXXXXXXXXXXXXXXXXXX

From now on, we will call the representation in the computer the internal representation. The representation for input to the computer we will call the external or TGL representation. We will also touch on a third system of representation

associated with the computer, that used as output based on the internal representation.

The next section describes the internal representation and the impact of certain features of the computer system on which it is implemented. Subsequent sections will describe the TGL representation, the choice of programming language and the programs written to carry out points a) and b) above.

o
o o

2. THE INTERNAL REPRESENTATION

A 3-graph could be represented in the computer in many ways, some of which would emphasize the roles of the different notions in the attributes. Others would emphasize the attributes, leaving the notions with a totally secondary role in the representation. The choice of a particular representation is influenced by two considerations :

- the amount of space it would occupy;
- the ways in which the structures will be accessed, in particular for the simulation of the dynamic aspect.

When we look at the descriptions of the basic actions we note certain characteristics :

- 1) the arguments of an occurrence, that is, the attributes to be created or suppressed are specified :
 - in every case by their root notion
 - often by both their root and nature notions
 - only occasionally by their root, nature and value notions.
- 2) In two of the basic actions, COMP and CREN the arguments of an occurrence are notions rather than attributes.
- 3) A notion is identified as an occurrence of a basic action because it is the root notion of an attribute with nature OCCDE. What is to be done is specified by a set of attributes whose natures are some of the special notions : ARG1, ARG2, ARG3, ARG4, SUC1, SUC2. These characteristics lead us to emphasize notions rather than attributes.

In a given 3-graph, only a few of the possible attributes will actually be present, so that a representation which enumerates the attributes that are present, seems a good choice. This can be achieved by enumerating the root, nature and value notions of each one.

From the description of the basic actions, we can see that paths through the 3-graph to be followed during a simulation lead from a root notion to nature and value, or from root and nature to a value. This leads us to sort our enumeration on the root notion of attributes and then on the nature of the attributes. The root notion does not now need to be explicitly present in each attribute's representation.

Since nearly all the basic action occurrences involve the creation or suppression of attributes, easy manipulation of these is important. So our internal representation must take the form of a list structure.

In the 3-graph it is not excluded that a set of different attributes may exist, where the root and nature are always the same and only the values differ.

e.g. < a, b, c >
 < a, b, d >
 < a, b, e >
 < a, b, f > etc ...

Representation of this situation in the strict pair-list representation would complicate the search for an attribute or a place for a new attribute unduly. It is easier to group such attributes "under" the same nature within the root notion grouping and the nature-value pair becomes a nature-pointer pair with the second element pointing to a secondary list containing the grouped notions that are values of the attribute.

One further grouping under the root notion is to be considered. This is also concerned with simplifying the search for particular attributes. Any notion can be or can become an occurrence of an action, and the identification of such a notion would be considerably simplified (and speeded-up) if the attributes defining it as an action occurrence were grouped, say at the beginning of the list of attributes. For an occurrence of a basic action, the attributes concerned are those with nature

one of the notions OCCDE, SUC1, SUC2, ARG1, ARG2, ARG3, ARG4, through these are not all significant for every basic action. However, if we are to be certain that these attributes are always the first when they are present they must be "potentially present" in every root notion's list of attributes. This can be achieved by reserving the first seven places in every list. The loss of space involved can be reduced by identifying the attribute by position in the list, its nature need no longer be explicitly mentioned leaving only the value to be identified.

Every root notion's attribute list begins with seven spaces reserved for the values of the attributes with nature OCCDE, SUC1, SUC2, ARG1, ARG2, ARG3, ARG4 in that order. These are followed by the nature-value pairs of other attributes. The space reserved for a value will contain 'NIL' if the attribute is non-significant, otherwise it will specify a notion or point to a list of notions that are values of the attribute.

2.1. Representation of a notion

We have not yet said anything about how a notion is to be specified when it is nature or value of an attribute or how we locate a notion.

When a notion exists in the representation, space has been reserved for the first seven "special" attributes, even if the notion has no attributes of any sort. The address, within the space occupied by the 3-graph, of the beginning of this list identifies the notion uniquely while it exists. This address is used to identify the notion when it is nature or value of an attribute of another root notion.

2.2. Page organisation

While the internal representation described so far is not in any way limited by size or space considerations they are important and they will affect the representation of the 3-graph in the computer. During the process of modification of a 3-graph (evolution of the 3-graph) the actual part involved at a given

instant in time is likely to be small in relation to the size of the whole. Practical considerations of memory size and its use lead to the idea of cutting the 3-graph into blocks that could be stored in auxiliary storage and brought into memory only when needed. Whenever an attribute is required, we would need to know whether the root notion's attribute list is already in memory or needs to be brought in from auxiliary storage. This would mean copying one or more blocks from auxiliary storage. A block already in memory might have to be ejected to make way for a new one, involving problems of updating the copy in auxiliary storage and the choice of the page to be ejected.

The actual implementation on the Siemens 4004 does not do any of this explicitly. Instead, it makes use of the virtual memory environment of the computer. This provides a program with up to 1M bytes of contiguous virtual memory, divided into pages of 4K bytes. The minimum number of pages required is determined when the program is loaded, and can be extended during execution (up to a maximum of 256). A copy of each page of the program is stored on magnetic drum storage and copied into memory when needed. A paging algorithm chooses the page which may be ejected from main memory, if necessary. If the contents of the page have been altered, they are copied back to drum, before the page is overwritten.

Not only does this save programming time since the equivalent routines are not included in the implementation but at execution time the computer uses hardware when paging and can thus go much faster than could a program that does the same thing.

The internal representation of the 3-graph is divided into 4K-byte pages and loaded as a program, leaving it to the paging system to ensure that the pages are in memory when required.

Since the original 3-graph is unlikely to be exactly an integral number of pages long, and during its evolution the space used will grow and contract, any unused space in each page is held in a free list from which it can be allocated when new notions are created or new attributes added, and to which space can be returned when attributes are removed. If the 3-graph grows beyond the original load-time allocation of pages, new pages can be acquired dynamically.

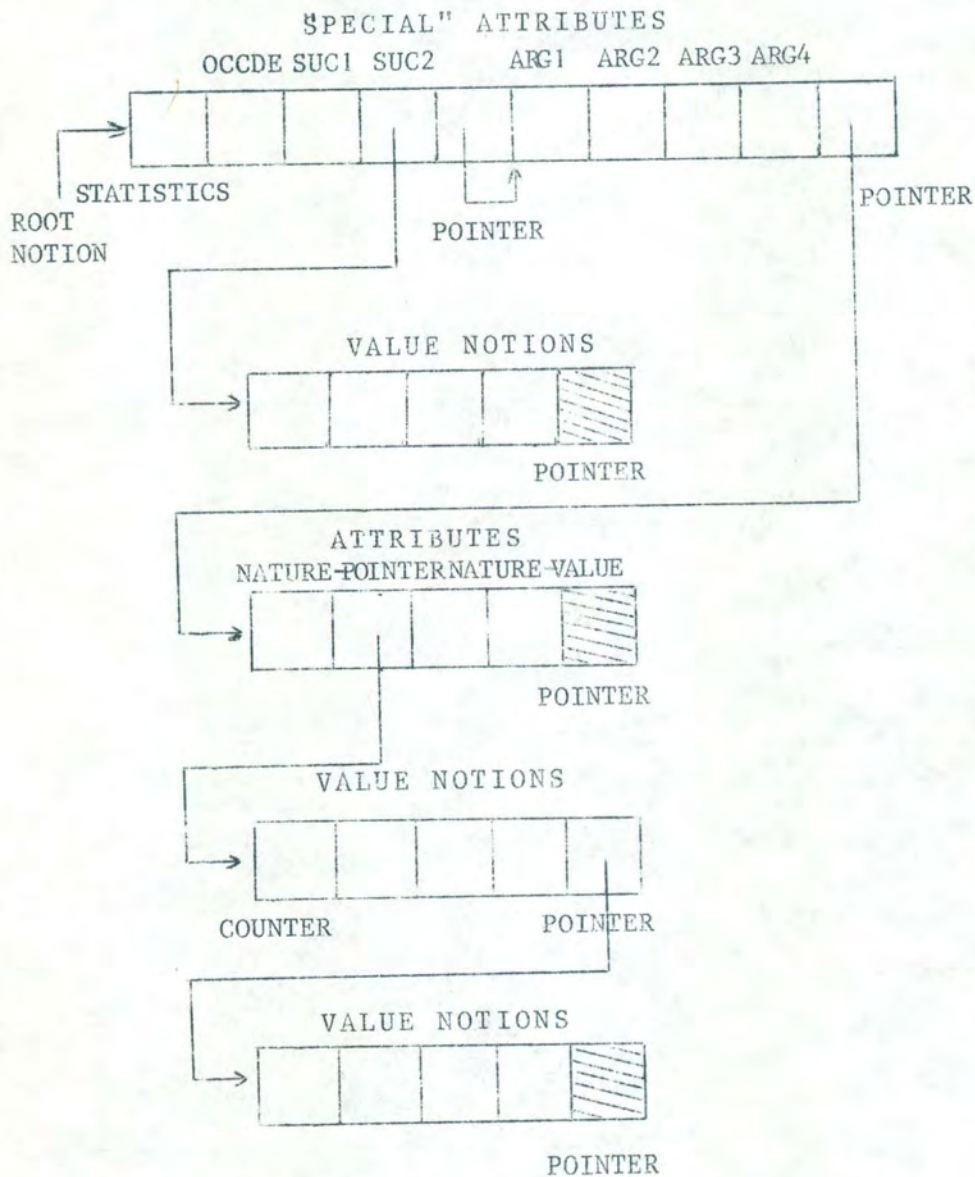
A notion is allocated the minimum space for the seven attributes OCCDE, ARG1, ARG2, ARG3, ARG4, SUC1, SUC2 when it is created. If more space is required, the minimum needed is usually for a nature-value pair specifying a new attribute. But this must be linked to the existing list of attributes. Allocation of this minimum unit is likely to be expensive in space since the proportion of links to information is large. The time needed to scan through the links when searching the list of attributes is also likely to be costly. It is more economic to allocate more than the minimum and so reduce the number of links, even though there is the risk that some of the space may never be used.

2.3. Attribute list organisation

A notion in the 3-graph is represented by the address of its first space allocation. An address occupies 3 bytes in the computer but this is not an easy unit to handle because the instruction set is word or half-word oriented so our basic unit is the computer word. The address occupies the 3 right-hand bytes of a word leaving the left-hand byte free for indicators or flags. Two words or cells are needed to specify a nature-value or nature-pointer pair with a flag to distinguish one from the other. For the special attributes a single cell is sufficient to specify the attribute, so the minimum primary allocation is 8 cells - 7 plus a pointer. There after the minimum allocation is 3 cells - nature-value or nature-pointer + pointer. Not only is this expensive as we have already noted but handling blocks of different lengths poses problems of allocation or realloca-

tion (dividing a block of 8 into blocks of 3 means you "lose" 2, regrouping poses similar problems), and also in scanning lists of attributes. It is easier to have blocks of a standard size that can be re-used anywhere, greater than the minimum allocation and with a pointer to its successor in the same position in every block.

We have chosen to allocate space for 2 nature-value or nature-pointer pairs at once. With the pointer to a succeeding block, we have a block of 5 cells (20 bytes). Thus, when a block is allocated, at most one pair of cells remains unused in any block. Two blocks are sufficient to contain the seven special attributes leaving one empty cell. This size of block is also used in the secondary lists. The organisation of different blocks is shown below :



The exact contents of each cell is indicated by its position in the block and by flags in the cell itself. The value cell of an attribute pair specifies the notion which is value of the attribute except when a flag is set to indicate that it points to a secondary value list. Other flags indicate, for example, that the cell reserved for the attribute with nature OCCDE specifies a basic action occurrence.

The unused blocks are chained together by their pointers and the address of the first block in the chain is kept in one of the four words left at the end of each page. Blocks are added to or removed from the chain last-in first-out and a record is kept for the whole 3-graph of the pages where space is available.

2.4. The_statistics_cell

In the two blocks allocated for the special attributes of a notion only 9 cells are used leaving a spare cell. The special attributes are so positioned that this is the first cell in the first block, which means that its access is immediate when the root notion is accessed. It is used for the storage of certain information about the notion's role in the 3-graph. It contains a count = $n + v$

where n is the number of times the notion is nature of an attribute, and

v is the number of times the notion is value of an attribute.

In the implementation this information has an important practical application : when this count becomes zero the space allocated to the notion is returned to the free list, in effect the notion is suppressed.

2.5. The counter cell

The counter cell is the first cell in the first block of a secondary list. It contains a count of the total number of cells, used or unused, in the list and is used in the choice of a value from the list, as we shall see later.

2.6. Empty block indicators

The ability to free unused blocks whenever possible is important for the most efficient use of the space available. Blocks may become available when an attribute is suppressed and as a consequence, one or more notions that are no longer attached to the 3-graph, because they are no longer nature or value of any attribute. Note that, a notion may be suppressed even though it is still root of an attribute. In [1], only notions that are "isolated" are suppressed, substructures that are "inaccessible" (see [1]) from the rest of the 3-graph would remain. In the implementation such substructures will disappear.

As a general rule, when an attribute is suppressed, all blocks freed are returned to the free list. However, during the transformation process, it is possible that certain notions will acquire and lose attributes rapidly and frequently. This could lead to repeated allocation and removal of blocks from the same notion, a situation to be avoided if possible. The counter and statistics cells contain flags that indicate the presence of an empty block in the list. When a block in the list becomes empty, it is returned to the free list only if the flag indicates that there is another empty block in the attribute or secondary list.

2.7. The special notions

The eight basic actions and seven special notions plus the notion NIL are always "known", whether or not they are attached to the rest of the 3-graph. They are never created or suppressed and normally, they are not root of any attribute. For this reason only the seven special notions - OCCDE, ARG1, ARG2, ARG3, ARG4, SUC1, SUC2 - are physically present in the 3-graph like other notions. They are the first notions specified in the 3-graph's address space.

In the next section we will describe how the basic actions are specified. The notion represented by 'NIL' is represented in the 3-graph by a high value that cannot be confused with the address of any notion.

2.8. Simulation of the dynamic aspect

We have seen how a static 3-graph structure is represented in the computer and how this has been influenced by the basic modifications - location, addition and removal of attributes - that are necessary for simulating the dynamic aspect. From this internal representation those elements defining the process of transformation must be extracted. The attributes of a root notion that identify it as an occurrence of an action modifying the 3-graph must be interpreted and the corresponding modification carried out.

2.9. Identification of actions in the 3-graph

We distinguish two kinds of actions transforming the 3-graph :

- the eight basic actions : COMP, LAT, CREN, CRER, SUP, SUPR, TMV, REP
- non-basic actions.

If such a thing as a '3-graph computer' existed, the basic actions would form the machine's basic instruction set. The non-basic actions would have to be interpreted as a combination of these basic actions to be directly executable by the machine.

The basic instruction set of this mythical computer is simulated in the current implementation by a set of routines. This set of routines, which we will call the "simulator" is linked with the original 3-graph in internal representation, and the result loaded as one pageable program in the virtual memory environment. The links between the simulator and the 3-graph are established via the OCCDE attributes (*) of the notions in -----

(*) When we wish to refer to an attribute by specifying the notion that is nature of the attribute, we will say nature name attribute, for example, OCCDE attribute here.

the 3-graph. These links identify the actions to be simulated in any 3-graph evolution process.

A flag, used only in the cell reserved for the OCCDE attribute indicates that a notion is an occurrence of a basic action. This flag is not set for a non-basic action and the cell contents specify a notion. At present, the interpretation of these is not part of the simulator. The simulator merely passes on to the successor of a non-basic action which thus corresponds to a no-operation. In this way, with the use of the "basic action" flag, it should be possible to add to the list of basic actions or to include interpretation of non-basic actions in the simulator at a later stage. However, we will usually ignore non-basic actions in this discussion. From now on, action is to be taken to mean basic action. When the flag is set, the cell contents identify the routine that simulates the action.

Although, it is theoretically possible, (see [1]) for a notion to be an occurrence of several actions at the same time, the current version of the simulator excludes this possibility.

XXXXXXXXXXXXXXXXXXXX

Once the action has been identified, we distinguish three stages in its simulation :

- the arguments involved must be chosen;
- the action itself can then be simulated;
- the successors to this action must be determined.

This distinction between the second and third stages is not always clearcut as we shall see.

2.10. Choosing the arguments

The possible arguments are the values of the attributes ARG1, ARG2, ARG3, ARG4 of the occurrence. Not all of these attributes are required in every action, for example, CREN needs only ARG1, ARG2. The attributes not required may have values but they are ignored in the simulation. If one or more of the attributes required are non-significant, that is, the value is the notion 'NIL' then the action is null and the only result is to determine its successors. There is one exception to this rule : a notion can be compared to 'NIL' by COMP. If one of the attributes has several values (the cell contains a pointer to a secondary list of notions), a value is chosen "at random" to be the argument used in simulation of the action's current occurrence.

2.11. Simulation of an action

The last two sections described how an action occurrence can be detected and identified so that the correct simulator routine is invoked, and how this routine first determines its arguments. Table 1 shows the main functions needed to simulate each action. Certain of these functions call on other functions such as allocation of a block or return of a block to the free list. We will discuss each in turn and the conditions in which it is used.

Neither Table 1 nor the following discussion indicate all the separate functions used in the simulation of action occurrences. In general, each function isolated logically is also isolated physically in the simulator routines. The programming is to a great extent modular with the different functions communicating only by the passing of parameters. Each separate routine has, with few exceptions, one entry and one exit point and performs one function. This function may be a complex one, in which case the routine will issue a series of calls to others that perform simplex sub-functions, and so on to the simplest sub-functions that are performed directly.

These last sub-functions are the only ones that deal with the physical representation. The aim is to facilitate modification in two ways :

- the logic of the simulation of the basic actions can be altered or added to since it depends on the sequence of function calls;
- the physical representation can be changed and only one level of subfunction will be affected.

This method of programming is designed to simplify the maintenance of the simulator and to allow modifications and extensions to be made fairly easily. As we indicated in section 1 the implementation must be highly adaptable in order to keep abreast of modifications in the theory of 3-graphs.

2.12. Comparison of two notions

A notion is uniquely identified by its address. COMP compares the two notion addresses that are its arguments and sets the choice of successor depending on whether they are equal or not.

2.13. Scan of a root notion

With the exception of COMP and LAT, the arguments chosen specify the root and nature of an attribute and in the cases of CRER and SUPR the value of an attribute. This attribute must be located in the root notion's attribute list. The absence of this attribute often means that the effect of the action is nullified, see table 2. When the nature of the attribute is one of the special natures, (OCCDE, etc ...) the attribute is located by position. For other attributes the chain of blocks is scanned and the contents of the first cell of each nature-value pair is checked against the nature specified until there is a match or the end of the chain is reached.

This function is also used to find an unused nature-value pair for the creation of a new attribute. Unused cells always contain a value conventionally used to specify the notion 'NIL'.

When blocks are allocated, all cells except the pointer cell are initialised with this value and when the contents of a cell are removed the cell is reinitialised to 'NIL'. The search for an unused nature-value pair is thus a search for an attribute whose nature is the notion 'NIL'.

2.14. Scan of a secondary list

When the attribute has been located by its nature in the root notion's list, the second cell may point to a list of associated values.

For the CRER and SUPR actions, this list must be scanned block by block and each cell checked against the value of the attribute specified by the third argument. The effect of the action depends on the absence or presence of this value, see Table 2.

This function is also used to locate an unused cell in a secondary list when adding a new value in creating a new attribute.

2.15. Choice of an attribute at random

This function is specific to simulation of the action LAT. The number of nature-value pairs allocated to the root notion specified by the first argument is determined by a rapid scan of the list. A number, a timer obtained from the system, is divided by this count to generate a "random number" (the remainder) which is used as the ordinal number of a nature-value pair. The attribute is then located.

Should the attribute be non-significant a second and then a third number can be generated to locate a significant attribute. If even these fail, the first non-significant attribute to be found in a systematic scan will be chosen. The preliminary counting scan also ensures that the root notion possesses at least one attribute.

TABLE 1.

	COMP	CREN	CRER	SUP	SUPR	TMV	REP	LAT
Comparison of notions	X							
Scan of a root notion to find an attribute		X	X	X	X	X	X	
Scan of a secondary list to find a value			X	X	X	X	X	X
Choice of an attribute at random								X
Choice of a value at random				X		X	X	X
Creation of a notion		X						
Addition of an attribute		X	X			X	X	X
Addition of a value		X	X			X	X	X
Suppression of a notion				X	X		X	
Suppression of an attribute				X	X		X	
Suppression of a value				X	X		X	

TABLE 2

Effect of action

	CREN	CRER	SUP	SUPR	TMV	REP
1st attribute : root, nature absent	ATTR. CREATED		NULL		NULL	NULL
present	NULL		ATTR. SUPPR		VALUE CAN BE TRANSM.	VALUE CAN BE TRANSM
1st attribute : root, nature, val. spec. absent		ATTR. CREA- TED		NULL		
present		NULL		ATTR. SUPPR.		
2nd attribute : root, nature spec. absent					VALUE TRANSM.	VALUE TRANSM. AS TMV
present					NULL	VALUE CAN BE REPLA- CES

2.16. Choice of a value at random

This function has already been used in the choice of the arguments for the action simulation. It is used whenever it is necessary to completely specify an attribute that has been specified by root and nature only and there is a list of values associated with it. A 'random number' is generated by dividing the timer value obtained from the system by the contents of the list's counter cell and taking the remainder. This remainder is used as the ordinal number of a cell containing the value notion chosen. Up to 3 numbers will be generated in order to find a significant value before a systematic search is used.

2.17. Creation of a notion

Specific to simulation of the CREN action, this function calls for the allocation of two blocks for the first seven special attributes and returns the address of the first block as the address of the new notion.

2.18. Addition of an attribute

If an attribute with the same nature already exists, this function calls for the addition of the new attribute's value to the existing values (see below). Otherwise it requires a scan for an unused nature-value pair with automatic allocation of a new block to the attribute list, if necessary. The nature-value pair is completed and the reference counts of the notions specified, updated to reflect the new attribute's creation.

2.19. Addition of a value

This function is a special case of the previous one and follows the same plan. It requires a scan of the secondary list to locate an empty cell in which to store the new value. The reference count of the notion specified is updated. Location of an empty cell may imply the addition of a new block to the list. Allocation of a block is also required when a list does not exist and is to be created (a nature-value pair is transformed into a nature-pointer pair plus a list).

2.20. Suppression of a notion

A notion is never explicitly suppressed in the 3-graph. It is removed as a result of the suppression of the only remaining attribute linking it to the rest of the 3-graph. This function is thus a side-effect of the following one.

2.21. Suppression of an attribute

This function updates the reference counts of the notions that are nature and value of the attribute to reflect its suppression then reinitialises (to 'NIL') the nature-value pair of cells that contained it. If, instead of a nature-value pair there is a nature-pointer pair, only the value is suppressed (see below). As a result of the suppression one or more blocks may be returned to the free list :

- the block containing the attribute is now completely unused, the block can be freed if the empty block indicator is set.
- one or both notions updated are no longer attached to the 3-graph (their reference count = 0) and the space they occupy can be freed. The seven special notions - OCCDE, SUC1, SUC2, ARG1, ARG2, ARG3, ARG4 - are an exception, they are never physically removed even if their reference counts are zero.

The suppression of a notion may have a snowball effect if it is the base of a substructure that was attached to the rest of the 3-graph only by the attribute that has been suppressed. The space used by each of the notions is returned to the free list.

2.22. Suppression of a value

This is a particular case of the suppression of an attribute. The value notion's reference count is updated and the value cell contents reinitialised. If the whole block is then unused it may be returned to the free list under control of the empty block indicator.

2.23. The successors of an action

The last thing in the simulation of an action occurrence is the determination of the successors of the occurrence. The attributes whose natures are the notions SUC1 and SUC2 specify the possible successors. Except in the case of COMP only the SUC1 attribute is considered. In the case of COMP the choice of the SUC1 or SUC2 attribute is determined by the arguments of the occurrence as we have seen.

An action occurrence may have zero, one or any number of successors.

This is specified by the contents of the cell reserved for the SUC1 (or SUC2) attribute. If the action has no successors, we have reached the end of one process of transformation though there may be others still in progress. If there is one successor then it is the next occurrence to be simulated. The existence of a list of notions associated with the attribute does not cause a random choice as it did for the arguments of the occurrence. Instead, all the actions are taken together and theoretically a set of parallel processes is initiated. Since the simulator works in a sequential environment this parallelism must be simulated also.

2.24. Simulation of parallelism

In [1], the set of actions to be executed at time t_i is the set of all values of all attributes of the notion TODO. After execution of these actions, the values of the attributes of TODO are their successors and the actions to be executed at time t_{i+1} . We stated in section 1 that the notion TODO does not exist in the version of 3-graphs implemented, so the set of actions to be executed is not explicit in the 3-graph itself. This information is kept externally in the simulator, in the form of a pointer to the current action occurrence to be simulated and a stack of pointers to the successors of previous actions.

The successors of an action occurrence are transferred to the stack from the list associated with the SUC1 (or SUC2) attribute. In this way, the stack contains a reference to each parallel process to be initiated. Then one occurrence is transferred from the stack to the current action pointer, and the process is initiated.

The current process will be executed until it terminates or itself gives birth to another set of parallel processes. In the first case, one of the remaining processes on the stack will be initiated. In the second case the new set will be added to the stack and one of these processes will be initiated.

Simulation will halt when all the processes have been removed from the stack and the last one terminated.

It is clear that this first approach to the simulation of parallel processes is unsatisfactory in several ways and priority must be given to improving this in future versions of the implementation.

2.25. Initiation of the simulation

The first action or actions to be executed are given by the original attributes of TODO, in [1]. In the implemented version, the simulator must be given this information by the user, since it cannot be deduced from the 3-graph itself. The simulator is designed for an interactive environment and it prompts the user to give it the first action. At present, only one action can be specified, that is, the user cannot initiate parallel processes.

The way in which the user can specify the first action will be discussed in the section on dialogue with the simulator.

3. THE TGL REPRESENTATION

In section 2 we described how the 3-graph is represented in the computer and how the dynamic aspect is simulated. We now turn to the representation used as input to the computer and how it is transformed into the internal representation.

We need a way of describing a 3-graph that is simple and also practical to use. The graphical representation and the triplet representation described in section 1 are basically simple but far from practical. It is extremely difficult in the graphical representation to represent anything but the simplest structures clearly. In a list of triplets it is difficult to discern the structure described, so that, although it would be quite possible to use a triplet notation for our input representation it would not be very practical.

As computer scientists we tend, by training and habit, to divide input to a computer into two categories :

- programs or sequences of actions to be executed by the computer;
- data on which these sequences act.

If we project this distinction onto descriptions of 3-graphs we distinguish sequences of occurrences of basic actions from more general structures. This is an arbitrary distinction that is not reflected in the 3-graph itself, but it seems at the moment, to be useful in practice.

It leads us to express occurrences of basic actions as instructions of a simple language. Each of the basic actions has a corresponding "operation code" with arguments that define a specific occurrence of the action. More general structures are described using "pseudo-operation codes" that specify one or more attributes by giving their root, nature and value notions in a form of triplet notation.

Now we want the format of our language to be simple and easy to use. A format resembling an Assembler-type language is both simple and easy to handle.

Since we have to program the transformation of a 3-graph described in the language into internal representation such a format allows us to take advantage of the Siemens Assembler language. The description of a 3-graph is written in a language - TGL - that conforms to the format of the Assembler. A 3-graph description in this language, presented as input to the computer, we will call a TGL text.

The process of transforming a description into internal representation falls into two parts :

- analysis of the text;
- generation of 3-graph structures in internal representation based on this analysis.

We have used the system's macro-assembler and macro library facilities to eliminate the programming of the text analysis phase and concentrated on the generation part of the transformation process.

The existence of the macro-assembler allows a programmer working in assembly language to extend the set of "operation codes" or "pseudo-operation codes" available to him. He can create, in this way, an assembly language tailor-made for the application he is programming, and understandable by the machine. The system also provides a utility program for creating and updating libraries of macros. When a program containing the macro codes is assembled, the programmer can direct the Assembler to use a macro library containing their definitions.

In our case, each of the TGL operation and pseudo-operation codes is defined as a macro. The Assembler performs the analysis of the input description, identifying the operation or pseudo-operation code and isolating the different notions.

These last correspond to the arguments of the macros and the Assembler establishes the correspondence between the arguments in the definition and in the text. It also deals with the recognition of notions when they first appear and when they are used subsequently.

For someone who is unaware of this link between TGL and Assembler, a TGL text is written in lines divided into 3 columns. The central column contains the operation code or pseudo-operation code. Each line defines one or more attributes of a root notion which may be defined at the same time or may previously have been defined.

So in TGL we must be able to denote a notion and in particular the eight basic actions and eight special notions.

3.1. The name of a notion

We denote a notion by giving it a name, a string of up to six alphanumeric characters beginning with an alphabetic character.

The strings of characters we have used to denote the basic actions - COMP, CREN, CRER, SUP, SUPR, LAT, TMV, REP and the special notions - OCCDE, ARG1, ARG2, ARG3, ARG4, SUC1, SUC2, NIL are those used in TGL. The names of the basic actions become the "operation codes" when they appear in the central column of a TGL line. The notion defined by the line is an occurrence of the basic action and the list of notion names in the third column specifies the attributes associated with it. For example,

```
JOE  REP  BILL, APPLE, PEAR, ORANGE, SOAP
```

defines an occurrence of the basic action REP, the notion named BILL is the value of the attribute ARG1, APPLE, PEAR and ORANGE are the names of the notions that are the values of the ARG2, ARG3, ARG4 attributes respectively and SOAP is the name of the notion that is the successor to this action occurrence - value of the SUC1 attribute. The string JOE is the name of

the notion (occurrence of the action). If there is nothing in the left-hand column then the notion has no name.

3.2. Name blocks and the dictionary

In connection with the notion names, we return briefly to the internal representation and the simulator routines.

We have seen that every notion existing in the 3-graph is allocated at least two blocks for the special attributes. A notion with a name has a third block physically following these two but not chained to them. This block contains the name and the address, in the 3-graph space, of the notion.

Further, the statistics cell in the first block contains a flag indicating the presence of a name block.

The blocks remain in the 3-graph but their contents are also copied, before the simulator routines take over, to a dictionary of notion names. With this dictionary it is possible during the simulation, to dialogue with the 3-graph about attributes and notions using the notion names given in the TGL text. The use of the name blocks is necessary since there is no other way of preserving the notion names after the Assembler has completed its work.

3.3. Sections of a 3-graph.

TGL is a simple language, and though more concise than the triplet notation of section 1, it shares the disadvantage of this simplicity : descriptions of complex structures are long and tedious to do. We would like to be able to build descriptions of parts of a 3-graph that are fairly independent, preserve these original descriptions separately and then join them together to form a complete 3-graph for simulation of the transformation processes they contain. Different 3-graphs can be formed by joining different parts together, and extra parts can be added on.

This brings us to the concept of a section of a 3-graph. A section is a description in TGL of part of a 3-graph that is transformed as a single unit into internal representation. It will usually be joined to other sections to form a complete 3-graph before simulation of the transformation processes contained in one or more of the component sections.

Two pseudo-operation codes are used to delimit a 3-graph section - BEGIN and TGEND, BEGIN initialises the process of transformation of a TGL text into internal representation. The right-hand column contains a character string and a number. The character string allows the user to give the section a mnemonic title but is otherwise ignored. The number is associated with the section and is used to identify it, particularly when a number of sections are joined together.

TGEND indicates the end of a TGL text.

3.4. Communication between sections

The different sections of a 3-graph are linked by attributes. A root notion's attribute list in one section can contain as nature or value of an attribute, notions that are defined in another section. In this way, for example, a section containing a transformation process can have attributes whose values are the root notions, in another section, which provide access to the structure on which the process will act. It is not possible at assembly-time, because of limitations imposed by the use of the Assembler, to define other types of links between 3-graph sections.

It would be possible to define other types of links using the 3-graph initialisation phase but we have not yet envisaged these possibilities.

In a TGL text we must be able to indicate in one section those notions that are defined in another and form the links between sections. The pseudo-operation EXT provides this capability. In the right-hand column the user identifies the

other section by its number and the notions concerned by their names. Notions in several different sections can be specified by the use of as many EXT lines and in this way several sections can be linked together.

In each section, the notion name and the number of the section are concatenated when the notion is defined and this composite name is the notion's name in the total 3-graph although it is referred to, within the section, by its name in the TGL text. For example, in 3-graph section number 3, the notion named SNOOPY will be defined as SNOOPY3, and every reference to SNOOPY in the section is a reference to SNOOPY3. (A reference, in this context, is the appearance of the notion as nature or value of an attribute). In section 5 references to the same notion must be given as SNOOPY3.

3.5. The INIT pseudo-operation

In connection with the concept of 3-graph sections we have another pseudo-operation used in TGL. When we discussed the special notions - OCCDE, ARG1, ARG2, ARG3, ARG4, SUC1, SUC2 in the section on the internal representation we stated that these notions are always the first ones to be found in the 3-graph and they are always "known". This means that, when several sections of a 3-graph are joined together, one of them must contain these notions in the correct positions.

To be certain that this is always the case we impose two conditions on any set of sections linked together. At least one of these sections must bear the number 1 and in the TGL text of this section the 1st line following the BEGIN pseudo-operation must be an INIT pseudo-operation. This ensures three things :

- INIT causes the creation of the seven notions at the beginning of the section numbered 1.
- This section is always the first in the complete 3-graph.
- In sections numbered other than 1, the notions are automatically identified as EXTERNAL when the transformation process is initialised by BEGIN.

3.6. Specification of basic action occurrences

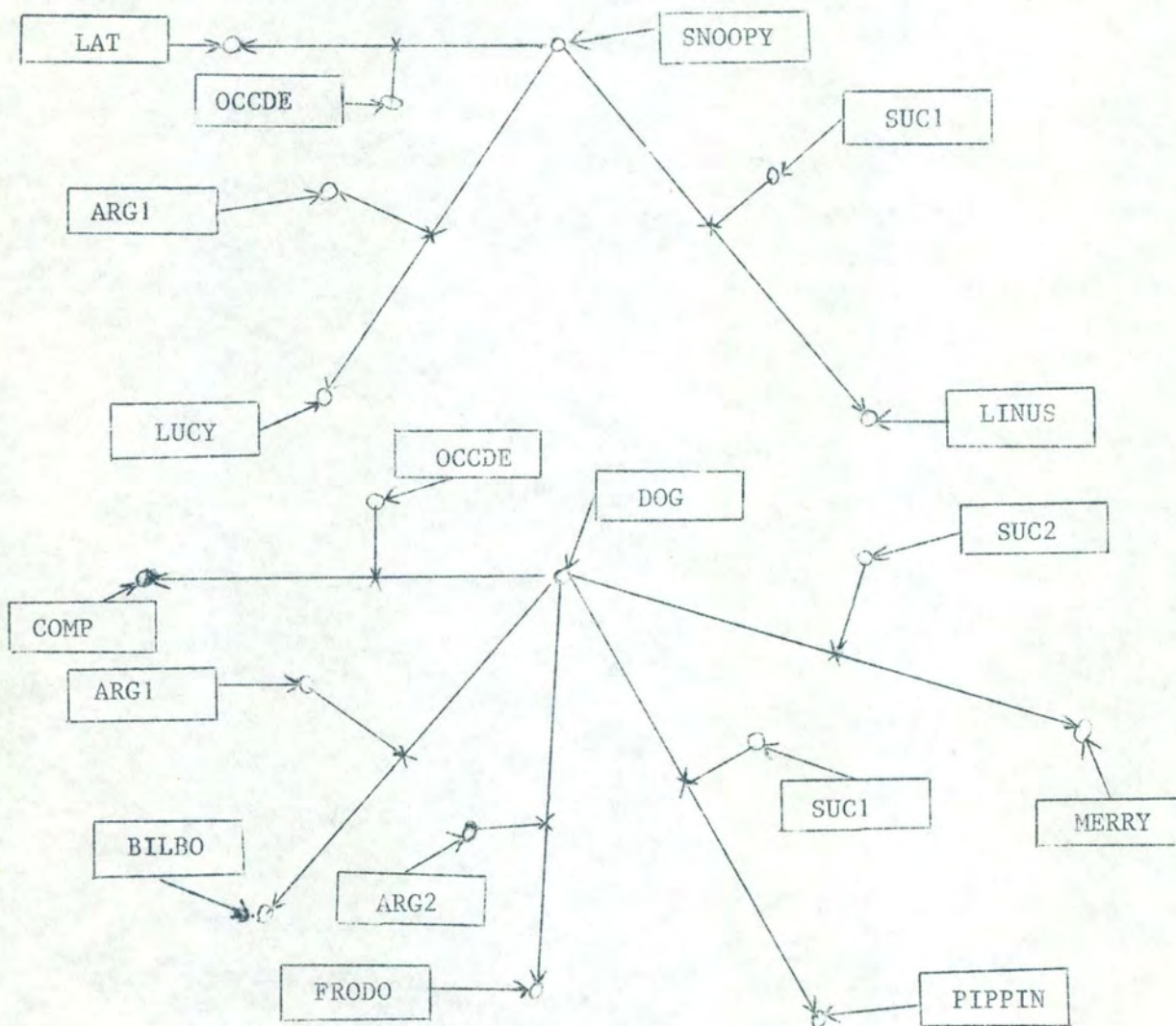
A basic action occurrence is defined by the operation code used. The notion is created that will be the occurrence and its arguments are specified by the list of names in the third column separated by commas. They are specified in the order ARG1, ARG2, ARG3, ARG4, SUC1, SUC2 though only those needed for the action are given.

For example, the lines

```

SNOOPY    LAT    LUCY, LINUS
DOG       COMP   BILBO, FRODO, PIPPIN, MERRY
    
```

represent the following structures :



If the successor of an occurrence is not explicitly named, it is the notion defined on the following line in a TGL text.

For example, if the successor of SNOOPY were DOG instead of LINUS, the above two lines could be written :

	SNOOPY	LAT	LUCY
		COMP	BILBO, FRODO, PIPPIN, MERRY
OR	SNOOPY	LAT	LUCY, DOG
	DOG	COMP	BILBO, FRODO, PIPPIN, MERRY

When more than one attribute with the same root and nature notions are to be defined for a basic action occurrence, for example :

< SNOOPY, ARG1, LUCY >
 < SNOOPY, ARG1, LIKES >
 < SNOOPY, ARG1, LUDWIG >

they can be specified by writing the names of the value notions as a list separated by commas and enclosed in parentheses, thus

SNOOPY	LAT	(LUCY, LIKES, LUDWIG), DOG
--------	-----	----------------------------

When the value of an attribute will be determined during simulation or does not exist in the case of the last action in a process, an asterisk (*) is used to indicate the absence of a value notion. The attribute is created with NIL as value notion, as it would be if the name NIL had been used but the * notation indicates that the attribute will change during simulation whereas NIL defines the attribute's value notion once and for all.

3.7. Specification of other attributes

In TGL we have two "pseudo-operation codes" for the specification of attributes in a general way. These are denoted by DEF and DEFS and each line defines one or more attributes whose nature notion is the same. The nature of the attribute is given by the first notion name in the right-hand column of the line, and the value notion or notions by the other names in this column.

If there is a name in the left-hand column it specifies the root of the attribute, otherwise this attribute belongs to the last root notion given previously. For example, the lines :

PATTY	DEF	SNOOPY, SALLY
	DEF	BROWN, DOG, LINUS
	DEF	LUCY, MIKE
PETE	DEF	SNOOPY, LINUS

define the following attributes :

< PATTY, SNOOPY, SALLY >
< PATTY, BROWN, DOG >
< PATTY, BROWN, LINUS >
< PATTY, LUCY, MIKE >
< PETE, SNOOPY, LINUS >

The special attributes of a notion can also be specified using DEF or DEFS. The asterisk is used to indicate a nature or value that may be defined during the process of transformation of the 3-graph but when used with DEF it may have a specific significance. This stems from a restriction imposed on the implementation that any notion referred to by name must have its name occur at least once in the left-hand column. Usually, when a name appears in this column it means the notion is the root of the attributes being defined. But certain notions in a 3-graph are not roots of any attribute, so they must be declared without attributes. This is done by specifying an asterisk in the nature and value position in the right-hand column of the defining TGL line.

The necessity for two pseudo-operations DEF and DEFS also stems from a restriction on the implementation. DEFS allows the definition of attributes of a notion anywhere in a TGL text after the line originally defining the root notion. For example, the root notion EX2 given earlier with the attributes :

< SNOOPY, OCCDE, LAT >
< SNOOPY, ARG1, LUCY >
< SNOOPY, SUC1, LINUS >

If we wish to add the attributes :

< SNOOPY, BILBO, PIPPIN >

< SNOOPY, LINUS, MERRY >

we could write, anywhere after the original line,

SNOOPY	DEFS	BILBO, PIPPIN
	DEFS	LINUS, MERRY

An attribute specified by an asterisk in a previous line can also be redefined using DEFS but it cannot be used to add attributes with the same root and nature notions, that is :

LUCY	COMP	☆, NIL
	

LUCY	DEFS	ARG1, LINUS
------	------	-------------

is permitted :

LUCY	CREN	LINUS, SNOOPY
	...	

LUCY	DEFS	ARG1, BILBO
------	------	-------------

is not.

3.8. Restrictions in TGL imposed by the use of the Macro-assembler

Before going on to discuss the transformation of a TGL text into internal representation we collect together the restrictions imposed by the use of the Macro-assembler in this transformation. Most of these have been previously mentioned.

1) A notion cannot be referred to by name, unless it is explicitly defined which means that its name must appear in the left-hand column of a TGL line, hence the

KNOT	DEF	☆, ☆
------	-----	------

notation to define notions that are not root of any attribute.

2) It is impossible to know whether a notion has been previously defined so that, when defining a general set of attributes the pseudo-operation code must indicate whether the root notion is to be defined or whether it has already been defined, hence DEF and DEFS;

3) We cannot have access to the information previously generated so it is impossible to add attributes where the root and nature notions are the same as those of previously defined attributes.

- 4) We cannot specify any information other than the address of a notion defined in another section hence the limited way in which sections can be linked. Also the attribute lists of root notions in other sections cannot be extended in the current one.
- 5) It is impossible to generate a dynamic number of assembly-time variables so we cannot associate external notion names with their section numbers to create their complete names automatically. Hence, the complete names must be used.

3.9. Transformation of a TGL text into internal representation

Now that we have described TGL, we turn to the process of transformation of a TGL text into internal representation.

The raw input to this process, the TGL text, is a string of characters. The macro-assembler analyses this string and produces the information required to generate the attribute lists and secondary lists that form the internal representation of the 3-graph based on the TGL description.

These lists will be generated within the page framework imposed, as described earlier, in order to take advantage of the computer system's virtual memory environment. In addition to the chains of blocks forming the internal representation, the blocks containing the name of each named notion will be generated. The free list headers and chains of free blocks are also to be generated.

We have already stated that each of the TGL operation and pseudo-operation codes is defined as a macro to the Macro-assembler. A macro definition can contain calls to other macros whose definitions can, in turn, contain macro calls. In this way the definitions of the TGL operations and pseudo-operations contain calls to other subordinate macros. These usually correspond to functions needed for the generation of attribute lists and secondary lists. They may contain calls

to more elementary functions involved in the generation process. The depth of nesting varies with the complexity of the original and intermediate functions. At the bottom level we find the simplest functions such as the entry into a cell of an address of a notion, secondary list or succeeding block, or the setting of a flag in a cell.

The macros, including the TGL operation and pseudo-operation code definitions, will be referred to collectively as the TGL Reader. (They form a macro library that was created and can be updated using the MLU utility program). In the following discussion we will divide the set of macros into 3 groups :

- the TGL operation code definitions and their subordinate macros
- the DEF and DEFS definitions and their subordinate macros
- the BEGIN, TGEND, EXT and INIT definitions, of which only INIT has any subordinates.

Certain subordinate macros belong to all three groups, while others belonging to different groups have almost identical functions and only the conditions in which they are applied force the existence of more than one macro for a function.

However, the groups are fairly independent and can be discussed separately.

3.10. Generation of a basic action occurrence

The macro definitions of the TGL operation codes are almost identical. The only differences are in the generation of the contents of the OCCDE attribute cell, since the cell contents indicate the routine in the simulator that simulates the corresponding basic action, and in the number of arguments and, therefore, the number of calls to the appropriate functions. Those attributes that are not significant as arguments of a basic action occurrence are initialised to NIL. Table 3 lists the main functions required to generate a notion as an occurrence of a basic action, they are further discussed below.

TABLE 3

<p>Creation of the root notion (TNAME)</p>	<p>Allocation of two blocks for the special attributes. Testing of the successor flags, see below(1). If the notion is named creation of the block containing its name and address, definition of the name as a symbol for the assembler (with concatenation of the section no).</p>
<p>Completion of the OCCDE attribute</p>	<p>Indicate the correct routine in the simulator. Set the flag for a basic action occurrence</p>
<p>Completion of the SUC1, SUC2 attributes (TESDF)</p>	<p>Setting of a special flag if the successor is not explicit. This flag(1) is tested when the successor is created and if set, the attribute will then be completed. If one successor explicit, completion of the attribute cell. If a list of successors, creation of the secondary list and its pointer. If * specified, cell completed with NIL.</p>
<p>Chaining of the 2nd block to the 1st.</p>	
<p>Completion of the ARG1, ARG2, ARG3, ARG4 attributes (TESDF)</p>	<p>If one notion is given, completion of the attribute cell. If a list of notions, creation of the secondary list and its pointer. If * or NIL specified, cell completed with NIL. (A null string causes generation of an error message).</p>

(1) The successor flag is an assembly-time indicator, not a flag that appears in the 3-graph.

Allocation of a block or blocks : A record is kept of the number of bytes allocated in the current page. When a block is allocated this count is updated and if it exceeds the page size the current page is completed and a new page started. In addition, if required, the new block will be chained to its predecessor or to a value cell. (ALLOC and TROOM macros).

Definition of a notion's name and creation of the name block : When the 1st two blocks are allocated to the notion the name is declared attached to the beginning so that name and notion address are associated. These can then be inserted in the name block and the flag that indicates the notion is named is set (TNAME, DEFN macros).

Setting and testing of the successor flag (assembly-time indicators): a successor is implicit when the corresponding argument is a null string. There are two flags, one to indicate that SUC1 is implicit, and the other to indicate SUC2 is implicit. The address of the SUC1 or SUC2 cell is saved when the flag is set so that it can be located later (when the flag is tested) (SFLAG and TFLAG macros).

Setting of a flag in a cell : This function sets the flags that indicate that a cell contains a basic action occurrence, or a pointer to a secondary value list or a notion. (FLAG macro). Not included are the notion name flag (set by TNAME) and the empty block flags (set only by the simulator).

Creation of a secondary list : This function involves the iteration over the list of notion names to complete a cell in the secondary list for each one. Before this, a number of blocks sufficient to cover the list is allocated and chained to the value cell of the attribute (ALLOC macro) and the counter cell value is set (SETCNT macro).

Completion of a value cell of an attribute : The TSTAR macro deals with an * or NIL argument for a value of an attribute. The TSVAl macro detects a reference to one of the special

notions (OCCDE, ARG1, ARG2, ARG3, ARG4, SUC1, SUC2) and completes the value cell. The TESDF macro completes the value cell in all other cases. TSVAl is not strictly necessary. It would be sufficient to distinguish between notions created in the current 3-graph section and those external to it, including the special notions as a particular case (except in section 1). This distinction must be made, in any case, since before reference to a notion created in the current section can be made, the section number must be added to its name and must obviously not be added to a notion that is external. However, the detection of the seven notions is kept as a separate function because it possesses two advantages :

- section 1 is not treated as a special case as it would have to be if one wished to avoid concatenating the section no with these notion names;
- to remove it would be to presuppose that the handling of the special notions will remain the same and in the event of a change, make it much more difficult to modify this.

3.11. Generation of attributes from DEF and DEFS lines

We have already discussed the basic differences in the use of DEF and DEFS to define attributes. Because of these, there are one or two differences in the macro definitions. We will note these differences first before discussing the main functions that are common to both.

- 1) A name in the left-hand column of a DEF line means that a new notion is to be created with this name. The name in the the left-hand column of a DEFS macro is the name of a notion that must previously have been created in the same 3-graph section. Thus the DEF macro definition contains a creation function while the DEFS macro definition contains a function to locate the notion concerned.
- 2) A special case of a notion created by the DEF function is the notion with no attributes. The right-hand column contains asterisks for the nature and value of the attribute. This special case does not, of course, apply in the DEFS macro definition.

Although a DEF or DEFS line defines one or more attributes, there will usually be a group of such lines defining a set of attributes, all with the same root notion that is specified in the left-hand column of the first line. The DEF and DEFS function definitions were designed with this situation in mind and the first line of a group is treated as a special case.

The location counter of the assembler is used as a pointer to the current position in the 3-graph space. In the general case, it points to the next available nature-value pair in the root notion's attribute list. The first line of a DEF group causes the creation of a new notion, that is, the allocation of the 1st two attribute blocks and the name block, after which the location counter points to the beginning of the 1st block. The first line of a DEFS group also forces the location counter to the beginning of the notion's 1st block. For the simple case where a nature-value pair is added to an attribute list the DEF or DEFS generation is straightforward. It is the special cases that make the DEF and DEFS definitions complex since a lot of indicators are required to keep track of the current situation.

The simple case follows the basic pattern :

- 1) The location counter is set at the next free nature-value pair.
- 2) The notion that is nature of the attribute is not one of the special notions. Its address is inserted into the nature cell.
- 3) The notion that is value of the attribute is not a special notion. Its address is inserted into the value cell.
- 4) No special flags are needed and the location counter is set to the cell following the newly created attribute.

This basic pattern is disrupted when one or more of the following occurs :

- the first line of a DEF or DEFS group : involves creation of a new notion or location of an existing notion. The location counter is not set to a nature-value pair but to the beginning of the notion's attribute list.

- the location counter is set to the pointer cell of the current block and not to a nature-value pair; involves allocating a new block, chaining it to the list and setting the location counter before creating the attribute;
- the nature of the attribute is one of the special notions; involves saving the current position of the location counter, setting it to the attribute position and resetting it after the attribute has been created. If the attribute is OCCDE this must be noted during creation of the attribute.
- there is a list of values of the attribute : involves saving the current location counter position so it can be reset afterwards, allocating a sufficient number of blocks for the secondary list, setting the counter cell and pointer to the list and filling in the values of the attribute.
- the value of the attribute is a special notion or a basic action : the cell must be completed with the appropriate contents including flags (for an occurrence of a basic action).

Table IV shows the most important macros that are subordinate to DEF or DEFS, and their functions.

TABLE IV

ALLOC	allocates a block, fills in the pointer to the new block.
DEFNOT	creates a new notion, requires allocation of two blocks for special attributes and a third for name block which it completes.
LISTVAL	completes a cell in a secondary list of the OCCDE attribute, calls TSOCC to detect basic action occurrences.
VALST	completes a cell in any other secondary list, calls TSVAl to detect special notions.
VALUE	completes the value cell of a nature-value pair, calls TSVAl to detect special notions
NATRE	completes nature cell of a nature-value pair unless call to TSNAT detects a special notion and resets location counter.
SETCNT	sets counter cell in a secondary list.

3.12. BEGIN, TGEND, EXT and INIT

The generated output of the Assembler with the TGL reader is an object module containing the internal representation of a 3-graph section. The BEGIN and TGEND macros generate the initial and terminal coding that the Assembler requires to produce an object module, and BEGIN initialises certain global information required during generation.

The EXT macro causes the Assembler to generate the information needed when the object module is linked with others, thus forming a complete 3-graph from the different sections.

We have already discussed the function of INIT.

oooooooooooooooooooo

The result of the transformation of the TGL text is a 3-graph section in internal representation that is still incomplete in two ways :

- it contains references to notions in other sections which will only be completed when all the sections are linked together and the simulator routines loaded.
- the statistics cells in the notions have not been initialised to their correct values. This will be done as part of an initialisation phase before simulation takes place. At the same time the dictionary of notion names will be created. This initialisation phase will be discussed in the next section.

o
o o

4. THE SIMULATOR -LANGUAGE, INITIALISATION AND INPUT-OUTPUT

Now that we have described TGL and the TGL reader which produces a 3-graph in internal representation, we return to the simulation part of the implementation where several aspects remain to be discussed :

- the programming language used to program the routines;
- the organisation of the 3-graph sections, the simulator routines, initialisation and input-output routines into a pageable program in virtual memory;
- the initialisation of the 3-graph, mentioned in the previous section, before the transformation processes can be simulated;
- the possibilities provided by the input-output routines for the user to query the 3-graph.

4.1. Choice of programming language

The choice of programming language was influenced by the following requirements or aims :

- since the 3-graph sections and simulator routines (including input-output and initialisation routines) form one program from the system's point-of-view we wished to minimise the space taken by the latter in order to maximise the possibilities of expansion of the former (every page or part of a page taken up by the routines is "dead" space for the expansion of the 3-graph).
- we need to be able to manipulate addresses directly and indirectly and indirectly and to check bits in a word to test the flags in a cell, that is, we need to work at a very basic level;
- facility of maintenance and modification of the routines means that we wish to be able to isolate the different functions i.e to create a highly modular structure that is also easy to follow and as obvious as possible without requiring a lot of explanatory documentation.

The first two objectives may seem to be contradictory to the third in that the power required for the first two implies use of a low-level language in which it is notoriously difficult to achieve the third.

It is easier to control the size and internal organization of the machine code of a program written in an assembly language than in a high-level language. An assembly language also gives direct access to memory addresses and individual bits of a machine word without recourse to the sort of "clever" programming so often criticized as a source of errors and obscurities in programs. On the other hand, an assembly language program too often, presents itself to a reader as a long string of instructions where any structure is extremely difficult to discern and where the functions of the different parts are not clear even when they are not so inextricably linked as to disappear altogether in a homogeneous mass. However, we believe that by using to the full the possibilities of a macro-assembler and a modular style of programming, a program written in assembly language need not be a long ribbon of instructions but can reflect the structure of the problem.

The analysis of the problem leads to the definition of the different functions needed to solve it.

These functions usually form a hierarchy with several levels. The macro-assembler provides us with a tool for creating instructions corresponding to the functions at any level from the simplest to the most complex. The coding finally produced, whether it be a sequence of basic instructions or a call to a routine that performs the function is not important, in either case the structure is reflected by the use of the macro-instruction.

Macro-instructions can be used not only to invoke functions but also to define complex data structures. The TGL reader is a good example of this use of macros.

It produces no executable code, the internal representation of the 3-graph is entirely composed of constant and storage definition operations.

Nevertheless, at each level the programmer can still retain a close contact with the machine since he decides what to include in the macro definition. The possibilities offered by the macro-assembler, of testing assembly-time variables and varying the coding generated can be a great advantage. Specific, and often shorter, coding can be produced for a particular case in the function. A routine to perform the same function would have to consider all cases and thus do the testing at execution time. Also the possibilities for varying the coding are greater at assembly time since the arguments of a macro can be other things than just the values that may be passed a routine at execution time.

Macros can also be used to document a program or a set of programs. For example, the documentation of common variables that are passed between several independent routines. This documentation, if done once in a macro, can be made to appear easily in each routine and when the use or meaning of the variable changes, the documentation is changed in the macro and the modifications appear in the routines when they are re-assembled.

Since, in this way, we can take advantage of the power of an assembly language and still have a program that is structured, making maintenance and adaptability simpler, the choice of the macro-assembler as programming language is obvious.

This is not to imply that there are no more problems. Indeed, the limitations of the macro-assembler available to us, has caused problems though much less so in the simulator rou-

tines than in the TGL reader. Also, any program in whatever language it is written, but especially an assembly language program must be carefully documented if all the programming effort is not to be a sheer waste of time.

4.2. Programming style and documentation of the simulator

The main feature of the programming is the combined use of macros and subroutines to perform the different functions required in the simulation of the 3-graph basic actions. A subroutine in this context is a part of a program that performs one function in the simulation. While not necessarily a separately assembled module, it usually has only one entry point and one exit. It cannot be reached sequentially in the program and the information it needs to perform its function is given to it explicitly when it is invoked. This isolation is intended to limit the impact of changes in the program.

For certain functions we have a 'twinning' of a macro and a subroutine. The macro call provides the in-line indication of a function to be performed. The macro expansion calls the subroutine that carries out the function. It may also perform some "housekeeping" for the subroutine.

Each macro or subroutine contains in its coding the totality of its documentation. This avoids the necessity of separate documents that may get lost or quickly become obsolete because changes in the program are not reflected therein. A short description of the function of each routine and the way in which this is carried out heads the function, together with a specification of its input and output parameters, the routines it calls and the routines by which it is called. In addition, the coding contains abundant comments.

The macros are similarly documented and in the macro library there is also a macro (MXREF) that contains a cross-reference table of macro and routine calls. Since the documentation and source code are kept together, changes in the macros or routines and the updating of the documentation can be

done at the same time without the need to keep several documents in parallel. Consequently, less effort is needed and the programmer is less likely to forget to update the documentation.

4.3. Loading and initialisation of a 3-graph

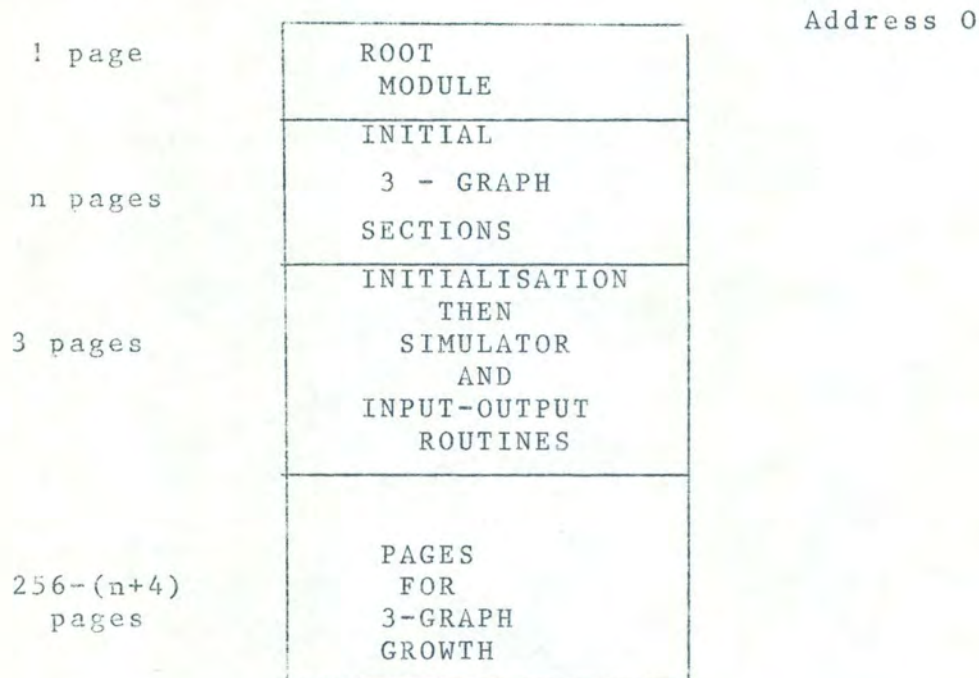
The output of the transformation of a TGL text by the TGL reader is an object module : the format for input to the BS-2000 linkage editor program. Such an object module is stored in a library which will be the principal source for the linkage editor when it resolves unsatisfied references in a specified module. A 3-graph section in its object module form will contain unsatisfied references when the EXT pseudo-operation has been used to specify notions in other sections. Unless it is section #1, it will contain, in any case, unsatisfied references to the notions OCCDE, ARG1, ARG2, ARG3, ARG4, SUC1, SUC2.

When a 3-graph is to be simulated its different sections must be linked together and the simulator routines added to make a single program. The linkage editor performs this task, producing a loadable module. It must be given the names of the object modules it is to link together. For a 3-graph simulation these are :

- TRGR1, the name of 3-graph section 1;
- the name(s) of the other main 3-graph section(s) required (the name is generated by the TGL reader as TRGRn where n is the section number);
- the module containing the simulator routines;
- the module containing the initialisation routines and root module (see below);
- the module containing the input-output routines.

All the 3-graph sections required do not need to be specified, since they will be included by the linkage editor resolving references. Section 1 must be given explicitly because the special notions must be the first notions in the program's address space.

To save space, the final program has an overlay structure. Since the initialisation routines are no longer needed after the 3-graph has been initialised, they are overlaid by the simulator routines. This technique requires the existence of a root module whose sole purpose is to call the initialisation routines and then the simulator routines. Since this root module is not overlaid it also contains the definition of the dictionary of notion names used by the input-output routines and created by the initialisation routines. The layout of the 3-graph and routines in the virtual memory space is shown in the diagram :



When the program resulting from the linkage edit is loaded for execution the root module receives control and immediately invokes the initialisation routines. These routines perform three tasks :

- Initialisation of statistics cells or reference counts

Each notion's attribute list and associated secondary lists are scanned. Each notion that appears in the lists as a nature or value notion is accessed and its reference count incremented by one.

Here we have taken into account the paging environment of the program and attempted to avoid excessive paging. When the notions in the lists are accessed for updating of their reference counts they may be widely dispersed and in a heavily loaded system this could lead to frequent paging requests. The technique used to avoid this consists in discriminating between notions in the same page and notions in other pages. A notion in the same page is accessed and its reference count updated. For a notion in another page, the reference is noted in a table.

At the end of a page, the notions noted in the table are accessed and their reference counts updated. This is done by dividing the pages of the 3-graph into groups of contiguous pages. All the notions in a group of pages are accessed, then all the notions in the next group and so on until all the notions in the table have been accessed. In this way, we hope to keep the paging rate down.

- Creation of the dictionary of notion names

The dictionary is created only on the request of the user, who is asked at the beginning of the initialisation whether a dictionary is to be created or not. The dictionary is usually created the first time a particular 3-graph is simulated and need not be re-created each time.

To create the dictionary, the 3-graph is scanned to find those notions that have names (flagged in the statistics cell) and their names and addresses are transferred from the name blocks.

The dictionary is created as an indexed sequential file. The name of the notion is the retrieval key for a record in the file. Thus, the dictionary gives a notion's address when its name is known. The name blocks in the 3-graph give a notion's name when its address is known.

The scan of the 3-graph to find the name blocks is a much simpler scan than the one to initialise the statistics cells, so we preferred to use two scans. With separate scans, the initialisation routines are also more modular.

- Initialisation of the page table

The page table is contained in the root module (page 0) and contains an entry for each of the 256 pages in the program's virtual memory space. For each page containing part of the 3-graph the entry indicates :

- . the section to which the contents of the page belongs;
- . an indication of whether the free list of the page is empty or not.

It is used when, during simulation, space is required for allocation to an attribute or secondary list and the page in which the list is located is complete. The page table is scanned to find another page with space available. Preference is given to pages with the same section number to keep the notions of each section together. If all currently existing pages are full their the system is asked to allocate another page.

After initialisation is finished, the root module loads and hands control to the simulator routines. The first thing that happens is that the simulator asks for the name of the first action occurrence to be simulated. It consults the dictionary to find the corresponding notion address and then starts the simulation process.

- The input-output routines

The simulator routines do not provide any method of conserving or retrieving the resultant 3-graph after a simulation. It would be possible to provide a sort of dump, in readable form, of the 3-graph at the end of a simulation. We decided, instead, to provide a set of routines that permit a limited form of dialogue with the 3-graph during the simulation.

The reasons for this are twofold :

- the sheer volume of information that would be produced by a dump of the 3-graph. Most of it would be of little interest but a dump is not discriminating;
- the interesting part of the simulation is not necessarily the terminal results. It is also, the process which provides the results, and the intermediate stages.

The input-output routines are invoked when the user interrupts the simulation process from his terminal or when a particular point in the process is reached, due to an earlier call to these routines. When invoked they prompt the user to send a command to be executed. The command can be one of the following :

- display of an attribute or all the attributes with a given root notion. This command is

D < notion name >
or D < notion name 1> OF <notion name 2>

In the first case, all the attributes in the notion's list of attributes are listed. In the second case the attribute whose root notion is specified by notion name 2, and nature notion by notion name 1, is listed. The command :

D ?

provokes the listing of the attribute list of the notion that is the next action occurrence to be simulated.

- setting a halt point

The command is AT <notion name>

The notion specified must be an action occurrence. Its OCCDE attribute is saved and replaced by a halt point indicator. When the simulation process reaches the notion, the input-output routines are invoked (and produce the message 'HALT POINT'). Only one halt point at a time is currently permitted.

- return to the simulation process. This can be done in two ways. The command

R

indicates simulation is to resume where it left off. The command

BR <notion name >

indicates simulation is to resume at the notion specified.

Except when the command R or BR is given, the routines prompt the user for further commands after execution of the previous one. When a display command is given the output is in three column format. The left-hand column gives the name of the root notion, the central column the name of the nature notion and the third column the name(s) of the value notion(s) of the attributes. If a notion has no name, a unique name is generated by the routines, which can be subsequently used to identify the notion.

o

• •

5. FUTURE VERSIONS OF THE IMPLEMENTATION

We have tried to show the main points of interest in the current version of the 3-graph implementation on the Siemens 4004 computer. It is, however, only a first version and there are several unsatisfactory points about it, in particular certain choices made during the implementation have proved to be questionable. Although, to date, the implementation has not been used very much to treat 3-graphs so it is difficult to say how it will stand up in practice or what errors exist, we can point out one or two modifications that will be necessary, or useful in future versions. These fall into three categories :

- those necessary to bring the implementation into line with the current theory;
- those necessary to correct certain doubtful choices in the implementation
- those that will extend the current possibilities of the implementation.

5.1. Implementation and theory

The modifications are required to bring the implementation into line involve the addition of the notion TODO and the treatment of the basic actions COMP, CREN, CRER, SUP, SUPR, LAT, TMV, REP. These do not appear as notions in the 3-graph implementation in the same way as other notions. They usually appear as particular values of the OCCDE attributes and the way in which they are handled means that they can not be root or nature of any attribute. The other special notions can be root, nature or value of attributes (though all those in which they are root notions must be defined in 3-graph section # 1 (see restrictions in the section on TGL)) and, since in the theory

the basic actions can also play any role in an attribute they must be included in the functions that declare the special notions in TGL, INIT and BEGIN. Also in TGL, the functions that detect references to the special notions will be slightly altered to take into account the new way in which the basic actions are represented. In the simulator too, this will mean slight changes, for example where the special notions have to be protected from removal from the 3-graph, or where they are treated as special cases in the creation of attributes.

The most important modifications to the simulator are those required for the addition of the notion TODO. The TGL reader is not greatly affected, the notion must be declared and recognised in the same way as the others. In the simulator, however, a new function must be added. At the end of the simulation of each action the attributes of TODO must be updated so that they specify the actions to be executed next. The function that indicates, on exit from each basic action simulation the successors of the current action will be altered to include the new function. The choice of successor and simulation of parallelism functions will be slightly altered.

5.2. Doubtful choices in the current version of the implementation

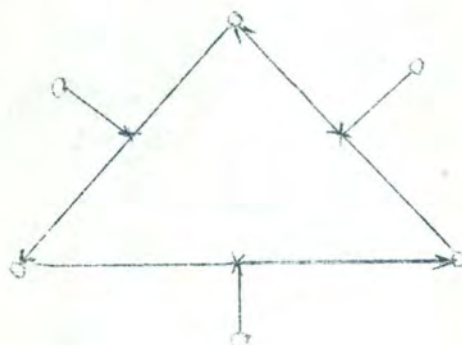
Independently of any modifications caused by the introduction of the notion TODO the simulation of parallelism is a prime candidate for change. The current method used is highly unsatisfactory for the following reason:

when an action occurrence initiates a set of parallel processes, that is, there is a secondary list of successors the contents of this list is copied onto a stack, and one of the processes is initiated. Only when this process terminates will another be initiated, and we end up with, in effect

a sequence of single processes. Furthermore, if one process never terminates, those left on the stack can never be initiated. Thus it is important to find another way of simulating parallelism in the 3-graph.

The routines that suppress inaccessible substructures from the 3-graph can also be improved, from the user's point of view and in the space-saving aspect. These substructures are a waste of valuable space to the simulator but they are not necessarily uninteresting to the user. The introduction of an indicator that could be set to prevent their automatic suppression would be useful. It would allow the user to preserve them for later use or ask for them to be copied to a file before suppression.

Not all inaccessible structures are detected by the present methods. Structures such as the following :



where none of the notions is a special notion, are inaccessible but the notions are all nature or value of an attribute and cannot be suppressed. To eliminate such cases, a rescan similar to the initialisation scan is required to mark all accessible notions and then remove those that are left unmarked (garbage collector).

5.3. Extensions to the possibilities

At the moment, these concern mainly the facilities for obtaining results from the 3-graph, conserving a resultant 3-graph from one simulation to another and interaction with the 3-graph during simulation.

The commands for input and output described in section 4 need to be extended. In particular, it would be interesting to have more than 1 halt point at a time and have a halt point that remained in the 3-graph until explicitly removed. It would also be interesting to be able to specify halt points in a TGL text. A special halt point at the end of a simulation process when final results are available is, in the present case, almost a necessity since the final state of the 3-graph is lost.

The possibilities of the display commands could be extended to permit the display of structures starting from a particular root notion and extending downward through its immediate attributes.

In the current version of the implementation it is impossible to halt the process of simulation and resume it at a later date or to conserve the state of a 3-graph from one simulation to another. This is an important obstacle to the use of the implementaton and its removal is high in the list of extensions to be made in future versions.

G. CONCLUSION

Of necessity, many details of the implementation have been left out of this description. We refer the interested reader to the program listings for the detailed description of every function, whether macro or routine.

In conclusion, we can only hope that the implementation in the current and future versions will be used for the study of semantics, and that it will prove to be as easy to maintain and modify as we have tried to make it.

◦
◦ •

BIBLIOGRAPHY

- [1] A Proposal for the Formalisation of Semantics :
C. Cherton, M. Hewitt, F. Doyen
- [2] Siemens Assembly System Reference Manual
- [3] Siemens 4004/35, 45 and 55 Processors Reference Manual
- [4] Siemens 4004 VMOS Utility Routines Reference Manual
- [5] Siemens 4004 VMOS Executive Macros Reference Manual

o
o o

AN IMPLEMENTATION OF 3-GRAPHS

FIRST VERSION

APPENDIX : PROGRAM LISTINGS

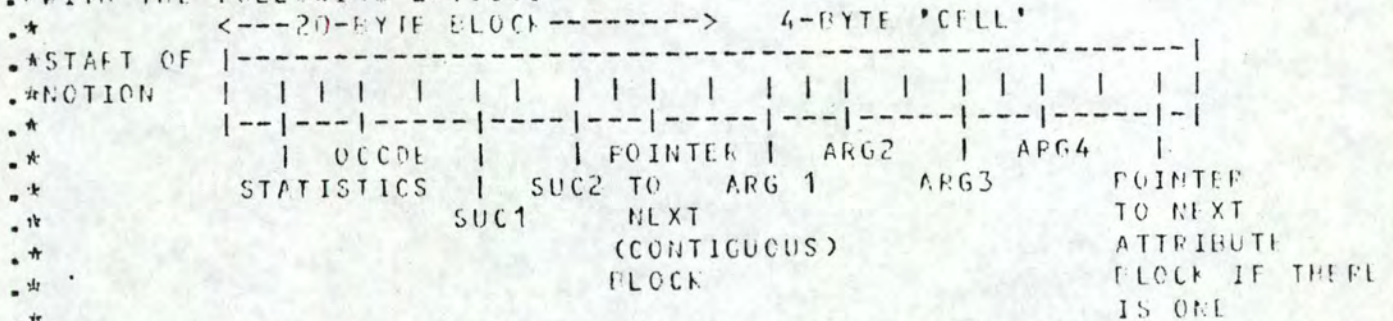
M. HEWITT

GENERAL 01411500:01433600 12/20/74 12/20/74

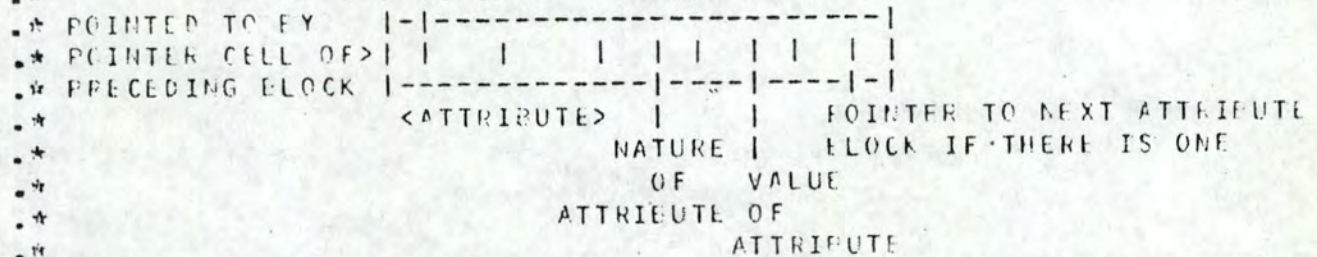
MACRO
GENERAL

*ORGANISATION OF A NOTION

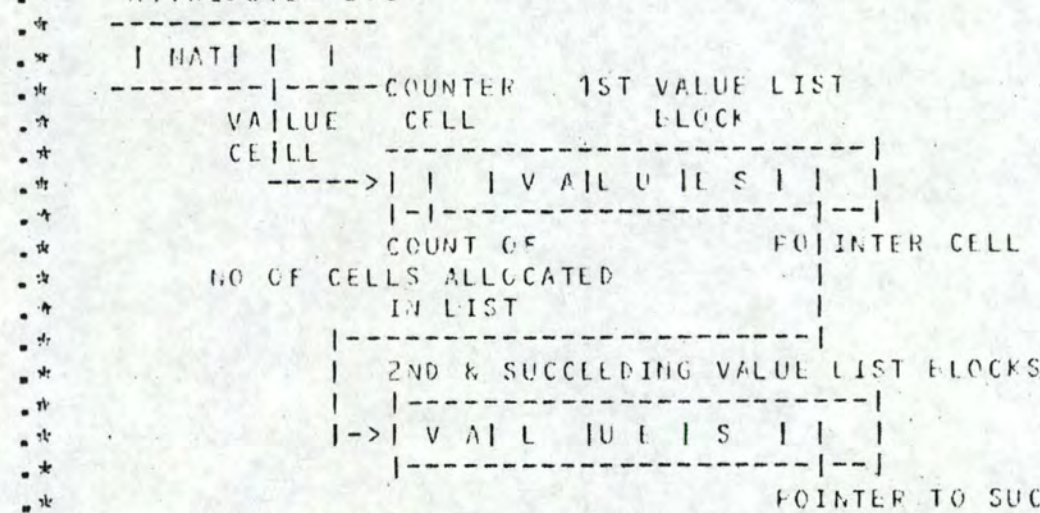
*EACH NOTION DEFINED CONSISTS OF AT LEAST 2 CONTIGUOUS 20-BYTE BLOCKS
*WITH THE FOLLOWING LAYOUT:



*THIS MAY BE FOLLOWED BY ANY NO OF 20-BYTE ATTRIBUTE OR 'TAIL' BLOCKS
* 4-BYTE CELL <ATTRIBUTE>



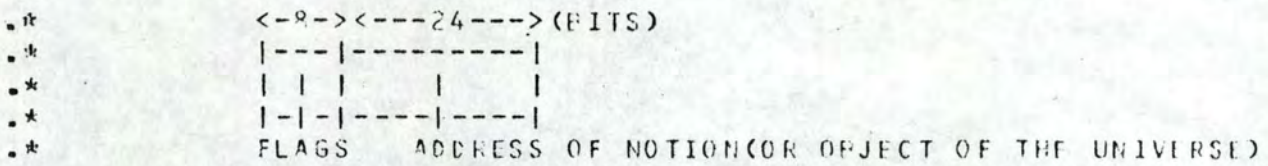
*IF AN ATTRIBUTE HAS MORE THAN 1 VALUE THE VALUE CELL CONTAINS A POINTER
*TO ONE OR MORE VALUE LIST BLOCKS
* ATTRIBUTE BLOCK



*THE FIRST 2 BLOCKS OF A NOTION WITH A NAME ARE FOLLOWED BY A
*20-BYTE BLOCK CONTAINING THE NOTION'S NAME AND ADDRESS

*ORGANISATION OF A CELL

GENERAL 01411500:01433600 12/20/74 12/20/74



*SPECIAL CONTENTS OF A CELL

*A)THE OCCDE CELL CONTAINS AN OFFSET INTO A TABLE IN THE SIMULATOR

*ORGANISED AS FOLLOWS:

*START OF TABLE: 4 BYTE ENTRIES

- * ADDRESS COMP SIMULATION ROUTINE
- * ADDRESS CREN SIMULATION ROUTINE
- * BLANK ENTRY
- * ADDRESS LAT SIMULATION ROUTINE
- * ADDRESS REP SIMULATION ROUTINE
- * ADDRESS SUP SIMULATION ROUTINE
- * BLANK ENTRY
- * ADDRESS SUPR SIMULATION ROUTINE
- * ADDRESS TMV SIMULATION ROUTINE
- * ADDRESS CRER SIMULATION ROUTINE

*B)A NATURE OR VALUE CELL IS UNOCCUPIED IF ITS CONTENTS = X'0FFFFFFF'

*CORRESPONDS TO THE NOTION 'NIL'

*C)THE END OF A CHAIN OF ATTRIBUTE OR VALUE LIST BLOCKS IS INDICATED

*IN THE POINTER CELL WHOSE CONTENTS = X'0FFFFFFF'

*FLAG BITS

CELL	BIT 7	6	5	4	3	2	1	0
*OCCDE-BASIC ACTION	1	0	-	-	-	-	-	-
*-NON-BASIC ACTION	0	0	-	-	-	-	-	-
*-POINTER TO LIST	0	1	-	-	-	-	-	-
*SUC1								
*SUC2 -NOTION	0	0	-	-	-	-	-	-
*ARG1 -POINTER TO LIST	0	1	-	-	-	-	-	-
*ARG2								
*ARG3								
*ARG4								
*NATURE OF ATTRIBUTE	0	0	-	-	-	-	-	-
*VALUE								
*OF -NOTION	0	0	-	-	-	-	-	-
*ATTRIBUTE-POINTER TO LIST	0	1	-	-	-	-	-	-
*VALUE-NATURE IS OCCDE								
*CELL -BASIC ACTION	1	0	-	-	-	-	-	-
*IN -NON-BASIC	0	0	-	-	-	-	-	-
*VALUE-NATURE ANY NOTION								
*LIST								
*-NOTION	0	0	-	-	-	-	-	-
*POINTER TO ATTRIBUTE BLOCK	0	0	-	-	-	-	-	-
*STATISTICS CELL-NAMED NOTION	1	-	-	-	-	-	-	-

GENERAL 01411500:01433600 12/20/74 12/20/74

* * * * *	-UNNAMED	C	-	-	-	-	-	-	-
* * * * *	*STATISTICS OR COUNTER CELL/EMPTY	0	0	0	1	-	-	-	-
* * * * *	*BLOCK IN CHAIN OF BLOCKS								
* * * * *	*COUNTER IN LIST OF VALUES	-	-	-	-	-	-	-	-

* * * * *	*GLOBAL MACRO VARIABLES (CROSS-REFERENCE TABLE)								

* * * * *	*NAME	TYPE	TESTED IN	SET, RESET, UPDATED IN	USED IN				
* * * * *			(MACRO NAME)	(MACRO NAME)	(MACRO NAME)				
* * * * *	*&ASACT	BOOL	LISTVAL	DEF					
* * * * *			VALUE	TSOCC					
* * * * *	*&DEFCON	BOOL	DEF	DEF					
* * * * *			DEF	DEF					
* * * * *			NATRE	VALUE					
* * * * *	*&ELAB	ARITH		SFLAG	SFLAG				
* * * * *					TFLAG				
* * * * *	*&NAMGEN	ARITH		DEF	DEF				
* * * * *				DEF	DEF				
* * * * *					VALUE				
* * * * *	*&NOBY	ARITH		ALLOC	ALLOC				
* * * * *				INIT	TROON				
* * * * *				TROON					
* * * * *	*&PASSNO	ARITH		BEGIN	TGEND				
* * * * *					DEF				
* * * * *					DEFS				
* * * * *					LISTVAL				
* * * * *					NATRE				
* * * * *					SUBLST				
* * * * *					TESDF				
* * * * *					TNAME				
* * * * *					VALST				
* * * * *					VALUE				
* * * * *	*&POS	ARITH		SUELST	DEF				
* * * * *				TSNAT	DEFS				
* * * * *					SUBLST				
* * * * *					TSNAT				
* * * * *	*&RPATH	ARITH	NATRE	DEFS					
* * * * *				DEF					
* * * * *				NATRE					
* * * * *				VALUE					
* * * * *	*&RMVAB	ARITH	DEF	DEF					
* * * * *			DEFS	DEFS					
* * * * *			LISTVAL	LISTVAL					
* * * * *			SUBLST	SUBLST					
* * * * *			VALST	VALST					
* * * * *	*&SFNAT	BOOL	DEF	DEF					
* * * * *			DEFS	TSNAT					
* * * * *			NATRE						
* * * * *			VALUE						
* * * * *	*&SPOCCDEE	BOOL	ALLOC	DLF					

GENERAL 01411500:01433600 12/20/74 12/20/74

```

.*          DEF          TSNAT
.*          DEFS
.*          VALUE
.*&SPVAL    BOOL    SUBLST          DEF
.*          TESDF          TSVAL
.*          VALST
.*          VALUE
.*&STAR     BOOL    TESDF          TSTAR
.*&SUCC1    BOOL    TFLAG          SFLAG
.*          TFLAG
.*&SUCC2    BOOL    TFLAG          SFLAG
.*          TFLAG
.*          *****
.*MACRO TABLE (CROSS-REFERENC)
.*          *****
.*MACRO NAME | CALLED BY;          | CALLS;
.*ALLOC      | DEF, DEFS, LISTVAL, NATRE, SUBLST | FLAG
.*          | VALST          |
.*PLGIN      | 3-GRAPH PSEUDO-OPERATION          | -
.*COMP       | 3-GRAPH BASIC OPERATION            | FLAG, TNAME, TESDF
.*CREN       | 3-GRAPH BASIC OPERATION            | FLAG, TNAME, TESDF
.*CRER       | 3-GRAPH BASIC OPERATION            | FLAG, TNAME, TESDF
.*DEF        | 3-GRAPH PSEUDO-OPERATION          | ALLOC, DEFNOT, LISTVAL, NATRE
.*          |          | VALST, VALUE, SETCNT
.*DEFN       | TNAME          | TROOM
.*DEFNOT     | DEF            | FLAG, TROOM
.*DEFS       | 3-GRAPH PSEUDO-OPERATION          | ALLOC, LISTVAL, NATRE, VALST,
.*          |          | VALUE, SETCNT
.*EXT        | 3-GRAPH PSEUDO-OPERATION          | -
.*FLAG       | ALLOC, COMP, CREN, CRER, DEFNOT, | -
.*          | LAT, LISTVAL, NATRE, OUTIT,      |
.*          | REP, SUBLST, SUP, SUPR,          |
.*          | TESDF, TFLAG, TMV, TSOCC, TSVAL, |
.*          | VALST, VALUE          |
.*INIT       | 3-GRAPH PSEUDO-OPERATION          | OUTIT
.*LAT        | 3-GRAPH BASIC OPERATION            | FLAG, TESDF, TNAME
.*LISTVAL    | DEF, DEFS          | ALLOC, FLAG, TSOCC
.*NATRE      | DEF, DEFS          | ALLOC, FLAG, TSNAT
.*OUTIT      | INIT              | FLAG
.*REP        | 3-GRAPH BASIC OPERATION            | FLAG, TESDF, TNAME
.*SETCNT     | DEF, DEFS, SUBLST          | -
.*SFLAG      | TESDF              | -
.*SUBLST     | TESDF              | ALLOC, FLAG, TSVAL, SETCNT
.*SUP        | 3-GRAPH BASIC OPERATION            | FLAG, TESDF, TNAME
.*SUPR       | 3-GRAPH BASIC OPERATION            | FLAG, TESDF, TNAME
.*TESDF      | COMP, CREN, CRER, LAT, REP,      | FLAG, SFLAG, SUBLST, TSTAR, TSVAL
.*          | SUP, SUPR, TMV          |
.*TFLAG      | TNAME              | FLAG
.*TGEND      | 3-GRAPH PSEUDO-OPERATION          | -
.*TMV        | 3-GRAPH BASIC OPERATION            | FLAG, TESDF, TNAME

```


GENERAL 01411500:01433600 12/20/74 12/20/74

```

.*TNAME      |COMP,CREN,CRFF,      LAT,REP, |DEFN,TFLAG,TROOM
.*          |SUP,      SUPR,TMV   |
.*TROOM      |DEFN,DEFNOT,TNAME   | -
.*TSNAT      |NATRE               | -
.*TSOCC      |LISTVAL,VALUE       |FLAG
.*TSTAR      |TESDF               | -
.*TSVAL      |SUBLST,TESDF,VALST,VALUE |FLAG
.*VALST      |DEF,DEFS            |ALLOC,FLAG,TSVAL
.*VALUE      |DEF,DEFS,          |FLAG,TSOCC,TSVAL

```

.*WRITING MACRO CALLS

- .*1) NOTION NAME-1 TO 6 ALPHANUMERIC CHARACTERS STARTING WITH AN ALPHABETIC CHARACTER (EXCLUDING @)
- .*THIS NAME IS CONCATENATED WITH THE SECTION NUMBER(SEE BEGIN MACRO)
- .*2) IN BASIC ACTION MACROS A PARAMETER MAY BE REPLACED BY A LIST WHICH IS ENCLOSED IN PARENTHESES WITH THE NOTION NAMES SEPARATED BY COMMAS. THE WHOLE LIST INCLUDING PARENTHESES MAY NOT EXCEED 127 CHARACTERS.
- .*3) A PARAMETER MAY BE REPLACED BY AN * WHICH INDICATES THAT THE VALUE(S) OF THE ATTRIBUTE WILL BE SPECIFIED EITHER BY A DEFS MACRO (LIST OF VALUES >127 CHARACTERS) OR DURING EVOLUTION OF THE 3-GRAPH.
- .*4) IF THE SUC1 OR SUC2 OF A BASIC ACTION IS THE ACTION DIRECTLY FOLLOWING IT, IT NEED NOT BE EXPLICITLY MENTIONED. IF SUC1 IS IMPLICIT WHILE SUC2 IS EXPLICIT THE SEPARATING COMMA MUST BE WRITTEN E.G.
- .*1) COMP A,B,SUCC,NEXT
- .* NEXT TMV
- .*IS EQUIVALENT TO
- .* COMP A,B,SUCC
- .* TMV SUC2 NOT EXPLICIT
- .*2) COMP A,E,NEXT,SUCC
- .* NEXT TMV
- .*IS EQUIVALENT TO
- .* COMP A,E,,SUCC
- .* TMV SUC1 NOT EXPLICIT
- .*5) THE STRING 'NIL' CAN BE USED TO INDICATE THE NOTION 'NIL' (TSTAR MACRO)

MEND

COMP 01333800:01340800 12/20/74 12/20/74

MACRO

&NAME COMP RARG1,RARG2,&SUC1,&SUC2

*GENERAL DESCRIPTION

*COMP IS A BASIC OPERATION ON A 3-GRAPH;THE NOTION SPECIFIED BY THE *VALUE OF ARG1 IS COMPARED TO THAT SPECIFIED BY THE VALUE OF ARG2.IF *THEY ARE THE SAME THEN THE NEXT ACTION TO BE TAKEN IS THAT SPECIFIED *BY THE VALUE OF SUC1 OTHERWISE THE NEXT ACTION IS SPECIFIED BY THE *VALUE OF SUC2.

*EXPANSION OF THIS MACRO AND THE MACROS IT CALLS GENERATES A NEW *NOTION IN THE 3-GRAPH WHICH IS AN OCCURRENCE OF THE BASIC ACTION-COMP *THIS NOTION MAY BE NAMED (&NAME PARAMETER).

*DEFINITION OF THE NEW NOTION

TNAME RNAME

*EXPANSION OF THE TNAME MACRO ALLOCATES 2CONTIGUOUS 20-BYTE BLOCKS *FOR THE NEW NOTION AND DEFINES THE NAME IF THE NOTION IS NAMED.

*STATISTICS CELL

AIF ('&NAME' EQ '') .NONAM ,
DC XL4'80000000'
AGD .0CCDE
.NONAM DC F'0'

*THE FIRST CELL IS RESERVED FOR STATISTICS ABOUT THE NOTION AND IS *INITIALISED TO 0. A FLAG BIT IS SET IF THE NOTION IS NAMED.

*0CCDE CELL

0CCDE FLAG BASE
DC AL3(0)

*THE (2ND CELL) SPECIFY THE ACTION WHICH THE NOTION IS AN OCCURRENCE *OF.THE FLAG BITS SET INDICATE THAT THIS IS A BASIC ACTION.

* SUC1 AND SUC2 CELLS

TESDF &SUC1,F1
TESDF &SUC2,F2

*EXPANSION OF THE TESDF MACRO TESTS FOR THE ABSENCE OF AN EXPLICIT *SUCCESSOR IN WHICH CASE A FLAG IS SET TO INDICATE THAT THE SUCCESSOR *IS THE NEXT SEQUENTIAL ACTION.IF THE ACTUAL PARAMETER = '*' THEN THE *CELL IS LEFT EMPTY OTHERWISE THE ADDRESS OF THE NOTION SPECIFIED IS * FILLED IN.

*POINTER CELL

FLAG NOT
DC AL3(*+3)

*THE FIRST CLOCK IS CHAINED TO ITS SUCCESSOR WHICH IN THIS CASE IS *CONTIGUOUS.THE FLAG BITS IN A POINTER CELL ARE ALL ZEROS.

*ARG1,ARG2 CELLS

TESDF RARG1,M1

COMP 01333800:01349800 12/20/74 12/20/74

TLSDF RARG2, *2

- .*EXPANSION OF THE TESDF MACRO, AND THE MACROS IT CALLS, DEAL WITH THE
- .*POSSIBLE VALUES AN ARG CELL MAY CONTAIN. ABSENCE OF THE CORRESPONDING
- .*ACTUAL PARAMETER PROVOKES AN ERROR MESSAGE. AN '*' OR THE NAME OF A
- .*3-GRAPH NOTION OR A LIST OF SUCH NOTIONS ARE THE POSSIBLE OPTIONS.

.* *****

.*ARG3, ARG4 CELLS

DC 2X 'FFFFFF'

- *NO FLAGS IN EMPTY CELLS
- .*THE CORRESPONDING CELLS ARE INITIALISED TO EMPTY SINCE THESE ARGUMENTS
- .*DO NOT OCCUR IN THE BASIC ACTION OF WHICH THIS NOTION IS AN OCCURRENCE

.* *****

.*POINTER CELL

DC X 'FFFFFF'

- *NO FLAGS IN POINTER CELL
- .*AT PRESENT THIS NOTION HAS NO ATTRIBUTES OTHER THAN THOSE JUST
- .*DEFINED SO THIS CELL IS INITIALISED TO INDICATE 'END OF ACTION'.

OPG
MEND

CREN 01340900:01348200 12/20/74 12/20/74

.MACRO

&NAME CREN &ARG1,&ARG2,&SUC1

.*GENERAL DESCRIPTION

.* CREN IS A BASIC OPERATION ON A 3-GRAPH. A NEW NOTION IS CREATED IN THE 3-GRAPH AND IT BECOMES A VALUE OF THE ATTRIBUTE WHOSE NATURE IS THE VALUE OF ARG2 AND ROOT THE VALUE OF ARG1. THE NEXT ACTION TO BE EXECUTED IS SPECIFIED BY THE VALUE OF SUC1.

.* EXPANSION OF THIS MACRO AND THE MACROS IT CALLS GENERATES A NEW NOTION IN THE 3-GRAPH WHICH IS AN OCCURRENCE OF THE BASIC ACTION-CREN. THIS NOTION MAY BE NAMED (&NAME PARAMETER).

.* DEFINITION OF THE NEW NOTION

TNAME &NAME

.* EXPANSION OF THE TNAME MACRO ALLOCATES 2 CONTIGUOUS 20-BYTE BLOCKS FOR THE NEW NOTION AND DEFINES THE NAME IF THE NOTION IS NAMED.

.* STATISTICS CELL

AIF ('&NAME' EQ '').NONAM

DC XL4'80000000'

AGO .OCCDE

.* THE FIRST CELL IS RESERVED FOR STATISTICS ABOUT THE NOTION AND IS INITIALISED TO 0. A FLAG BIT IS SET IF THE NOTION IS NAMED.

.* OCCDE CELL

FLAG BASE

DC AL3(4)

.* THE (2ND CELL) SPECIFY THE ACTION WHICH THIS NOTION IS AN OCCURRENCE OF. THE FLAG BITS SET INDICATE THAT THIS IS A BASIC ACTION.

.* SUC1 CELL

TESDF &SUC1,F1

.* EXPANSION OF THE TESDF MACRO TESTS FOR THE ABSENCE OF AN EXPLICIT SUCCESSOR IN WHICH CASE A FLAG IS SET TO INDICATE THAT THE SUCCESSOR IS THE NEXT SEQUENTIAL ACTION. IF THE ACTUAL PARAMETER = '' THEN THE CELL IS LEFT EMPTY OTHERWISE THE ADDRESS OF THE NOTION SPECIFIED IS FILLED IN.

.* SUC2 CELL

DC X'FFFFFFE'

.* THE CORRESPONDING CELL IS INITIALISED TO EMPTY SINCE THIS ACTION CANNOT CAUSE A CHOICE OF SUCCESSOR.

.* POINTER CELL

FLAG NOT

DC AL3(*+3)

.* THE FIRST BLOCK IS CHAINED TO ITS SUCCESSOR WHICH IN THIS CASE IS CONTIGUOUS. THE FLAG BITS IN A POINTER CELL ARE ALL ZEROES.

CPEN 01340900:01348200 12/20/74 12/20/74

.* *****

.*ARG1, ARG2 CELLS

TESDF &ARG1, #1
TESDF &ARG2, #2

- .* EXPANSION OF THE TESDF MACRO, AND THE MACROS IT CALLS, DEAL WITH THE
- .* POSSIBLE VALUES AN ARG CELL MAY CONTAIN. ABSENCE OF THE CORRESPONDING
- .* ACTUAL PARAMETER PROVOKES AN ERROR MESSAGE. AN '*' OR THE NAME OF A
- .* 3-GRAPH NOTION OR A LIST OF SUCH NOTIONS ARE THE POSSIBLE OPTIONS.

.* *****

.*ARG3, ARG4 CELLS

DC 2X'FFFFFFL'

.*NO FLAGS IN EMPTY CELLS

- .* THE CORRESPONDING CELLS ARE INITIALISED TO EMPTY SINCE THESE ARGUMENTS
- .* DO NOT OCCUR IN THE BASIC ACTION OF WHICH THIS NOTION IS AN OCCURRENCE

.* *****

.*POINTER CELL

DC X'FFFFFFF'

.*NO FLAGS IN POINTER CELL

- .* AT PRESENT THIS NOTION HAS NO ATTRIBUTES OTHER THAN THOSE JUST
- .* DEFINED SO THIS CELL IS INITIALISED TO INDICATE 'END OF NOTION'.

ORC
MEND

CRER 0134830J:0135610U 12/20/74 12/20/74

MACRO

&NAME CRER &ARG1,&ARG2,&ARG3,&SUC1

*GENERAL DESCRIPTION

*CRER IS A BASIC OPERATION ON A 3-GRAPH. A RELATION IS CREATED BETWEEN
 *3 EXISTING NOTIONS, IN EFFECT THE NOTION SPECIFIED BY THE VALUE OF
 *ARG1 IS THE ROOT NOTION TO WHICH AN ATTRIBUTE IS ADDED WHOSE NATURE
 *IS SPECIFIED BY (THE VALUE OF) ARG2 AND WHOSE VALUE IS SPECIFIED BY
 *(THE VALUE OF) ARG3. THE NEXT ACTION TO BE EXECUTED IS SPECIFIED BY
 *THE VALUE OF SUC1.

*EXPANSION OF THIS MACRO AND THE MACROS IT CALLS GENERATES A NEW
 *NOTION IN THE 3-GRAPH WHICH IS AN OCCURRENCE OF THE BASIC ACTION-CRER
 *THIS NOTION MAY BE NAMED (&NAME PARAMETER).

*DEFINITION OF THE NEW NOTION

TNAME &NAME

*EXPANSION OF THE TNAME MACRO ALLOCATES 2 CONTIGUOUS 20-BYTE BLOCKS
 *FOR THE NEW NOTION AND DEFINES THE NAME IF THE NOTION IS NAMED.

*STATISTICS CELL

AIF ('&NAME' EQ '*').NONAM
 DC XL4'80000000'
 AGO .OCCDE
 .NONAM DC F'0'

*THE FIRST CELL IS RESERVED FOR STATISTICS ABOUT THE NOTION AND IS
 *INITIALISED TO 0. A FLAG BIT IS SET IF THE NOTION IS NAMED.

*OCCDE CELL

.OCCDE FLAG PASE
 DC AL3(36)

* THE (2ND CELL) SPECIFY THE ACTION WHICH THIS NOTION IS AN OCCURRENCE
 *OF. THE FLAG BITS SET INDICATE THAT THIS IS A BASIC ACTION.

*SUC1 CELL

TTSDF &SUC1,F1

*[EXPANSION OF THE TTSDF MACRO TESTS FOR THE ABSENCE OF AN EXPLICIT
 *SUCCESSOR IN WHICH CASE A FLAG IS SET TO INDICATE THAT THE SUCCESSOR
 IS THE NEXT SEQUENTIAL ACTION. IF THE ACTUAL PARAMETER = '' THEN THE
 *CELL IS LEFT EMPTY OTHERWISE THE ADDRESS OF THE NOTION SPECIFIED IS
 *FILLED IN.

*SUC2 CELL

DC X'FFFFFFE'

*NO FLAGS IN EMPTY CELL

*THE CORRESPONDING CELL IS INITIALISED TO EMPTY SINCE THIS ACTION
 *CANNOT CAUSE A CHOICE OF SUCCESSOR.

*POINTER CELL

FLAG NOT

CREF 01348300:01356100 12/20/74 12/20/74

DC AL3(*+3)

- *THE FIRST BLOCK IS CHAINED TO ITS SUCCESSOR WHICH IN THIS CASE IS
- *CONTIGUOUS. THE FLAG BITS IN A POINTER CELL ARE ALL ZEROES.

* *****

- *ARG1, ARG2, ARG3 CELLS

TESDF RARG1, M1

TESDF RARG2, M2

TESDF RARG3, M3

- *EXPANSION OF THE TESDF MACRO, AND THE MACROS IT CALLS, DEAL WITH THE
- *POSSIBLE VALUES AN ARG CELL MAY CONTAIN. ABSENCE OF THE CORRESPONDING
- *ACTUAL PARAMETER PROVOKES AN ERROR MESSAGE. AN '*' OR THE NAME OF A
- *3-GRAPH NOTION OR A LIST OF SUCH NOTIONS ARE THE POSSIBLE OPTIONS.

* *****

- *ARG4 CELL

DC X'FFFFFFF'

- *NO FLAGS IN EMPTY CELL

- *THE CORRESPONDING CELL IS INITIALISED TO EMPTY SINCE THIS ARGUMENT
- *DOES NOT OCCUR IN THE BASIC ACTION OF WHICH THIS NOTION IS AN
- *OCCURRENCE.

* *****

- *POINTER CELL

DC X'FFFFFFF'

- *NO FLAGS IN POINTER CELL

- *AT PRESENT THIS NOTION HAS NO ATTRIBUTES OTHER THAN THOSE JUST
- *DEFINED SO THIS CELL IS INITIALISED TO INDICATE 'END OF NOTION'.

ORG
MEND

LAT 01442900:01450300 12/20/74 12/20/74

MACRO

&NAME LAT &ARG1,&SUC1

*GENERAL DESCRIPTION

*LAT IS A BASIC OPERATION ON A 3-GRAPH. AN ATTRIBUTE OF THE NOTION
 *SPECIFIED BY THE VALUE OF ARG1 IS CHOSEN AT RANDOM. THE NATURE OF THE
 *ATTRIBUTE BECOMES THE VALUE OF ARG2, AND THE VALUE OF THE ATTRIBUTE
 *THE VALUE OF ARG3. THE NEXT ACTION IN THE 3-GRAPH TO BE EXECUTED IS
 *SPECIFIED BY THE VALUE OF SUC1.

*EXPANSION OF THIS MACRO AND THE MACROS IT CALLS GENERATES A NEW
 *NOTION IN THE 3-GRAPH WHICH IS AN OCCURRENCE OF THE BASIC ACTION-LAT
 *THIS NOTION MAY BE NAMED (&NAME PARAMETER).

*DEFINITION OF THE NEW NOTION
 TNAME &NAME

*EXPANSION OF THE TNAME MACRO ALLOCATES 2 CONTIGUOUS 20-BYTE BLOCKS
 *FOR THE NEW NOTION AND DEFINES THE NAME IF THE NOTION IS NAMED.

*STATISTICS CELL

AIF ('&NAME' EQ '') .NONAM,
 DC XL4'80000000'
 AGO .OCCDE
 .NONAM DC F'0'

*THE FIRST CELL IS RESERVED FOR STATISTICS ABOUT THE NOTION AND IS
 *INITIALISED TO 0. A FLAG BIT IS SET IF THE NOTION IS NAMED.

*OCCDE CELL

OCCDE FLAG BASE
 DC AL3(12)

*THE (2ND CELL) SPECIFY THE ACTION WHICH THIS NOTION IS AN OCCURRENCE
 *OF. THE FLAG BITS SET INDICATE THAT THIS IS A BASIC ACTION.

*SUC1 CELL

TESDF &SUC1,F1

*EXPANSION OF THE TESDF MACRO TESTS FOR THE ABSENCE OF AN EXPLICIT
 *SUCCESSOR IN WHICH CASE A FLAG IS SET TO INDICATE THAT THE SUCCESSOR
 IS THE NEXT SEQUENTIAL ACTION. IF THE ACTUAL PARAMETER = '' THEN THE
 *CELL IS LEFT EMPTY OTHERWISE THE ADDRESS OF THE NOTION SPECIFIED IS
 *FILLED IN.

*SUC2 CELL

DC X'FFFFFFE'

*NO FLAGS IN EMPTY CELL
 *THE CORRESPONDING CELL IS INITIALISED TO EMPTY SINCE THIS ACTION
 *CANNOT CAUSE A CHOICE OF SUCCESSOR.

*POINTER CELL

FLAG NOT
 DC AL3(++3)

LAT 01442900:01450300 12/20/74 12/20/74

.*THE FIRST FLOCK IS CHAINED TO ITS SUCCESSOR WHICH IN THIS CASE IS
.*CONTIGUOUS.THE FLAG BITS IN A POINTER CELL ARE ALL ZEROES.

.* *****

.*ARG1 CELL

TESDF RARG1,M1

.*EXPANSION OF THE TESDF MACRO,AND THE MACROS IT CALLS,DEAL WITH THE
.*POSSIBLE VALUES AN ARG CELL MAY CONTAIN.ABSENCE OF THE CORRESPONDING
.*ACTUAL PARAMETER PROVOKES AN ERROR MESSAGE.AN '*' OF THE NAME OF A
.*3-GRAPH NOTION OR A LIST OF SUCH NOTIONS ARE THE POSSIBLE OPTIONS.

.* *****

.*ARG2,ARG3,ARG4 CELLS

DC 3X'FFFFFF'

.*NO FLAGS IN EMPTY CELLS

.*THE CORRESPONDING CELLS ARE INITIALISED TO EMPTY SINCE THESE ARGUMENTS
.*DO NOT OCCUR IN THE BASIC ACTION OF WHICH THIS NOTION IS AN OCCURRENCE

.* *****

.*POINTER CELL

DC X'FFFFFF'

.*NO FLAGS IN POINTER CELL

.*AT PRESENT THIS NOTION HAS NO ATTRIBUTES OTHER THAN THOSE JUST
.*DEFINED SO THIS CELL IS INITIALISED TO INDICATE 'END OF NOTION'.

ORG
MEND

REP 01463000:01470100 12/20/74 12/20/74

MACRO

&NAME REP &ARG1,&ARG2,&ARG3,&ARG4,&SUC1

*GENERAL DESCRIPTION

*REP IS A BASIC OPERATION ON A 3-GRAPH. THE ATTRIBUTE OF THE NOTION SPECIFIED BY (THE VALUE OF) ARG3 WHOSE NATURE IS (THE VALUE OF) ARG4 IS REPLACED BY THE ATTRIBUTE OF THE NOTION SPECIFIED BY (THE VALUE OF) ARG1 WHOSE NATURE IS (THE VALUE OF) ARG2. THE NEXT ACTION TO BE EXECUTED IN THE 3-GRAPH IS SPECIFIED BY THE VALUE OF SUC1.

*EXPANSION OF THIS MACRO AND THE MACROS IT CALLS GENERATES A NEW ACTION IN THE 3-GRAPH WHICH IS AN OCCURENCE OF THE BASIC ACTION-REP. THIS NOTION MAY BE NAMED (&NAME PARAMETER).

*DEFINITION OF THE NEW NOTION

TNAME &NAME

*EXPANSION OF THE TNAME MACRO ALLOCATES 2 CONTIGUOUS 20-BYTE BLOCKS FOR THE NEW NOTION AND DEFINES THE NAME IF THE NOTION IS NAMED.

*STATISTICS CELL

AIF ('&NAME' EQ '').NONAM

DC XL4'80000000'

AGO .OCCDE

.NONAM DC F'0'

*THE FIRST CELL IS RESERVED FOR STATISTICS ABOUT THE NOTION AND IS INITIALISED TO 0. A FLAG BIT IS SET IF THE NOTION IS NAMED.

*OCCDE CELL

.OCCDE FLAG BASE

DC AL3(16)

*THE (2ND CELL) SPECIFY THE ACTION WHICH THIS NOTION IS AN OCCURRENCE OF. THE FLAG BITS SET INDICATE THAT THIS IS A BASIC ACTION.

*SUC1 CELL

TESDF &SUC1,F1

EXPANSION OF THE TESDF MACRO TESTS FOR THE ABSENCE OF AN EXPLICIT SUCCESSOR IN WHICH CASE A FLAG IS SET TO INDICATE THAT THE SUCCESSOR IS THE NEXT SEQUENTIAL ACTION. IF THE ACTUAL PARAMETER = '' THEN THE CELL IS LEFT EMPTY OTHERWISE THE ADDRESS OF THE NOTION SPECIFIED IS FILLED IN.

*SUC2 CELL

DC X'FFFFFFE'

*NO FLAGS IN EMPTY CELL

*THE CORRESPONDING CELL IS INITIALISED TO EMPTY SINCE THIS ACTION CANNOT CAUSE A CHOICE OF SUCCESSOR.

*FOINTER CELL

FLAG NOT

DC AL3(*+3)

REP 01463000:01470100 12/20/74 12/20/74

```

.*THE FIRST BLOCK IS CHAINED TO ITS SUCCESSOR WHICH IN THIS CASE IS
.*CONTIGUOUS. THE FLAG BITS IN A POINTER CELL ARE ALL ZEROS.
.*
.******
.*ARG1, ARG2, ARG3, ARG4 CELLS
  TESDF &ARG1, M1
  TESDF &ARG2, M2
  TESDF &ARG3, M3
  TESDF &ARG4, M4
.*EXPANSION OF THE TESDF MACRO, AND THE MACROS IT CALLS, DEAL WITH THE
.*POSSIBLE VALUES AN ARG CELL MAY CONTAIN. ABSENCE OF THE CORRESPONDING
.*ACTUAL PARAMETER PROVOKES AN ERROR MESSAGE. AN '*' OR THE NAME OF A
.*3-GRAPH NOTION OR A LIST OF SUCH NOTIONS ARE THE POSSIBLE OPTIONS.
.*
.******
.*POINTER CELL
  DC      X'FFFFFFF'
.*NO FLAGS IN POINTER CELL
.*AT PRESENT THIS NOTION HAS NO ATTRIBUTES OTHER THAN THOSE JUST
.*DEFINED SO THIS CELL IS INITIALISED TO INDICATE 'END OF NOTION'.
  OPG
  PEND

```

SUP 01490200:01497600 12/20/74 12/20/74

MACRO

&NAME SUP &ARG1,&ARG2,&SUC1

*GENERAL DESCRIPTION

* *****
 * SUP IS A BASIC OPERATION ON A 3-GRAPH. THE ATTRIBUTE WHOSE ROOT IS
 * SPECIFIED BY (THE VALUE OF) ARG1 AND NATURE BY (THE VALUE OF) ARG2 IS
 * REMOVED FROM THE 3-GRAPH. THE NEXT ACTION IN THE 3-GRAPH TO BE
 * EXECUTED IS SPECIFIED BY THE VALUE OF SUC1.

* *****
 * EXPANSION OF THIS MACRO AND THE MACROS IT CALLS GENERATES A NEW
 * NOTION IN THE 3-GRAPH WHICH IS AN OCCURRENCE OF THE BASIC ACTION-SUP.
 * THIS NOTION MAY BE NAMED (&NAME PARAMETER).

*DEFINITION OF THE NEW NOTION

TNAME &NAME

* EXPANSION OF THE TNAME MACRO ALLOCATES 2 CONTIGUOUS 20-BYTE BLOCKS
 * FOR THE NEW NOTION AND DEFINES THE NAME IF THE NOTION IS NAMED.

*STATISTICS CELL

AIF ('&NAME' EQ '').NONAM
 DC XL4'80000000'
 AGO .OCCDF
 NONAM DC F'0'

* THE FIRST CELL IS RESERVED FOR STATISTICS ABOUT THE NOTION AND IS
 * INITIALISED TO 0. A FLAG BIT IS SET IF THE NOTION IS NAMED.

*OCCDF CELL

OCCDF FLAG BASE
 DC AL3(20)

* THE (2ND CELL) SPECIFY THE ACTION WHICH THIS NOTION IS AN OCCURRENCE
 * OF. THE FLAG BITS SET INDICATE THAT THIS IS A BASIC ACTION.

*SUC1 CELL

TESDF &SUC1,F1

* EXPANSION OF THE TESDF MACRO TESTS FOR THE ABSENCE OF AN EXPLICIT
 * SUCCESSOR IN WHICH CASE A FLAG IS SET TO INDICATE THAT THE SUCCESSOR
 * IS THE NEXT SEQUENTIAL ACTION. IF THE ACTUAL PARAMETER = '*' THEN THE
 * CELL IS LEFT EMPTY OTHERWISE THE ADDRESS OF THE NOTION SPECIFIED IS
 * FILLED IN.

*SUC2 CELL

DC X'FFFFFFE'

*NO FLAGS IN EMPTY CELL

* THE CORRESPONDING CELL IS INITIALISED TO EMPTY SINCE THIS ACTION
 * CANNOT CAUSE A CHOICE OF SUCCESSOR.

*POINTER CELL

FLAG NOT
 DC AL3(++3)

* THE FIRST BLOCK IS CHAINED TO ITS SUCCESSOR WHICH IN THIS CASE IS

SUP 01490200:01497600 12/20/74 12/20/74

```

.*CONTIGUOUS THE FLAG BITS IN A POINTER CELL ARE ALL ZEROS.
.*
.******
.*ARG1, ARG2 CELLS
    TESDF 2ARG1, M1
    TESDF 2ARG2, M2
.*EXPANSION OF THE TESDF MACRO, AND THE MACROS IT CALLS, DEAL WITH THE
.*POSSIBLE VALUES AN ARG CELL MAY CONTAIN. ABSENCE OF THE CORRESPONDING
.*ACTUAL PARAMETER PROVOKES AN ERROR MESSAGE. AN '*' OR THE NAME OF A
.*3-GRAPH NOTION OR A LIST OF SUCH NOTIONS ARE THE POSSIBLE OPTIONS.
.*
.******
.*ARG3, ARG4 CELLS
    DC 2X'FFFFFF'
.*NO FLAGS IN EMPTY CELLS
.*THE CORRESPONDING CELLS ARE INITIALISED TO EMPTY SINCE THESE ARGUMENTS
.*DO NOT OCCUR IN THE BASIC ACTION OF WHICH THIS NOTION IS AN OCCURRENCE
.*
.******
.*POINTER CELL
    DC X'FFFFFF'
.*NO FLAGS IN POINTER CELL
.*AT PRESENT THIS NOTION HAS NO ATTRIBUTES OTHER THAN THOSE JUST
.*DEFINED SO THIS CELL IS INITIALISED TO INDICATE 'END OF NOTION'.
    ORG
    MEND

```

SUPP 01505300:01512900 12/20/74 12/20/74

MACRO

&NAME SUPR &ARG1,&ARG2,&ARG3,&SUC1

```

.*GENERAL DESCRIPTION
.*
.******
.*SUPR IS A BASIC ACTION ON A 3-GRAPH.THE RELATION SPECIFIED BY THE
.*VALUES OF ARG1 (ROOT NOTION),ARG2 (NATURE OF ATTRIBUTE),AND ARG3
.*(VALUE OF ATTRIBUTE) IS REMOVED FROM THE 3-GRAPH.THE NEXT ACTION TO
.*BE EXECUTED IS SPECIFIED BY THE VALUE OF SUC1.
.*
.******
.*EXPANSION OF THIS MACRO AND THE MACROS IT CALLS GENERATES A NEW
.*NOTION IN THE 3-GRAPH WHICH IS AN OCCURRENCE OF THE BASIC ACTION-SUPR
.*THIS NOTION MAY BE NAMED (&NAME PARAMETER).
.*
.******
.*DEFINITION OF THE NEW NOTION
    TNAME &NAME
.*EXPANSION OF THE TNAME MACRO ALLOCATES 2 CONTIGUOUS 20-BYTE BLOCKS
.*FOR THE NEW NOTION AND DEFINES THE NAME IF THE NOTION IS NAMED.
.*
.******
.*STATISTICS CELL
    AIF ('&NAME' EQ '').NONAM
    DC XL4'80000000'
    ACO .OCCDE
.NONAM DC F'0'
.*THE FIRST CELL IS RESERVED FOR STATISTICS ABOUT THE NOTION AND IS
.*INITIALISED TO 0. A FLAG BIT IS SET IF THE NOTION IS NAMED.
.*
.******
.*OCCDE CELL
.OCCDE FLAG PASE
    DC AL3(2R)
.* THE (2ND CELL) SPECIFY THE ACTION WHICH THIS NOTION IS AN OCCURRENCE
.*OF.THE FLAG BITS SET INDICATE THAT THIS IS A BASIC ACTION.
.*
.******
.*SUC1 CELL
    TESDF &SUC1,F1
.*EXPANSION OF THE TESDF MACRO TESTS FOR THE ABSENCE OF AN EXPLICIT
.*SUCCESSOR IN WHICH CASE A FLAG IS SET TO INDICATE THAT THE SUCCESSOR
.*IS THE NEXT SEQUENTIAL ACTION.IF THE ACTUAL PARAMETER = '*' THEN THE
.*CELL IS LEFT EMPTY OTHERWISE THE ADDRESS OF THE NOTION SPECIFIED IS
.*FILLED IN.
.*
.******
.*SUC2 CELL
    DC X'FFFFFFF'
.*NO FLAGS IN EMPTY CELL
.*THE CORRESPONDING CELL IS INITIALISED TO EMPTY SINCE THIS ACTION
.*CANNOT CAUSE A CHOICE OF SUCCESSOR.
.*
.******
.*POINTER CELL
    FLAG NOT
    DC AL3(**+3)
.*THE FIRST BLOCK IS CHAINED TO ITS SUCCESSOR WHICH IN THIS CASE IS

```

SUPR 01505300:01512900 12/20/74 12/20/74

```

.*CONTIGUOUS. THE FLAG BITS IN A POINTER CELL ARE ALL ZEROES.
.*
.******
.*ARG1, ARG2, ARG3 CELLS
  TESDF 8ARG1, *1
  TESDF 8ARG2, *2
  TESDF 8ARG3, *3
.*EXPANSION OF THE TESDF MACRO, AND THE MACROS IT CALLS, DEAL WITH THE
.*POSSIBLE VALUES AN ARG CELL MAY CONTAIN. ABSENCE OF THE CORRESPONDING
.*ACTUAL PARAMETER PROVOKES AN ERROR MESSAGE. AN '*' OR THE NAME OF A
.*3-GRAPH NOTION OR A LIST OF SUCH NOTIONS ARE THE POSSIBLE OPTIONS.
.*
.******
.*ARG4 CELL
  DC    X'FFFFFFE'
.*NO FLAGS IN EMPTY CELL
.*THE CORRESPONDING CELL IS INITIALISED TO EMPTY SINCE THIS ARGUMENT
.*DOES NOT OCCUR IN THE BASIC ACTION OF WHICH THIS NOTION IS AN
.*OCCURRENCE.
.*
.******
.*POINTER CELL
  DC    X'FFFFFFF'
.*NO FLAGS IN POINTER CELL
.*AT PRESENT THIS NOTION HAS NO ATTRIBUTES OTHER THAN THOSE JUST
.*DEFINED SO THIS CELL IS INITIALISED TO INDICATE 'END OF NOTION'.
  ORG
  MEND

```

TMV 01534400:01541500 12/20/74 12/20/74

MACRO

&NAME TMV PARG1, &ARG2, &ARG3, &ARG4, &SUC1

*GENERAL DESCRIPTION

*TMV IS A BASIC ACTION ON A 3-GRAPH. THE VALUE OF THE ATTRIBUTE SPECIFIED BY THE VALUES OF ARG1 (ROOT NOTION) AND ARG2 (NATURE OF THE ATTRIBUTE) BECOMES THE VALUE OF THE ATTRIBUTE SPECIFIED BY THE VALUES OF ARG3 (ROOT NOTION) AND ARG4 (NATURE OF THE ATTRIBUTE). THE NEXT ACTION TO BE TAKEN IS SPECIFIED BY THE VALUE OF SUC1.

*EXPANSION OF THIS MACRO AND THE MACROS IT CALLS GENERATES A NEW NOTION IN THE 3-GRAPH WHICH IS AN OCCURRENCE OF THE BASIC ACTION-TMV. THIS NOTION MAY BE NAMED (&NAME PARAMETER).

*DEFINITION OF THE NEW NOTION

TNAME &NAME

*EXPANSION OF THE TNAME MACRO ALLOCATES 2 CONTIGUOUS 20-BYTE BLOCKS FOR THE NEW NOTION AND DEFINES THE NAME IF THE NOTION IS NAMED.

*STATISTICS CELL

AIF ('&NAME' EQ '') .NONAM,

DC XL4'80000000'

AGO .0CCDE

.NONAM DC F'0'

*THE FIRST CELL IS RESERVED FOR STATISTICS ABOUT THE NOTION AND IS INITIALISED TO 0. A FLAG BIT IS SET IF THE NOTION IS NAMED.

*0CCDE CELL

.0CCDE FLAG BASE

DC AL3(32)

*THE (2ND CELL) SPECIFY THE ACTION WHICH THIS NOTION IS AN OCCURRENCE OF. THE FLAG BITS SET INDICATE THAT THIS IS A BASIC ACTION.

*SUC1 CELL

TESDF &SUC1, F1

EXPANSION OF THE TESDF MACRO TESTS FOR THE ABSENCE OF AN EXPLICIT SUCCESSOR IN WHICH CASE A FLAG IS SET TO INDICATE THAT THE SUCCESSOR IS THE NEXT SEQUENTIAL ACTION. IF THE ACTUAL PARAMETER = '' THEN THE CELL IS LEFT EMPTY OTHERWISE THE ADDRESS OF THE NOTION SPECIFIED IS FILLED IN.

*SUC2 CELL

DC X'FFFFFFE'

*NO FLAGS IN EMPTY CELL

*THE CORRESPONDING CELL IS INITIALISED TO EMPTY SINCE THIS ACTION CANNOT CAUSE A CHOICE OF SUCCESSOR.

*POINTER CELL

FLAG NOT

DC AL3(++3)

TMV 01534400:01541500 12/20/74 12/20/74

- .*THE FIRST BLOCK IS CHAINED TO ITS SUCCESSOR WHICH IN THIS CASE IS
- .*CONTIGUOUS.THE FLAG BITS IN A POINTER CELL ARE ALL ZEROES.
- .* *****
- .*ARG1,ARG2,ARG3,ARG4 CELLS
- TESDF &ARG1,M1
- TESDF &ARG2,M2
- TESDF &ARG3,M3
- TESDF &ARG4,M4
- .*EXPANSION OF THE TESDF MACRO,AND THE MACROS IT CALLS,DEAL WITH THE
- .*POSSIBLE VALUES AN ARG CELL MAY CONTAIN.ABSENCE OF THE CORRESPONDING
- .*ACTUAL PARAMETER PROVOKES AN ERROR MESSAGE.AN '*' OR THE NAME OF A
- .*3-GRAPH NOTION OR A LIST OF SUCH NOTIONS ARE THE POSSIBLE OPTIONS.
- .* *****
- .*POINTER CELL
- DC X'FFFFFF'
- .*NO FLAGS IN POINTER CELL
- .*AT PRESENT THIS NOTION HAS NO ATTRIBUTES OTHER THAN THOSE JUST
- .*DEFINED SO THIS CELL IS INITIALISED TO INDICATE 'END OF NOTION'.
- ORC
- MLND

DEF 01356200:01377300 12/20/74 01/07/75

MACRO

&NAME DEF &NAT,&VAL

*GENERAL DESCRIPTION

*DEF IS A PSEUDO-OPERATION ON A 3-GRAPH. IT ADDS AN ATTRIBUTE TO A NOTION. IN GENERAL, WE HAVE A GROUP OF DEF CALLS ALL REFERRING TO THE SAME NOTION AND DEFINING SEVERAL ATTRIBUTES. AN EXCEPTION IS A DEF USED TO DEFINE A NOTION WITHOUT ATTRIBUTES BECAUSE ITS NAME IS USED IN OTHER PARTS OF THE 3-GRAPH AND ALL NOTIONS NAMES MUST BE EXPLICITLY DEFINED. SUCH A DEF HAS THE NAME OF THE NOTION IN THE NAME COLUMN (COL 1-8) AND AN * IN THE NATURE AND VALUE COLUMNS (CORRESPONDING TO THE &NAME, &NAT, &VAL FORMAL PARAMETERS, RESP).

*THE FIRST (OR ONLY) DEF OPERATION IN A GROUP MUST NAME THE ROOT NOTION (&NAME PARAMETER). THIS IS DEFINED AS A NEW NOTION IN THE 3-GRAPH, AND THE OTHER DEF(S) IN THE GROUP (WITHOUT AN &NAME PARAMETER) REFER TO IT IMPLICITLY.

*EACH DEF DEFINES ONE ATTRIBUTE OF THE ROOT NOTION WHOSE NATURE IS THE 1ST PARAMETER AND WHICH MAY HAVE ONE OR MORE VALUES (NOTION NAMES SEPARATED BY COMMAS). AN ATTRIBUTE IS DEFINED BY ONE AND ONLY ONE DEF (IE THE SAME NATURE MAY NOT APPEAR TWICE IN A DEF GROUP) OTHERWISE THERE ARE NO RESTRICTIONS ON THE NOTIONS WHICH MAY APPEAR.

*MACRO VARIABLES.

GBLD &DEFCON, &SPOCCDE, &SPNAT, &FASACT, &SPVAL
 CELA &PASSNO
 CELA &NAMGEN, &RMATB, &RMVAB, &POS
 LCLA &COUNT, &CNT

*&DEFCON IS A BOOLEAN INDICATOR. AT THE BEGINNING OF A DEF (DEFS) GROUP IT IS SET TO 0 (WHEN THE MACRO CALL HAS A NAME (COL 1-8)) AND IT IS SET TO 1 FOR THE OTHER MACRO CALLS BELONGING TO THE SAME GROUP. SO WE KNOW, FOR ANY DEF (DEFS) MACRO CALL WITHOUT A NAME THAT WE ARE CORRECTLY POSITIONED WITHIN A NOTION WHEN DEFINING A NEW ATTRIBUTE.

*&SPOCCDE INDICATES WHETHER THE NATURE OF THE CURRENT ATTRIBUTE IS 'OCCDE' OR NOT (TSNAT MACRO)

*&SPNAT INDICATES WHETHER THE NATURE OF THE CURRENT ATTRIBUTE IS ONE OF THE SPECIAL NOTIONS OF THE 3-GRAPH (TSNAT MACRO)

*&FASACT INDICATES WHETHER THE VALUE OF THE ATTRIBUTE WHOSE NATURE IS 'OCCDE' IS A BASIC ACTION OF THE 3-GRAPH (TSOCC MACRO)

*&SPVAL INDICATES WHETHER THE VALUE OF THE ATTRIBUTE IS ONE OF THE SPECIAL NOTIONS OF THE 3-GRAPH (TSVAL MACRO)

*&PASSNO IS THE NO OF THE CURRENT 3-GRAPH SECTION

*&NAMGEN AND &POS ARE USED FOR GENERATING UNIQUE SYMBOLS TO BE ATTACHED TO LOCATION COUNTER POSITIONS

*&RMATB INDICATES THE NO OF EMPTY ATTRIBUTES IN THE CURRENT ATTRIBUTE BLOCK

*&RMVAB INDICATES THE NO OF EMPTY CELLS IN THE CURRENT VALUE LIST BLOCK

*&COUNT, &CNT ARE COUNTER VARIABLES USED FOR LISTS OF VALUES

*NOTE ON GENERATED SYMBOLS.

DEF 01356200:01377300 12/20/74 01/07/75

```

.*A)@NO&NAMGEN.THE NATURE OF AN ATTRIBUTE MAY BE ANY NOTION INCLUDING
.*ONE OF THE SPECIAL NOTIONS OF THE 3-GRAPH.WHEN ONE OF THESE OCCURS
.*THE LOCATION COUNTER IS REPOSITIONED RELATIVE TO THE BEGINNING OF THE
.*ROOT NOTION WHOSE ADDRESS MUST ALWAYS BE AVAILABLE EVEN WHEN ITS
.*NAME IS NOT,SO A UNIQUE SYMBOL IS ATTACHED TO IT.
.*E)@NA&POS.AN ATTRIBUTE WHOSE NATURE IS ONE OF THE SPECIAL NOTIONS
.*MAY OCCUR ANYWHERE IN A DEF (DEFS) GROUP AND MAY BE FOLLOWED BY AN
.*ATTRIBUTE WHOSE NATURE IS NOT SPECIAL.SO A UNIQUE SYMBOL IS ATTACHED
.*TO THE CURRENT POSITION IN THE ATTRIBUTE BLOCK WHEN THE NEW ATTRIBUTE
.*IS 'SPECIAL' THEN THE LOCATION COUNTER CAN BE CORRECTLY REPOSITIONED
.*AFTERWARDS.
.*C)@VA&SYSNOX.WHEN AN ATTRIBUTE HAS A LIST OF VALUES THE CURRENT
.*ATTRIBUTE BLOCK IS ABANDONED WHILE A VALUE LIST IS SET UP.THE LOCATION
.*COUNTER CAN BE REPOSITIONED FOR THE FOLLOWING ATTRIBUTE BECAUSE A
.*UNIQUE SYMBOL IS ATTACHED TO THE VALUE CELL POINTING
.*TO THE VALUE LIST.
.*
.******
.*TEST FOR NEW DEF GROUP,IF NOT GO TO .L1
    AIF ('&NAME' EQ '').L1
.*
.******
.*TEST IF NOTION TO BE DEFINED IS ATTRIBUTELESS,IF SO,GO TO .DUMMY
    AIF (('&NAT' EQ '*') AND ('&VAL' EQ '*')).DUMMY
.*
.******
.*INITIALISATION AT START OF A DEF GROUP
&NAMGEN SETA &NAMGEN+1
&DEFCON SETA 0
&RMATH SETA 0
.*
.******
.*DEFINE THE NEW NOTION WITH THE NAME GIVEN,POSITION AT START OF NOTION
.*AND ATTACH A UNIQUE GENERATED SYMBOL TO THE START OF THE NOTION
.*(TO BE USED FOR POSITIONING IF NECESSARY,SEE NATURE MACRO)
    DEFNOT &NAME&PASSNO
    ORG &NAME&PASSNO
&NO&NAMGEN EQU &NAME&PASSNO
    AGO .CONT
.*
.******
.*IF NO NAME GIVEN TO CURRENT DEF MACRO CALL AND FLAG NOT SET TO INDIC
.*ATE THAT A DEF GROUP HAS BEEN STARTED,OUTPUT LRROR MESSAGE
.L1 AIF (&DEFCON NE 1).LRR1
.*
.******
.*NATURE OF ATTRIBUTE
    NATURE &NAT
    AGO .CONT1
.*CONT ANOP
&NAME&PASSNO NATURE &NAT
.*NATURE MACRO DEALS WITH THE DIFFERENT POSSIBILITIES E.G. SPECIAL NOTION.
.*AT THE END OF THE EXPANSION THE LOCATION COUNTER IS POSITIONED ON THE
.*VALUE CELL OF THE NEW ATTRIBUTE,AND INDICATORS (&SPOCCDE,&SPMAT,ETC)
.*HAVE BEEN SET.
.*
.******

```

DEF 01356200:01377300 12/20/74 01/07/75

```

.*TEST FOR LIST OF VALUES ASSOCIATED WITH THE ATTRIBUTE (IF THE 3RD
.*PARAMETER IS NOT A NULL STRING THEN THERE IS A LIST).
.CONT1 AIF ('&SYSLIST(3)' NE '').LIST
.*
.*VALUE OF ATTRIBUTE
AIF ('&NAME' NE '').N1
VALUE RVAL
ACC .N2
.N1 ANOP
&NAME&PASSNO VALUE RVAL
.*THE VALUE MACRO DEALS WITH THE DIFFERENT POSSIBILITIES AND FILLS IN
.*THE VALUE CELL OF THE ATTRIBUTE
.*
.*IF THE ATTRIBUTE IS 'SPECIAL' (IE THE NATURE IS ONE OF THE SPECIAL
.*NOTIONS OF THE 3-GRAPH, THE LOCATION COUNTER IS REPOSITIONED (SEE
.*NATRE MACRO)
.N2 AIF (&SPNAT EQ 0).OUT
ORG &NA&POS
.OUT MEXIT
.*
.*LIST OF VALUES
.*LOOP WHICH COUNTS THE NO. OF VALUES IN THE LIST.WHEN &COUNT=N
.*&SYSLIST(N) PICKS OUT THE NTH PARAMETER OF THE MACRO CALL.WHEN THIS
.*IS A NULL STRING THE LIST IS EXHAUSTED
.LIST ANOP
&COUNT SETA 2
.LOOP AIF ('&SYSLIST(&COUNT)' EQ '').FIN
&COUNT SETA &COUNT+1
ACC .LOOP
.*
.*FIN ANOP
@VA&SYSNDX EQU *
.*SAVE ADDRESS OF CURRENT VALUE CELL BY ATTACHING A UNIQUE LABEL TO IT
.*
ALLOC VAL,20
SETCNT &COUNT,2
&COUNT SETA &COUNT-1
&RMVAF SLTA 3
.*ALL FLAG BITS 0 IN COUNT CELL
.*ALLOCATE 20-BYTE BLOCK FOR VALUE LIST, FILL IN COUNTER CELL OF THIS
.*LIST;UPDATE &RMVAF TO INDICATE 3 EMPTY CELLS IN CURRENT VALUE LIST
.*ELOCK
.*
AIF (&SPOCCDE EQ 1).EPA
.*TEST IF NATURE OF ATTRIBUTE WAS 'OCCDE'.TREATMENT OF THE VALUE LIST
.*IN THIS CASE IS DIFFERENT AS THE LIST MAY CONTAIN BASIC ACTIONS OF
.*THE 3-GRAPH
.*
&CNT SETA 2
.VALOOP VALST &SYSLIST(&CNT)

```

DEF 01356200:01377300 12/20/74 01/07/75

```

&CNT SETA &CNT+1
      AIF (&CNT LE &COUNT).VALOOP
.*LOOP DEALS WITH EACH ITEM IN THE VALUE LIST IN TURN CALLING THE VALST
.*MACRO TO FILL IN THE CURRENT VALUE CELL.&SYSLIST (N) PICKS OUT THE
.*NTH PARAMETER OF THE MACRO CALL (IN THIS CASE THE (N-1)ST VALUE IN THE
.*LIST OF VALUES (THE NATURE OF THE ATTRIBUTE IS THE 1ST PARAMETER)).
.*
.******
.LAB3 AIF (&RMVAB NE 0).LAB2
      DC X'FFFFFFF'
.*ALL FLAGS IN POINTER CELL 0
.*AT THE END OF THE VALUE LIST THE CURRENT VALUE LIST BLOCK IS COMPLETED
.*WITH VALUE CELLS INITIALISED TO EMPTY IF THERE ARE ANY LEFT AND THE
.*POINTER CELL INITIALISED TO 'LAST POINTER'
.*
.******
      ORG @VARSYSNDX+4
&DEFCON SETA 1
.*THE LOCATION COUNTER IS REPOSITIONED TO THE CELL FOLLOWING THE VALUE
.*CELL OF THE ATTRIBUTE JUST DEALT WITH.(@VARSYSNDX IS ASSOCIATED WITH
.*THE VALUE CELL .&DEFCON IS SET TO INDICATE A DEF (DEFS)
.*GROUP STARTED.
.*
.******
      AIF (&SPNAT EQ 1).L2
&RMATB SETA &RMATB-1
.L2 AIF (&SPNAT EQ 0).MEXIT
     ORG @NA&POS
.*MEXIT MEXIT
.*IF &SPNAT=1 THE NATURE OF THE ATTRIBUTE WAS ONE OF THE SPECIAL NOTIONS
.*SO A)&RMATB IS NOT UPDATED (NO ATTRIBUTE SPACE HAS BEEN USED)
.* B)THE LOCATION COUNTER IS REPOSITIONED ON THE NEXT FREE ATTRIBUTE
.*IN THE CURRENT ATTRIBUTE BLOCK WHOSE ADDRESS WAS SAVED WHEN THE NATURE
.*WAS IDENTIFIED AS SPECIAL (NATRE AND TSNAT MACROS).
.*
.******
.*INITIALISE CELL TO EMPTY AND UPDATE &RMVAB
.LAB2 DC X'FFFFFFF'
.*ALL FLAGS 0 IN EMPTY CELL
&RMVAB SETA &RMVAB-1
      AGO .LAB3
.*
.******
.*NATURE OF ATTRIBUTE IS OCCDE WITH A LIST OF VALUES ASSOCIATED.
.*LOOP ITERATES OVER THE LIST.THE MACRO LISTVAL COMPLETES THE
.*CORRESPONDING CELL IN THE 3-GRAPH.THE END OF THE LIST IS GIVEN BY
.*THE VALUE OF &COUNT .
.FRA ANOP
&CNT SETA 2
.*TSLOOP LISTVAL &SYSLIST(&CNT)
&CNT SETA &CNT+1
      AIF (&CNT LE &COUNT).TSLOOP
      AGO .LAB3
.*
.******
.*ERROR MESSAGE
    
```

DEF 01356200:01377300 12/20/74 01/07/75

.ERR1 'NOTE 'FIRST DEF IN A GROUP MUST HAVE A NAME '
'EXIT

* *****

.*DEFINE NOTION WITH NO ATTRIBUTES, SET ALL INDICATORS TO 0 (FALSE).

.DUMMY DEFNOT &NAME&PASSNO

&DEFCON SETP 0

&SPOCCDE SETP 0

&SPNAT SETP 0

&BASACT SETP 0

&SPVAL SETC 0

&RMATB SETA 0

&PMVAD SETA 0

ME ND

DEFS 01383500:01402900 12/20/74 12/20/74

MACRO

DEFS &NAME,&NAT,&VAL

*GENERAL DESCRIPTION

* *****

*THE DEFS PSEUDO-OPERATION PERFORMS THE SAME FUNCTIONS AS THE DEF
 *MACRO FOR A ROOT NOTION ALREADY DEFINED EITHER AS AN
 *OCCURRENCE OF A BASIC ACTION OR BY A PREVIOUS DEF GROUP.
 *THIS MEANS THAT THE FIRST DEFS OF A GROUP MUST EXPLICITLY NAME THE
 *ROOT NOTION CONCERNED (&NAME PARAMETER) WHICH MUST PREVIOUSLY HAVE
 *BEEN DEFINED AND THAT THE NATURE OF ANY ATTRIBUTE OCCURRING IN A DEFS
 *MUST NOT HAVE ALREADY APPEARED. THIS APPLIES IN PARTICULAR TO THE
 *SPECIAL NOTIONS WHERE THERE ARE TOO MANY VALUES FOR THE ATTRIBUTE
 *TO APPEAR IN A BASIC ACTION MACRO CALL. THE VALUES CANNOT BE PARTLY
 *LISTED IN THE BASIC ACTION MACRO CALL AND PARTLY IN A DEFS.
 *HOWEVER, UNLIKE A DEF GROUP, A SAME ROOT NOTION CAN HAVE ATTRIBUTES
 *DEFINED BY MORE THAN ONE DEFS GROUP.

* *****

*MACRO VARIABLES.

GDLE &DEFCON,&SFOCODE,&SPNAT,&EASACT,&SPVAL
 GELA &NAMEGEN,&EMATE,&EMVAE,&EPS
 GELA &PASSNO
 LCLA &COUNT,&CNT

*&DEFCON IS A BOOLEAN INDICATOR. AT THE BEGINNING OF A DEF (DEFS) GROUP
 *IT IS SET TO 0 (WHEN THE MACRO CALL HAS A NAME) AND IT IS
 *SET TO 1 FOR THE OTHER MACRO CALLS BELONGING TO THE SAME GROUP. SO WE
 *KNOW, FOR ANY DEF (DEFS) MACRO CALL WITHOUT A NAME THAT WE ARE
 *CORRECTLY POSITIONED WITHIN A NOTION WHEN DEFINING A NEW ATTRIBUTE.
 *&SFOCODE INDICATES WHETHER THE NATURE OF THE CURRENT ATTRIBUTE IS
 *'OCCODE' OR NOT (TSNAT MACRO)
 *&SPNAT INDICATES WHETHER THE NATURE OF THE CURRENT ATTRIBUTE IS ONE OF
 *THE SPECIAL NOTIONS OF THE 3-GRAPH (TSNAT MACRO)
 *&EASACT INDICATES WHETHER THE VALUE OF THE ATTRIBUTE WHOSE NATURE IS
 *'OCCODE' IS A BASIC ACTION OF THE 3-GRAPH (TSOCC MACRO)
 *&SPVAL INDICATES WHETHER THE VALUE OF THE ATTRIBUTE IS ONE OF THE
 *SPECIAL NOTIONS OF THE 3-GRAPH (TSVAL MACRO)
 *&NAMEGEN AND &EPS ARE USED FOR GENERATING UNIQUE SYMBOLS TO BE
 *ATTACHED TO LOCATION COUNTER POSITIONS
 *&EMATE INDICATES THE NO OF EMPTY ATTRIBUTES IN THE CURRENT ATTRIBUTE
 *BLOCK
 *&EMVAB INDICATES THE NO OF EMPTY CELLS IN THE CURRENT VALUE LIST
 *BLOCK
 *&COUNT, &CNT ARE COUNTER VARIABLES USED FOR LISTS OF VALUES
 *&PASSNO IS THE NO OF THE CURRENT 3-GRAPH SECTION

* *****

*NOTE ON GENERATED SYMBOLS.

*A) @NO&NAMEGEN. THE NATURE OF AN ATTRIBUTE MAY BE ANY NOTION INCLUDING
 *ONE OF THE SPECIAL NOTIONS OF THE 3-GRAPH. WHEN ONE OF THESE OCCURS
 *THE LOCATION COUNTER IS REPOSITIONED RELATIVE TO THE BEGINNING OF THE
 *ROOT NOTION WHOSE ADDRESS MUST ALWAYS BE AVAILABLE EVEN WHEN ITS
 *NAME IS NOT, SO A UNIQUE SYMBOL IS ATTACHED TO IT.

DEFS 01383500:01402900 12/20/74 12/20/74

```

.*B)&NAB&POS .AN ATTRIBUTE WHOSE NATURE IS ONE OF THE SPECIAL NOTIONS
.*MAY OCCUR ANYWHERE IN A DEF (DEFS) GROUP AND MAY BE FOLLOWED BY AN
.*ATTRIBUTE WHOSE NATURE IS NOT SPECIAL,SO A UNIQUE SYMBOL IS ATTACHED
.*TO THE CURRENT POSITION IN THE ATTRIBUTE BLOCK WHEN THE NEW ATTRIBUTE
.*IS 'SPECIAL' THEN THE LOCATION COUNTER CAN BE CORRECTLY REPOSITIONED
.*AFTERWARDS.
.*C)&VA&SYSNDX.WHEN AN ATTRIBUTE HAS A LIST OF VALUES THE CURRENT
.*ATTRIBUTE BLOCK IS ABANDONED WHILE A VALUE LIST IS SET UP.THE LOCATION
.*COUNTER CAN BE REPOSITIONED FOR THE FOLLOWING ATTRIBUTE BECAUSE A
.*UNIQUE SYMBOL IS ATTACHED TO THE VALUE CELL POINTING
.*TO THE VALUE LIST.
.*
.******
.*TEST IF CURRENT DEFS MACRO CALL IS FIRST IN A GROUP.
    AIF ('&NAME' EQ '').DEFS1
.*
.******
.*IF SO,POSITION LOCATION COUNTER TO START OF NOTION (NOTE:IF THE
.*CONDITIONS FOR THE USE OF THIS MACRO HAVE NOT BEEN FULFILLED AN
.*ASSEMBLER ERROR MESSAGE WILL BE PRODUCED HERE).
    ORG  &NAME&PASSNO
.*
.******
.*INITIALISATION AT START OF A DEFS GROUP.
&NAME&GEN SETA  &NAME&GEN+1
&DEFCON SETB  0
&RMATE SETA  0
.*
.******
.*ATTACH UNIQUE GENERATED SYMBOL TO START OF NOTION (USED FOR
.*REPOSITIONING,SEE NATRE MACRO)
&NO&NAME&GEN EGU  &NAME&PASSNO
    ACC  .DEFS2
.*
.******
.*IF &NAME PARAMETER IS NULL AND INDICATOR SHOWS THAT A DEFS GROUP HAS
.*NOT BEEN STARTED OUTPUT ERROR MESSAGE.
DEFS1  AIF  (&DEFCON NE 1).ERR
        NATRE &NAT
        AGO  .DEFS7
.*
.******
.*NATURE OF ATTRIBUTE
DEFS2  ANOP
&NAME&PASSNO NATRE &NAT
.*NATRE MACRO DEALS WITH THE DIFFERENT POSSIBILITIES E.G. SPECIAL NOTION.
.*AT THE END OF THE EXPANSION THE LOCATION COUNTER IS POSITIONED ON THE
.*VALUE CELL OF THE NEW ATTRIBUTE,AND INDICATORS (&SFOCCDE,&SPNAT,ETC)
.*HAVE BEEN SET.
.*
.******
.*TEST FOR LIST OF VALUES ASSOCIATED WITH THE ATTRIBUTE (IF THE 3RD
.*PARAMETER IS NOT A NULL STRING THEN THERE IS A LIST).
DEFS7  AIF  ('&SYSLIST(4)' NE '').DEFS3
.*
.******
.*VALUE OF ATTRIBUTE
    AIF  ('&NAME' EQ '').DEFS8

```


DEFS 01383500:01402900 12/20/74 12/20/74

&NAME&PASSNO VALUE &VAL

AGO .DEFS9

.DEFS8 VALUE &VAL

.*THE VALUE MACRO DEALS WITH THE DIFFERENT POSSIBILITIES AND FILLS IN
.*THE VALUE CELL OF THE ATTRIBUTE

.*
.*IF NATURE OF ATTRIBUTE IS ONE OF THE SPLCIAL NOTIONS THE LOCATION COUNTER
.*IS REPOSITIONED TO WHERE IT WAS BEFORE THIS ATTRIBUTE WAS DEALT WITH
.*(SEE GENERAL DESCRIPTION).

.DEFS9 AIF (&SNAT EQ 0).L1
ORC @NA&POS

.L1 REXIT

.*LIST OF VALUES

.*LOOP WHICH COUNTS THE NO. OF VALUES IN THE LIST.WHEN &COUNT=N
.*&SYSLIST(N) PICKS OUT THE NTH PARAMETER OF THE MACRO CALL.WHEN THIS
.*IS A NULL STRING THE LIST IS EXHAUSTED

.DEFS3 ANOP
&COUNT SETA 3
.FOUC AIF ('&SYSLIST(&COUNT)' LG '').END
&COUNT SETA &COUNT+1
AGO .BOUC

.END ANOP

@VA&SYSNDX EQU *

.*SAVE ADDRESS OF CURRENT VALUE CELL BY ATTACHING A UNIQUE LABEL TO IT

.*
ALLOC VAL,20
SETCNT &COUNT,3
&COUNT SETA &COUNT-1
&RMVAB SETA 3

.*ALL FLAG FITS 0 IN COUNT CELL

.*ALLOCATE 20-BYTE BLOCK FOR VALUE LIST,FILL IN COUNTER CELL OF THIS
.*LIST;UPDATE &RMVAB TO INDICATE 3 EMPTY CELLS IN CURRENT VALUE LIST
.*BLOCK

.*
AIF (&SPOCCDE LQ 1).DEFS4

.*TEST IF NATURE OF ATTRIBUTE WAS 'CCODE'.TREATMENT OF THE VALUE LIST
.*IN THIS CASE IS DIFFERENT AS THE LIST MAY CONTAIN BASIC ACTIONS.

.*
&CNT SETA 3
.VALOOP VALST &SYSLIST(&CNT)
&CNT SETA &CNT+1
AIF (&CNT LE &COUNT).VALCOP

.*LOOP DEALS WITH EACH ITEM IN THE VALUE LIST IN TURN CALLING THE VALST
.*MACRO TO FILL IN THE CURRENT VALUE CELL.&SYSLIST (N) PICKS OUT THE
.*NTH PARAMETER OF THE MACRO CALL (IN THIS CASE THE (N-1)ST VALUE IN THE
.*LIST OF VALUES (THE NATURE OF THE ATTRIBUTE IS THE 1ST PARAMETER)).

.*
.DEFS5 AIF (&RMVAB NE 0).DEFS6

DEFS 01303500:01402900 12/20/74 12/20/74

DC X'FFFFFF'

*ALL FLAGS IN POINTER CELL 0

.*AT THE END OF THE VALUE LIST THE CURRENT VALUE LIST BLOCK IS COMPLETED
 .*WITH VALUE CELLS INITIALISED TO EMPTY IF THERE ARE ANY LEFT AND THE
 .*POINTER CELL INITIALISED TO 'LAST POINTER'

.* *****

OPC @VA&SYSNDX+4

&DEFCON SETB 1

.*THE LOCATION COUNTER IS REPOSITIONED TO THE CELL FOLLOWING THE VALUE
 .*CELL OF THE ATTRIBUTE JUST DEALT WITH. (@VA&SYSNDX IS ASSOCIATED WITH
 .*THE VALUE CELL. &DEFCON IS SET TO INDICATE A DEF (DEFS)
 .*GROUP STARTED.

.* *****

AIF (&SPNAT EQ 1).L3

&RMATE SETA &RMATE-1

.L3 AIF (&SPNAT EQ 0).L2

OPC @NA&POS

.L2 MEXIT

.*IF &SPNAT=1 THE NATURE OF THE ATTRIBUTE WAS ONE OF THE SPECIAL NOTIONS
 .*SO A) &RMATE IS NOT UPDATED (NO ATTRIBUTE SPACE HAS BEEN USED)
 .* B) THE LOCATION COUNTER IS REPOSITIONED ON THE NEXT FREE ATTRIBUTE
 .*IN THE CURRENT ATTRIBUTE BLOCK WHOSE ADDRESS WAS SAVED WHEN THE NATURE
 .*WAS IDENTIFIED AS SPECIAL (NATRE AND TSNAT MACROS).

.* *****

.*INITIALISE CELL TO EMPTY AND UPDATE &RMVAR

.DEFS6 DC X'FFFFFF'

*ALL FLAGS 0 IN EMPTY CELL

&RMVAR SETA &RMVAR-1

AGC .DEFS5

.* *****

.*NATURE OF ATTRIBUTE IS OCCDF WITH A LIST OF VALUES ASSOCIATED.
 .*LOOP ITERATES OVER THE LIST. THE MACRO LISTVAL COMPLETES THE
 .*CORRESPONDING CELL IN THE 3-GRAPH. THE END OF THE LIST IS GIVEN BY
 .*THE VALUE OF &COUNT .

.DEFS4 ANOP

&CNT SETA 3

.TSBOUC LISTVAL &SYSLIST(&CNT)

&CNT SETA &CNT+1

AIF (&CNT LE &COUNT).TSBOUC

AGC .DEFS5

.* *****

*ERROR MESSAGE

.ERR FNOTE: 'FIRST DEFS IN A GROUP MUST HAVE A NAME'
 .END

BEGIN 01330500:01333700 12/20/74 12/20/74

MACRO
BEGIN &SECTN,&PASS

.*GENERAL DESCRIPTION

.*
.******
.*THIS MACRO HEADS ANY DEFINITION OF A 3-GRAPH OR PART OF A 3-GRAPH
.*WHICH IS AUTONOMOUS IN THE SENSE THAT IT CONSTITUTES ONE SEPARATE
.*ASSEMBLY. THE PARAMETER &PASS IS A DECIMAL NUMBER N WHICH INDICATES
.*THAT THIS IS THE NTH SEPARATE ASSEMBLY OF THE 3-GRAPH. THE PARAMETER
.*&SECTN ALLOWS THE USER TO NAME THIS PART OF A 3-GRAPH (AN ALPHANUMERIC
.*NAME WITH A MAX OF 127 CHARACTERS).
.*
.******

.*MACRO VARIABLE

CELA &PASSNO

&PASSNO SETA &PASS

.*&PASSNO IS SET EQUAL TO &PASS FOR USE IN OTHER MACROS

.*
.******

TRGR&PASS CSECT PAGE

USING *,12

.*THE OUTPUT OF AN ASSEMBLY MUST CONSIST OF AT LEAST ONE CSECT AND EACH
.*CSECT MUST HAVE AT LEAST ONE BASE REGISTER. THE CSECT IS GIVEN THE
.*ATTRIBUTE PAGE, IT WILL BE ALIGNED ON A PAGE BOUNDARY ADDRESS IN
.*MEMORY (MULTIPLE OF 4K).
.*
.******

AIF (&PASS EQ 1).END

EXTRN OCCDE,SUC1,SUC2,ARG1,ARG2,ARG3,ARG4

.*THE POLICY OF SEPARATELY ASSEMBLED 3-GRAPH SECTIONS MEANS THAT
.*NOTIONS DEFINED IN OTHER SECTIONS AND REFERRED TO IN THE PRESENT ONE
.*MUST BE DECLARED AS EXTRN. THIS APPLIES IN PARTICULAR TO THE SPECIAL
.*NOTIONS-DEFINED IN THE
.*1ST SEPARATE ASSEMBLY (SEE MACRO INIT) AND AUTOMATICALLY DECLARED AS
.*EXTRN IN ALL OTHERS.
.*
.******

.*END
MEHD

INIT 01440600:01442800 12/20/74 12/20/74

MACRO
INIT

.*GENERAL DESCRIPTION

- .* *****
- .*EXPANSION OF THIS MACRO AND THE MACRO IT CALLS IS DESIGNED TO DEFINE
- .*THE SPECIAL NOTIONS. THESE NOTIONS
- .*WILL BE DEFINED AT THE VERY BEGINNING OF THE WHOLE 3-GRAPH AND
- .*THEREFORE THE SOLE CALL OF THIS MACRO IS TO BE INSERTED AFTER THE
- .*CALL TO THE BEGIN MACRO (WITH &FAS=1) IN THE 1ST 3-GRAPH SECTION.
- .*THE MACRO OUTIT IS CALLED ONCE FOR EACH MOTION TO BE DEFINED, THEN THE
- .*COUNT (&NOBY) OF THE NUMBER OF BYTES USED IN THE CURRENT PAGE IS
- .*UPDATED.

.* *****

GBLA &NOBY
OUTIT OCCDE
OUTIT SUC1
OUTIT SUC2
OUTIT ARG1
OUTIT ARG2
OUTIT ARG3
OUTIT ARG4
&NOBY SETA 420
MEND

OUTIT 01591600:01594000 01/07/75 01/07/75

MACRO
OUTIT &A1

.*GENERAL DESCRIPTION

- .* *****
- .*EXPANSION OF THIS MACRO DEFINES A NEW NOTION WITH THE NAME SPECIFIED
- .*BY THE PARAMETER &A1.

.* *****

.*STATISTICS CELL, INITIALISED TO 0, WITH FLAG BIT FOR NAMED MOTION
&A1 DC XL4'00000000'

.*OCCDE, SUC1, SUC2 CELLS, INITIALISED TO EMPTY.
DC 3X'FFFFFFE'

.L2 ANOP

.*POINTER CELL, CHAIN TO NEXT (CONTIGUOUS) BLOCK.
FLAG NOT

DC AL3(++3)
.*ARG1, ARG2, ARG3, ARG4 CELLS, INITIALISED TO EMPTY.
DC 4X'FFFFFFE'

.*POINTER CELL, INITIALISED TO 'END OF MOTION'.
DC X'FFFFFFF'

.*NAME OF NOTION
DC CL8'&A1'

DC A(&A1)
DS CL8

.*NAME OF NOTION DECLARED AS ENTRY POINT, SO THAT IT MAY BE REFERRED TO
.*IN OTHER ASSEMBLIES.

ENTRY &A1
MEND

TGEN0 01594100:01600000 01/07/75 01/07/75

MACRO

TGEN0

*GENERAL DESCRIPTION

- * THIS MACRO INDICATES THE END OF A 3-GRAPH SECTION WHICH IS TO BE ASSEMBLED SEPARATELY. THE FIRST UNUSED BYTE AT THE END OF THE 3-GRAPH IS GIVEN A UNIQUE NAME
- * THE REST OF THE CURRENT PAGE IS INITIALISED INTO A CHAINED LIST OF EMPTY BLOCKS, AND THE ADDRESS OF THE FIRST BLOCK IS STORED IN ONE OF THE UNUSED CELLS AT THE END OF THE PAGE.

*MACRO VARIABLES

GBLA &NOBY
GELA &PASSNO

- * &NOBY IS A COUNT OF THE NO. OF BYTES USED IN THE CURRENT PAGE.
- * &PASSNO IDENTIFIES THE SECTION OF THE 3-GRAPH BEING TERMINATED. IT IS USED TO GENERATE UNIQUE NAMES.

ORG

- *SET LOCATION COUNTER TO END OF 3-GRAPH.

@TGEN0&PASSNO EQU *

- *UNIQUE NAME FOR END OF 3-GRAPH SECTION.

AIF (&NOBY NE 4080).TGEN02
DC X'FFFFFFFF'
AGO .TGEN03

- *IF THE END OF THE 3-GRAPH SECTION COINCIDES WITH THE END OF THE CURRENT PAGE THE CELL WHICH SHOULD CONTAIN THE ADDRESS OF THE FIRST FREE BLOCK IN THE PAGE IS INITIALISED TO EMPTY (&NOBY=4080) + FLAGS FOR END OF SECTION.

.TGEN02 DC 4X'FFFFFFFF'

- *THE CELLS OF A 20-BYTE FREE BLOCK ARE INITIALISED

AIF ((&NOBY+20) EQ 4080).TGEN01
FLAG NOT
DC AL3(+3)

- *IF THE CURRENT FREE BLOCK IS NOT THE LAST IN THE PAGE (&NOBY+20 < 4080) IT IS CHAINED TO THE FOLLOWING ONE

&NOBY SETA &NOBY+20

AGO .TGEN02

- *UPDATE &NOBY AND LOOP

.TGEN01 DC X'FFFFFFFF'

- *END OF CHAIN OF FREE BLOCKS INDICATED IN POINTER CELL OF LAST ONE

DC A(@TGEN0&PASSNO)

- *ADDRESS OF 1ST FREE BLOCK STORED AT END OF PAGE

TESDF 01513000:01520800 12/20/74 12/20/74

MACRO

TESDF &NOT, &M

*GENERAL DESCRIPTION

 *THIS MACRO IS CALLED BY THE COMP, CREN, CPER, IFOU, LAT, SUP, SUPN, SUPP
 *MACROS ONCE FOR EACH OF THE POSSIBLE ARGUMENTS IN THE OUTER MACRO CALL
 *(IE THE PARAMETERS &ARG1, &ARG2, &ARG3, &ARG4, &SUC1, &SUC2 WHICH MAY HAVE
 *VALUES IN THE PARTICULAR CALL). THE PARAMETER &NOT IS REPLACED BY THE
 *ACTUAL ARGUMENT CONCERNED WHICH CORRESPONDS TO THE VALUE OF ONE OF
 *THE SPECIAL NOTIONS OF THE 3-GRAPH (ARG1, ARG2, ARG3, ARG4, SUC1, SUC2).
 *THE VALUE OF THE 2ND PARAMETER (&M) IS USED TO GENERATE A MACRO
 *SEQUENCE SYMBOL TO WHICH CONTROL TRANSFERS IF THE ACTUAL PARAMETER
 *TURNS OUT TO BE A NULL STRING (IE ARGUMENT MISSING OR SUCCESSOR NOT
 *EXPLICIT).

*MACRO VARIABLES USED

GELB &STAR, &SPVAL
 GPLA &PASSNO
 GSEQ LF(2), LM(4)

&STAR SET BY THE TSTAR MACRO INDICATES ACTUAL PARAMETER = '' OR 'NIL'.
 *&SPVAL SET BY TSVAL MACRO INDICATES ACTUAL PARAMETER = ONE OF
 *SPECIAL NOTIONS.
 *&PASSNO IS THE NO OF THE CURRENT 3-GRAPH SECTION
 *GSEQ LISTS THE SEQUENCE SYMBOLS TO BE GENERATED USING THE &M
 *PARAMETER.

 *TESTS MADE ON VALUE OF &NOT
 *THE FIRST TEST IS FOR A NULL STRING WHICH CAUSES AN ERROR MESSAGE IF
 *THE MISSING ACTUAL PARAMETER CORRESPONDS TO ONE OF ARG1, ARG2, ARG3 OR
 *ARG4. IF IT CORRESPONDS TO SUC1 OR SUC2 THEN THE SFLAG MACRO WILL SET
 *A FLAG TO INDICATE THAT THE SUCCESSOR TO THE NOTION DEFINED BY THE
 *CALLING MACRO IS THE NEXT ACTION IN SEQUENCE (SEE SFLAG MACRO).

AIF (&NOT EQ '').L8M

 THE NEXT TEST IS FOR '' OR 'NIL' AS ACTUAL PARAMETER, THE TSTAR MACRO
 *DEALS WITH THIS CASE.

TSTAR &NOT
 AIF (&STAR EQ 1).L2

 *NEXT, THE ACTUAL PARAMETER IS TESTED TO SEE IF IT CONSISTS OF ONE OR
 *A LIST OF NOTIONS (ENCLOSED IN PARENTHESES AND SEPARATED BY COMMAS).
 *A LIST OF NOTIONS IS DEALT WITH BY THE SUBLST MACRO SETTING UP A
 *LIST OF VALUES CHAINED TO THE ORIGINAL VALUE CELL AS DESCRIBED IN THE
 *GENERAL DESCRIPTION OF A 3-GRAPH.

AIF (&NOT(2) NE '').L1

 *FINALLY, HAVING ESTABLISHED THAT THE ACTUAL PARAMETER IS A SINGLE
 *NOTION THIS IS TESTED TO SEE IF IT IS ONE OF THE SPECIAL 3-GRAPH
 *NOTIONS (TSVAL MACRO) AND THE CORRESPONDING VALUE CELL IS FILLED IN
 *WITH THE FLAG BITS AND THE ADDRESS OF THE NOTION.

TESDF 01513000:01520800 12/20/74 12/20/74

TSVAL &NOT
AIF (&SFVAL EQ 1).L2
FLAG NOT

.*IF NOTION INTERNAL CONCATENATE NAME WITH CURRENT SECTION #

AIF (T'&NOT NE 'M').EXTRN
DC AL3(&NOT&PASSNO)
MEXIT

.EXTRN DC AL3(&NOT)

.L2 MEXIT

.* *****

.*PARAMETER IS A SUBLST

.L1 SUBLST &NOT

MEXIT

.* *****

.*SUC1 NOT EXPLICIT

.LF1 SFLAG 1

MEXIT

.* *****

.*SUC2 NOT EXPLICIT

.LF2 SFLAG 2

MEXIT

.* *****

.*ERROR MESSAGES

.LM1 MNOTE 'FIRST ARGUMENT MISSING'

MEXIT

.LM2 MNOTE 'SECOND ARGUMENT MISSING'

MEXIT

.LM3 MNOTE 'THIRD ARGUMENT MISSING'

MEXIT

.LM4 MNOTE 'FOURTH ARGUMENT MISSING'

MEND

SUBLST 01480400:01490100 12/20/74 12/20/74

MACRO
SUBLST &PAR

*GENERAL DESCRIPTION

*THIS MACRO IS CALLED BY THE TESDF MACRO WHEN AN ACTUAL PARAMETER
 *CORRESPONDING TO ONE OF THE SPECIAL NOTIONS TAKES THE FORM OF A LIST .
 *THIS LIST (&PAR) CONSISTS OF A NUMBER OF NOTION NAMES SEPARATED BY
 *COMMAS AND ENCLOSED IN PARENTHESES (MAX OF 127 CHARACTERS).
 *THIS MACRO CREATES A VALUE LIST IN THE 3-GRAPH
 *CHAINED TO THE CORRESPONDING VALUE CELL IN THE NOTION BEING DEFINED.

*MACRO VARIABLES

GCLA &RMVAB,&POS
 GPLA &PASSNO
 GELP &SPVAL
 LCLA &COUNT,&CNT

*&RMVAB IS AN INDICATOR OF THE NO OF CELLS LEFT IN A VALUE LIST BLOCK
 *&POS IS USED TO CREATE UNIQUE SYMBOLS FOR LABELLING LOCATION
 *COUNTER POSITIONS.
 *&PASSNO IS THE NO OF THE CURRENT 3-GRAPH SLCTION
 *&SPVAL (SEE TSVAL MACRO) IS A BOOLEAN INDICATOR USED IN CONNECTION
 *WITH THE SPECIAL NOTIONS-OCODE,SUC1,SUC2,ARG1,ARG2,ARG3,ARG4.
 *&COUNT,&CNT ARE USED FOR IDENTIFYING AND KEEPING TRACK OF THE NOTIONS
 *IN THE LIST.

*INITIALISATION OF VARIABLES

&CNT SETA 1
 &POS SETA &POS+1

*DETERMINE THE NO. OF NOTIONS IN THE LIST BY TESTING EACH ACTUAL
 *PARAMETER IN THE LIST UNTIL A NULL STRING IS ENCOUNTERED AND
 *INCREMENTING A COUNTER (&CNT)

SUB2 AIF ('&PAR(&CNT)' EQ '').SUB1
 &CNT SETA &CNT+1
 AGO .SUB2

.SUB1 ANOP

*SAVE THE CURRENT LOCATION POSITION (IE LABEL IT WITH A UNIQUE
 *GENERATED SYMBOL)

@NA&POS FCU *

*ALLOCATE A NEW 20-BYTE BLOCK AND CHAIN IT TO THE CURRENT CELL,
 *POSITION THE LOCATION COUNTER AT THE START OF THE NEW BLOCK.

ALLOC VAL,20

*SET &RMVAB TO INDICATE 3 CELLS LEFT,FILL IN COUNTER CELL.

&RMVAB SETA 3
 SETCNT &CNT,1

&CNT SETA &CNT-1

SUBLST 01480400:01490100 12/20/74 12/20/74

```

.*INITIALISE A NEW COUNTER
&COUNT SETA 1
.*
*****
.*TEST IF THERE IS ROOM IN THE CURRENT BLOCK FOR THE NEXT NOTION IN
.*THE LIST. IF SO GO TO .SKIP.
.SUB4 AIF (&RMVAB NE 0).SKIP
.*
*****
.*OTHERWISE ALLOCATE A NEW 20-BYTE BLOCK, CHAIN IT TO THE LAST ONE
.*AND POSITION THE LOCATION COUNTER TO THE START OF THE NEW BLOCK.
ALLOC SUI,20
.*
*****
.*SET &RMVAB TO INDICATE 4 CELLS LEFT IN BLOCK.
&RMVAB SETA 4
.*
*****
.*TEST NEXT NOTION IN LIST (INDEXED BY &COUNT) TO SEE IF IT IS ONE OF
.*THE SPECIAL NOTIONS. (SEE TSVAL MACRO) IF SO GO TO .SUB3
.SKIP TSVAL &PAR(&COUNT)
AIF (&SPVAL EQ 1).SUB3
.*
*****
.*OTHERWISE COMPLETE CELL WITH ADDRESS OF NOTION AND FLAG BITS.
FLAG NOT
.*IF NOTION INTERNAL CONCATENATE NAME WITH CURRENT SECTION #
AIF (T'&PAR(&COUNT) NE 'I').EXTEN
DC AL3(&PAR(&COUNT)&PASSNO)
AGO .SUB3
.EXTEN DC AL3(&PAR(&COUNT))
.SUB3 ANOP
.*
*****
.*UPDATE &RMVAB & &COUNT
&RMVAB SETA &RMVAB-1
&COUNT SETA &COUNT+1
.*
*****
.*TEST FOR END OF LIST, IF NOT END GO TO .SUB4
AIF (&COUNT LE &CNT).SUB4
.*
*****
.*OTHERWISE COMPLETE CURRENT VALUE LIST BLOCK BY INITIALISING ANY
.*LEFT-OVER CELLS TO EMPTY AND THE POINTER CELL TO 'END OF LIST'
.SUB6 AIF (&RMVAB NE 0).SUB5
DC X'FFFFFF'
.*NO FLAGS IN EMPTY CELL
.*
*****
.*RESET LOCATION COUNTER TO NEXT CELL IN ORIGINAL NOTION.
OPG @NA&POS+4
MEXIT
.*
*****
.*INITIALISE CELL TO EMPTY AND UPDATE &RMVAB
.SUB5 DC X'FFFFFFE'
&RMVAB SETA &RMVAB-1
ACC .SUB6
MLND

```

TNAME 01541600:01545200 12/20/74 12/20/74

MACRO

TNAME RNAM

*GENERAL DESCRIPTION

 *THIS MACRO AND THE MACROS IT CALLS DEFINE THE NEW NOTION (IF IT
 *IS NAMED) AND ALLOCATE SPACE FOR IT. IF THE LAST ACTION DEFINED DID
 *NOT HAVE AN EXPLICIT SUCCESSOR (SUC1 OR SUC2) THE ADDRESS OF
 *THE NEW NOTION IS STORED AS THE SUCCESSOR ACTION WHICH IS REQUIRED.

 *THIS MACRO IS CALLED BY THE COMP, CREN, CRER, IFOU, LAT, REP, SUP, SUFN,
 *SUFR, TMV MACROS. ITS ONLY PARAMETER IS THE NAME GIVEN (CCL 1-8)
 * TO THE NEW NOTION OTHERWISE THE PARAMETER IS NULL.

 GBLA 8PASSNO

*8PASSNO IS THE NO OF THE CURRENT 3-GRAPH SECTION
 AIF ('&NAM' EQ '').L1

*IF THE NEW NOTION HAS A NAME THE DEFN MACRO IS CALLED TO DEFINE IT
 *AND ALLOCATE SPACE, THE LOCATION COUNTER IS SET TO THE START OF THE
 *NEW NOTION.

DEFN RNAM&PASSNO

 *THE TFLAG MACRO IS CALLED TWICE TO SEE IF THE LAST ACTION DEFINED
 *REQUIRES A SUC1 AND/OR SUC2, IF SO, THE APPROPRIATE CILL IS
 *COMPLETED WITH THE ADDRESS OF THE NEW NOTION AND THE FLAG IS
 *RESET.

.L3 TFLAG 1
 TFLAG 2
 MEXIT

 *WHEN THE NEW NOTION IS UNNAMED SPACE IS ALLOCATED FOR IT AND THE
 *LOCATION COUNTER IS SET TO THE BEGINNING OF THE NEW NOTION.

.L1 ORG
 TROOM 40
 DS CL20
 DS CL20
 ORG *-40
 AGO .L3
 MEND

NATRE 01454300:01460500 12/20/74 12/20/74

MACRO

&NAME NATRE &NAT

*GENERAL DESCRIPTION

* *****
* CALLED BY DEF AND DEFS MACROS, EXPANSION OF THE NATRE MACRO FILLS IN
* THE NATURE CELL OF A NEW ATTRIBUTE, ALLOWING FOR SPECIAL CASES.

*MACRO VARIABLES

GLF &SPNAT, &DEFCON
GBLA &PASSNO
GBLA &RMATH, &NANGEN

* &SPNAT IS SET BY THE TSNAT MACRO TO 1, IF THE NATURE OF THE ATTRIBUTE
* IS ONE OF THE SPECIAL NOTIONS IN THE 3-GRAPH, TO 0 OTHERWISE.
* &DEFCON IS SET TO INDICATE THAT THE CALLING MACRO (DEF OR DEFS) IS
* PART OF A DEF OR DEFS GROUP.
* &RMATH INDICATES THE NO OF ATTRIBUTES WHICH CAN STILL BE STORED IN
* THE CURRENT BLOCK (EG 2, 1, 0). IT IS SET AFTER A NEW TAIL BLOCK HAS
* BEEN ADDED, AND UPDATED AFTER AN ATTRIBUTE HAS BEEN ADDED TO THE
* NOTION.

* &NANGEN IS USED FOR GENERATING UNIQUE SYMBOLS

* &PASSNO IS THE NO OF THE CURRENT 3-GRAPH SECTION

* *****
* THE FIRST THING IS TO TEST FOR A SPECIAL
* NOTION. THIS IS DONE BY THE TSNAT MACRO WHICH THEN POSITION'S THE
* LOCATION COUNTER ON THE CORRECT CELL IN THE ROOT NOTION. FOR
* THIS, IT REQUIRES A SYMBOLIC ADDRESS FOR THE START OF THE ROOT NOTION
* WHICH IS THE NAME OF THE NOTION WHEN THE CALLING DEF OR DEFS MACRO IS
* THE FIRST IN A GROUP OF SUCH MACRO CALLS, AND IS GIVEN BY A GENERATED
* SYMBOL IN THE OTHERS. SO THE &NAME PARAMETER IS TESTED. IF NOT NULL
* THE NAME OF THE NOTION CAN BE USED, OTHERWISE THE GENERATED SYMBOL IS
* USED (AT .NAT1)

AIF ('&NAME' LQ '').NAT1

* *****

*TEST FOR SPECIAL NOTION

TSNAT &NAT, &NAME

* *****

* IF THE TSNAT TEST IS POSITIVE (&SPNAT=1) THE NATRE MACRO HAS NOTHING
* TO DO. (NOTE: LOCATION COUNTER POSITIONED BY TSNAT MACRO)

.NAT2 AIF (&SPNAT EQ 1).NAT3

* *****

* IF CALLING DEF OR DEFS MACRO IS THE FIRST IN A GROUP AND NATURE OF
* ATTRIBUTE NOT SPECIAL, POSITION ON POINTER CELL AT END OF 1ST 2 BLOCKS
* OF NOTION

AIF (&DEFCON NL 0).NAT4

ORG **36

* *****

* IF THE CURRENT ATTRIBUTE BLOCK IS FULL (OR NO ATTRIBUTES YET ADDED)
* ALLOCATE A NEW TAIL BLOCK AND CHAIN TO END OF OLD ONE. RESET &RMATH

.NAT4 AIF (&RMATH NE 0).SKIP

ALLOC SUI, 20

NATRE 01454300:01460500 12/20/74 12/20/74

&RMATB SETA 2

```

.*
.*FILL IN NATUPE CELL (LOCATION COUNTER NOW POSITIONED ON VALUE CELL)
.*SKIP FLAG NOT
.*IF NOTION INTERNAL CONCATENATE NAME WITH CURRENT SECTION #
AIF (T'&NAT NE 'M').EXTRN
DC AL3(&NAT&FASSNO)
MEXIT
.*EXTRN DC AL3(&NAT)
.*NAT3 MEXIT
.*
.*TEST FOR SPECIAL NOTION
.*NAT1 TSNAT &NAT,@NO&NANGEN
AGO .NAT2
MEND

```

DEFN 01588900:01591500 01/07/75 01/07/75

MACRO DEFN &PAR1

```

.*GENERAL DESCRIPTION
.*
.*THIS MACRO IS CALLED BY THE TNAME MACRO TO DEFINE THE NEW NOTION
.*WHICH HAS BEEN GIVEN A NAME.THE VALUE OF &PAR1 IS THE NAME OF THE NEW
.*NOTION.
.*
.*SET LOCATION COUNTER TO 1ST AVAILAELE SPACE (IE HIGHEST VALUE YET
.*ENCOUNTERED)
ORG
.*
.*TEST IF THERE IS ROOM LEFT IN THE CURRENT PAGE FOR A NEW NOTION
TFROOM 60
.*
.*DEFINE THE NEW NOTION AND RESET LOCATION COUNTER TO THE BEGINNING OF
.*IT.
&PAR1 DS CL40
.*NAME OF NOTION
DC CL3'&PAR1'
DC A(&PAR1)
DS CL8
ORG &PAR1
.*
.*DEFINE THE NAME GIVEN AS AN ENTRY POINT SO THAT IT MAY BE REFERRED TO
.*IN SUBSEQUENT 3-GRAPH SECTIONS.
ENTRY &PAR1
MEND

```

DEFNOT 01585300:01588800 01/07/75 01/07/75

MACRO

DEFNOT &NOTNAME

.*GENERAL DESCRIPTION

.* *****

.*CALLED BY THE DEF MACRO, THE EXPANSION OF THE DEFNOT MACRO DEFINES A

.*NEW NOTION IN THE 3-GRAPH WITH A NAME. THE

.*NOTION IS DEFINED WITHOUT ATTRIBUTES (ALL CELLS INITIALISED TO

.*'EMPTY'.

.* *****

.*POSITION LOCATION COUNTER ON FIRST FREE ADDRESS IN 3-GRAPH (IE

.*HIGHEST ADDRESS SO FAR).

ORG

.* *****

.*TEST IF ENOUGH ROOM IN CURRENT PAGE.

TPOOM 60

.* *****

.*DEFINE NOTION

.*STATISTICS CELL, INITIALISED TO 0 FLAG BIT FOR NAMED NOTION

&NOTNAME DC XL4'00000000'

.*OCCDE, SUC1, SUC2 CELLS INITIALISED TO 'EMPTY'

DC 3X'FFFFFFF'

.*POINTER CELL, CHAIN TO NEXT (CONTIGUOUS) BLOCK

FLAG NOT

DC AL3(*+3)

.*ARG1, ARG2, ARG3, ARG4 CELLS, INITIALISED TO 'EMPTY'

DC 4X'FFFFFFF'

.*POINTER CELL, INITIALISED TO 'END OF NOTION'.

DC X'FFFFFFF'

.*NAME OF NOTION

DC CL8'&NOTNAME'

DC A(&NOTNAME)

DS CL8

.* *****

.*DEFINE NAME OF NOTION AS ENTRY POINT (PERMITS REFERENCES TO THIS

.*NOTION IN SUBSEQUENT 3-GRAPH SECTIONS)

ENTRY &NOTNAME

MEND

VALUE 01577600:01585200 12/20/74 12/20/74

MACRO

RNAME VALUE RVAL

*GENERAL DESCRIPTION

* *****
* CALLED BY THE DEF AND DEFS MACROS, EXPANSION OF THE VALUE MACRO DEALS
* WITH THE DIFFERENT CASES FOR THE VALUE OF THE ATTRIBUTE (DEPENDENT
* ON THE NATURE).

* *****

*MACRO VARIABLES

CCLE &DEFCON, &SPOCCDE, &SPNAT, &BASACT, &SPVAL
GPLA &PASSNO
GPLA &RMATE, &NANGEN

* &DEFCON INDICATES WHETHER THE CALLING DEF OR DEFS MACRO IS THE FIRST
* IN A GROUP (&DEFCON=0) OR NOT (&DEFCON=1).

* &SPOCCDE INDICATES WHETHER THE NATURE OF THE ATTRIBUTE IS ONE OF THE
* 'SPECIAL' NOTIONS (SET BY TSNAT MACRO).

* &BASACT (SET BY TSOCC MACRO) INDICATES WHETHER THE VALUE OF THE
* ATTRIBUTE (IN THE CASE WHERE THE NATURE IS 'OCCDE') IS ONE OF THE
* BASIC ACTIONS OF THE 3-GRAPH.

* &SPVAL (SET BY TSVAL MACRO) INDICATES WHETHER THE VALUE OF THE
* ATTRIBUTE IS ONE OF THE 'SPECIAL' NOTIONS.

* &RMATE SPECIFIES THE NO OF ATTRIBUTE SPACES LEFT IN AN ATTRIBUTE
* FLOCK.

* &NANGEN IS USED FOR GENERATING UNIQUE SYMBOLS

* &PASSNO IS THE NO OF THE CURRENT 3-GRAPH SECTION

* *****

* TEST &SPOCCDE. IF =1 NATURE OF ATTRIBUTE IS 'OCCDE' SO TSOCC MACRO
* IS CALLED TO TEST VALUE OF ATTRIBUTE. IF THIS IS ONE OF BASIC ACTIONS
* OF 3-GRAPH, THE CELL IS COMPLETED AND &BASACT IS SET TO 1.

AIF (&SPOCCDE NE 1).VAL1

TSOCC RVAL

AIF (&BASACT NE 1).VAL2

* *****

* TEST &SPNAT. IF =1 THEN THE LOCATION COUNTER IS TO BE REPOSITIONED

AIF (&SPNAT EQ 1).PESET

* *****

* UPDATE &RMATE AND SET &DEFCON TO 1 TO INDICATE THAT AT LEAST ONE OF A
* GROUP OF DEF OR DEFS MACRO CALLS HAS BEEN ENCOUNTERED.

&RMATE SETA &RMATE-1

&DEFCON SETE 1

NEXIT

* *****

* VALUE OF ATTRIBUTE IS AN ORDINARY NOTION OF THE 3-GRAPH SO COMPLETE
* CELL IN USUAL WAY.

VAL2 FLAG NOT

* IF NOTION INTERNAL CONCATENATE NAME WITH CURRENT SECTION #

AIF (T'RVAL NE 'M').EXTRN

DC AL3(RVAL&PASSNO)

AGO .NEXT

* EXTRN DC AL3(&VAL)

VALUE 01577600:01585200 12/20/74 12/20/74

```

.*
.*IF &SPNAT=1 LOCATION COUNTER IS TO BE RESET
.NEXT AIF (&SPNAT EQ 1).RESET
.*
.*UPDATE &RMATP AND SET &DEFCON.
&RMATP SETA &RMATP-1
&DEFCON SETE 1
MEXIT

.*
.*NATURE OF ATTRIBUTE NOT 'OCODE'. TSVAL MACRO IS CALLED TO TEST VALUE
.*OF ATTRIBUTE. IF IT CORRESPONDS TO ONE OF THE 'SPECIAL' NOTIONS, THE
.*CELL IS FILLED IN AND &SPVAL IS SET TO 1.
.VAL1 TSVAL &VAL
.*
.*IF VALUE NOT 'SPECIAL' GO TO .VAL2
AIF (&SPVAL NE 1).VAL2
.*
.*IF &SPNAT=1 LOCATION COUNTER IS TO BE RESET
AIF (&SPNAT EQ 1).RESET
.*
.*UPDATE &RMATP AND SET &DEFCON.
&RMATP SETA &RMATP-1
&DEFCON SETE 1
MEXIT

.*
.*RESET LOCATION COUNTER TO START OF NOTION AND SET &DEFCON
.RESET ORG @NO&NAMGEN
&DEFCON SETE 1
MCLID

```


LISTVAL 01450400:01454200 12/20/74 12/20/74

MACRO
LISTVAL &VAL

.*GENERAL DESCRIPTION

.*
.******
.*CALLED BY THE DEF AND DEFS MACROS, EXPANSION OF THE LISTVAL MACRO
.*DEALS WITH ONE OF A LIST OF VALUES OF AN ATTRIBUTE WHEN THE NATURE
.*IS 'OCODE'. IT IS CALLED ONCE FOR EACH OF THE VALUES IN THE LIST.
.*
.******

.*MACRO VARIABLES

GELA &PASSNO
GELA &RMVAR
GELA &BASACT

.*&RMVAR INDICATES THE NO OF EMPTY CELLS LEFT ON THE CURRENT BLOCK
.*&BASACT INDICATES WHETHER THE VALUE IS A BASIC ACTION OF THE 3-GRAPH
.*&PASSNO IS THE NO OF THE CURRENT 3-GRAPH SECTION

.*
.******
.*IF THE CURRENT BLOCK IS FULL (&RMVAR=0) ALLOCATE A NEW BLOCK AND
.*RESET &RMVAR

AIF (&RMVAR NL 0).LST1
ALLOC SUI,20

&RMVAR SETA 4

.*
.******
.*TEST IF VALUE IS A BASIC ACTION. TSOCC MACRO SETS &BASACT=1 AND FILLS
.*VALUE CELL IF TEST SUCCESSFUL.

.LST1 TSOCC &VAL
AIF (&BASACT NE 1).LST2

.*
.******
.*IF TEST SUCCESSFUL UPDATE &RMVAR

&RMVAR SETA &RMVAR-1
MEXIT

.*
.******
.*VALUE IS AN ORDINARY NOTION. FILL IN VALUE CELL AND UPDATE &RMVAR
.*THE NAME OF THE NOTION IS CONCATENATED WITH THE CURRENT SECTION NUMBER
.*IF IT IS NOT AN EXTERNAL NOTION (TYPE OF NOTION = 'M' IF INTERNAL)

.LST2 FLAG NOT
AIF (T*&VAL NL 'M').EXTRN
DC AL3(&VAL&PASSNO)
AGO .NEXT

.EXTRN DC AL3(&VAL)

.NEXT ANOP

&RMVAR SETA &RMVAR-1
MEND

VALST 01573600:01577500 12/20/74 12/20/74

MACRO
VALST &VAL

.*GENERAL DESCRIPTION

.* *****
.* CALLED BY THE DEF AND DLFS MACROS TO DEAL WITH A VALUE OF A VALUE
.* LIST EXCEPT WHEN THE NATURE OF THE ATTRIBUTE IS 'OCDF'. IT IS CALLED
.* ONCE FOR EACH VALUE IN THE LIST AND FILLS IN THE CORRESPONDING
.* VALUE CELL, ADDING NEW BLOCKS TO THE NOTION AS NECESSARY.

.*MACRO VARIABLES

GELA &PASSNO
GELA &RMVAB
GELA &SPVAL

.*&RMVAB INDICATES THE NO OF EMPTY CELLS LEFT ON THE CURRENT BLOCK
.*&SPVAL INDICATES WHETHER THE VALUE IS ONE OF THE 'SPECIAL' NOTIONS
.* OF THE 3-GRAPH
.*&PASSNO IS THE CURRENT 3-GRAPH SECTION NO.

.* *****
.* IF THE CURRENT BLOCK IS FULL (&RMVAB=0) ALLOCATE A NEW BLOCK AND
.* RESET &RMVAB

AIF (&RMVAB NE 0).JUMP
ALLOC SUI,20

&RMVAB SETA 4

.* *****
.* TEST IF THE VALUE IS ONE OF THE 'SPECIAL' NOTIONS OF THE 3-GRAPH.
.* THE TSVAL MACRO FILLS IN THE CELL IF IT IS AND SETS &SPVAL=1.UPDATE
.* &RMVAB

JUMP TSVAL &VAL
AIF (&SPVAL NE 1).VALST1

&RMVAB SETA &RMVAB-1

MEXIT

.* *****
.* THE VALUE IS AN ORDINARY NOTION. FILL IN VALUE CELL AND UPDATE &RMVAB.
.* VALST1 FLAG NOT
.* IF NOTION INTERNAL CONCATENATE NAME WITH CURRENT SECTION #

AIF (T'&VAL NE 'M').EXTRN
DC AL3(&VAL&PASSNO)
AGO .NEXT

.EXTRN DC AL3(&VAL)

.NEXT ANOP

&RMVAB SETA &RMVAB-1

MEND

TSNAT 01549300:01558500 12/20/74 12/20/74

MACRO
TSNAT &NAT,&NAME

```

.*GENERAL DESCRIPTION
.*
.******
.*CALLED BY THE NATURE MACRO TO DEAL WITH THE NATURE
.*OF AN ATTRIBUTE BEING DEFINED BY A DEF OF DEFS MACRO CALL
.*
.******
.*PARAMETERS
.*&NAT IS REPLACED BY THE NAME OF THE NOTION WHICH IS NATURE OF THE
.*ATTRIBUTE
.*&NAME IS REPLACED BY THE NAME OF THE ROOT NOTION OR BY A GENERATED
.*SYMBOL ATTACHED TO THE BEGINNING OF THE ROOT NOTION.
.*
.******
.*VARIABLE SYMBOLS
GRLP  &SPNAT,&SPOCCDE
GRLA  &POS
.*&SPNAT IS SET IN THIS MACRO TO INDICATE THAT THE VALUE OF &NAT IS ONE
.*OF THE SPECIAL NOTIONS (&SPNAT = 1) OR NOT (&SPNAT = 0)
.*&SPOCCDE IS SET = 1 IF THE VALUE OF &NAT IS 'OCCDE' AND IS SET = 0
.*OTHERWISE.
.*&POS IS USED TO GENERATE UNIQUE SYMBOLS.
.*
.******
.*ERROR MESSAGES
AIF  ('&NAME' EQ '') .ERR
AIF  ('&NAT' EQ '') .ERR1
.*IF EITHER &NAT OR &NAME HAS BEEN REPLACED BY A NULL STRING AN ERROR
.*MESSAGE IS OUTPUT.
.*NOTE:THE LOCATION COUNTER VALUE IS NOT ALTERED IN THIS CASE.
.*
.******
&POS  SETA  &POS+1
.*&POS IS INCREMENTED TO ENSURE THAT GENERATED SYMBOLS WILL BE UNIQUE.
.*
.******
.*TESTS ON &NAT
.*THE VALUE OF &NAT IS TESTED AGAINST THE SPECIAL NOTION NAMES
.*IN TURN. IF A TEST IS SUCCESSFUL THE CURRENT VALUE OF THE LOCATION
.*COUNTER IS SAVED, &SPNAT IS SET TO 1 (IF 'OCCDE' IS DETECTED &SPOCCDE
.*IS ALSO SET TO 1 OTHERWISE TO 0) AND THE LOCATION COUNTER IS
.*POSITIONED AT THE VALUE CLL IN THE ROOT NOTION CORRESPONDING TO THE
.*NOTION DETECTED
.*NOTE:THIS POSITIONING RELIES ON THE FACT THAT THE
.*FIRST TWO BLOCKS OF A NOTION ARE CONTIGUOUS AND ON THE ORDER OF THE
.*CELLS CORRESPONDING TO THE SPECIAL ATTRIBUTES.
.*
.******
AIF  ('&NAT' NE 'OCCDE') .L1
&SPNAT  SETB  1
&SPOCCDE SETB  1
@NA&PCS EQU  *
ORG  &NAME+4
MEXIT
.L1  ANOP
    
```

TSNAT 01549300:01558500 12/20/74 12/20/74

&SPCCODE SETB 0
AIF ('&NAT' NE 'SUC1').L2

&SPNAT SETB 1
&NA&POS EQU *
ORG &NAME+8
MEXIT

.L2 AIF ('&NAT' NE 'SUC2').L3
&SPNAT SETB 1

&NA&POS EQU *
ORG &NAME+12
MEXIT

.L3 AIF ('&NAT' NE 'ARG1').L4
&SPNAT SETB 1

&NA&POS EQU *
ORG &NAME+20
MEXIT

.L4 AIF ('&NAT' NE 'ARG2').L5
&SPNAT SETB 1

&NA&POS EQU *
ORG &NAME+24
MEXIT

.L5 AIF ('&NAT' NE 'ARG3').L6
&SPNAT SETB 1

&NA&POS EQU *
ORG &NAME+28
MEXIT

.L6 AIF ('&NAT' NE 'ARG4').L7
&SPNAT SETB 1

&NA&POS EQU *
ORG &NAME+32
MEXIT

* *****
*IF ALL TLSTS ARE NEGATIVE &SPNAT IS SET TO 0.

.L7 ANOP
&SPNAT SETB 0
MEXIT

* *****
*ERROR MESSAGES

.ERR MNOTE 'NOTION HAS NO NAME,TSNAT MACRO'
MEXIT

.ERR1 MNOTE 'NATURE IS NULL,TSNAT MACRO'
MEND

TSVAL 01568700:01573500 12/20/74 12/20/74

MACRO
TSVAL &A1

.*GENERAL DESCRIPTION

.* THIS MACRO IS CALLED BY THE TESDF, SUBLST, VALUE AND VALST MACROS. IT
.* TESTS WHETHER THE ACTUAL PARAMETER CORRESPONDING TO &A1 IS ONE OF THE
.* SPECIAL NOTIONS OCCDE, SUC1, SUC2, ARG1, ARG2, ARG3 OR ARG4. IF SO THE
.* CURRENT CELL IS FILLED IN WITH THE ADDRESS OF THE SPECIAL NOTION (AND
.* CORRESPONDING FLAG BITS) AND THE GLOBAL POOLEAN VARIABLE &SPVAL IS
.* SET TO 1. OTHERWISE &SPVAL IS SIMPLY SET TO 0.

.* *****

GPLB &SPVAL
AIF ('&A1' NE 'OCCDE').L1

FLAG NOT
DC AL3(OCCDE)
AGO .SET

.L1 AIF ('&A1' NE 'SUC1').L2

FLAG NOT
DC AL3(SUC1)
AGO .SET

.L2 AIF ('&A1' NE 'SUC2').L3

FLAG NOT
DC AL3(SUC2)
AGO .SET

.L3 AIF ('&A1' NE 'ARG1').L4

FLAG NOT
DC AL3(ARG1)
AGO .SET

.L4 AIF ('&A1' NE 'ARG2').L5

FLAG NOT
DC AL3(ARG2)
AGO .SET

.L5 AIF ('&A1' NE 'ARG3').L6

FLAG NOT
DC AL3(ARG3)
AGO .SET

.L6 AIF ('&A1' NE 'ARG4').L7

FLAG NOT
DC AL3(ARG4)

.* *****

.*TESTS SUCCESSFUL

.SET ANOP
&SPVAL SETP 1
MEXIT

.* *****

.*TESTS UNSUCCESSFUL

.L16 ANOP
&SPVAL SETP 0
MEND

TS000 01558600:01566600 12/20/74 12/20/74

MACRO
TS000 EVAL

.*GENERAL DESCRIPTION

.* THIS MACRO IS CALLED BY THE VALUE, VALST AND LISTVAL MACROS TO TEST
 .* THE VALUE OF AN ATTRIBUTE BEING DEFINED WHEN THE NATURE OF THE
 .* ATTRIBUTE WAS THE SPECIAL NOTION CCCDE.

.*PARAMETER

.* &EVAL IS REPLACED BY THE NAME OF THE VALUE OF THE ATTRIBUTE IN
 .* QUESTION.

.*VARIABLE SYMBOL

GILEB &BASACT

.* &BASACT IS SET = 1 IF THE ACTUAL PARAMETER CORRESPONDS TO ONE OF THE
 .* BASIC ACTIONS OF THE 3-GRAPH.

.*ERROR MESSAGE

AIF (('&VAL' EQ '') OR ('&VAL' EQ '*')).ERP

.* IF THE ACTUAL PARAMETER IS A NULL STRING OR '*' AN ERROR MESSAGE IS
 .* OUTPUT. NOTE: THE CURRENT CELL IS NOT FILLED IN AND THE LOCATION
 .* COUNTER DOES NOT MOVE.

.*TESTS ON &VAL

.* THE ACTUAL PARAMETER IS TESTED AGAINST EACH OF THE BASIC ACTION NAMES
 .* IN TURN. IF A TEST IS SUCCESSFUL THE CURRENT CELL IS FILLED IN WITH
 .* THE FLAG BITS + THE OFFSET IN THE TABLE OF BASIC ACTIONS
 .* CORRESPONDING TO THE ACTION DETECTED, &BASACT IS SET TO 1.

```

.*
AIF ('&VAL' NE 'COMP').L0
FLAG BASE
DC AL3(0)
AGO .L9
.L0 AIF ('&VAL' NE 'CREN').L1
FLAG BASE
DC AL3(4)
AGO .L9
.L1 ANOP
.L2 AIF ('&VAL' NE 'LAT').L3
FLAG BASE
DC AL3(12)
AGO .L9
.L3 AIF ('&VAL' NE 'REP').L4
FLAG BASE
DC AL3(16)
AGO .L9
.L4 AIF ('&VAL' NE 'SUP').L5
FLAG BASE
DC AL3(20)
AGO .L9

```

TSOCC 01558600:01566600 12/20/74 12/20/74

```

.L5 ANOP
.L6 AIF ('&VAL' NE 'SUPR').L7
   FLAG BASE
   DC AL3(28)
   AGO .L9
.L7 AIF ('&VAL' NE 'TMV').L8
   FLAG BASE
   DC AL3(32)
   AGO .L9
.L8 AIF ('&VAL' NE 'CREF').L10
   FLAG BASE
   DC AL3(36)

```

* *****

*TEST SUCCESSFUL

```

.L9 ANOP
&BASACT SETB 1
MEXIT

```

* *****

*ERROR MESSAGE

```

.ERR MNOTE 'ILLEGAL OPERAND,TSOCC MACRO'

```

* *****

*IF ALL TESTS FAIL &BASACT IS SET TO 0.

```

.L10 ANOP
&BASACT SETB 0
MEND

```

TSTAR 01566700:01568600 12/20/74 12/20/74

MACRO
TSTAR &A1

*GENERAL DESCRIPTION

* *****

*THIS MACRO IS CALLED BY THE TESDF MACRO TO TEST WHETHER THE VALUE OF
*THE PARAMETER &A1 (CORRESPONDING TO THE VALUE OF ONE OF THE SPECIAL
*NOTIONS) IS '+' OR 'NIL'.IF SO THE GLOBAL BOOLEAN VARIABLE &STAR IS
*SET TO 1 AND THE CURRENT CELL IS INITIALISED TO EMPTY,OTHERWISE &STAR
*IS SET TO 0.IT IS ASSUMED THAT THE LOCATION COUNTER IS CORRECTLY
*POSITIONED BEFORE ENTRY TO THIS MACRO.

* *****

```

GELE &STAR
AIF ('&A1' EQ '+').L1
AIF ('&A1' EQ 'NIL').L1
&STAR SETB 0
MEXIT

```

```

.L1 DC X'FFFFFFF'
*NO FLAGS IN EMPTY CELL
&STAR SETB 1
MEND

```

ALLOC 01321600:01330400 12/20/74 12/20/74

MACRO
ALLOC &WF,&LNG

*GENERAL DESCRIPTION

* THIS MACRO IS CALLED BY THE SUPLST,DEF,DEFS,NATRE,VALST & LISTVAL
* MACROS. IT IS USED TO ALLOCATE AND CHAIN NEW BLOCKS IN THE 3-GRAPH.

*PARAMETERS

* &WF CAN BE REPLACED BY THE STRING 'SUI' OR THE STRING 'VAL' WHICH
* INDICATES THAT THE NEW BLOCK IS TO BE CHAINED TO THE END OF THE
* CURRENT BLOCK (TO THE POINTER CELL) OR TO THE CURRENT CELL (IF NEW
* BLOCK IS TO CONTAIN THE BEGINNING OF A VALUE LIST).
* &LNG SPECIFIES THE LENGTH OF THE NEW BLOCK (IN BYTES).

*VARIABLE SYMBOLS

GRLB &SPOCCDE
GELA &NOBY
LCLA &LOCNOBY,&REM

* &SPOCCDE SPECIFIES WHETHER THE NATURE OF THE ATTRIBUTE CONCERNED IS
* OCCDE OR NOT
* &NOBY IS A COUNT OF THE NUMBER OF BYTES USED IN THE CURRENT PAGE.
* &LOCNOBY,&REM ARE WORKING VARIABLES.

AIF (('&WF' NE 'SUI') AND ('&WF' NE 'VAL')).L7

* THE VALIDITY OF &WF IS CHECKED AND AN ERROR MESSAGE IS OUTPUT IF IT
* IS NOT O.K. NOTE: IN THIS CASE NO NEW BLOCK IS DEFINED.

@LCT&SYSNDX EQU *

*SAVE ADDRESS OF CURRENT CELL (TO WHICH NEW BLOCK WILL BE CHAINED).
ORG

*MOVE TO 1ST FREE LOCATION IE HIGHEST ADDRESS SO FAR ENCOUNTERED.

&LOCNOBY SETA &NOBY+&LNG

AIF (&LOCNOBY GT 4096).L1

*TEST IF ENOUGH ROOM IN CURRENT PAGE,IF NOT GOTO .L1

.L4 ANOF

&NOBY SETA &NOBY+&LNG

*UPDATE &NOBY TO INCLUDE NEW BLOCK.

@LCP&SYSNDX EQU *

*SAVE ADDRESS OF NEW BLOCK.

DC 4X'FFFFFFF'
DC X'FFFFFFF'

*INITIALISE NEW BLOCK.

ORG @LCT&SYSNDX

*PREPARE TO CHAIN NEW BLOCK TO POINTER CELL

ALLOC 01321600:01330400 12/20/74 12/20/74

```

.*
.* *****
AIF ('&WF' EQ 'SUI').L2
AIF ('&WF' EQ 'VAL').L3
.*TEST WHETHER BLOCK IS A TAIL BLOCK OR A VALUE LIST BLOCK FOR FLAG BITS
.*WHICH ARE DIFFERENT.
.* *****
.*ERROR MESSAGE
.L7 MNOTE 'PAR INVALID,ALLOC MACRO'
MEXIT
.* *****
.*VALUE LIST FLAGS
.L3 FLAG LV
AGO .L5
.* *****
.*TAIL BLOCK FLAGS
.L2 FLAG NOT
.* *****
.L5 DC AL3(@LCP&SYSNDX)
ORG @LCP&SYSNDX
.*FILL IN ADDRESS OF NEW BLOCK AND POSITION LOCATION COUNTER AT START
.*OF NEW BLOCK.
MEXIT
.* *****
.L1 ANOP
&REM SETA (4096-&NOBY)/4
DC &REM,X'FFFFFFE'
&NOBY SETA 0
.*THE CELLS WHICH ARE LEFT AT THE END OF THE PAGE ARE INITIALISED TO
.*'EMPTY' (FOR COMPATIBILITY).&NOBY IS RESET TO 0.
AGO .L4
.* *****
MEND

```

TROOM 01545300:01549200 12/20/74 12/20/74

MACRO
TROOM RA1

*GENERAL DESCRIPTION

*TROOM MACRO IS CALLED BY THE TNAME, DEFN, DEFNCT, MACROS.

*PARAMETER RA1 IS THE LENGTH OF THE NEW BLOCK REQUIRED BY THE

*CALLING MACRO. A BLOCK IN THE 3-GRAPH IS NOT ALLOWED TO SIT ASTRIDE

*THE BOUNDARY OF TWO PAGES SO THE TROOM MACRO IS DESIGNED TO TEST

*WHETHER A NEW BLOCK OF THE REQUIRED LENGTH WILL FIT INTO THE CURRENT

*PAGE.

*MACRO VARIABLES

GPLA &NOBY
LCLA &REM, &LOCNOBY

*THE GLOBAL ARITHMETIC VARIABLE &NOBY IS USED TO KEEP TRACK OF THE

*NUMBER OF BYTES USED IN THE CURRENT PAGE. IT IS INITIALISED TO 0 AT

*THE START OF EACH ASSEMBLY AND IS UPDATED BY THE INIT, TROOM AND ALLOC

*MACROS.

*LOCAL VARIABLE &LOCNOBY IS SET TO THE SUM OF &NOBY (NO. BYTES USED)

*AND THE LENGTH OF THE BLOCK REQUIRED. IF THE SUM IS NOT GREATER THAN

*4080 BYTES THEN THE NEW BLOCK FITS INTO THE CURRENT PAGE (THE LIMIT

*IS 4080 SINCE, BECAUSE ALL BLOCKS IN THE 3-GRAPH ARE EITHER 20 OR 40

*BYTES THE LAST 16 BYTES OF EACH 4K PAGE WILL NEVER BE USED).

&LOCNOBY SETA &NOBY+RA1
AIF (&LOCNOBY LE 4080).TR1

*THE NEW BLOCK WILL NOT FIT SO THE NO. OF 4-BYTE CELLS REMAINING IS

*CALCULATED AND EACH OF THESE IS THEN INITIALISED TO EMPTY (FOR

*COMPATIBILITY).

&REM SETA (4096-&NOBY)/4
DC &REM.X'FFFFFFF'

*&NOBY IS REINITIALISED AND A NEW PAGE IS STARTED.

&NOBY SETA RA1
MEXIT

*&NOBY IS UPDATED BY THE LENGTH OF THE NEW BLOCK.

.TR1 ANOP
&NOBY SETA &NOBY+RA1
MEND

SETCNT 01470200:01474700 12/20/74 12/20/74

MACRO

SETCNT %CNT, %NO

*GENERAL DESCRIPTION

* *****

*SETCNT IS CALLED BY THE DLF, DEFS, SUBLST MACROS TO FILL IN THE COUNTER
 *CELL OF A VALUE LIST. IT ASSUMES THAT THE LOCATION COUNTER IS SET TO THE
 *ADDRESS OF THE COUNTER CELL INTO WHICH IT PLACES THE NO OF CELLS
 *AVAILABLE IN THE VALUE LIST.

* *****

*PARAMETERS

*%CNT IS REPLACED BY THE VALUE OF THE COUNTER USED IN THE CALLING
 *MACRO TO COUNT THE NO OF VALUES IN THE VALUE LIST.
 *%NO IS REPLACED BY '1' IF THE CALLING MACRO IS SUBLST, THE COUNTER
 *CONTAINS 1 MORE THAN THE ACTUAL NO OF VALUES IN THE LIST; BY '2' IF
 *THE CALLING MACRO IS DEF, BY '3' IF THE CALLING MACRO IS DEFS

* *****

*MACRO VARIABLES

LCLA %CT1, %CT2

*%CT1, %CT2 ARE WORKING VARIABLES

* *****

*%CT1 IS SET TO N+1 WHERE N IS THE ACTUAL NO OF VALUES IN THE VALUE
 *LIST.

%CT1 SETA %CNT-%NO+1

* *****

*THE NO OF CELLS ALLOCATED WILL BE THE MULTIPLE OF 4 THAT IS GREATER
 *THAN OR EQUAL TO THE NO OF VALUES IN THE LIST, -1 FOR THE COUNTER CELL
 *SO THE FOLLOWING LOOP ALTEPNATELY TESTS TO SEE IF %CT1 IS A MULTIPLE
 *OF 4 AND INCREASES IT BY 1 IF IT IS NOT.

.L1 ANOP

%CT2 SETA (%CT1/4)*4
 AIF (%CT2 EQ %CT1).L2

%CT1 SETA %CT1+1
 AGO .L1

* *****

*WHEN %CT1 HAS REACHED THE MULTIPLE OF 4 REQUIRED IT IS DECREASED TO
 *ACCOUNT FOR THE COUNTER CELL AND THEN THE COUNTER CELL IS FILLED IN.

.L2 ANOP

%CT1 SETA %CT1-1

.L3 DC F'%CT1'

* *****

MEMD

SFLAG 01474800:01480300 12/20/74 12/20/74

MACRO
SFLAG BA1

*GENERAL DESCRIPTION

 *THIS MACRO IS CALLED BY TESDF WHEN AN
 *EXPLICIT SUCCESSOR TO THE CURRENT 3-GRAPH ACTION IS APSENT,THE VALUE
 *OF THE PARAMETER BA1 INDICATES WHETHER IT IS SUC1 OR SUC2 AND THIS
 *MACRO ASSUMES THAT THE LOCATION COUNTER IS CURRENTLY POSITIONED AT
 *THE CELL CONCERNED.

*MACRO VARIABLES

GLOBAL &SUCC1,&SUCC2
 GLOBAL &LAB

*&SUCC1,&SUCC2 ARE GLOBAL BOOLEAN VARIABLES WHICH INDICATE THE
 *APSENCE OF AN EXPLICIT SUCCESSOR.
 *THE GLOBAL ARITHMETIC VARIABLE &LAB IS USED FOR GENERATING UNIQUE
 *SYMBOLS.IT IS INCREMENTED JUST BEFORE EXIT FROM THIS MACRO.

*SUC1 NOT EXPLICIT

AIF ('&A1' NE '1').L2

&SUCC1 SETB 1

*&SUCC1 IS SET TO 1 TO INDICATE THAT A SUC1 IS
 *NEEDED (SEE TNAME AND TFLAG MACROS).

*THE CURRENT VALUE OF THE LOCATION COUNTER IS ASSOCIATED WITH A
 *SPECIAL GENERATED SYMBOL WHICH WILL BE USED FOR REPOSITIONING WHEN
 *THE SUCCESSOR IS LATER FILLED IN.(SEE TFLAG MACRO)

@S1&LAB EQU *
 ACO .L3

*SUC2 NOT EXPLICIT

.L2 AIF ('&A1' NE '2').L1

&SUCC2 SLTB 1

*&SUCC2 IS SET TO INDICATE THAT A SUC2 IS NEEDED.
 *(SEE TNAME AND TFLAG MACROS).

*THE CURRENT VALUE OF THE LOCATION COUNTER IS ASSOCIATED WITH A
 *SPECIAL GENERATED SYMBOL WHICH WILL BE USED FOR REPOSITIONING WHEN
 *THE SUCCESSOR IS LATER FILLED IN.(SEE TFLAG MACRO)

@S2&LAB EQU *

*FINALLY THE CELL IS INITIALISED TO EMPTY
 *(THIS ENSURES THAT THE CONTENTS OF THE
 *CELL ARE COMPATIBLE WITH THE REST OF THE 3-GRAPH IN THE EVENTUALITY
 *OF THERE BEING NO IMPLICIT SUCCESSOR).

.L3 DC X'FFFFFF'

*NO FLAGS IN EMPTY CELL

&LAB SETA &LAB+1
 MEXIT

*ERROR MESSAGE

.L1 NNOTE 'INCORRECT CALL:MACRO SFLAG'

*AN ERROR MESSAGE IS GENERATED IF THE VALUE OF THE PARAMETER IS NOT
 *'1' OR '2'.NOTE:THE VALUE OF THE LOCATION COUNTER IS NOT ALTERED
 *WHEN THIS OCCURS.

MEND

TFLAG 01520900:01525400 12/20/74 12/20/74

MACRO
TFLAG ENR

.*GENERAL DESCRIPTION

.*
.******
.*THIS MACRO IS CALLED BY TNAME ONCE THE NEW NOTION HAS BEEN
.*DEFINED. DEPENDING ON THE VALUE OF THE PARAMETER ENR IT TESTS THE
.*VALUE OF THE GLOBAL BOOLEAN VARIABLE &SUCC1 OR &SUCC2. IF THIS IS =1
.*(IE THE CURRENT NOTION IS THE IMPLICIT SUCCESSOR OF A PREVIOUS NOTION)
.*IT COMPLETES THE APPROPRIATE SUCCESSOR CELL OF THE PRECEDING NOTION

.*MACRO VARIABLES

GRLE &SUCC1,&SUCC2
GELA &LAP
LCLA &LOCLAB

.*THE GLOBAL BOOLEAN VARIABLES &SUCC1 AND &SUCC2 ARE SET BY THE SFLAG
.*MACRO TO INDICATE WHEN THE SUCCESSOR TO AN ACTION (THE NOTION BEING
.*DEFINED WHEN THE MACRO IS CALLED) IS NOT EXPLICIT.
.*THE GLOBAL ARITHMETIC VARIABLE &LAP IS USED IN THE SFLAG MACRO TO
.*GENERATE A UNIQUE LABEL ATTACHED TO THE SUCCESSOR CELL
.* TO BE COMPLETED BY THE TFLAG MACRO.
.*THE LOCAL ARITHMETIC VARIABLE &LOCLAB IS USED TO REGENERATE THIS LABEL.

.*&SUCC1 TO BE TESTED (&NR='1')
AIF ('&NR' NE '1').L2
AIF (&SUCC1 NE 1).END

.*IF &SUCC1 = 0 CONTROL RETURNS TO THE CALLING MACRO. OTHERWISE A LABEL
.*IS GENERATED AND ATTACHED TO THE CURRENT LOCATION COUNTER VALUE.
@LCT&SYSNDX EQU *

.*
.******
.*LABEL GENERATED BY THE SFLAG MACRO IS REGENERATED AND THE LOCATION
.*COUNTER VALUE RESET TO THAT ADDRESS. THE CELL IS FILLED IN WITH THE
.*ADDRESS OF THE NEW NOTION (ASSUMING THAT THE LOCATION COUNTER WAS SET
.*TO THE BEGINNING OF THIS NOTION AT THE START OF THE TFLAG MACRO) +
.*FLAGS. &SUCC1 IS RESET TO 0. THE LOCATION COUNTER IS RESET TO THE START
.*OF THE NEW NOTION (USING LABEL GENERATED IN THIS MACRO).

&LOCLAB SETA &LAP-1
ORG @S1&LOCLAB
FLAG NOT
DC AL3(@LCT&SYSNDX)
&SUCC1 SETB 0
ORG @LCT&SYSNDX
MEXIT

.*
.******
.*&SUCC2 TO BE TESTED (&NR='2')
L2 AIF ('&NR' NE '2').L1
.*IF &SUCC2 = 0 EXIT.
AIF (&SUCC2 NE 1).END

.*
.******
.*OTHERWISE SAVE CURRENT VALUE OF LOCATION COUNTER IF GENERATE LABEL
.*ATTACHED TO THIS VALUE

TFLAG 01520900:01528400 12/20/74 12/20/74

@LCT&SYSNDX EQU *

```

.*
.*RECOVER LABEL GENERATED BY SFLAG MACRO AND RESET LOCATION COUNTER TO
.*CORRESPONDING LOCATION.
&LOCLAB SETA &LAB-1
      ORG  &S2&LOCLAB
.*
.*FILL IN CORRESPONDING SUC2 CELL WITH FLAG BITS AND ADDRESS OF NEW
.*MOTION (ASSUMING THAT AT THE START OF THIS MACRO THE LOCATION COUNTER
.*WAS POSITIONED AT THAT ADDRESS).
      FLAG  NOT
      DC    AL3(@LCT&SYSNDX)
.*
.*RESET &SUCC2 TO 0
&SUCC2  SETD  0
.*
.*RESET LOCATION COUNTER TO START OF NEW MOTION (&SYSNDX IS SYSTEM
.*VARIABLE).
      ORG  @LCT&SYSNDX
      MEXIT
.*
.*IF &NR NE 1 OR 2 THEN OUTPUT ERROR MESSAGE.
.*NOTE: LOCATION COUNTER NOT CHANGED.
.L1     MNOTE 'TFLAG MACRO CALL INCORRECT'
.END    MEND

```

FLAC 01405300:01411400 12/20/74 12/20/74

MACRO
FLAG 8B1

*GENERAL DESCRIPTION

 *EACH CELL (4 BYTES) IN A NOTION WITH THE EXCEPTION OF THE STATISTICS
 *CELL AT THE BEGINNING OF A NOTION AND THE COUNTER CELL AT THE
 *BEGINNING OF A LIST OF VALUES HAS 4 FLAG BITS INDICATING THE
 *NATURE OF THE CONTENTS OF THE CELL (DEPENDLING ON THE POSITION OF THE
 *CELL IN THE NOTION).

 *THE MACRO TESTS THE VALIDITY OF THE ACTUAL PARAMETERS
 *AND IF OK SETS THE LEFTHAND BYTL OF THE CELL ACCORDING TO THE
 *INDICATIONS GIVEN.
 *NOTE:THE 4 LOW-ORDER BITS ARE ALL SET TO ONES;THEY
 *CAN EQUALLY WELL BE SET TO ZEROES AS LONG AS NO CONFUSION IS POSSIBLE
 *ABOUT THE CONTENTS OF THE CELL.

*8B1 CAN BE:

- *BASE - FOR BASIC ACTION OCCURRENCE (BIT 2:7)
- *LV - FOR LIST OF VALUES POINTER (BIT 2:6)
- *NOT - FOR NOTION (NO FLAG BITS)

```

AIF ('8B1' NE 'BASE').L1
DC    X'8F'
ACC   .L8
.L1   AIF ('8B1' NE 'LV').L2
DC    X'4F'
ACC   .L8
.L2   ANOP
.L3   AIF ('8B1' NE 'NOT').ERR
DC    X'0F'
ACC   .L8
.ERR  MNOTE 'ERROR IN FLAG PARAMLTERS'
.L8   MEND
    
```

MXREF 01061700:01067300 04/30/75 04/30/75

MACRO
MXREF ,XREF OF SIMULATOR MACROS

- *ROUTINE MACROS CALLED
*ROOT PHASE
*INITIALISER
*MAIN
*SCANPAGE
*TPTPOUT
*CPREDICT
*SIMULATOR
*SIMCOMP
*SIMCREN
*SIMCRER
*SIMIFOU
*SIMLAT
*SIMREP
*SIMSUP
*SIMSUPR
*SIMTMV
*FNDATSUP
*FNDVALSU
*FSTATSUB
*GETDLK
*FARLSUP
*RETNOTSE
*RETVALST
*TSTPLY
*I/O ROUTINES
*ANALYSIS
*ATHALT
*FRANCP
*NLXTVAL
*PRINOT
*PRTATTR
*SETHALT
*MACRO
*ADDVAL
*CRATTR
*DECRF
*FNDNAME
*FNDVAL
*GETADD
*GETNAM
*LATNAT
*OUTATT
*REFVAL
*SPATTR
*SUPATTR
*SUPVAL

MCND

ADDVAL 01000100:01003400 04/30/75 04/30/75

MACRO

&LAE ADDVAL &ADDR,&VAL

**
**

*(&ADDR)= ADDRESS OF THE VALUE CELL OF AN ATTRIBUTE, (&VAL) ARE ADDED
*TO THE VALUES OF THIS ATTRIBUTE. A VALUE LIST IS CREATED IF NECESSARY

&LAR TSLIST &ADDR,L2&SYSNDX

*IF A VALUE LIST ALREADY EXISTS CONTROL PASSES TO L2&SYSNDX, OTHERWISE
*THE NEXT INSTRUCTIONS CREATE A VALUE LIST FOR THE ATTRIBUTE

MVI NOBLOCKS,X'14' NOBLOCKS=20,PARAM FOR GETBLK ROUTINE
LR NEWADD,&ADDR START ADDR FOR SEARCH,PARAM GETBLK
BAL LINK,GETBLK CALL ROUTINE TO ALLOCATE NEW BLOCK

*ADDRESS OF NEW BLOCK RETURNED IN NEWADD

MVC 4(4,NEWADD),0(&ADDR) MOVE EXISTING VALUE INTO LIST
ST NEWADD,0(&ADDR) CHAIN LIST TO VALUE CELL
MVI 0(&ADDR),X'4F' SET 'VALUE LIST' FLAGS
MVC 0(4,NEWADD),=F'3' COUNTER CLLL,NO OF CELLS ALLOCATED
MVC 8(4,NEWADD),&VAL ADD NEW VALUE TO LIST
B EX&SYSNDX

L2&SYSNDX L VALADD,EMPTY VALUE REQUIRED,PARAM FOR FNDVALSU

AIF ('&ADDR' EQ 'ATADD').L1

LR ATADD,&ADDR ADDR OF VALUE LIST,PARAM FNDVALSU

.L1 BAL LINK,FNDVALSU CALL ROUTINE TO SEARCH VALUE LIST

*FOR CELL CONTAINING GIVEN VALUE,RESULT OF SEARCH RETURNED IN VALADD

MVC 0(4,VALADD),&VAL STORE NEW VALUE IN EMPTY CELL

*INCREMENT REF COUNT IF NECESSARY

EX&SYSNDX TSTFLAG (OBJUN,&VAL,EX1&SYSNDX),(EASIC,&VAL,EX1&SYSNDX)

INCR &VAL

EX1&SYSNDX EQU *

**
**

MFND

CHATRAN 01003500:01005800 04/30/75 04/30/75

MACRO

&LAP CHATRAN &NOT, &ATADD, &NAT, &EXIT

**

**

.*(&NOT) = ADDRESS OF A NOTION. AN ATTRIBUTE IS CHOSEN AT RANDOM, ITS
 .*(VALUE CELL) ADDRESS IS RETURNED IN &ATADD, ITS NATURE (NOTION
 .*(ADDRESS) IN &NAT AND IF THE ATTRIBUTE CHOSEN IS 'NIL' CONTROL GOES TO
 .*(&EXIT).

&LAB L ROOTAD, &NOT ADDRESS OF NOTION, CHRATSUB PARAMETER
 BAL LINK, CHRATSUB CALL ROUTINE TO CHOOSE AT RANDOM, AN
 *ATTRIBUTE OF A GIVEN NOTION ADDR OF ATTRIBUTE'S VALUE CELL RETURNED IN
 *ATADD, ADDRESS OF NOTION (NATURE OF ATTR) IN NATADD
 AIF ('&ATADD' EQ 'ATADD').L1
 LP RATADD, ATADD STORE ATTRIBUTE ADDRESS
 .L1 ST NATADD, &NAT STORE NATURE OF ATTRIBUTE
 CLC &NAT, EMPTY
 BE &EXIT

*IF THE ATTRIBUTE IS NIL, THE VALUE OF THE ATTRIBUTE IS ALSO NIL AND
 *CONTROL GOES TO &EXIT

**

**

MEND

CHVAL 01005900:01003700 04/30/75 04/30/75

MACRO

&LAP CHVAL &ATADD, &RET, &ZONE, &EXIT

**

**

.*(&ATADD) = ADDRESS OF VALUE CELL OF AN ATTRIBUTE WITH A LIST OF VALUES
 .*(A VALUE CELL IN THE LIST IS CHOSEN AT RANDOM, ITS ADDRESS IS RETURNED
 .*(IN &RET, ITS CONTENTS IN &ZONE, IF THE VALUE CHOSEN IS 'NIL' &EXIT IS
 .*(TAKEN).

AIF ('&ATADD' EQ 'ATADD').L1
 &LAB LP ATADD, &ATADD ADDRESS OF VALUE LIST, RANSUP PARAM
 BAL LINK, RANSUB CALL ROUTINE WHICH CHOOSES A VALUE
 *AT RANDOM, ADDRESS OF CELL CHOSEN RETURNED IN VALADD
 .L3 AIF ('&RET' EQ 'VALADD').L2
 LP &RET, VALADD STORE ADDRESS OF CELL CHOSEN
 .L2 AIF ('&EXIT' EQ '').L4
 C VALADD, EMPTY VALUE RETURNED IS NIL?
 BE &EXIT YES->EXIT
 .L4 AIF ('&ZONE' EQ '').END
 MVC &ZONE, C(VALADD) STORE VALUE CHOSEN
 .END MEXIT
 .L1 ANOP
 &LAB BAL LINK, RANSUP CALL ROUTINE WHICH CHOOSES A VALUE
 *AT RANDOM, ADDRESS OF CELL CHOSEN RETURNED IN VALADD
 AGO .L3

**

**

MEND

CPAGE 01008800:01011200 04/30/75 04/30/75

MACRO

&LAB CPAGE ®,&ZONE,&EXIT,&SAVE2

**
 **
 * ® ADDRESSES A POINTER CELL, THE PAGE NO. OF THE BLOCK POINTED TO IS
 * COMPARED WITH THE PAGE NO. IN &ZONE. IF THE SAME, &EXIT IS TAKEN,
 * OTHERWISE THE CHAIN OF BLOCKS UP TO AND INCLUDING THE CURRENT ONE IS
 * RETURNED TO THE FREE LIST. &SAVE2 IS A 2-WORD SAVE AREA.

&LAB	L	WKREG1,0(®)	NEXT BLOCK
	SRL	WKREG1,12	ISOLATE PAGE NO
	STC	WKREG1,WORK	
	CLC	&ZONE(1),WORK	=CURRENT PAGE NO?
	PE	&EXIT	YES->BRANCH
*RETURN		BLOCKS TO FREE LIST, ASSUME	ROOTAD O.K.
	MVC	&SAVE2(4),0(®)	SAVE NEXT BLOCK ADDR
	MVC	0(4,11),LSTPT	END OF CHAIN FOR RETBLK
	ST	LINK,&SAVE2+4	SAVE CURRENT RETURN ADDR
	EAL	LINK,RETBLK	REMOVE BLOCKS
	L	LINK,&SAVE2+4	RESTORE RETURN ADDR
	L	ROOTAD,&SAVE2	START ADDRESS OF LIST

**
 **

MEND

PAGNO 01073300:01074500 04/30/75 04/30/75

MACRO

&LAB PAGNO ®,&ZONE

**
 **
 * ISOLATE PAGE NO. OF ADDRESS IN ® AND STORE IN &ZONE.

&LAB	LR	WKREG1,®	ADDRESS IN PAGE
	SRL	WKREG1,12	REMOVE PEL ADDRESS IN PAGE
	STC	WKREG1,&ZONE	STORE PAGE NUMBER

**
 **

MEND

CRENOT 01013300:01014900 04/30/75 04/30/75

MACRO

&LAB CRENOT &NOTADDR,&CHADDR

**
**

*SPACE FOR A NEW NOTION IS ALLOCATED AND ITS ADDRESS RETURNED IN
*&NOTADDR.&CHADDR SERVES AS A BASIS FOR THE ALLOCATION SEARCH.

&LAB MVI NOBLOCKS,X'28' NOBLOCKS SET TO 40,PARAM FOR GETBLK
L NEWADD,&CHADDR START ADDR FOR SEARCH,PAR FOR GETBLK
BAL LINK,GETBLK CALL ROUTINE TO ALLOCATE SPACE FOR
*NEW NOTION,ADDRESS OF NEW BLOCK RETURNED IN NEWADD
ST NEWADD,&NOTADDR SAVE ADDRESS OF NEW NOTION
MVC 0(4,NEWADD),=F'0' INITIALISE REF COUNT

**
**

MEND

CRATTR 01011300:01013200 04/30/75 04/30/75

MACRO

&LAB CRATTR &ADD,&NAT,&VAL

**
**

*&NAT AND &VAL CONTAIN THE NATURE AND VALUE OF A NEW ATTRIBUTE REF.
*&ADD POINTS TO THE VALUE CELL OF AN EMPTY ATTRIBUTE WHERE THE NEW
*ATTRIBUTE IS STORED.

&LAB MVC 0(4,&ADD),&VAL VALUE OF NEW ATTRIBUTE STORED
S &ADD,=F'4' POSITION ON NATURE CELL
MVC 0(4,&ADD),&NAT NATURE OF NEW ATTRIBUTE STORED
*INCREMENT REF COUNT OF NATURE &,IF NECESSARY,VALUE OF ATTRIBUTE
INCR &NAT
TSTFLAG (OPJUN,&VAL,CR&SYSNDX),(EASIC,&VAL,CR&SYSNDX)
INCR &VAL
CR&SYSNDX LQU *

**
**

MEND

CVAL 01017000:01018400 04/30/75 04/30/75

MACRO

&LAB CVAL &ADDR,&VAL,&EXIT1,&EXIT2

**
**

*IF (&ADDR)=(&VAL) THEN &EXIT2 ELSE &EXIT1.

&LAB CLC 0(4,&ADDR),&VAL DOES CELL CONTAIN GIVEN VALUE?
AIF ('&EXIT1' EQ '').L1
BNE &EXIT1 NO,TRANSFER CONTROL
.L1 AIF ('&EXIT2' EQ '').END
BE &EXIT2 YES,TRANSFER CONTROL

**
**

END MEND

DECR 01095800:01101800 05/02/75 05/02/75

MACRO

&LAB DEC& RINDAD

**
**

*DECREMENT REF COUNT OF NOTION REFERENCED IN RINDAD, IF 0 REMOVE NOTION
*FROM GRAPH (UNLESS A SPECIAL NOTION).

*NOTE: (&RINDAD) = ADDR OF NOTION

&LAB	L	WKREG1,0(&RINDAD)	ADDRESS OF STATISTICS CELL
	L	WKREG2,0(WKREG1)	CONTENTS (REFERENCE COUNT)
	OC	SAVE,0(WKREG1)	SAVE FLAGS
	LA	WKREG2,0(WKREG2)	MARK FLAGS
	PCT	WKREG2,DECR&SYSNDX	DECREASE REFERENCE COUNT, WHILE IT IS
			*GREATER THAN 0 CONTROL TRANSFERS TO DECR&SYSNDX
			*WHEN REFERENCE COUNT IS ZERO NOTION IS NO LONGER ACCESSIBLE SO THE
			*SPACE IT USES CAN BE RETURNED TO THE FREE LIST
	LA	WKREG1,0(WKREG1)	REMOVE FLAG BITS
	C	WKREG1,=A(AR4)	SPECIAL NOTION?
	PNH	DECR&SYSNDX	YES, NOTION NOT REMOVED
	LR	ROOTAD, WKREG1	START ADDRESS OF NOTION, PETRLX PARAM
	EAL	LINK, RFTNOTSB	CALL ROUTINE TO RETURN BLOCKS OF
			NOTION TO FREE LIST
	P	DCR1&SYSNDX	SKIP NEXT INSTRUCTIONS
DLCR&SYSNDX	ST	WKREG2,0(WKREG1)	STORE REFERENCE COUNT
	OC	0(1, WKREG1), SAVE	RESTORE FLAGS
DCR1&SYSNDX	FCU	*	
	XC	SAVE, SAVE	REINITIALISE

**
**

MEMD

INCR 01047900:01049600 04/30/75 04/30/75

MACRO

&LAB INCR &NOT

**
**

*&NOT INDIRECTLY ADDRESSES THE REFERENCE COUNT OF A NOTION.
*THIS IS INCREMENTED TO REFLECT AN EXTRA REFERENCE TO THE NOTION.

&LAB	L	WKREG1,&NOT	ADDRESS OF STATISTICS CELL
	L	WKREG2,0(WKREG1)	CONTENTS (REFERENCE COUNT)
	OC	SAVE,0(WKREG1)	SAVE FLAGS
	LA	WKREG2,1(WKREG2)	INCREMENT REFERENCE COUNT
	ST	WKREG2,0(WKREG1)	STORE IN STATISTICS CELL
	OC	0(1, WKREG1), SAVE	RESTORE FLAGS
	XC	SAVE, SAVE	REINITIALISE

**
**

MEMD

DECLF 01021200:01024900 04/30/75 04/30/75

MACRO
 &LAC DLCRF ®, &EXIT
 GELB &DFLAG

**

**

.*DECREMENT REF COUNT OF NOTION REFERENCED IN ®. IF REF COUNT=0 ADD
 .*NOTION TO NOTSTACK FOR LATER REMOVAL FROM THE GRAPH, THEN GO TO &EXIT.

&LAB L WKREG1,0(®) ADDRESS OF NOTION
 LA WKREG2,&EXIT RETURN ADDRESS
 AIF (NOT &DFLAG).L1

.*THE 1ST CALL TO THIS MACRO GENERATES A SMALL ROUTINE

.*SUBSEQUENT CALLS OF THE MACRO GENERATE CALLS

.*TO THE ROUTINE.

P @DECR1 TO ROUTINE

MXIT

.L1 ANOP

@DECR1 ST WKREG2,@DECRS
 L WKREG2,0(WKREG1) REF COUNT
 OC SAVE,0(WKREG1) SAVE FLAGS
 LA WKREG2,0(WKREG2) MASK FLAGS
 PCT WKREG2,@DECR2 DECR REF COUNT:WHILE >0 BRANCH
 ST WKREG1,0(10) ADD NOTION ADDRESS TO STACK
 LA 10,4(10) UPDATE STACK POINTER
 C 1),=A(NOTSTEND) STACK FULL?
 LNL @DECR3 NG->EXIT

ERRCALL MESS ERROR MESSAGE & TERM'D
 @DECR2 ST WKREG2,0(WKREG1) STORE UPDATED REFERENCE COUNT
 OC 0(1,WKREG1),SAVE RESTORE FLAGS
 XC SAVE,SAVE REINITIALISE

@DECR3 L WKREG2,@DECRS RETURN ADDRESS
 BR WKREG2 EXIT

@DECRS DS F
 &DFLAG SETB 1

**

**

MEWD

FNDATTR 01026400:01028100 04/30/75 04/30/75

```

MACRO
&LAB FNDATTR &ROOT,&NAT,&ATADD
*****
**
**
.*&ROOT AND &NAT SPECIFY THE ROOT AND NATURE OF AN ATTRIBUTE RESF.&ROOT
.*IS SEARCHED FOR THIS ATTRIBUTE.(&ATADD)=VALUE CELL OF THE ATTRIBUTE
.*OF INDICATE 'NO ATTRIBUTE FOUND' AFTER SEARCH.
&LAB L ROOTAD,&ROOT ADDR OF ROOT NOTION,PAR FOR FNDATSUB
L NATADD,&NAT ADDR OF NATURE NOTION,PAR FNDATSUB
BAL LINK,FNDATSUB CALL ROUTINE TO FIND ATTRIBUTE,
*RESULT OF SEARCH RETURNED IN ATADD
AIF ('&ATADD' EQ 'ATADD')_END
LR RATADD,ATADD STORE RESULT OF SEARCH
**
**
*****
.END MEND
    
```

FNDVAL 01031400:01033900 04/30/75 04/30/75

```

MACRO
&LAB FNDVAL &ADDR,&VAL,&INDIC
*****
**
**
.*(&ADDR)= VALUE CELL OF AN ATTRIBUTE.THE VALUE(S) OF THE ATTRIBUTE IS
.*(AKE) COMPARED WITH (&VAL) TO SEE IF THE VALUE SPECIFIED IS A VALUE
.*OF THE ATTRIBUTE.&INDIC INDICATES THE RESULT OF THE COMPARISON.
&LAB TSLIST &ADDR,L2&SYSNDX
CLC RVAL,0(&ADDR) VALUE CORRESPONDS?
BE L1&SYSNDX YES
PNE L3&SYSNDX NO
L2&SYSNDX L VALADD,&VAL VALUE REQUIRED,PARAM FOR FNDVALSU
AIF ('&ADDR' EQ 'ATADD')_L1
LR ATADD,&ADDR ADDR OF VALUE LIST,PARAM FNDVALSU
_L1 BAL LINK,FNDVALSU CALL ROUTINE TO SEARCH VALUE LIST
*FOR CELL CONTAINING GIVEN VALUE,RESULT OF SEARCH RETURNED IN VALADD
C VALADD,LSTFT SEARCH FAILED?
PNE L1&SYSNDX NO->L1&SYSNDX
L3&SYSNDX MVI &INDIC,X'00' INDICATE SEARCH FAILED
B L1&SYSNDX+4
L1&SYSNDX MVI &INDIC,X'01' INDICATE SEARCH SUCCESSFUL
**
**
*****
MEND
    
```

GBLCK 01034000:01036600 04/30/75 04/30/75

MACRO

&LAB GPLCK &SAVE,®,&ROOT,&RET

**

**

.*A NEW BLOCK IS ALLOCATED AND CHAINED TO THE POINTER CELL ADDRESSED BY
.*®. (&ROOT SERVES AS A BASIS FOR THE ALLOCATION SEARCH). THE ADDRESS
.*OF THE NEW BLOCK IS RETURNED IN &RET. &SAVE IS A 1-WORD SAVE AREA.

&LAB MVI NOBLOCKS,X'14' 1 BLOCK REQUIRED,GETBLK PARAM
LR NEWADD,&ROOT SEARCH ADDR,GETBLK PARAM
ST LINK,&SAVE SAVE CURRENT RETURN ADDRESS
HAL LINK,GETBLK CALL ROUTINE TO ALLOCATE NEW BLOCK,

*ADDRESS OF NEW BLOCK RETURNED IN NEWADD

ST NEWADD,0(®) CHAIN NEW BLOCK TO END OF LIST

MVI 0(®),X'0F' SET POINTER CELL FLAGS

AIF ('&ROOT' EQ 'ROOTAD').L1

L &ROOT,0(&ROOT) COUNTER CELL ADDRESS

L WKREG1,0(&ROOT) UPDATE

LA WKREG1,4(WKREG1) COUNTER

ST WKREG1,0(&ROOT) CELL

.L1 NI 0(&ROOT),X'EF' INDICATE NO EMPTY BLOCKS IN LIST

LR &RET,NEWADD RETURN ADDRESS OF NEW BLOCK

L LINK,&SAVE RESTORE RETURN ADDRESS

**

**

MEND

MVARG 01060300:01061600 04/30/75 04/30/75

MACRO

&LAB MVARG &ACT,&DISP,&LINK,&SAVE

**

**

.*(&ACT)= NOTION, (&DISP)= DISPLACEMENT IN THE NOTION TO POINT TO A

.*SPECIAL ATTRIBUTE. (&LINK)= RETURN ADDRESS STORED IN &SAVE.

&LAB LA &ACT,&DISP.(&ACT) MOVE TO SPECIAL ATTR CELL INDICATED

AIF ('&SAVE' LQ '').END

L &LINK,&SAVE RESTORE RETURN ADDR TO CALLING ROUT

**

**

.END MEND

LATNAT 01049700:01054100 04/30/75 04/30/75

MACRO

&LAB LATNAT &ACT,&DISP,&ZONE,&EXIT

**

**

*(&ACT)= ADDRESS OF CURRENT LAT ACTION OCCURRENCE.
 *(&DISP)= DISPLACEMENT FROM (&ACT) FOR ARG2(3) ATTRIBUTE. (&ZONE) ARE
 *ADDED AS A VALUE TO THE ATTRIBUTE INDICATED.
 *NOTE:FROM LATATCLC TO LATSW IS A SUBROUTINE ALSO CALLED FROM THE
 *EXPANSION OF LATVAL MACRO WHICH RESETS LATSW TO A 'B'.

```

&LAB      MVI    LATSW+1,X'00'          BRANCH ADDRESS
          LA     ATADD,&DISP,&ACT      ADDRESS OF ARG CELL
          LA     NATADD,SPATTAB+&DISP-8 ADDR OF ARG2 NOTION
          MVC    ADDSAVE,&ZONE        STORE VALUE TO BE ADDED TO ARG
LATATCLC  CLC    0(4,ATADD),EMPTY     VALUE OF ARG ALREADY EXISTS?
          BNF   LATATEX              YES->LATATEX
          MVC    0(4,ATADD),ADDSAVE   STORE VALUE
          INCP  0(NATADD)

*UPDATE STATISTICS CELL OF ARG NOTION CONCERNED
          B     LATINC

LATATEX   TSLIST ATADD,,LATATCP
*IF LIST OF VALUES DOES NOT YET EXIST,GO TO LATATCP
          L     VALADD,EMPTY          EMPTY CELL REQUIRED,FNDVALSU PARAM
          *
          BAL   LINK,FNDVALSU        CALL ROUTINE TO SEARCH VALUE LIST
*FOR EMPTY CELL,RESULT OF SEARCH RETURNED IN VALADD
          MVC    0(4,VALADD),ADDSAVE  STORE VALUE IN LIST
          B     LATINC

LATATCR   MVI    NOBLOCKS,X'14'       NOBLOCKS=20,GETBLK PARAM
          LR    NEWADD,ATADD          SEARCH ADDRESS,GETBLK PARAM
          BAL   LINK,GETELK          CALL ROUTINE TO ALLOCATE NEW BLOCK,
*ADDRESS OF NEW BLOCK RETURNED IN NEWADD
          MVC    4(4,NEWADD),0(ATADD) STORE EXISTING VALUE IN LIST
          ST    NEWADD,0(ATADD)       CHAIN NEW BLOCK TO VALUE CELL
          MVI    0(ATADD),X'4F'       SET 'VALUE LIST' FLAGS
          MVC    8(4,NEWADD),ADDSAVE  STORE VALUE
          MVC    0(4,NEWADD),=F'3'    COUNTER CELL,NO OF CELLS ALLOCATED
LATINC    TSTFLAG (ORJUN,ADDSAVE,LATSW),(EASIC,ADDSAVE,LATSW)
          INCR  ADDSAVE

*UPDATE STATISTICS CELL OF NOTION (VALUE OF ARG ATTRIBUTE) IF NECESSARY
LATSW     B     LATSUC1              EXIT
  
```

**

**

MEND

LATVAL 01054200:01055700 04/30/75 04/30/75

MACRO

&LAE LATVAL &ACT,&DISP,&ZONE,&EXIT

**
**

.*NOTE:EXPANSION OF THIS MACRO MERELY SETS PARAMETERS FOR THE
.*SUBROUTINE GENERATED BY LATNAT MACRO.

&LAP LA ATADD,&DISP.(&ACT) ADDR OF ARG CELL
LA MATADD,SPATTAB+&DISP-8 ADDR OF ARG3 NCTION
MVC ADDSAVE,&ZONE VALUE TO BE ADDED TO ARG
MVI LATSW+1,X'FO' SET RETURN ADDRESS
B LATATCLC

**
**

MEND

MVAL 01058700:01060200 04/30/75 04/30/75

MACRO

&LAE MVAL &ADDR,&ZONE,&DIR

**
**

.*IF &DIR IS NULL CONTENTS OF ZONES ADDRESSED BY &ADDR ARE MOVED TO
.*&ZONE, OTHERWISE REVERSE HAPPENS.

AIF ('&DIR' EQ 'REV').L1
&LAB MVC &ZONE,0(&ADDR) STORE VALUE
MEXIT
.L1 ANOP
&LAB MVC 0(4,&ADDR),&ZONE STORE VALUE

**
**

MEND

REFVAL 01079200:01080900 04/30/75 04/30/75

MACRO

&LAE REFVAL &CELL,&VALUE,&EXIT

**
**

.*REPLACES CONTENTS OF CELL ADDRESSED BY &CELL WITH (&VALUE) THEN
.*CONTROL GOES TO &EXIT.

&LAE TSTFLAG (OPJUN,0(&CELL),REF&SYSNDX),(BASIC,0(&CELL),REF&SYSNDX)
DECR &CELL DECR REF COUNT OF VALUE TO BE
REPLACED
REF&SYSNDX MVAL &CELL,&VALUE,REV REPLACE VALUE
TSTFLAG (OPJUN,&VALUE,&EXIT),(BASIC,&VALUE,&EXIT)
INCR &VALUE INCR NEW VALUE REF COUNT
B &EXIT EXIT

**
**

MEND

RETVC 01081000:01082900 04/30/75 04/30/75

MACRO

&LAB RETVC &ZONE1,&DISP,®

**

**

*CALLS RETVALST ROUTINE TO REMOVE VALUE LIST POINTED TO BY CELL AT
 *&DISP (DISPLACEMENT) FROM ADDRESS IN ®.&ZONE1 IS 2-WORD SAVE AREA

&LAB ST ROOTAD,&ZONE1 SAVE START ADDRESS
 ST LINK,&ZONE1+4 SAVE CURRENT RETURN ADDRESS
 ST 10,NOTSTEND & CURRENT POSITION IN STACK
 L ROOTAD,&DISP.(®) PARAM FOR RETVALST ROUTINE

*SW ALREADY POSITIONED

DAL LINK,RETVLST
 L LINK,&ZONE1+4 RESTORE REGS
 L ROOTAD,&ZONE1
 L 10,NOTSTEND

**

**

MEMD

NAMELK 01067400:01070100 04/30/75 04/30/75

MACRO

&LAB NAMELK &ROOT,&EXIT,&KEYARG,&FILE,&SAVE

**

**

*(&ROOT)= ADDRESS OF A NOTION. IF THE NOTION HAS NO NAME BLOCK GOTC
 *&EXIT. OTHERWISE NAME IS REMOVED FROM THE DICTIONARY (&FILE,&KEYARG).
 *&SAVE IS A 2-WORD SAVE AREA.

&LAB TM 0(&ROOT),NAMELK NOTION NAMED?
 RZ &EXIT NO->
 I 1,=V(#NOFIND) SET
 MVI 0(1),X'02' ERROR CODE
 LA WKREG1,40(&ROOT) REMOVE ENTRY
 L 1,=V(&KEYARG)
 MVC 0(8,1),0(WKREG1) FROM
 L 1,=V(&FILE)
 ELIM (1),KEY DICTIONARY
 MVC 16(4,WKREG1),LSTPT SET END OF BLOCK FOR RETBLK ROUTINE
 ST LINK,&SAVE SAVE CURRENT RETURN ADDR
 ST ROOTAD,&SAVE+4 SAVE NOTION ADDRESS
 LP ROOTAD,WKREG1 PARAM,RETELK ROUTINE
 DAL LINK,RETELK RETURN NAME TO FREE LIST
 L LINK,&SAVE RESTORE RETURN ADDR
 L ROOTAD,&SAVE+4 RESTORE NOTION ADDRESS

**

**

MEMD

SPATTR 01083000:01085100 04/30/75 04/30/75

MACRO

&LAB SPATTR &NAT,&ADDR,&VAL,&EXIT1,&EXIT2

**
**

.*A NEW ATTRIBUTE WITH NATURE AND VALUE SPECIFIED BY &NAT AND &VAL RESP
.*IS TO BE ADDED TO A NOTION AT &ADDR. IF THE NATURE IS NOT SPECIAL THEN
.*&EXIT1 ELSE STORE (&VAL) AT &ADDR, INCREMENT NATURE AND VALUE REF
.*COUNTS AND GOTO &EXIT2.

&LAB NC &NAT, MASK MASK FLAGS
CLC &NAT, =A(ARG4) NATURE SPECIAL?
BH &EXIT1 NO
L &ADDR, &ADDR ADDR OF SPECIAL ATTRIBUTE
MVC 0(4, &ADDR), &VAL STORE VALUE
INCR &NAT INCR NATURE REF COUNT
TSTFLAG (ORJUN, &VAL, &EXIT2), (BASIC, &VAL, &EXIT2)
INCR &VAL INCR VALUE REF COUNT
E &EXIT2 EXIT

**
**

MEND

TSLIST 01090800:01092300 04/30/75 04/30/75

MACRO

&LAB TSLIST &ADDR, &EXIT1, &EXIT2

**
**

.*IF (&ADDR) POINTS TO LIST OF VALUES TRANSFER CONTROL WHEN &EXIT1
.*SPECIFIED. IF NOT POINTER TRANSFER CONTROL WHEN &EXIT2 IS SPECIFIED.

&LAB TM 0(&ADDR), LIST LIST OF VALUES?
AIF ('&EXIT1' EQ '') .L1
BO &EXIT1 YES: TRANSFER CONTROL
.L1 AIF ('&EXIT2' EQ '') .END
BZ &EXIT2 NO, TRANSFER CONTROL

**
**

.END MEND

WRERR 01097500:01098700 04/30/75 04/30/75

MACRO

&LAB WRERR &MESS

**
**

.*WRROUTRET OUTPUTS MESSAGE WITH ADDRESS &MESS.

&LAB LA 1, WRPARAM PARAM LIST
MVC 1(3, 1), =AL3(&MESS) MESSAGE ADDRESS
B WROUTRET TO MESSAGE OUTPUT

**
**

MEND

SUPATTR 01085200:01088400 04/30/75 04/30/75

MACRO

&LAB SUPATTR &ATADDR,&NAT,&ROOT

**
**

*SUPPRESSES ATTRIBUTE OF NOTION-(&ROOT)= ADDRESS OF NOTION-WITH NATURE
*SPEC BY &NAT, THAT IS AT &ATADDR. DECREMENTS REF COUNTS, THEN TESTS IF
*BLOCK CONTAINING ATTRIBUTE IS EMPTY AND CAN BE REMOVED FROM NOTION.
&LAB TSTFLAG (OBJUN,0(&ATADDR),L3&SYSNDX),(BASIC,0(&ATADDR),L3&SYSNDX
DX)

DECR &ATADDR

*STATISTICS CELL OF NOTION (VALUE OF ATTRIBUTE) UPDATED

L3&SYSNDX MVC 0(4,&ATADDR),EMPTY SUPPRESS VALUE OF ATTRIBUTE
CLC &NAT+1(3),=AL3(ARG4) NATURE OF ATTRIBUTE SPECIAL?
PNH L1&SYSNDX YES->L1&SYSNDX
S &ATADDR,='4' POSITION ON NATURE CELL
DECR &ATADDR

*STATISTICS CELL OF NOTION (NATURE OF ATTRIBUTE) UPDATED

MVC 0(4,&ATADDR),EMPTY SUPPRESS NATURE OF ATTRIBUTE
B L2&SYSNDX
L1&SYSNDX L WKREG1,&NAT UPDATE
L WKREG2,0(WKREG1) STATISTICS CELL;
BCTR WKREG2,0 NATURE OF ATTRIBUTE
ST WKREG2,0(WKREG1) IS SPECIAL
L2&SYSNDX LR CELL,&ATADDR ADDR OF CELL EMPTIED,TSTBLK PARAM
L STADDR,&ROOT START ADDR OF NOTION:TSTBLK PARAM
MVI INDIC,'N' INDICATE NOTION CHAIN,TSTBLK PARAM
BAL LINK,TSTBLK CALL ROUTINE TO DECIDE IF A BLOCK

*CAN BE RETURNED TO FREE LIST,IF SO THIS IS CARRIED OUT

**
**

MEND

SUPVAL 01088500:01090700 04/30/75 04/30/75

MACRO

&LAB SUPVAL &VALADD,&ATADD

**
**

*(&VALADD)= ADDR OF VALUE LIST CELL CONTAINING VALUE TO BE SUPPRESSED.
*(&ATADD)= ADDR OF VALUE CELL OF ATTRIBUTE, POINTS TO START OF VALUE
*LIST.VALUE IS REMOVED,ITS REF COUNT DECREASED AND BLOCK IS CHECKED
*TO SEE IF IT IS EMPTY AND CAN BE REMOVED.

&LAB TSTFLAG (OBJUN,0(&VALADD),L1&SYSNDX),(BASIC,0(&VALADD),L1&SYSNDX
DX)

DECR &VALADD

*STATISTICS CELL OF NOTION (VALUE OF ATTRIBUTE) UPDATED

L1&SYSNDX MVC 0(4,&VALADD),EMPTY SUPPRESS VALUE
L STADDR,0(&ATADD) START ADDRESS OF LIST,TSTBLK PARAM
LR CELL,&VALADD ADDR OF CELL EMPTIED,TSTBLK PARAM
MVI INDIC,'V' INDICATE VALUE LIST,TSTBLK PARAM
BAL LINK,TSTBLK CALL ROUTINE TO DECIDE IF A BLOCK IS

*TO BE RETURNED TO FREE LIST,IF SO THIS IS DONE

**
**

MEND

TSTARG 01092400:01095200 04/30/75 04/30/75

MACRO

```

&LAF TSTARG &ACT,&DISP,&ZONE,&LXIT,&LINK,&SAVE
*****
**
**
.*CHOOSE A VALUE OF THE ATTRIBUTE,DISPLACEMENT &DISP IN NOTION &ACT
.*AND STORE IN &ZONE.IF &EXIT IS SPECIFIED IT IS TAKEN IF THE VALUE
.*CHOSFN, IS 'NIL'.IF &SAVE IS SPECIFIED,&LINK IS SAVED.
AIF ('&SAVE' EQ '').L1
&LAB ST &LINK,&SAVE SAVE RETURN ADDRESS TO CALLING ROUT.
TM &DISP.(&ACT),LIST LIST OF VALUES FOR ARG?
.L2 BZ L1&SYSNDX NO->L1&SYSNDX
LA ATADD,&DISP.(&ACT) ADDR OF VALUE CELL,PARAM FOR RANSUB
BAL &LINK,RANSUB CALL ROUTINE TO CHOOSE A VALUE AT
*RANDOM FROM THE LIST,ADDR OF CELL CHOSEN IS RETURNED IN VALADD
MVC &ZONE,0(VAADD) STORE CHOSEN VALUE
B *+10 SKIP NEXT INSTRUCTION
L1&SYSNDX MVC &ZONE,&DISP.(&ACT) STORE ONLY VALUE
AIF ('&EXIT' EQ '').END
CLC &ZONE,EMPTY VALUE OF ARGUMENT IS NIL?
BE &EXIT YES->EXIT
.END MEXIT
.L1 ANOP
&LAB TM &DISP.(&ACT),LIST LIST OF VALUES FOR ARG?
AGO .L2

```

**

**

MEND

TSTFLAG 01095300:01097400 04/30/75 04/30/75

MACRO

```

&LAB TSTFLAG &F1
LCLA &N
.*CALLS TO THIS MACRO HAVE A LIST OF PARAMETERS, EACH OF WHICH IS IN
.*TURN A SUPLIST.THE 1ST ELEMEN OF EACH SUPLIST IS THE FLAG CONFIGURAT-
.*ION,THE 2ND IS THE CELL CONCERNED,THE 3RD IS THE EXIT TAKEN WHEN THE
.*TEST RESULT IS POSITIVL.
&N SETA 1
*****
**
**
AIF ('&LAB' EQ '').L1
&LAB EQU *
.L1 AIF ('&SYSLIST(&N)' EQ '').END
TM &SYSLIST(&N,2),&SYSLIST(&N,1)
BC &SYSLIST(&N,3)
&N SETA &N+1
AGO .L1
**
**
*****
.END MEND

```

FNDNAME 01028200:01031300 04/30/75 04/30/75

MACRO

&LAB FNDNAME &INPUT,&ZONE,&TAB
GBLD &FLAG

**

**

.*(&INPUT)=START ADDRESS OF A ZONE CONTAINING A NOTION NAME, THE NAME IS
. ISOLATED USING &TAB AND THEN TRANSFERRED TO &ZONE.

&LAE MVC &ZONE.(8),#BLANKS INITIALISE NAME ZONE
LA WKREG1,&INPUT START ADDRESS
TRT 0(9,WKREG1),&TAB FIND 1ST SPACE WITH MAX LNTH NAME=?
EC 8,#TRTEXIT ERROR
SR 1,WKREG1 LENGTH
BZ #TRTEXIT ERROR
BCIP 1,0 LENGTH-1
STC 1,#TRM&SYSNDX+1 INTO MVC
#TRM&SYSNDX MVC &ZONE,0(WKREG1) MOVE NAME
AIF (&FLAG).L1

.*TREATMENT OF ERRORS IS GENERATED ONCE ONLY
.*ON 1ST CALL TO THIS MACRO.

B #TREXIT

*ERROR

#TRTEXIT WRERR #NAMERR ERROR MESSAGE

#NAMERR DC X'0010404000'
DC 'NOTION NAME IN ERROR'

#BLANKS DC CL8'

#TREXIT DS 0H

&FLAG SETB 1

**

**

.L1 MEND

CRNAM 01015000:01016900 04/30/75 04/30/75

MACRO

&LAE CRNAM &ADD,&NAMZON,&EXIT

**

**

.*&ADD CONTAINS A NOTION ADDRESS FROM WHICH A NAME IS CREATED FOR THE
.*ADDRESS EG ADDRESS IS X'1FC4',NAME IS '01FC4'.THEN CTRL GOES TO
.*PEXIT.

&LAB ST &ADD,#DWORD CONVERT ADDRESS
UNPK &NAMZON+1(5),#DWORD+2(3) TO READABLE FORM
MVI &NAMZON,'0' CREATE
MVC &NAMZON+5(3),=' ' NAME
TR &NAMZON+1(4),#TAB2-240 TRANS UNPRINTABLE CHARS
*#TAB2-240 GIVES DISPLACEMENTS SO THAT 256 BYTES ARE NOT EXPLICITLY RESE
*-RVED

B &EXIT EXIT

**

**

MEND

GETADD 01036700:01040600 04/30/75 04/30/75

MACRO

&LAB GETADD &NAMZON,&ADD,&INDIC

**

**

.*(NAMZON)=NAME OF A NOTION WHOSE ADDRESS IS OBTAINED AND RETURNED IN
 .*&ADD.&INDIC WILL CONTAIN AN ERROR CODE WHEN THE DICTIONARY IS
 .*CONSULTED (SEE ROOT PHASE).

AIF ('&NAMZON' NE '#ROOT').L1

&LAB CLI &NAMZON,'?' CURRENT ACTION?

PNE #GT&SYSNDX NO->

ST CURRADD,&ADD ADDRESS OF CURRENT ACTION

CRNAM CURRADD,&NAMZON,#GT1&SYSNDX NAME FOR CURRENT ACTION

#GT&SYSNDX CLI &NAMZON,'@' CREATED NAME?

AGO .L2

.L1 ANOP

&LAB CLI &NAMZON,'@' CREATED NAME?

.L2 PNE #GET&SYSNDX NO->

TR &NAMZON+1(4),#TAB1-193 HEX LETTERS TO HEX NUMBERS BEFORE

*PACKING,#TAB1-193 GIVES DISPLACEMENT SO THAT 256 BYTES ARE NOT

*EXPLICITLY RESERVED

PACK #DWORD(3),&NAMZON+1(5) CONVERT

MVC &ADD+2(2),#DWORD TO INTERNAL FORM

TR &NAMZON+1(4),#TAB2-240 RESTORE NAME,#TAB2-240 GIVES

*DISPLACEMENTS OF 256 BYTES WITHOUT RESERVING THE TOTAL EXPLICITLY

R #GT1&SYSNDX

#GET&SYSNDX L 1,=V(KEY)

MVC 0(8,1),&NAMZON NAME TO KEY

L 1,=V(&INDIC)

MVI 0(1),X'01' SET ERROR CODE

L 1,=V(DICT)

L 0,=V(INAREA)

GETKY (1),(0) GET RECORD

LR 1,0 ADDR OF IOAREA

MVC &ADD,R(1) STORE ADDRESS

#GT1&SYSNDX EQU *

**

**

MEME

GETNAM 01043700:01047800 04/30/75 04/30/75

MACRO

RLAF GETNAM &ADD,&NAMZON,&NIL

**

**

.*&ADD ADDRESSES A CELL OF A NOTION, THE MACRO GETS, OR IF NECESSARY
 .*CREATES, THE NAME CORRESPONDING TO THE CONTENTS OF THE CELL AND STORES
 .*IT IN &NAMZON. &NIL INDICATES THAT THE CELL COULD CONTAIN 'NIL' AND
 .*CONTROLS GENERATION OF INSTRUCTIONS TO DEAL WITH THIS CASE.

AIF ('&NIL' EQ '').L1

&LAB CLC 0(4,&ADD),EMPTY CELL EMPTY

ENE #GET&SYSNDX NO->

MVC &NAMZON,=C'NIL' SET 'NIL'

E #END&SYSNDX SKIP

#GET&SYSNDX TSTFLAG (BASIC,0(&ADD),#BAS&SYSNDX)

AGO .L2

.L1 ANOP

&LAB TSTFLAG (BASIC,0(&ADD),#BAS&SYSNDX)

.L2 ANOP

*IF BASIC ACTION OCC OR OBJ OF UNIV->BRANCH

L WKREG1,0(&ADD) ADDRESS OF NOTION

TSTFLAG (NAMEL,0(WKREG1),#NOT&SYSNDX)

*IF NAMED NOTION ->BRANCH, ELSE CREATE NAME

CRNAM WKREG1,&NAMZON,#END&SYSNDX

*BASIC ACTION OCCURRENCE

#BAS&SYSNDX LA WKREG1,#BASACT TABLE OF BASIC ACTIONS

AP WKREG1,2(&ADD) +DISPLACEMENT

MVC &NAMZON,0(WKREG1) NAME OF BASIC ACTION

MVC &NAMZON+4,=' ' + PADDING

E #END&SYSNDX

*NAMED NOTION

#NOT&SYSNDX MVC &NAMZON,40(WKREG1) NAME TO OUTPUT ZONE

#END&SYSNDX EQU *

**

**

MEND

GETATTR 01040700:01043600 04/30/75 04/30/75

MACRO

&LAB GETATTR &ROOT,&NAT,&ADDR

**

**

*CALLS AND LINKS TO TPL FNDATSUE ROUTINE IN THE SIMULATOR FROM THE I/O
*ROUTINES,&ROOT SPECIFIES A NOTION TO BE SEARCHED FOR AN ATTRIBUTE
*WHOSE NATURE IS SPECIFIED BY &NAT.THE RESULT OF THE SEARCH IS RETURNED
*IN &ADDR.

*SAVE REGISTERS

&LAB STM BR1, BR2, #GETSAVE BR1, BR2 SAVED

*PARAMETERS

L ROOTAD, &ROOT POOT & NATURE
L NATADD, &NAT OF ATTRIBUTE

*LINKAGE AND CALL

L 15, =A(FNDATSUE) ENTRY POINT
L BR2, =A(BASE+4096) BASE
L BR1, =A(BASE) REGISTERS

*CALL ROUTINE TO FIND ATTRIBUTE SPECIFIED BY ROOT (PCOTAD) AND NATURE
*(NATADD) RESP. RESULT OF SEARCH RETURNED IN ADDR
BALR LINK, 15

*RETURN

USING *, LINK
LM BR1, BR2, #GETSAVE RESTORE REGS
USING #RDATA, BR1
DROP LINK

**

**

MEND

OUTATT 01070200:01073200 04/30/75 04/30/75

MACRO

&LAB OUTATT &ADD,&EXIT,&LIST,&TYPE,®

**

**

*OUTPUT ATTRIBUTE ADDRESSED BY &ADD. IF NO ATTRIBUTE THEN &EXIT, IF
 *ATTRIBUTE HAS LIST OF VALUES THEN &LIST. &TYPE INDICATES SPECIAL
 *ATTRIBUTE OR NOT. IF &TYPE= 'SPEC' ® POINTS INTO A TABLE OF SPECIAL
 *ATTRIBUTE NAMES.

&LAB CLC 0(4,&ADD),EMPTY NO ATTR?
 BE REXIT ->EXIT
 AIF ('&TYPE' NE 'SPEC').L1
 L WKREG2,0(®) SPATTAP ENTRY
 MVC #NATURE(8),40(WKREG2) SPECIAL ATTRIBUTE NAME
 AGO .L2

.L1 GETNAM &ADD,#NATURE GET NAME OF NATURE
 .L2 LA LENG,8 SET LENGTH

PUTNAM PTR,#NATURE,LENG

*PUT NATURE OF ATTRIBUTE IN OUTPUT LINE

AIF ('&TYPE' NE 'NORM').L3
 LA &ADD,4(&ADD) VALUE CELL

.L3 TSLIST &ADD,&LIST IF LIST OF VALUES->BRANCH
 GETNAM &ADD,#NOTION,NIL GET NAME OF VALUE
 PUTNAM PTR,#NOTION,LENG

*PUT VALUE OF ATTRIBUTE IN OUTPUT LINE

PUTLINE #OUTLINE,PTR,#TERMD

*OUTPUT LINE TO SYSOUT FILE

**

**

MEND

ERRCALL 01025000:01026300 04/30/75 04/30/75

MACRO

&LAB ERRCALL &MESS

**

**

*WROUT PRINTS THE MESSAGE WHOSE ADDRESS IS &MESS THEN TERMINATES THE
 *PROGRAM.

&LAB LA 1,WPPARAM PARAM LIST
 MVC 1(3,1),=AL3(&MESS) MESSAGE ADDRESS
 P WROUT TO ERROR MESSAGE OUTPUT

**

**

MEND

PUTLINE 01104900:01106600 05/02/75 05/02/75

MACRO

&LAB PUTLINE &LINE,&POS,&ERR

**

**

.*OUTPUTS LINE STARTING FROM &LINE UP TO POSITION IN &POS.&ERR IS EXIT
.*IN CASE OF WROUT ERROR.

&LAB	LA	WKREG1,&LINE	LENGTH TO
	SR	&POS,WKREG1	EE OUTPUT
	STH	&POS,&LINE	
	WROUT	&LINE,&ERR	OUTPUT LINE
	MVI	&LINE+5,' '	RL INITIALISE
	MVC	&LINE+6(114),&LINE+5	LINE
	LA	&POS,&LINE+5	POINT TO START OF NEW LINE

**

**

MEND

PUTNAM 01076400:01077900 04/30/75 04/30/75

MACRO

&LAB PUTNAM &POS,&NAMZON,&LENG

**

**

.*THE NOTION NAME IN &NAMZON WITH LENGTH (&LENG) IS STORED IN THE OUTPUT
.*LINE AT &POS.

&LAB	BCTR	&LENG,0	LENGTH-1
	STC	&LENG,#PN&SYSNDX+1	INTO MOVE
&PN&SYSNDX	MVC	0(&,&POS),&NAMZON	NAME TO LINE
	AP	&POS,&LENG	POINT TO NEXT FREE SPACE
	LA	&POS,2(&POS)	IN OUTPUT LINE

**

**

MEND

LENGTH 01101900:01104800 05/02/75 05/02/75

MACRO

&LAB LENGTH &NAMZON,&LENG,&NROOM,&TAB,&POS,&LINE

**

.*USING &TAB THE NOTION IN &NAMZON IS ISOLATED.ITS LENGTH IS CALCULATED
 .*AND RETURNED IN &LENG.&POS POINTS TO THE CURRENT POSITION IN &LINE
 .*(OUTPUT ZONE).IF &NROOM IS SPECIFIED IT IS SET TO INDICATE WHETHER
 .*THERE IS ROOM FOR THE NAME IN &LINE.

&LAB SLP 1,1 CLEAR REG 1
 TRT &NAMZON,&TAB FIND END OF NAME
 BC 8,#LEN&SYSNDX NOT FOUND->
 LA WKREG1,&NAMZON FINISH
 SR 1,WKREG1 - START
 #STL&SYSNDX LR &LENG,1 =LENGTH
 AIF ('&NROOM' EQ '').L1
 LR WKREG2,&POS ROOM IN
 AR WKREG2,1 LINE FOR
 C WKREG2,=A(&LINE+114) NAME?
 BHH #END&SYSNDX YES->
 MVI &NROOM,X'01' NO->SET FLAG

.L1 ANOP
 F #END&SYSNDX
 #LEN&SYSNDX LA 1,8 LENGTH=8
 B #STL&SYSNDX
 #END&SYSNDX EQU *

**

MEND

PDACHK 01078000:01079100 04/30/75 04/30/75

MACRO

&LAB PDACHK &ZONE,&LEN,&TEST,&EXIT

**

.*CHECKS LENGTH OF MESSAGE IN &ZONE IS OK.

&LAB CLC &ZONE.(2),=XL2 '&LEN' LEN OK?
 B&TEST &EXIT

**

MEND

M SOURCE

```

      TITLE '3-GRAPH SIMULATOR,ROOT PHASE'
*THE 3-GRAPH SIMULATOR IS DESIGNED WITH AN OVERLAY STRUCTURE TO LEAVE
*THE MAXIMUM AMOUNT OF SPACE FOR THE 3-GRAPH ITSELF.THE ROOT PHASE
*CONSISTS OF THE FOLLOWING CODE AND THE INITIAL 3-GRAPH.IT LOADS
*FIRST THE INITIALISER PHASE DIRECTLY BEHIND THE GRAPH AND THEN THE
*SIMULATOR ON TOP OF THE INITIALISER.
*THE ROOT PHASE ALSO CONTAINS THE DICTIONARY FILE DEFINITION AND ERROR
*ROUTINES
ROOTPH  START
        PRINT NOGEN
        EXTRN INITPP          INITIALISER ENTRY POINT
        EXTRN SIMULATE       SIMULATOR ENTRY POINT
        EXTRN #RDATA         RETURN IN I/O ROUTINES
        ENTRY PAGETAB        TABLE OF PAGES ALLOCATED IN 3-GRAPH
        ENTRY LDSIMUL,DICT,FILERR,KEY,#NOFIND
BR2     EQU 4
        BALR BR2,0          LOAD BASE REGISTER
        USING *,BR2
        LPOV INIT,INITPR    LOAD INITIALISER PHASE
*RETURN FROM INITIALISER PHASE TO HERE
LDSIMUL LPOV SIMUL,SIMULATE LOAD SIMULATOR PROPER
        TERM
*DICTIONARY FILE DEFINITION
DICT    FCB LINK=SYMDICT,FCBTYPE=ISAM,RECFORM=F,RECSIZE=12,PLKSIZE=
        TD,EXIT=FILERR,KEYLEN=8,OPEN=OUTIN,KEYARG=KEY,DUPEKY=Y
*ERROR EXIT LIST AND ROUTINES
FILERR  EXLST NOFIND=NOFIND,DUPEKY=DUPEKY,OPENER=OPENER,USERERR=USER
        ,COMMON=TERMD,NOSPACE=NOSPACE,ISPERR=NOSPACE
*
NOFIND  BALR 2,0          NEW BASE REGISTER(TEMPORARY)
        USING *,2
        DROP 4
        CLI #NOFIND,X'01'  ERROR TYPE 1,I/O ROUTINES
        EE  IGNOFIND
        CLI #NOFIND,X'02'  ERROR TYPE 2,NAMBLK(SIMULATOR)
        EE  ELINNOFI
        CLI #NOFIND,X'03'  ERROR TYPE 3,SIMULATOR MAIN
        ENE  TERMD
MAINNOFI WROUT NOFMESS1,TERMD
        L 1,=A(SIMULATE)
        BR 1          RETURN
ELINNOFI ERRCALL NOFMESS2          NO RETURN
IGNOFIND WROUT NOFMESS3,TERMD
        L 1,=A(#RDATA)
        BR 1          RETURN
NOSPACE  ERRCALL NOSPMESS          NO RETURN
OPENERR  ERRCALL OPENMESS          NO RETURN
USERR    ERRCALL USLPMESS          NO RETURN
DUPEKY   ERRCALL DUPKMESS          NO RETURN
*
TERMD    TERMD

```

M SOURCE

WROUT	WROUT (1)	WRITE ERR MESS
ERR	TERM'D	
*		
WRPARAM	DS A	PARAM LIST FOR WROUT
	DS C	
	DC AL3(CERR)	
PAGETAB	DS 256C	PAGE TABLE
KEY	DC CL8' '	KEY FOR DICTIONARY
#NOFIND	DC X'00'	ERROR CODE FOR DICTIONARY
*ERROR MESSAGES		
NOSPMESS	DC X'001E404041'	
	DC 'NO ROOM TO EXTEND FILE'	
OPENMESS	DC X'001D404041'	
	DC 'OPEN ERROR ON DICT,TERM'D'	
USERMESS	DC X'0022404041'	
	DC 'IMPROPER ACTION ON DICT,TERM'D'	
DUPKMESS	DC X'001F404000'	
	DC 'DUPLICATE KEY FOUND,TERM'D'	
NOFMESS1	DC X'001F404000'	
	DC 'NOTION SPECIFIED NOT FOUND'	
NOFMESS2	DC X'002D404000'	
	DC 'NOTION TO BE REMOVED DOESN'T EXIST,TERM'D'	
NOFMESS3	DC X'001A404000'	
	DC 'NOTION NAME NOT FOUND'	

END ROOTPH

GS, 000 MNOTES

2000 ASSEMBLER VERS. 0021

M SOURCE

TITLE '3-GRAPH SIMULATOR, OVERLAY 1'

*DESCRIPTION:INITIALISER PHASE

*THIS IS THE FIRST PART OF THE SIMULATION OF A 3-GRAPH. THE PREFERENCE

*COUNTS OF ALL NOTIONS ARE INITIALISED TO THE NUMBER OF TIMES EACH ONE

*IS EITHER NATURE OR VALUE OF A NOTION. PAGLTAB-A TABLE INDICATING THE

*SECTION TO WHICH EACH 3-GRAPH PAGE BELONGS - IS ALSO INITIALISED.

*IF REQUESTED BY THE USER A DICTIONARY OF NOTION NAMES AND ADDRESSES IS

*CREATED

INITPR CSECT

PRINT NOGEN

EXTRN TRGR1

START OF 3-GRAPH

EXTRN LDSIMUL

RETURN TO ROOT

EXTRN PAGETAB

TABLE OF 3-GRAPH PAGES IN USE

*REGISTER ALLOCATIONS

CURRADD EQU 12

CURRENT ADDRESS IN PAGE

CURPPAGE EQU 6

CURRENT PAGE IN 3-GRAPH

LINK EQU 13

LINKS BETWEEN ROUTINES

WKREG1 EQU 14

WORK

WKREG2 EQU 15

REGISTERS

BP1 EQU 3

BASE REGISTER

SAVEPEG EQU 7

SAVE ZONE

*SYMBOLIC IMMEDIATE OPERANDS

LIST EQU X'40'

FLAGS FOR LIST OF VALUES

NAMFL EQU X'80'

FLAGS FOR NAMED NOTION

**

BASE PALR BP1,0

LOAD

USING *,BP1

BASE REG

**

*USER IS ASKED IF A DICTIONARY IS TO BE CREATED

QUERY WRDOUT QUERYDIC,ERROR

RDATA REPLYDIC,ERROR

RDACHK REPLYDIC,7,11,QUERY CHECK REPLY LENGTH OK

CLC REPLYDIC+4(2),='NO' NO->

PE DICTEX

DICTEX

CLC REPLYDIC+4(3),='YES' REPLY NOT 'YES' OR 'NO'

BNE QUERY

->LOOP

L 1,=V(DICT)

OPEN (1),OUTIN

OPEN FILE TO CREATE

MVI DICTSW+1,X'F0'

SET SWITCH,BRANCH TO CREATE DICT

R INIT

DICTEX L 1,=V(DICT)

OPEN (1),INOUT

OPEN EXISTING DICT

M SOURCE

**

*TO PREVENT EXCESSIVE PAGING THE 3-GRAPH IS DIVIDED INTO GROUPS OF
 *CONTIGUCOUS PAGES AND THE USER IS ASKED TO DETERMINE THE SIZE OF A GPOL
 *THIS IS THE PARAMETER K WHERE.2.LE.K.LE TOTAL NO OF PAGES (DETERMINED
 *AT LINKAGE).THE REPLY IS 4 DIGITS INCLUDING LEADING ZEROES

INIT WROUT REQ1,ERROP ASK FOR K,NO OF PAGES IN A GROUP
 RDATA INFO1,EKRROR
 RDACHK INFO1,8,NE,INIT CHECK REPLY LENGTH OK

**

*INITIALISATION OF PARAMETERS-FIRST PAGE, LAST PAGE, SIZE OF GROUP, NO OF
 *GROUPS, START ADDRESS

PACK	DWORD+5(3),INFO1+4(4)	CONVERT TO
CVB	11,DWORD	USEFUL FORM
BCTR	11,0	K-1
ST	11,KM1	STORE (K-1) FOR LATER USE
L	11,=A(INITPR)	START ADDR OF SIMULATOR
SRL	11,12	ISOLATE PAGE NO
BCTR	11,0	
STC	11,LSTPAGE	NO OF LAST PAGE OF 3-GRAPH
L	11,=A(TRGR1)	ADDRESS BEGINNING OF 3-GRAPH
SRL	11,12	
STC	11,FSTPAGE	NO OF 1ST PAGE OF 3-GRAPH
SLL	11,12	
LR	CURRADD,11	ADDRESS OF 1ST CELL,1ST PAGE
XR	11,11	PREPARE TO
IC	11,FSTPAGE	CALCULATE
XR	10,10	NO OF PAGES TO
IC	10,LSTPAGE	BE INITIALISED
SR	10,11	LSTPAGE-FSTPAGE
C	10,=F'0'	1 PAGE?
ENE	INITLOOP	NO->INITLOOP
MVI	ONEPAGSW+1,X'FO'	SET SWITCH TO SKIP UNNECESSARY
		ROUTINES
INITLOOP	SPDL 10,32	PREPARE FOR DIVISION
	L 9,KM1	K-1
	DR 10,9	(LSTPAGE-FSTPAGE)/(K-1)
	C 10,=F'0'	REMAINDER=0?
	BE INITCONT	YES
	LA 11,1(11)	QUOTIENT+1
INITCONT	ST 11,LOOPCONT	NO OF PAGE GROUPS,(K-1) PAGES, TO
		COVER 3-GRAPH

*

M SOURCE

**

DICTSW NOP CREDIT WHEN RESET ROUTINE TO CREATE DICT
IS INVOKED

*

INITSCAN BAL LINK, PAGTAPSR CALL ROUTINE TO INITIALISE PAGETAP
ENTRY FOR CURRENT PAGE

*

BAL LINK, SCANPAGE CALL ROUTINE TO SCAN PAGE, UPDATE

*INTERNAL REFERENCES AND FILL IN REFTAB, OUTPUT PARAMETER: CURPPAGE

**

*WHEN A PAGE HAS BEEN TREATED BY SCANPAGE THE REMAINDER OF THE 3-GRAPH
*IS SCANNED IN GROUPS OF K-1 PAGES UPDATING REFERENCE COUNTS OF NOTIONS
*REFERRED TO IN PAGE JUST DEALT WITH.

**

CNEPAGSW NOP FINISH SWITCH, IF ONLY 1 PAGE THEN REST OF
PROGRAM UNNECESSARY

*

L 11, LOOPCONT LOOP CONTROL

LA CURPPAGE, 1(CURPPAGE) PAGE NO OF 1ST

CALCT1 STC CURPPAGE, PAGET1 PAGE OF GROUP, TRTINIT PARAM

BAL LINK, TRTINIT CALL ROUTINE TO INITIALISE TRT TABLE

*

FOR CURRENT GROUP OF PAGES

BAL LINK, TRTROUT CALL ROUTINE TO UPDATE REFERENCE

*

COUNTS INDICATED BY REFTAB

IC CURPPAGE, PAGET1 LAST PAGE OF GROUP +1

STC CURPPAGE, WORK

CLC WORK, LSTPAGE WRAPAROUND NEEDED?

BNH CALCCONT NO

IC CURPPAGE, FSTPAGE YLS

CALCCONT BCT 11, CALCT1

SRL CURRADD, 12 ADDRESS OF

LA CURRADD, 1(CURRADD) NEXT PAGE

STC CURRADD, WORK LAST PAGE

CLC WORK, LSTPAGE HAS BEEN INITIALISED?

BNH FINISH YES->EXIT

SLL CURRADD, 12 NEXT PAGE

B INITSCAN LOOP

FINISH L LINK, ALDSIMUL RETURN ADDRESS IN ROOT PHASE
BR LINK RETURN TO ROOT PHASE

M SOURCE

*INPUT PARAMETERS
 *CURRADD CONTAINS START ADDRESS OF CURRENT PAGE
 *SECTNO CONTAINS CURRENT SECTION NO
 *OUTPUT PARAMETERS
 *SECTNO CONTAINS SECTION NO FOR NEXT 3-GRAPH PAGE
 *DESCRIPTION: PAGTABSE ROUTINE
 *THIS ROUTINE INITIALISES PAGETAB FOR THE 3-GRAPH. PAGETAB CONTAINS A
 *1-BYTE ENTRY FOR EACH PAGE OF THE 3-GRAPH. EACH CONTAINS THE NO OF THE
 *SECTION TO WHICH THE PAGE BELONGS AND AN INDICATION OF WHETHER THE
 *PAGE IS FULL OR NOT. THE ENTRY IS (N*2)+1 IF A PAGE IS NOT FULL, (N*2)+0
 *IF THE PAGE IS FULL (N IS THE SECTION NO : THE PAGE BELONGS TO THE
 *NTH SECTION INCLUDED IN THIS 3-GRAPH). WHEN A PAGE IS NOT FULL IT IS
 *ASSUMED, BECAUSE OF THE WAY THE 3-GRAPH IS CREATED, THAT THE END OF A
 *SECTION HAS BEEN REACHED, SO THE SECTION NO IS INCREMENTED FOR THE NEXT
 *PAGE. IF THE FREE LIST FLAG BITS ARE X'FF' THEN THE END OF A SECTION
 *COINCIDES WITH A FULL PAGE.

*
 *NOTE: THE SECTION NO. N IS NOT THE SECTION NO. GIVEN BY THE USER TO HIS
 *3-GRAPH DESCRIPTIONS.

*
 *CALLS: 0
 *CALLED BY: INITIALISER MAIN ROUTINE

PAGTABSE	STM	9,11,PAGTSAVE	SAVE WORK REG CONTENTS
	LR	11,CURRADD	CALCULATE ADDRESS OF
	SRL	11,12	PAGE ENTRY
	A	11,APAGETAB	IN PAGETAB
	LR	10,CURRADD	ADDRESS OF FREE
	C	10,FRLSTAD	LIST HEADER
	CLC	0(4,10),EMPTY	PAGE FULL?
	BE	PAGTFULL	YES
	XR	9,9	
	IC	9,SECTNO	CURRENT SECTION NO
	SLL	9,1	* BY 2
	TM	0(10),X'FF'	END OF SECTION COINCIDES WITH FULL
			PAGE

	EO	PAGTST	YES
	LA	9,1(9)	+ 1 INDICATES PAGE NOT FULL
PAGTST	STC	9,0(11)	STORE ENTRY IN PAGETAB
	SRL	9,1	DIVIDE BY 2
	LA	9,1(9)	SECTION NO INCREASED BY 1
	STC	9,SECTNO	
	NI	0(10),X'0F'	RESET FLAG BITS IF NECESSARY
PAGTEXTIT	LM	9,11,PAGTSAVE	RESTORE REGS
	BR	LINK	EXIT
PAGTFULL	XR	9,9	
	IC	9,SECTNO	CURRENT SECTION NO
	SLL	9,1	* BY 2
			+ 0 INDICATES PAGE FULL
	STC	9,0(11)	STORE ENTRY IN PAGETAB
	B	PAGTEXTIT	EXIT

M SOURCE

```

*INPUT PARAMETERS
*CURRADD CONTAINS START ADDRESS OF PAGE TO BE SCANNED
*OUTPUT PARAMETERS
*CURRADD IS UNCHANGED
*CURRPAGE CONTAINS THE NO OF THE PAGE JUST SCANNED
*REFTAB HAS BEEN INITIALISED FOR THE CURRENT PAGE
*DESCRIPTION:SCANPAGE ROUTINE
*AFTER CURRPAGE HAS BEEN INITIALISED THE CURRENT PAGE IS SCANNED, CELLS
*NOT CONTAINING REFERENCES TO 3-GRAPH NOTIONS ARE SKIPPED, CELLS THAT
*CONTAIN A REFERENCE CAUSE ONE OF TWO ACTIONS-IF THE REFERENCE IS TO A
*NOTION IN THE CURRENT PAGE THIS NOTION'S REFERENCE COUNT IS INCREMENT-
*-ED. IF THE NOTION REFERENCED IS IN ANOTHER PAGE AN ENTRY IS MADE IN
*REFTAB, THE CURRENT CELL ADDRESS IS TURNED INTO AN OFFSET IN REFTAB,
*THE PAGE NO OF THE NOTION REFERENCED IS ENTERED INTO REFTAB, AT THAT
*POINT.
*CALLS:0
*CALLED BY:INITIALISER MAIN ROUTINE
SCANPAGE STM 7,11,SCANSAVE WORK REGS

LR CURRPAGE,CURRADD INITIALISE
SLL CURRPAGE,12 CURRPAGE
SRL CURRPAGE,24 (CURRENT PAGE NO)
*LIMIT SCAN (EXCLUDE FRELLIST)
LR 11,CURRADD ADDRESS BEGINNING OF PAGE
O 11,FRLSTAD FREE LIST HEADER ADDRESS
CLC 0(4,11),EMPTY PAGE FULL?
PE SCANPCFU YES
L 10,0(11)
SH 10,=H'4' ADDRESS OF LAST CELL
ST 10,ENDADDR TO BE SCANNED
*SCAN PAGE
LR 11,CURRADD ADDRESS OF 1ST CELL IN PAGE
SCANTEST LA 10,4 4 CELLS/BLOCK:LOOP CONTROL
TSTFLAG (NAMEFL,0(11),SETSW) IF NAMED NOTION->SETSW
SCANLOOP CLI 0(11),X'0F' IF NOT A NOTION OR

BNE SCANNEXT
CLC 0(4,11),EMPTY IF EMPTY CELL ->SKIP
BE SCANNEXT
*INCREMENT REF COUNT OR PLACE ENTRY IN REFTAB
L 9,0(11) NOTION ADDRESSED
SLL 9,12 ISOLATE
SRL 9,24 PAGE NO
CR 9,CURRPAGE REFERENCE IN CURRENT PAGE?
BNE SCANTAB NO->
INCR 0(11) INCREMENT REFERENCE COUNT
B SCANNEXT
SCANTAB STC 9,REFNO SAVE PAGE NO OF REF
LR 8,11 INITIALISE
SR 8,CURRADD REL ADDR IN PAGE
LR WKREG1,8
SRDL 8,32 FOR DIVISION

```

M SOURCE

D	8,=F'4'	DIVIDE BY CELL LENGTH
SRDL	WKREG1,32	INITIALISE FOR DIVISION
D	WKREG1,=F'20'	DIVIDE BY BLOCK LENGTH
SR	9,WKREG2	RESULT IS CELL NO
*CELL NO=RELATIVE NO OF CELL-NO OF POINTER CELLS PRECEDING IT		
*RELATIVE NO OF CELL=REL ADDR OF CELL/CELL LENGTH		
*NO OF POINTER CELLS=NO OF BLOCKS PRECEDING CELL		
*NO OF BLOCKS=REL ADDR OF CELL/BLOCK LENGTH		
A	9,=A(LEFTAB)	RESULT IS ADDR OF ENTRY FOR CELL
MVC	C(1,9),REFNO	STORE PAGE NO FOR FXT PFF IN
*CONTROL SCAN		
SCANNEXT	LA 11,4(11)	NEXT CELL
	BCT 10,SCANLOOP	
	BCTR 7,0	END OF BLOCK:
	LTP 7,7	IF (7) = 0 ->SKIPPL
	BZ SKIPPL	
SCANEND	C 11,ENDADDR	END OF PAGE?
	BNI SCANTERM	YES
	LA 11,4(11)	ADDR 1ST CELL NEXT PLOCK
	B SCANTEST	
SCANPGFU	SH 11,=H'4'	SCAN LIMIT IS
	ST 11,ENDADDR	END OF PAGE
	LR 11,CUPRADD	START ADDRESS
	B SCANTEST	
**		
SKIPBL	LA 11,20(11)	SKIP NAME BLOCK
	B SCANEND	
**		
SETSW	LA 7,2	AFTER 2 BLOCKS,NAME BLOCK TO SKIP
	B SCANNEXT	
**		
SCANTERM	LM 7,11,SCANSAVE	RESTORE WORK REGS
	BR LINK	EXIT

M SOURCE

```

*INPUT PARAMETERS
*REFTAB CONTAINS ENTRIES FOR EXTERNAL REFS IN CURRENT PAGE (SCANPAGE)
*TRTTAB HAS BEEN INITIALISED FOR A GROUP OF PAGES IN THE 3-GRAPH-TRTINIT
*OUTPUT PARAMETERS
*LEFTAB & TRTTAB ARE CLEARED
*DESCRIPTION: TRTROUT ROUTINE
*USING A TRT INSTRUCTION REFTAB IS SCANNED FOR REFERENCES TO NOTIONS IN
*A GROUP OF PAGES SPECIFIED BY TRTTAB. WHEN A REFERENCE IS FOUND THE
*ADDRESS OF THE ENTRY IN REFTAB IS USED TO GET THE ADDRESS OF THE CELL
*CONTAINING THE REFERENCE (THE REVERSE OF WHAT HAPPENS IN SCANPAGE)
*THEN THE NOTION REFERENCED IS UPDATED (REF COUNT INCREMENTED).
*BECAUSE REFTAB IS 816 BYTES LONG AND THE MAX LENGTH FOR A TRT IS 256
*THE SCAN IS EFFECTIVELY DIVIDED INTO 3 SCANS OF 256 BYTES AND ONE OF
*48 BYTES
*CALLS: 0
*CALLED BY: INITIALISER MAIN ROUTINE
TRTROUT  STM  9,11,TRTSAVE      WORK REGS
          MVI  TRT+1,X'FF'      INITIALISE TRT LENGTH
          LA   1,REFTAB        INITIALISE TRT ADDRESS
          LA   11,1            NO OF TIMES TRT EXECUTED OVER 2568
          LA   9,REFTAB        START ADDRESS OF CURRENT TRT
TRT      TRT  0(256,1),TRTTAB  NO REFERENCES->TRTPEIN
          UC   8,TRTREIN       RECOVER
          LR   10,1            CELL NO
          S    10,=A(REFTAB)    INITIALISE
          LR   WKREG1,10        FOR DIVISION
          SRDL WKREG1,32

          D    WKREG1,=F'4'     DIVIDE BY NO OF CELLS/BLOCK
          AR   10,WKREG2        ADD BLOCK NO
          MH   10,=H'4'        * BY CELL LENGTH
          AR   10,CURRADD       +PAGE ADDRESS GIVES CELL ADDRESS
          INCR 0(10)           INCREMENT REFERENCE COUNT
          MVI  0(1),X'FF'      REINITIALISE REFTAB ENTRY
          LP   WKREG1,1
          SR   WKREG1,9        LENGTH OF TRT SO FAR

          CH   WKREG1,=H'255'   MAX LENGTH?
          BE   TRTREIN
          LH   WKREG2,=H'254'   UPDATE
          SR   WKREG2,WKREG1    LENGTH
          STC  WKREG2,TRT+1     OF TRT
          LA   1,1(1)          UPDATE START ADDRESS
          B    TRT
TRTREIN  CH   11,=H'3'        REFTAB EXHAUSTED?
          RH   TRTEXIT        YES
          LA   1,REFTAB        NEW START ADDRESS
          LH   WKREG2,=H'256'   =A(REFTAB)
          RR   WKREG1,11       + N*256
          AR   1,WKREG2        N LF 3
          CH   11,=F'3'        LAST TRT?
          BE   TRTMVI         YES

```

M SOURCE

	MVI	TRT+1,X'FF'	REINITIALISE LENGTH
TRTRINCN	LA	11,1(11)	INCREASE N
	LR	9,1	NEW START ADDRESS OF CURRENT TRT
	B	TRT	
TRTMVI	MVI	TRT+1,X'2F'	LENGTH=48
	D	TRTRINCN	
TRTEXIT	MVI	TRTTAE,X'00'	REINITIALISE
	MVC	TRTTAB+1(255),TRTTAB	TRTTAB
	LM	9,11,TRTRSAVE	WORK REGS
	BR	LINK	LXIT

*INPUT PARAMETERS

*PAGE1 CONTAINS THE NO OF THE FIRST PAGE IN THE GROUP

*KM1 CONTAINS THE NO OF PAGES IN THE GROUP

*OUTPUT PARAMETERS

*PAGE1 CONTAINS THE NO OF THE LAST PAGE IN THE GROUP +1

*DESCRIPTION:TRTINIT ROUTINE

*TRTROUT HAS TO SCAN REFTAB FOR REFERENCES TO NOTIONS IN PAGES OF THE

*3-CRAPH OTHER THAN THE CURRENT ONE. IN ORDER TO AVOID EXCESSIVE PAGING

*THE SCAN IS LIMITED TO A CONTIGUOUS GROUP OF PAGES. THE SIZE OF THE

*GROUP IS GIVEN BY KM1 AND THE FIRST PAGE BY PAGE1. TRTTAB IS INITIALISE

*WITH AN ENTRY OF X'FF' FOR EACH PAGE IN THE GROUP

*CALLS:0

*CALLED BY:INITIALISER MAIN ROUTINE

TRTINIT	STM	9,11,TRTISAVE	WORK REGS
	XR	11,11	
	IC	11,PAGE1	FIRST PAGE IN GROUP
	L	10,KM1	K-1,NO OF PAGES IN GROUP,LOOPCONTROL
TRTCHK	STC	11,WORK	
	CLC	WORK,LSTPAGE	NEXT PAGE NO>LAST PAGE NO?
	BNH	TRTILOOP	NO
	IC	11,FSTPAGE	WRAPAROUND ON PAGE NOS
TRTILOOP	LA	9,TRTTAB	ADDRESS OF ENTRY
	AR	9,11	IN TRTTAB
	MVI	0(9),X'FF'	INITIALISE ENTRY
	LA	11,1(11)	NEXT PAGE NO
	BCT	10,TRTCHK	
	STC	11,PAGE1	RETURN NEXT PAGE NO
	LM	9,11,TRTISAVE	WORK REGS RESTORED
	BR	LINK	EXIT

M SOURCE

```

*INPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE START OF THE 3-GRAPH.
*DICT FILE HAS BEEN OPENED OUTIN.
*OUTPUT PARAMETERS
*CURRADD IS UNCHANGED
*GENERAL DESCRIPTION: CREDIT ROUTINE
*THE GRAPH IS SCANNED TO LOCATE NOTIONS WITH NAMES. WHEN ONE IS LOCATED
*ITS NAME BLOCK (NAME AND ADDRESS) IS TRANSFERRED TO THE DICT FILE
*CALLS: 0
*CALLED BY: INITIALISER MAIN ROUTINE
CREDIT LR   SAVEREG, CURRADD   SAVE CONTENTS CURRADD
*INITIALISE END-OF-PAGE LIMIT
LIMIT LR   WKREG1, CURRADD
O        CURRADD, FRLSTAD   FREE LIST HEADER
CLC     U(4, CURRADD), EMPTY PAGE FULL?
BE      FULLPAGE           YES->

        CLI   O(CURRADD), X'FF'   END OF SECTION & FULL PAGE?
        BE   FULLPAGE           YES->
        MVC  ENDADDR, O(CURRADD)  LIMIT SCAN
        B    LCCENTRY

FULLPAGE ST  CURRADD, ENDADDR   SCAN WHOLE PAGE
*LOCATE A DICTIONARY ENTRY
LCCENTRY LR  CURRADD, WKREG1
TSTFLAGS CLI U(CURRADD), NAMFL  NOTION NAMED?
        BNE  NONAME            NO->NONAME
        LA   CURRADD, 4O(CURRADD) GET
        MVC  ZONOUT, U(CURRADD)  ENTRY
*WRITE DICTIONARY ENTRY
        L    1, =V(DICT)
        INSRT (1), ZONOUT
NONAME LA   CURRADD, 2O(CURRADD) NEXT BLOCK
        C    CURRADD, ENDADDR   END OF PAGE?
        BNE  TSTFLAGS          NO->TSTFLAGS
*END OF A PAGE
        PAGNO CURRADD, WORK      CURRENT PAGE NO
        CLC  LSTPAGE, WORK      =LAST PAGE NO?
        BE   ENDOFGR           YES->END OF GRAPH
        M    CURRADD, SETZEROS  START ADDRESS
        AH   CURRADD, PGPLUS1  OF NEXT PAGE
        R    LIMIT
ENDOFGR LR  CURRADD, SAVEFFG    RESTORE CURRADD
        B    INITSCAN          RETURN TO INITIALISER

```


* M SOURCE

*ERROR EXITS

ERRCR TERMD

*IOAREA

ZONOUT DS OCL12
 KEY DS CL8
 DATA DS CL4
 *WORK ZONES
 ENDADDR DS F
 LOOPCONT DS F
 DWORD DS OD
 DC PL8'0'
 TRTTAB DC 256X'00'

REFNO DS C
 WORK DS C
 SAVE DC X'00'

DS OF
 SETZEROS DC X'FFFFFF00'
 PGPLUS1 DC X'1000'
 *REGISTER SAVE AREAS

SCANSAVE DS 5F
 PAGTSAVE EQU SCANSAVE
 TRTISAVE EQU SCANSAVE
 TRTRSAVE EQU SCANSAVE
 *SPECIAL ADDRESSES IN 3-GRAPH
 FRLSTAD DS OF

DC XL4'FFU'
 EMPTY DC X'FFFFFFE'

*EXTERNAL ADDRESSES

APAGETAB DC A(PAGETAB)
 ALDSIMUL DC A(LDSIMUL)

*TABLE OF REFERENCES EXTERNAL TO A GIVEN PAGE
 REFTAB DC 816X'FF'

*PARAMETERS GOVERNING LEXECUTION OF INITIALISER

FSTPAGE DS C
 LSTPAGE DS C
 PAGET1 DS C
 SECTNO DC X'01'

KM1 DS F

*MESSAGES TO USER AND REPLIES

INFO1 DS CL8
 REQ1 DC X'002A004040'
 DC 'HOW MANY PAGES IN A PAGE GROUP(NNNN)'
 QUERYDIC DC X'002E404041'
 DC 'DO YOU WANT A DICTIONARY CREATED (YES/NO)'

REPLYDIC EQU INFO1
 END INITPP

M SOURCE

```

TITLE '3-GRAPH SIMULATOR PROGRAM, OVERLAY 2'
SIMULATE CSECT
PRINT NOGEN
EXTRN OCCDE, SUC1, SUC2      THE SPECIAL NOTIONS OF THE 3-GRAPH
EXTRN ARG1, ARG2, ARG3, ARG4 WHOSE ADDRESSES WILL BE NEEDED
EXTRN PAGETAB              TABLE OF 3-GRAPH PAGES IN USE
EXTRN #ATHALT, #USERINT    LINK TO I/O ROUTINES
ENTRY MEXTACT, FNDATSUB, INAPEA, SPATTAB, BASE FOR I/O ROUTINES

*REGISTER ALLOCATIONS
BR1      EQU 3              BASE REGISTERS FOR THE
BR2      EQU 4              SIMULATION ROUTINES
ATADD    EQU 5              TO CONTAIN ATTRIBUTE ADDRESSES
STADDR   EQU 5              START ADDRESSES OF CHAINS OF BLOCKS
VALADD   EQU 6              VALUE CELL ADDRESSES
NATADD   EQU 6              ATTRIBUTE NATURES, ADDRESS OF NOTION
CELL     EQU 6              CELL ADDRESSES
NEWADD   EQU 8              ADDRESS OF NEWLY ALLOCATED BLOCKS
ROOTAD   EQU 7              ADDRESSES OF ROOT NOTIONS
CURRADD  EQU 12             ADDRESS OF CURRENT ACTION OCCURRENCE
LINK     EQU 13             LINKS BETWEEN ROUTINES
WKREG1   EQU 14             WORK
WKREG2   EQU 15             REGISTERS

*SYMBOLIC IMMEDIATE OPERANDS
FASIC    EQU X'80'          FLAGS FOR BASIC ACTION OCCURRENCE
OBJUN    EQU X'20'          FLAGS FOR OBJECT OF THE UNIVERSE
TRUE     EQU X'01'          BOOLEAN VALUE 'TRUE'
LIST     EQU X'40'          FLAGS FOR LIST OF VALUES
NAMEFL   EQU X'80'          FLAGS FOR NAMED NOTION

*DISPLACEMENTS FOR SPECIAL ATTRIBUTES
DSUC1    EQU 8
DSUC2    EQU 12
DARG1    EQU 20
DARG2    EQU 24
DARG3    EQU 28
DARG4    EQU 32

BALR     BR1, 0              LOAD
USING   *, BR1, BR2         BASE
LA      BR2, 4095(BR1)      REGISTERS
LA      BR2, 1(BR2)
STXIT   ,, MINTERR         CONTINGENCY EXIT
WROUT   ASK, LPR           ASK FOR 1ST ACTION
RDATA   REPLY, ERR        GET REPLY
SLR     WKREG1, WKREG1
LH      WKREG1, REPLY      LENGTH
SH      WKREG1, =H'5'      -1 OF NAME
STC     WKREG1, MMOVEKEY+1 TO MVC INSTR
L       1, =V(KEY)
MMOVEKEY MVC 0(8, 1), REPLY+4 NOTION NAME TO KEYARG
L       1, =V(#NOFIND)
MVI     0(1), X'03'        SET ERROR CODE
L       1, =V(DICT)
GETKY   (1), INAPEA        GET ADDRESS

```

M SOURCE

```

L      CURRADD,DATA      ADDRESS OF FIRST ACTION
BALR  BR1,0              REDEFINE
USING *,BR1,BR2         BASE
BASE   LA  BR2,4095(BR1)  BASE
      LA  BR2,1(BR2)     REGISTERS
NEXTACT L  WKREG2,4(CURRADD)  CONTENTS OCCDF CELL
      N  WKREG2,MASK      REMOVE ANY FLAG BITS
      A  WKREG2,=A(SIMTAB)  ADD BASE ADDRESS
      L  WKREG2,0(WKREG2)  ADDR OF SIMULATION ROUTINE
      BALR LINK,WKREG2     BRANCH TO SIMULATION ROUTINE
      BAL LINK,SIMSUCC    GET NEXT ACTION

```

```

MOUTSW  NOP  NEXTACT      NEXT ACTION WHEN SW IS 'B'

```

```

*OTHERWISE CONTROL GOES TO USER OUTPUT ROUTINES

```

```

L      15,=#USERINT)
BALR  14,15              CALL ROUTINES
MVI   MCUTSW+1,X'FO'     FLIP SW TO 'B'
      B  NEXTACT

```

```

*USER INTERRUPT ROUTINE,SETS SWITCH TO USER OUTPUT ROUTINES

```

```

MINTERR MVI MOUTSW+1,X'00'  FLIP SW TO NOP
      EXIT CR

```

```

LTORG

```

```

*GET SUCCESSOR

```

```

*THE FOLLOWING ROUTINE ASSUMES THAT CURRADD CONTAINS THE ADDRESS OF THE
*SUCC(2) CELL OF THE CURRENT ACTION OCCURRENCE.AT THE END OF THIS
*ROUTINE CURRADD WILL CONTAIN THE ADDRESS OF THE NEXT ACTION OCCURRENCE
*TO BE SIMULATED.

```

```

*IF THERE IS NO SUCCESSOR TO THE CURPENT ACTION OCCURRENCE THE
*SIMULATION IS TERMINATED.MULTIPLE SUCCESSORS ARE DEALT WITH IN THE
*PARLSUB ROUTINE

```

```

*CALLS:PARLSUB

```

```

SIMSUCC TM  0(CURPAD),LIST  LIST OF SUCCESSORS?
      BZ  SUCCONE          NO
SUCCPARL ST  LINK,SUCCSAVE  SAVE RETURN ADDRESS
      BAL LINK,PARLSUB    CALL PARALLELISM ROUTINE
      L  LINK,SUCCSAVE    RESTORE RETURN ADDRESS
      B  SUCCMASK
SUCCONE  CLC  0(4,CURRADD),EMPTY  NO SUCCESSORS?
      BE  SIMEND          NONE

```

```

L      CURRADD,0(CURRADD)  LOAD ADDR OF NEXT ACTION
SUCCMASK N  CURRADD,MASK   MASK FLAG BITS
      BR  LINK            EXIT
SIMEND  CLC  STACK(4),EMPTY  STACK OF SUCCESSORS EMPTY?

```

```

*THE ABOVE IS DEPENDENT ON THE WAY PARALLELISM IS HANDLED

```

```

*SEE PARLSUB

```

```

      BE  SIMTERM        YES:SIMTERM
      L  CURRADD,0(CURRADD)  PARAMETER FOR PARLSUB (= 'EMPTY')
      B  SUCCPARL

```

```

SIMTERM  TERM            END SIMULATION

```

```

*NOTE:ANY ADDITIONS MADE TO THE 3-GRAPH DURING A SIMULATION ARE LOST BY

```

```

*THIS METHOD.ONE METHOD OF SAVING THE CURRENT CONTENTS IS WITH THE

```

```

*CHKPT MACRO,ANOTHER IS THE USE OF A PAM FILE

```

```

      TERM  SAFETY MEASURE

```

M SOURCE

```

*INPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE CREN ACTION OCCURENCE TO BE
*SIMULATED
*OUTPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE SUC1 ATTRIBUTE
*DESCRIPTION:SIMCREN ROUTINE
*SIMCREN SIMULATES THE CREATION OF A NOTION WHICH BECOMES A VALUE OF
*AN ATTRIBUTE OF AN EXISTING NOTION
*IF ANY ARGUMENT TAKING PART IN THIS ACTION IS VALUELESS THE EFFECT IS
*A NO-OPERATION CONTROL PASSES DIRECTLY TO CRENSUC1
*CALLS:RANSUB,GETBLK,FNDATSUB,FNDVALSU
*****
SIMCREN TSTARG CURRADD,DARG1,FSTARG,CRENSUC1,LINK,CRENSAVE
*THE FIRST ARGUMENT IS CHOSEN AND STORED IN FSTARG.
      TSTARG CURRADD,DARG2,SNDARG,CRENSUC1,LINK
*THE SECOND ARGUMENT IS CHOSEN AND STORED IN SNDARG
      CRENOT THDARG,FSTARG
*SPACE IS ALLOCATED AND INITIALISED FOR THE NEW NOTION WHOSE ADDRESS IS
*STORED IN THDARG
      FNDATTR FSTARG,SNDARG,ATADD
*THE FIRST ARGUMENT NOTION IS SCANNED TO SEE IF AN ATTRIBUTE WITH NATURE
*THE SECOND ARGUMENT NOTION EXISTS,IF IT DOES ITS ADDRESS IS RETURNED
*IN ATADD
      C      ATADD,LSTPT
      BE      CRENEMPT
*THE ABSENCE OF THE ATTRIBUTE IS INDICATED BY A SPECIAL VALUE IN ATADD,
*IF SO CONTROL GOES TO CRENEMPT.
      ADDVAL ATADD,THDARG
CRENSUC1 HVARG CURRADD,DSUC1,LINK,CRENSAVE
*CURRADD IS SET TO THE SUC1 ATTRIBUTE.
      BR      LINK          EXIT
CRENEMPT SPATTR SNDARG,ADDSAVE,THDARG,CRENATTR,CRENSUC1
*IF THE ATTR IS A SPECIAL ONE THE NEW NOTION IS STORED OTHERWISE CONTROL
*GOES TO CRENATTR
CRENATTR FNDATTR FSTARG,EMPTY,ATADD
*THE FIRST ARGUMENT NOTION IS SCANNED TO FIND ROOM FOR A NEW ATTRIBUTE,
*THE POSITION IS STORED IN ATADD
      CRATTR ATADD,SNDARG,THDARG
*A NEW ATTRIBUTE IS ADDED WITH NATURE THE 2ND ARGUMENT NOTION AND VALUE
*THE NEW NOTION
      B      CRENSUC1

```

M SOURCE

```

*INPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE CRER ACTION OCCURENCE TO BE
*SIMULATED.
*OUTPUT PARAMLTERS
*CURRADD CONTAINS THE ADDRESS OF THE SUC1 ATTRIBUTE
*DESCRIPTION:SIMCREP ROUTINE
*SIMULATES THE CREATION OF A RELATION BETWEEN 3 EXISTING NOTIONS:ROOT,
*NATURE AND VALUE OF THE NEW RELATION RESP. IF A NOTION IS NOT SPECIFIED
*OR IS 'NIL' OR THE RELATION ALREADY EXISTS THE EFFECT IS A NO-OP
*CALLS:RANSUB,FNDATSUB,FNDVALSU,GETBLK
*****
SIMCRER TSTARG CURRADD,DARG1,FSTARG,CRERSUC1,LINK,CRERSAVE
*THE FIRST ARGUMENT IS CHOSEN AND STORED IN FSTARG.
TSTARG CURRADD,DARG2,SNDAAG,CPERSUC1,LINK
*THE SECOND ARGUMENT IS OBTAINED AND STORED IN SNDAAG.
TSTARG CURRADD,DARG3,THDARG,CRERSUC1,LINK
*THE THIRD ARGUMENT IS OBTAINED AND STORED IN THDARG.
FNDATTR FSTARG,SNDAAG,ATADD
*THE FIRST ARGUMENT NOTION IS SCANNED FOR AN ATTRIBUTE WHOSE NATUPE IS
*THE SECOND ARGUMENT NOTION,THE ADDRESS OF THE ATTRIPUTE IS STOPED IN
*ATADD
C ATADD,LSTPT ATTRIBUTE EXISTS?
PE CREREMPT NO:CREREMPT
FNDVAL ATADD,THDARG,VALFND
*THE ATTRIBUTE IS SCANNED FOR A VALUE WHICH IS THE THIPD ARGUMENT NOTION
*IF THE RELATION TO BE CREATED ALREADY EXISTS.EXISTENCE OR NON-EXISTENCE
*IS INDICATED BY VALFND
CLI VALFND,TRUE VALUE FOUND?
BNE CRERADVA NO:CRERADVA
CRERSUC1 MVARG CURRADD,DSUC1,LINK,CRERSAVE
*CURRADD IS SET TO THE SUC1 ATTRIBUTE.
BR LINK EXIT
CRERADVA ADDVAL ATADD,THDARG
*THE THDARG NOTION IS ADDED TO THE VALUES OF THE ATTRIBUTE,CREATING THE
*RELATION REQUIRED
B CRERSUC1
CREREMPT SPATTR SNDAAG,ADDSAVE,THDARG,CRERATTR,CPERSUC1
*IF THE NATURE OF THE ATTR IS 'SPECIAL' AND NO SUCH ATTR FYISTS IT IS
*CREATED.OTHERWISE CONTROL GOES TO CRERATTR.
CRERATTR FNDATTR FSTARG,EMPTY,ATADD
*ROOM FOR A NEW ATTRIBUTE OF THE FIRST ARGUMENT NOTION IS OBTAINED AND
*ITS ADDRESS STOPED IN ATADD
CRATTR ATADD,SNDAAG,THDARG
*A NEW ATTRIBUTE IS ADDED CREATING THE SPECIFIED RELATION
B CRERSUC1

```

M SOURCE

```

*INPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE LAT ACTION OCCURRENCE TO BE
*SIMULATED
*OUTPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE SUC1 ATTRIBUTE
*DESCRIPTION:SIMLAT ROUTINE
*THE ARG1 ATTRIBUTE OF THE LAT ACTION OCCURRENCE SPECIFIES A ROOT
*NOTION. FROM THIS NOTION AN ATTRIBUTE IS CHOSEN AT RANDOM. THE NATURE OF
*THE ATTRIBUTE BECOMES VALUE OF THE ARG2 ATTRIBUTE OF THE LAT OCCURRENCE
*THE VALUE BECOMES A VALUE OF THE ARG3 ATTRIBUTE. IF NO ROOT NOTION IS
*SPECIFIED THE EFFECT IS A NO-OPERATION.
*CALLS:RANSUE,CHRATSUB,FNDVALSU,GETBLK
*****
SIMLAT  TSTARG CURRADD,DARG1,FSTARG,LATSUC1,LINK,LATSAVE
*THE FIRST ARGUMENT IS CHOSEN AND STORED IN FSTARG
      CHATRN FSTARG,ATADD,NATSAVE,LATSUC1
*AN ATTRIBUTE OF THE FIRST ARGUMENT NOTION IS CHOSEN AT RANDOM,ITS
*ADDRESS IS STORED IN ATADD AND ITS NATURE IN NATSAVE
      TSLIST ATADD,,LATNOLST
*IF THE ATTRIBUTE HAS ONLY 1 VALUE GO TO LATNOLST
      CHVAL ATADD,VALADD,VALSAVE,LATSUC1
*A VALUE OF THE ATTRIBUTE IS CHOSEN AT RANDOM AND STORED IN VALSAVE
LATLOAD  LATNAT  CURPADD,24,NATSAVE,LATVALUE
*THE NATURE OF THE ATTRIBUTE IS MADE A VALUE OF THE ARG2 ATTRIBUTE OF
*THE LAT ACTION OCCURRENCE
LATVALUE LATVAL CURRADD,28,VALSAVE,LATSUC1
*THE VALUE OF THE ATTRIBUTE IS MADE A VALUE OF THE ARG3 ATTRIBUTE OF
*THE LAT ACTION OCCURRENCE
LATSUC1  MVARG CURRADD,DSUC1,LINK,LATSAVE
*CURPADD IS SET TO SUC1 ATTRIBUTE
      BR    LINK          EXIT
LATNOLST MVAL  ATADD,VALSAVE
*THE ATTRIBUTE'S ONLY VALUE IS STORED IN VALSAVE
      B    LATLOAD

```

M SOURCE

```

*INPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE REP ACTION OCCURENCE TO BE
*SIMULATED.
*OUTPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE SUC1 ATTRIBUTE.
*DESCRIPTION:SIMREP ROUTINE
*THE ACTION SIMULATED REPLACES A VALUE OF AN ATTRIBUTE SPECIFIED BY
*ROOT AND NATURE (ARG3 & ARG4 ATTR) BY A VALUE OF AN ATTRIBUTE ALSO
*SPECIFIED BY ROOT AND NATURE (ARG1 & ARG2 ATTR).EITHER OR BOTH VALUES
*WILL BE CHOSEN AT RANDOM IF NECESSARY.ABSENCE OF A VALUE TO BE REPLACED
*MEANS THAT THE ACTION REDUCES TO A TMV ACTION.ABSENCE OF A VALUE TO
*REPLACE THE 1ST MEANS THAT THE ACTION IS A NO-OPERATION.
*CALLS:RANSUB,FNDATSUB,RETNOTSB
*****
SIMREP  TSTARG CURRADD,DARG3,THDARG,REPSUC1,LINK,REPSAVE
*THE THIRD ARGUMENT IS OBTAINED AND STORED IN THDARG
      TSTARG CURRADD,DARG4,FTHARG,REPSUC1,LINK
*THE FOURTH ARGUMENT IS OBTAINED AND STORED IN FTHARG
      FNDATTR THDARG,FTHARG,ATADD
*THE THIRD ARGUMENT NOTION IS SCANNED FOR AN ATTRIBUTE WHOSE NATURE IS
*THE FOURTH ARGUMENT NOTION,THE ATTRIBUTE'S ADDRESS IS STORED IN ATADD
      C      ATADD,LSTPT      ATTRIBUTE EXISTS?
      BNE   REPCONT          YES:REPCONT
*IF THE ATTRIBUTE DOES NOT EXIST THE ACTION REDUCES TO A TMV
TMVCALL MVC   TMVSAVE,REPSAVE      TRANSFER RETURN ADDRESS
      B      TMVREPEN          TMV ROUTINE
REPCONT TSLIST ATADD,,REPNOLS2
      CHVAL ATADD,VALADD,,TMVCALL
*IF ATTRIBUTE HAS MORE THAN 1 VALUE A VALUE IS CHOSEN AT RANDOM,ITS
*ADDRESS IS GIVEN IN VALADD.IF ONLY 1 VALUE CONTROL TRANSFERS TO
*REPNOLS2.
      ST      VALADD,REPSAVE+4
*VALADD IS SAVED FOR LATER USE.
REPARG1 TSTARG CURRADD,DARG1,FSTARG,REPSUC1,LINK
*THE FIRST ARGUMENT IS OBTAINED AND STORED IN FSTARG
      TSTARG CURRADD,DARG2,SNDARG,REPSUC1,LINK
*THE SECOND ARGUMENT IS OBTAINED AND STORED IN SNDARG
      FNDATTR FSTARG,SNDARG,ATADD
*THE FIRST ARGUMENT NOTION IS SCANNED FOR AN ATTRIBUTE WHOSE NATURE IS
*THE SECOND ARGUMENT NOTION,IF THE ATTRIBUTE EXISTS ITS ADDRESS IS
*STORED IN ATADD
      C      ATADD,LSTPT      ATTRIBUTE EXISTS?
      BNE   REPATFND          YES:REPATFND
REPSUC1 MVARG CURRADD,DSUC1,LINK,REPSAVE
*CURRADD IS SET TO THE SUC1 ATTRIBUTE
      BR     LINK              EXIT
REPATFND TSLIST ATADD,,REPNOLST
*IF THE ATTRIBUTE HAS ONLY 1 VALUE GO TO REPNOLST
      CHVAL ATADD,VALADD,VALSAVE,REPSUC1
*CHOOSE A VALUE AT RANDOM AND STORE IT IN VALSAVE
REPVALUE L      VALADD,REPSAVE+4      GET ADDRESS OF VALUE TO BE REPLACED
      REPVAL VALADD,VALSAVE,REPSUC1
*REPLACE VALUE ADDRESSED BY VALADD BY VALUE IN VALSAVE,THEN EXIT
REPNOLST MVAL  ATADD,VALSAVE
*THE ATTRIBUTE'S ONLY VALUE IS STORED IN VALSAVE
      B      REPVALUL
REPNOLS2 ST     ATADD,REPSAVE+4      SAVE ADDRESS OF VALUE CELL
      B      REPARG1

```

M SOURCE

```

*INPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE SUP ACTION OCCURENCE TO BE
*SIMULATED.
*OUTPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE SUC1 ATTRIBUTE
*DESCRIPTION:SIMSUP ROUTINE
*SIMSUP SUPPRESSES AN ATTRIBUTE OF A NOTION. THE NOTION IS SPECIFIED BY
*THE VALUE OF ARG1 AND THE NATURE OF THE ATTRIBUTE BY THE VALUE OF ARG2
*OF THE SUP OCCURENCE. IF ONE OF THESE IS NOT SPECIFIED OR THE ATTRIBUTE
*DOES NOT EXIST THE RESULT IS A NO-OP. IF THE ATTRIBUTE HAS MORE THAN 1
*VALUE THE VALUE TO BE SUPPRESSED IS CHOSEN AT RANDOM. IF A NOTION IS NO
*LONGER REFERENCED AFTER ITS OCCURENCE AS NATURE OR VALUE OF THE
*ATTRIBUTE HAS BEEN SUPPRESSED IT IS REMOVED FROM THE GRAPH.
*CALLS:RANSUB,FNDATSUB,RETNOTS, TSTBLK
*****
SIMSUP  TSTARG CURRADD,DARG1,FSTARG,SUPSUC1,LINK,SUPSAVE
*THE FIRST ARGUMENT IS OBTAINED AND STORED IN FSTARG
      TSTARG CURRADD,DARG2,SNDRARG,SUPSUC1,LINK
*THE SECOND ARGUMENT IS OBTAINED AND STORED IN SNDRARG
      FNDATTR FSTARG,SNDRARG,ATADD
*THE FIRST ARGUMENT NOTION IS SCANNED FOR AN ATTRIBUTE WHOSE NATURE IS
*THE SECOND ARGUMENT NOTION IF IT EXISTS THE ATTRIBUTE'S ADDRESS IS
*STORED IN ATADD
      C   ATADD,LSTPT      ATTRIBUTE EXISTS?
      BNE SUPATFND      YES:SUPATFND
SUPSUC1 MVARG CURRADD,DSUC1,LINK,SUPSAVE
*CURRADD IS SET TO THE SUC1 ATTRIBUTE;
      BR   LINK          EXIT
SUPATFND TSLIST ATADD,SUPATLST
*IF ATTRIBUTE HAS MORE THAN 1 VALUE GO TO SUPATLST
      SUPATTR ATADD,SNDRARG,FSTARG
*SUPPRESS ATTRIBUTE
      B   SUPSUC1
SUPATLST CHVAL ATADD,VALADD,,SUPSUC1
*A VALUE OF THE ATTRIBUTE IS CHOSEN AT RANDOM,ITS POSITION IS STORED IN
*VALADD
      SUPVAL VALADD,ATADD
*THE VALUE IS REMOVED
      B   SUPSUC1

```


M SOURCE

```

*INPUT PARAMETERS
*CURPADD CONTAINS THE ADDRESS OF THE SUPR ACTION OCCURENCE TO BE
*SIMULATED.
*SIMSUPR SUPPRESSES AN ATTRIBUTE WHOSE ROOT, NATURE AND VALUE ARE
*SPECIFIED BY THE ARG1, ARG2, ARG3 ATTRIBUTES OF THE SUPR OCCURENCE
*THE RESULT IS A NO-OP IF ANY ONE ARGUMENT IS NOT SPECIFIED OR IF THE
*GIVEN ATTRIBUTE DOES NOT EXIST. IF THE VALUE OF THE ATTRIBUTE IS ONE OF
*SEVERAL ONLY THE SPECIFIED ONE IS SUPPRESSED. IF THE LAST REFERENCE TO
*A NOTION IS SUPPRESSED BY THE SUPR OCCURENCE THE NOTION IS REMOVED
*FROM THE 3-GRAPH
*CALLS: RANSUB, FNDATSUB, RETNOTSB, TSTELK, FNDVALSU
*****
SIMSUPR TSTARG CURRADD, DARG1, FSTARG, SUPRSUC1, LINK, SUPRSAVE
*THE FIRST ARGUMENT IS OBTAINED AND STORED IN FSTARG
TSTARG CURRADD, DARG2, SNDARG, SUPRSUC1, LINK
*THE SECOND ARGUMENT IS OBTAINED AND STORED IN SNDARG
TSTARG CURRADD, DARG3, THDARG, SUPRSUC1, LINK
*THE THIRD ARGUMENT IS OBTAINED AND STORED IN THDARG
FNDATTR FSTARG, SNDARG, ATADD
*THE FIRST ARGUMENT NOTION IS SCANNED FOR AN ATTRIBUTE WITH NATURE THE
*SECOND ARGUMENT NOTION. ATADD CONTAINS THE ADDRESS OF THE ATTRIBUTE IF
*IT IS FOUND.
C ATADD, LSTPT ATTRIBUTE EXISTS
BNE SUPRATFD YES: SUPRATFD
SUPRSUC1 MVARG CURRADD, DSUC1, LINK, SUPRSAVE
*CURRADD IS SET TO THE SUC1 ATTRIBUTE
BR LINK EXIT
SUPRATFD TSLIST ATADD, SUPRATLS
*IF THE ATTRIBUTE HAS MORE THAN 1 VALUE CONTROL PASSES TO SUPRATLS
CVAL ATADD, THDARG, SUPRSUC1
*THE VALUE OF THE ATTRIBUTE IS INSPECTED TO SEE IF IT CORRESPONDS TO
*THE THIRD ARGUMENT IF NOT CONTROL PASSES TO SUPRSUC1 IE THE RELATION
*TO BE SUPPRESSED DOES NOT EXIST
SUPATTR ATADD, SNDARG, FSTARG
*THE RELATION IS SUPPRESSED
B SUPRSUC1
SUPRATLS FNDVAL ATADD, THDARG, VALFND
*THE VALUES OF THE ATTRIBUTE ARE SCANNED FOR THE THIRD ARGUMENT NOTION
CLI VALFND, TRUE VALUE EXISTS?
BNE SUPRSUC1 NO, NO RELATION TO BE SUPPRESSED
SUPVAL VALADD, ATADD
*THE RELATION IS SUPPRESSED BY REMOVING THE THIRD ARGUMENT NOTION FROM
*THE VALUE LIST (ADDRESS OF CELL CONCERNED IS STORED IN VALADD BY
*FNDVAL).
B SUPRSUC1

```

* SOURCE

```

*INPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE TMV ACTION OCCURRENCE TO BE
*SIMULATED.
*OUTPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE SUC1 ATTRIBUTE
*DESCRIPTION:SIMTMV ROUTINE
*SIMTMV SIMULATES THE TRANSFER OF A VALUE OF AN ATTR OF A GIVEN NOTION
*TO AN ATTRIBUTE OF ANOTHER NOTION. THE FIRST NOTION IS SPECIFIED BY ARG1
*OF THE TMV OCCURENCE, THE ATTRIBUTE'S NATURE BY ARG2, THE 2ND NOTION BY
*ARG3 AND ITS ATTRIBUTE (NATURE) BY ARG4. IF ANY OF THESE IS NOT SPECIF-
*-IED OR THE FIRST ATTRIBUTE DOES NOT EXIST OR THE VALUE CHOSEN IS
*ALREADY A VALUE OF THE 2ND ATTRIBUTE THE ACTION OCCURRENCE HAS NO
*EFFECT.
*CALLS:RANSUB,FNDATSUB,FNDVALSU,GETBLK
*THE THIRD AND FOURTH ARGUMENTS ARE CHOSEN FIRST BECAUSE OF THE ENTRY
*POINT FROM THE SIMREP ROUTINE
*****
SIMTMV  TSTARG CURRADD,DARG3,THDARG,TMVSUC1,LINK,TMVSAVE
*THE THIRD ARGUMENT NOTION IS OBTAINED AND STORED IN THDARG
      TSTARG CURRADD,DARG4,FTHARG,TMVSUC1,LINK
*THE FOURTH ARGUMENT NOTION IS OBTAINED AND STORED IN FTHARG
*ENTRY POINT FROM SIMREP ROUTINE WHEN REP ACTION REDUCES TO A TMV
TMVREPEN TSTARG CURRADD,DARG1,FSTARG,TMVSUC1,LINK
*THE FIRST ARGUMENT IS OBTAINED AND STORED IN FSTARG
      TSTARG CURRADD,DARG2,SNDARG,TMVSUC1,LINK
*THE SECOND ARGUMENT IS OBTAINED AND STORED IN SNDARG
      FNDATTR FSTARG,SNDARG,ATADD
*THE FIRST ARGUMENT NOTION IS SCANNED FOR AN ATTRIBUTE WHOSE NATURE IS
*THE SECOND ARGUMENT NOTION, IF IT EXISTS THE ATTRIBUTE'S ADDRESS IS
*STORED IN ATADD
      C      ATADD,LSTPT      ATTRIBUTE EXISTS
      BNE   TMVATFND      YES:TMVATFND
TMVSUC1  MVARG CURRADD,DSUC1,LINK,TMVSAVE
*CURRADD IS SET TO SUC1 ATTR
      BR     LINK      EXIT
TMVATFND TSLIST ATADD,,TMVNOLST
*IF THE ATTRIBUTE HAS ONLY 1 VALUE GO TO TMVNOLST
      CHVAL ATADD,VALADD,VALSAVE,TMVSUC1
*A VALUE OF THE ATTR IS CHOSEN AT RANDOM AND STORED IN VALSAVE
TMVENDAT FNDATTR THDARG,FTHARG,ATADD
*THE THIRD ARGUMENT NOTION IS SCANNED FOR AN ATTRIBUTE WITH NATURE THE
*FOURTH ARGUMENT NOTION
      C      ATADD,LSTPT      ATTRIBUTE EXISTS?
      BNE   TMVAT2EX      YES:TMVAT2EX
      SPATTR FTHARG,ADDSAVE,VALSAVE,TMVNSPEC,TMVSUC1
*IF NATURE OF ATTRIBUTE SPECIAL,ATTRIBUTE IS ADDED AND
*CONTROL PASSES TO TMVSUC1
TMVNSPEC FNDATTR THDARG,EMPTY,ATADD
*SPACE IS FOUND FOR A NEW ATTRIBUTE OF THE THIRD ARGUMENT NOTION
      CRATTR ATADD,FTHARG,VALSAVE
*THE NEW ATTRIBUTE IS CREATED
      B      TMVSUC1

```

M SOURCE

TMVNOLST MVAL ATADD,VALSAVE

*THE ATTRIBUTE'S ONLY VALUE IS STORED IN VALSAVE

E TMVFNDAT

TMVATZEX FNDVAL ATADD,VALSAVE,VALFND

*THE ATTRIBUTE OF THE THIRD ARGUMENT NOTION IS SCANNED FOR THE VALUE TO
*BE ADDED.

CLI VALFND,TRUE

VALUE ALREADY EXISTS?

BE TMVSUC1

YES:TMVSUC1

ADDVAL ATADD,VALSAVE

*THE VALUE IS TRANSMITTED TO THE ATTRIBUTE OF THE THIRD ARGUMENT NOTION

B TMVSUC1

*INPUT PARAMETERS

*CURRADD CONTAINS THE ADDRESS OF THE COMP ACTION OCCURRENCE TO BE

*SIMULATED.

*OUTPUT PARAMETERS

*CURRADD CONTAINS THE ADDRESS OF THE SUC1 OR SUC2 ATTRIBUTE DEPENDING ON

*THE RESULT OF THE SIMULATION.

*DESCRIPTION:SIMCOMP ROUTINE

*SIMCOMP SIMULATES THE COMPARISON OF TWO 3-GRAPH NOTIONS(CHOSEN AT

*RANDOM IF NECESSARY) AND THE CHOICE OF SUCCESSOR ACTION DEPENDING ON

*THE RESULT

*CALLS:RANSUB

SIMCOMP TSTARG CURRADD,DARG1,FSTARG,,LINK,COMPSAVE

*A VALUE OF ARG1 IS CHOSEN FOR FSTARG.

TSTARG CURRADD,DARG2,SNDRG,,LINK

*THE SECOND ARGUMENT IS CHOSEN AND STORED IN SNDRG

CLC FSTARG,SNDRG

COMPARE THE TWO NOTIONS

BE COMPSUC1

IF THE SAME,SUC1 IS NEXT ACTION

COMPSUC2 MVARC CURRADD,DSUC2,LINK,COMPSAVE

*THE NOTIONS ARE NOT THE SAME;SUC2 IS THE NEXT ACTION SO CURRADD IS SET

*TO THE SUC2 ATTRIBUTE

BR LINK

EXIT

COMPSUC1 MVARC CURRADD,DSUC1,LINK,COMPSAVE

*CURRADD IS SET TO THE SUC1 ATTRIBUTE

BR LINK

EXIT

* M SOURCE

*INPUT PARAMETERS

*ATADD CONTAINS ADDRESS OF VALUE CELL POINTING TO LIST OF VALUES

*REG 11 CONTAINS ADDRESS OF 1ST BLOCK OF LIST TO BE SEARCHED

*OUTPUT PARAMETERS

*REG 11 CONTAINS ADDRESS OF NON-EMPTY CELL OR 'NIL'

*ATADD IS UNCHANGED

*DESCRIPTION: FSTVALSB ROUTINE

*THIS ROUTINE SCANS A VALUE LIST TO FIND A NON-EMPTY CELL. IT STARTS AT

*THE ADDRESS IN REG 11, SKIPS THE 1ST CELL OF THE BLOCK (AVOIDS PROBLEMS

*WITH THE COUNTER CELL) AND STOPS THE FIRST TIME A NON-EMPTY CELL IS

*ENCOUNTERED. IF THE END OF THE LIST IS REACHED THE ROUTINE STARTS AGAIN

*FROM THE BEGINNING OF THE LIST. IF IT REACHES THE END OF THE LIST AGAIN

*IT RETURNS THE VALUE 'NIL'

*CALLS: 0

*CALLED BY: RANSUB

FSTVALSB	STM	9,10,FSTVSAVE	SAVE WORK REG CONTENTS
	LA	9,2	CONTROL TO PREVENT INFINITE LOOPING
FSTVLA	LA	10,3	LOOP CONTROL (3 CELLS IN 1ST BLOCK)
FSTVLOOP	LA	11,4(11)	MOVE TO NEXT CELL
FSTVCLC	CLC	0(4,11),EMPTY	CELL EMPTY?
	BNE	FSTVFND	NO->FSTVFND
	BCT	10,FSTVLOOP	
	LA	11,4(11)	MOVE TO POINTER CELL
	CLC	0(4,11),LSTPT	END OF LIST?
	BE	FSTVSTAG	YES->FSTVSTAG
	L	11,0(11)	ADDRESS OF NEXT BLOCK
	LA	10,4	LOOP CONTROL
	B	FSTVCLC	
FSTVFND	LM	9,10,FSTVSAVE	RESTORE WORK REGS
	BR	LINK	EXIT
FSTVSTAG	L	11,0(ATADD)	START OF LIST
	BCT	9,FSTVLA	IF WRAPAROUND HAS NOT YET OCCURRED
			GO TO FSTVLA
	L	11,EMPTY	RETURN NIL SINCE LIST COMPLETELY
	B	FSTVFND	EMPTY

M SOURCE

*INPUT PARAMETERS
 *ROOTAD CONTAINS ADDRESS OF NOTION TO BE SCANNED
 *REG 11 CONTAINS ADDRESS OF FIRST BLOCK TO BE SCANNED
 *OUTPUT PARAMETERS
 *REG 11 CONTAINS ADDRESS OF VALUE CELL OF 1ST NON-EMPTY ATTRIBUTE
 *NATADD CONTAINS ADDRESS OF NOTION WHICH IS NATURE OF ATTRIBUTE
 *ROOTAD IS UNCHANGED
 *DESCRIPTION: FSTATSUB ROUTINE
 *THIS ROUTINE HAS TWO ENTRY POINTS. FSTATSUB IS THE NORMAL ENTRY POINT,
 *FSTABEG IS USED WHEN THE 1ST TWO BLOCKS OF THE NOTION ARE TO BE
 *SEARCHED FIRST.
 *STARTING FROM THE ADDRESS IN REG 11 THE NOTION IS SEARCHED BLOCK BY
 *BLOCK. THE SEARCH TERMINATES AS SOON AS A NON-EMPTY NATURE CELL IS
 *ENCOUNTERED. IF THE SEARCH REACHES THE END OF THE NOTION IT STARTS FROM
 *THE BEGINNING AGAIN (ROOTAD). IF THE NOTION IS EMPTY AN ERROR MESSAGE
 *IS OUTPUT AND THE PROGRAM TERMINATES
 *CALLS: 0
 *CALLED BY: CHRATSUB
 FSTATSUB STM 8,10,FSTASAVE SAVE WORK REG CONTENTS
 LA 9,2 CONTROL TO PREVENT INFINITE LOOPING
 FSTALOOP LA 10,2 LOOP CONTRL (2 ATTR/BLOCK)
 FSTACLC CLC 0(4,11),EMPTY NATURE OF ATTR EMPTY? (& ATTR)
 BNE FSTAFND NO->FSTAFND
 LA 11,8(11) MOVE TO NEXT ATTRIBUTE
 BCT 10,FSTACLC
 L 11,0(11) LOAD POINTER CELL CONTENTS
 FSTAPTR C 11,LSTPT END OF NOTION?
 BNE FSTALOOP NO->FSTALOOP
 BCT 9,FSTABEG WHILE WRAPAROUND HAS NOT OCCURRED GO
 * TO FSTABEG
 ERRCALL ERPMESS2
 *SET ERROR MESSAGE PARAMS AND BRANCH
 FSTAFND L NATADD,0(11) NATURE OF ATTRIBUTE RETURNED
 LA 11,4(11) ADDR OF (VALUE CELL OF) ATTR
 LM 8,10,FSTASAVE RESTORE WORK REGS
 BR LINK EXIT
 *SCAN OF 1ST 2 BLOCKS
 *SKIPPING THE STATISTICS CELL, THE BLOCKS ARE TESTED CELL BY CELL WHILE
 *REG 8 POINTS INTO A TABLE CONTAINING THE ADDRESS OF THE CORRESPONDING
 *NATURES. IF THE SEARCH REACHES THE END OF THIS TABLE THEN THE REST OF
 *THE NOTION IS SEARCHED IN THE ORDINARY WAY.
 FSTABEG LA 11,4(ROOTAD) ADDRESS OCCDE CELL OF NOTION
 LA 10,3 LOOP CONTROL (3 ATTR IN 1ST BLOCK)
 LA 8,SPATTAB TABLE OF SPECIAL NOTION ADDRESSES
 FSTALO1 CLC 0(4,11),EMPTY CELL EMPTY?
 BNE FSTAFND2 NO->FSTAFND2
 LA 8,4(8) MOVE POINTER IN SPATTAB
 LA 11,4(11) MOVE TO NEXT CELL
 BCT 10,FSTALO1
 C 8,=A(SPATTAB+28) END OF SPECIAL ATTRIBUTES?

* SOURCE

PE	FSTACONT	YES->FSTACONT
LA	10,4	LOOP CONTROL (4 ATTR IN 2ND BLOCK)
LA	11,4(11)	ADDRESS AFG1 CELL
B	FSTALO1	
FSTAFND2	L NATADD,0(8)	NATURE OF ATTRIBUTE RETURNED
*		ADDR OF VALUE OF ATTR OK
LM	8,10,FSTASAVE	RESTORE WORK REGS
BR	LINK	EXIT
FSTACONT	L 11,0(11)	CONTENTS OF POINTER CELL
B	FSTAPTR	

*INPUT PARAMETERS

*ROOTAD CONTAINS ADDRESS OF FIRST (OR ONLY) BLOCK TO BE RETURNED TO

*FREELIST

*OUTPUT PARAMETERS

*NONE, ROOTAD IS UNCHANGED

*DESCRIPTION: RETBLK ROUTINE

*THE ROUTINE SCANS THE POINTER CELL OF THE BLOCKS TO BE RETURNED TO THE
 *FREELIST UNTIL IT FINDS THE END OF THE CHAIN THEN IT FORMS THE ADDRESS
 *OF THE FREE LIST HEADER CELL AND CHECKS WHETHER THERE ARE ANY BLOCKS
 *IN THE FREE LIST. IF THERE ARE, THEY ARE CHAINED TO THE END OF THE NEW
 *CHAIN OF BLOCKS. THE ADDR OF THE 1ST BLOCK IN THE NEW OR UPDATED FREE
 *LIST IS STORED IN THE FREE LIST HEADER AND, FINALLY, THE CORRESPONDING
 *ENTRY IN THE PAGETAB IS RESET.

*CALLS:0

*CALLED BY: TSTBLK, RETVALST, RETNOTSB

RETBLK	STM	10,11,RETSAVE	STORE WORK REGISTER CONTENTS
	LA	11,16(POOTAD)	ADDRESS OF POINTER CELL
RETBCLC	CLC	0(4,11),LSTPT	END OF CHAIN?
	BE	PETFRLSA	YES:RETFRLSA
	L	11,0(11)	NEXT BLOCK
	LA	11,16(11)	POINTER CELL
	R	RETBCLC	
RETFRLSA	LR	10,ROOTAD	FORM
	SRL	10,12	ADDRESS OF
	SLL	10,12	FREELIST
	O	10,FRLSTAD	HEADER
	CLC	0(4,10),EMPTY	FREE LIST EMPTY?
	BE	RETRBLKS+6	YES
RETRBLKS	MVC	0(4,11),0(10)	CHAIN FREE LIST TO END OF NEW BLOCKS
	ST	ROOTAD,0(10)	START ADDR OF NEW BLOCKS IN FREELIST HEADER
*	N	10,MASK	MASK FLAG BITS
	SRL	10,12	REMOVE PAGE REL ADDR
	A	10,APAGETAB	ADDR CORRESPONDING ENTRY IN PAGETAB
	OI	0(10),X'01'	INDICATE NON-EMPTY FREELIST IN PAGE
	LM	10,11,RETSAVE	RESTORE WORK REGS
	BR	LINK	EXIT

M SOURCE

```

*INPUT PARAMETERS
*CURRADD CONTAINS EITHER THE ADDRESS OF THE SUC1(2) CELL OF THE CURRENT
*ACTION OR 'NIL' (EMPTY)
*OUTPUT PARAMETERS
*CURRADD CONTAINS THE ADDRESS OF THE NEXT ACTION TO BE SIMULATED
*DESCRIPTION:PARLSUB ROUTINE
*THIS ROUTINE HAS TWO SEPARATE FUNCTIONS
*A)WHEN CURRADD ADDRESSES A SUC1(2) CELL THE LIST OF (PARALLEL) SUCCESS-
*ORS OF THE CURRENT ACTION ARE ADDED TO THE TOP OF A STACK OF SUCCESSORS
*B)AFTER THIS OR IF CURRADD CONTAINS 'NIL' THE TOP ENTRY IN THE STACK
*IS REMOVED AND RETURNED TO THE CALLING ROUTINE
*CALLS:0
*CALLED BY:SIMSUCC
PARLSUB  STM  10,11,PARLSAVE      SAVE WORK REG CONTENTS
          L    11,STCKPNTR      CURRENT TOP ENTRY IN STACK
          C    CURRADD,EMPTY     ADD OR REMOVE ENTRIES IN STACK?

          BE   PARLREM          REMOVE:PARLREM
          L    CURRADD,0(CURRADD) ADDRESS OF START OF LIST OF VALUES
PARLADD  LA    10,3             LOOP CONTROL (BECAUSE OF COUNTER CELL
*                                     ONLY 3 VALUES IN 1ST BLOCK)
PARLOOP  LA    CURRADD,4(CURRADD) MOVE TO NEXT CELL
PARLCLC  CLC   0(4,CURRADD),EMPTY CELL EMPTY?
          BE   PARLBCT          YES->PARLBCT
          C    11,=A(STCKPNTR)  END OF STACK?
*NOTE:DEPENDS ON STCKPNTR BEING DECLARED IMMEDIATELY BEHIND STACK
          EE   PARLERR          YES->PARLERR
          MVC  0(4,11),0(CURRADD) ADD ENTRY TO STACK
          LA   11,4(11)         NEXT FREE ENTRY IN STACK
PARLBCT  BCT  10,PARLOOP
          LA   CURRADD,4(CURRADD) MOVE TO POINTER CELL

          CLC  0(4,CURRADD),LSTPT END OF LIST?
          BE   PARLREM          YES->PARLREM
          L    CURRADD,0(CURRADD) ADDRESS OF NEXT BLOCK
          LA   10,4             LOOP CONTROL
          B    PARLCLC

*SET ERROR PARAMS AND BRANCH
PARLERR  ERRCALL ERRMESS4      (NO RETURN)
PARLREM  S    11,=F'4'         UPDATE STCKPNTR
          L    CURRADD,0(11)    TAKE TOP ENTRY OFF STACK
          MVC  0(4,11),EMPTY    UPDATE STACK
          ST   11,STCKPNTR      UPDATE STCKPNTR

PARLEXIT LM  10,11,PARLSAVE    RESTORE WORK REGISTERS
          BR   LINK            EXIT

```

M SOURCE

*INFUT PARAMETERS

*ATADD CONTAINS ADDRESS OF VALUE CELL POINTING TO LIST OF VALUES

*OUTPUT PARAMETERS

*VALADD CONTAINS ADDRESS OF A NON-EMPTY VALUE CELL IN THE LIST

*ATADD IS UNCHANGED

*DESCRIPTION:RANSUB ROUTINE

*THIS ROUTINE GETS THE TASK TIME FOR THE CURRENT TASK AND DIVIDES IT BY

*THE NO OF CELLS ALLOCATED TO THE VALUE LIST ADDRESSED BY ATADD, THIS

*PRODUCES A 'RANDOM' NO WHICH IS USED TO PICK OUT A CELL FROM THE VALUE

*LIST. IF THIS CELL CONTAINS A VALUE, ITS ADDRESS IS RETURNED TO THE

*CALLING ROUTINE IN VALADD. IF THE CELL IS EMPTY THE ROUTINE GENERATES A

*NEW RANDOM NO, ETC. IF, AFTER 3 NOS HAVE BEEN GENERATED A NON-EMPTY CELL

*HAS NOT BEEN FOUND THE FSTVALSB ROUTINE IS CALLED TO SEARCH SYSTEMATIC-

*ALLY FOR A NON-EMPTY CELL.

*CALLS:FSTVALSB

*CALLED BY:SIMCOMP, SIMCREN, SIMIFOU, SIMCRER, SIMSUP, SIMSUPR, SIMTMV

RANSUB STM 8,11,PANSAVE WORK REGS

*NOTE:SAVE AREA=5 WORDS,1 WORD NEEDED BY ROUTINE.

	XR	10,10	INITIALISE TRY COUNT
RANSTART	L	11,0(ATADD)	ADDRESS OF COUNTER CELL
	N	11,MASK	MASK FLAG BITS
	TMODE	TASKINFO	GET TASK INFORMATION
	L	8,TASKINFO+24	CPU TIME

	SRDA	8,32	INITIALISE REGISTERS(PROPAGATE SIGN)
	L	WKREG1,0(11)	COUNTER CELL CONTENTS
	N	WKREG1,MASK	MASK FLAG BITS
	DR	8,WKREG1	DIVIDE BY NO OF CELLS ALLOCATED
	LA	8,1(8)	B CONTAINS REMAINDER R;0 LE R LE

*NO OF CELLS - 1.ADD 1 FOR COUNTER CELL

	SRDA	8,32	REINITIALISE REGISTERS
	D	8,=F'4'	DIV BY NO OF CELLS/BLOCK
	LTR	9,9	TEST NO OF BLOCK=0
	BZ	PANSKIP	YES->RANSKIP
RANLOOP	LA	11,16(11)	SKIP
	L	11,0(11)	TO
	BCT	9,RANLOOP	BLOCK CONTAINING CELL CHOSEN

*CELL NO BETWEEN 0 & 3

RANSKIP	MH	8,=H'4'	* BY CELL LENGTH
	AR	11,8	ADDRESS OF CELL
	CLC	0(4,11),EMPTY	CELL EMPTY?

	BE	RANRETRY	YES->RANRETRY
RANEXIT	LR	VALADD,11	RETURN CELL ADDRESS
	LM	8,11,PANSAVE	RESTORE REGS
	BR	LINK	

RANRETRY	LA	10,1(10)	INCREMENT TRY COUNT
	CH	10,=H'3'	3 TRIES?
	BL	RANSTART	NO->RANSTART
	SR	11,8	ADDRESS OF BLOCK OF LAST TRY
	ST	LINK,PANSAVE+16	SAVE CURRENT RETURN ADDRESS
	BAL	LINK,FSTVALSB	CALL ROUTINE TO SCAN LIST FOR 1ST

*NON-EMPTY CELL FOLLOWING LAST ATTEMPT, ADDRESS RETURNED IN REG11

	L	LINK,PANSAVE+16	RESTORE RETURN ADDRESS
	B	RANEXIT	

M SCURCL

```

*INPUT PARAMETERS
*INDIC INDICATES THE TYPE OF BLOCK TO BE TESTED IF 'N'-AN ATTRIBUTE
*BLOCK OF A NOTION, V-A BLOCK OF A VALUE LIST
*STADDR CONTAINS THE START ADDRESS OF THE CHAIN OF BLOCKS CONCERNED
*CELL CONTAINS THE ADDRESS OF A CELL IN THE BLOCK TO BE TESTED
*OUTPUT PARAMETERS
*NONE. INDIC IS UNCHANGED
*DESCRIPTION: TSTBLK ROUTINE
*AFTER MASKING THE FLAG BITS OF THE ADDRESS IN CELL, INDIC IS TESTED TO
*SEE WHICH TYPE OF BLOCK IS TO BE TESTED. IF IT IS AN ATTRIBUTE BLOCK AN
*PROVES TO BE ONE OF THE 1ST TWO BLOCKS OF THE NOTION CONTROL RETURNS
*TO THE CALLING ROUTINE SINCE THESE BLOCKS REMAIN WHILE THE NOTION
*EXISTS, THE SAME APPLIES TO THE 1ST BLOCK OF A VALUE LIST WHICH REMAINS
*WHILE THE ATTRIBUTE EXISTS
*IF NEITHER OF THE ABOVE IS THE CASE THE CHAIN IS SCANNED UNTIL THE
*BLOCK TO BE TESTED IS FOUND. EACH CELL OF THE BLOCK IS THEN SCANNED. IF
*A NON-EMPTY CELL IS FOUND CONTROL RETURNS TO THE CALLING ROUTINE IF
*THE BLOCK IS EMPTY BIT 24 OF THE STATISTICS OR COUNTER CELL (NOTION OR
*VALUE LIST) IS TESTED TO SEE IF THE CHAIN ALREADY CONTAINS AN EMPTY
*BLOCK. IF IT DOES, THE RETBLK ROUTINE IS CALLED TO RETURN THE CURRENT
*BLOCK TO THE FREE LIST, OTHERWISE THE BIT IS SET (=1) TO INDICATE THAT
*AN EMPTY BLOCK NOW EXISTS.
*CALLS: RETBLK
*CALLED BY: SIMSUP, SIMSUPR
TSTBLK  STM  8,11,TSTSAVE  STORE WORK REG CONTENTS
        N    CELL,MASK    REMOVE FLAGS
        CLI  INDIC,'N'    BLOCK IN MOTION OR VALUE LIST?
        BE  TSTNOT       NOTION->TSTNOT
        LR  11,STADDR    START OF CHAIN
        LA  10,16(11)    POINTER CELL OF 1ST BLOCK OF CHAIN
TSTBCOMP CR  CELL,10     BLOCK TO BE TESTED IS CURRENT ONE?
        BL  TSTBEND     YES->TSTBEND
TSTBEND  CLC  0(4,10),LSTPT  END OF LIST?
        BE  TSTBERR     YES->ERROR
        ST  10,TSTPTR    SAVE ADDR OF POINTER CELL
        L   11,0(10)    NEXT BLOCK
        LA  10,16(11)    POINTER CELL

        B   TSTBCOMP
TSTERR  ERRCALL  ERRM10   ERROR MESSAGE AND TERMD
TSTBEND  LR  0,11        ADDRESS OF NEXT BLOCK
        CR  9,STADDR    1ST BLOCK OF VALUE LIST IS NEVER
        BE  TSTBEMP     REMOVED
        LA  8,4         LOOP CONTROL
TSTBLOOP CLC  0(4,9),EMPTY  CELL EMPTY?
        BNE TSTBEMP     NO->TSTBEMP
        LA  9,4(9)     NEXT CELL
        BCT 8,TSTBLOOP
        TM  0(STADDR),X'10'  DOES EMPTY BLOCK ALREADY EXIST?
        BO  TSTBRET     YES->TSTBRET

        OI  0(STADDR),X'10'  INDICATE EMPTY BLOCK EXISTS

```

M SOURCE

TSTBNEMP	LM	8,11,TSTBSAVE	RESTORE WORK REGS
	BR	LINK	EXIT
TSTRET8	LR	ROOTAD,11	ADDR OF BLOCK,RETPLK PAPAM
	N	ROOTAD,MASK	MASK FLAG BITS
	L	10,TSTPTR	UPDATE CHAIN
	MVC	0(4,10),0(9)	TO EXCLUDE BLOCK REMOVED
	MVC	0(4,9),LSTPT	END OF CHAIN FOR RETPLK ROUTINES
	ST	LINK,TSTBSAVE+16	SAVE CURRENT RETURN ADDRESS
	BAL	LINK,RETBLK	CALL ROUTINE WHICH WILL RETURN GIVEN
			BLOCK TO FREELIST
	L	LINK,TSTBSAVE+16	RESTORE RETURN ADDRESS
	CLI	INDIC,'V'	VALUE LIST TESTED?
	BNE	TSTBNEMP	NO
	L	8,0(STADDR)	UPDATE COUNTER
	S	8,=F'4'	CELL OF
	ST	8,0(STADDR)	VALUE LIST
	B	TSTBNEMP	
TSTENCT	LA	11,36(STADDR)	ADDRESS OF POINTER CELL OF 2ND BLOCK
	CR	CELL,11	BLOCK TO BE TESTED ONE OF 1ST 2?
	PL	TSTBNEMP	YES->TSTBNEMP,THE 1ST 2 BLOCKS DO
			NOT COUNT
			POINTER CELL
	LR	10,11	
	B	TSTBEND	

M SOURCE

*INPUT PARAMETERS
 *NOBLCKS INDICATES THE NO OF (CONTIGUOUS) BYTES TO BE ALLOCATED
 *NEWADD CONTAINS THE ADDRESS TO WHICH THE NEW BLOCK(S) WILL BE CHAINED,
 *(PROVIDES A BASE FOR THE SEARCH)
 *OUTPUT PARAMETERS
 *NEWADD CONTAINS THE START ADDRESS OF THE NEW BLOCK(S)
 *NOELCKS IS UNCHANGED
 *DESCRIPTION:GETBLK ROUTINE
 *THE ADDRESS IN NEWADD IS USED TO GET THE FREE LIST HEADER CELL OF THE
 *PAGE REQUESTING NEW BLOCK(S).IF THE PAGE IS FULL THE PAGETABLE IS
 *SEARCHED FOR ANOTHER PAGE BELONGING TO THE SAME 3-GRAPH SECTION AND
 *NOT FULL.IF THERE IS NO SUCH PAGE AVAILABLE THE REQM SYSTEM MACRO IS
 *USED TO ALLOCATE A NEW PAGE TO THE PROGRAM.THE NEW PAGE IS INITIALISED
 *AND ENTERED IN PAGETAB.
 *ONCE A PAGE WITH ROOM AVAILABLE IS FOUND,NOBLCKS (PARAMETER) IS TESTED
 *TO SEE HOW MANY 20-BYTE BLOCKS ARE REQUIRED.IF ONLY 1 BLOCK IS WANTED
 *THE 1ST BLOCK OF THE FREE LIST IS EXTRACTED AND INITIALISED,THE FREE
 *LIST HEADER(AND PAGETABLE,IF NECESSARY) IS UPDATED AND CONTROL RETURNS
 *TO THE CALLING ROUTINE
 *IF 2 BLOCKS ARE NEEDED THINGS ARE MORE COMPLICATED,SINCE THE BLOCKS
 *MUST BE PHYSICALLY CONTIGUOUS AND THERE MAY NOT BE 2 SUCH BLOCKS IN THE
 *FREE LIST OF THE 1ST PAGE AVAILABLE,WITH THE RESULT THAT THE PAGETABLE
 *MAY HAVE TO BE SEARCHED MORE THAN ONCE AND EVENTUALLY A PGM MAY BE
 *REQUIRED.
 *CALLS:0
 *CALLED BY:FNDVALSU,FNDATSUB,SIMCKEN,SIMREP,SIMTMV,SIMLAT
 GETBLK STM 9,11,GETBSAVE SAVE WORK REG CONTENTS
 *NOTE:SAVE AREA=4 WORDS,1 WORD NEEDED IN ROUTINE
 SRL NEWADD,12 ISOLATE
 STC NEWADD,PAGENO PAGE NO
 SLL NEWADD,12 FORM FREE LIST
 O NEWADD,FRLSTAD HEADER ADDRESS
 XR 9,9 ZERO REG 9, DETERMINES INITIALISATION
 * OF TRT INSTRUCTION
 CLC O(4,NEWADD),EMPTY PAGE FULL?
 BE GETBFDPG YES->GETBFDPG
 GETBCLI CLI NOBLCKS,X*28* 1 OR 2 BLOCKS REQUIRED?
 BE GETB2P 2 BLOCKS->GETB2P
 *EXTRACT TOP BLOCK FROM FREE LIST AND INITIALISE
 GETB1B L 11,0(NEWADD) ADDRESS OF 1ST BLOCK IN FREE LIST
 L 10,16(11) ADDRESS OF 2ND BLOCK OR LSTPT
 LR WKREG1,11
 LA WKREG2,4 INITIALISE
 GETB1IN MVC O(4,WKREG1),EMPTY
 LA WKREG1,4(WKREG1) NEW
 BCT WKREG2,GETB1IN
 MVC O(4,WKREG1),LSTPT BLOCK
 C 10,LSTPT PAGE NOW FULL?
 BE GETBPGFL YES->GETBPGFL
 ST 10,0(NEWADD) UPDATE FREE LIST HEADER

M SOURCE

```

GETDEXIT LR NEWADD,11 RETURN ADDRESS OF NEW PLOCK
          LM 9,11,GETBSAVE RESTORE WORK REGS
          BR LINK EXIT
GETPPGFL MVC 0(4,NEWADD),EMPTY UPDATE FREE LIST HEADER
          XR WKREG1,WKREG1
          IC WKREG1,PAGENO
          A WKREG1,APAGETAB INDICATE
          NI 0(WKREG1),X'FE' PAGE FULL
          B GETBEXIT
*SEARCH FREE LIST OF PAGE FOR TWO CONTIGUOUS BLOCKS
GETB2B L 11,0(NEWADD) ADDRESS OF 1ST BLOCY IN FREE LIST
        LA 11,16(11) ADDRESS OF POINTER CELL
        LA 10,4(11) ADDRESS OF BLOCK CONTIGUOUS TO 1ST
        L WKREG1,0(11) MASK FLAGS
        N WKREG1,MASK BEFORE COMPAPISON

        CR 10,WKREG1 CONTIGUOUS BLOCK ALSO FREE?
        PE GETB2FND YES->GETB2FND
        C WKREG1,LSTPT END OF LIST?
        BE GETE2NO YES->GETE2NO
        LR NEWADD,11 SAVE POINTER CELL ADDRESS
        B GETB2B
GETE2NO XR 11,11 FORM FREE LIST
        IC 11,PAGENO HEADER ADDRESS
        O 11,FRLSTAD OF ORIGINAL PAGE
        CR 11,NEWADD STILL IN ORIGINAL PAGE?
        BNE GETB2REP NO->GETB2REP
        XR 9,9 ZERO REG 9, DETERMINES INITIALISATION
        * OF TRT INSTRUCTION
        B GETBFDPG
GETB2REP LA 9,1(9) INCR REG 9, TRT TO CONTINUE FROM LAST
        * POSITION SAVED
        B GETBFDPG
*EXTRACT CONTIGUOUS BLOCKS FROM FREE LIST AND INITIALISE
GETB2FND S 11,=F'16' ADDRESS OF NEW PLOCKS

        L 10,16(10) ADDRESS OF FOLLOWING BLOCY
        LA 9,2 LOOP CONTROL
        LR WKREG1,11 INITIALISE
GETB2INN LA WKREG2,4 LOOP CONTROL
GETE2IN MVC 0(4,WKREG1),EMPTY INITIALISE
        LA WKREG1,4(WKREG1)
        BCT WKREG2,GETB2IN
        L WKREG1,0(WKREG1)
        BCT 9,GETE2INN
        MVC 36(4,11),LSTPT BLOCKS
        C 10,LSTPT PAGE NOW FULL?
        BE GETPPGFL YES->GETPPGFL
        ST 10,0(NEWADD) UPDATE FREE LIST

        B GETBEXIT
*SEARCH PAGE TABLE FOR PAGE IN SAME SECTION WITH FREE LIST

```

M SOURCE

GETBFDPG	XR	11,11	
	XR	WKREG1, WKREG1	
	IC	WKREG1, PAGENO	GET PAGE TABLE
	A	WKREG1, APAGETAB	ENTRY FOR ORIGINAL
	IC	11,0(WKREG1)	PAGE (SECTN NO *2)
	LA	11,1(11)	(SECTNNO*2)+1=OFFSET IN TRTTAB
	A	11,=A(TRTTAP)	+ BASE ADDRESS
	MVI	0(11),X'FF'	INITIALISE TRTTAB
	LTR	9,9	1ST TRT FOR THIS PAGE?
	BZ	GETBFRST	YES->GETBFRST
	L	1,GETESAVE+12	ADDR TRT STOPPED AT LAST TIME
	LA	1,1(1)	NEW START ADDRESS
	L	10,APAGETAB	NEW
	LA	10,256(10)	
	SR	10,1	TRT
	STC	10,GETBTRT+1	LENGTH
GETBTRT	TRT	0(256,1),TRTTAB	TEST FOR NON-FULL PAGE
	BC	8,GETBREQM	
	ST	1,GETESAVE+12	STORE HALT ADDRESS
	S	1,APAGETAB	GET PAGE NO
	SLL	1,12	FORM
	O	1,FRLSTAD	FREE LIST
	LR	NEWADD,1	HEADER ADDRESS
	MVI	0(11),X'00'	RESET TRTTAB
	B	GETBCLI	
GETBFRST	L	1,APAGETAB	INITIALISE
	MVI	GETBTRT+1,X'FF'	TRT
	B	GETBTPT	
*GET NEW PAGE AND INITIALISE IT			
GETBREQM	REQM	1	
*ALLOCATES 1 PAGE OF VIRTUAL MEMORY, ADDRESS RETURNED IN REG 1, ERROR			
*CODES IN REG 15			
	LTR	15,15	REQM CARRIED OUT?
	BZ	GETBRQOK	YES->GETBRQOK
	ERRCALL	ERRMESS3	ERROR MESSAGE AND TERM'D
GETBRQOK	MVI	0(11),X'00'	RESET TRTTAB
	LR	11,1	ADDRESS OF NEW PAGE
	LA	WKREG1,204	NO OF BLOCKS IN PAGE(LOOP CONTROL)
GETBINPG	LA	WKREG2,4	NO OF CELLS IN BLOCK
GETBLOOP	MVC	0(4,11),EMPTY	INITIALISE
	LA	11,4(11)	BLOCK
	BCT	WKREG2,GETBLOOP	
	LA	10,4(11)	POINTER CELL
	ST	10,0(11)	INITIALISED
	LA	11,4(11)	NEXT BLOCK
	BCT	WKREG1,GETBINPG	
	S	11,=F'4'	LAST POINTER
	MVC	0(4,11),LSTPT	CELL IN PAGE
	LA	11,4(11)	FREE LIST HEADER
	ST	1,0(11)	INITIALISED

M SOURCE

LR	NEWADD, 11	ADDRESS OF FREE LIST HEADER
LA	WKREG1, 3	INITIALISE
GETBLO MVC	4(4, 11), EMPTY	LAST
LA	11, 4(11)	CELLS IN
BCT	WKREG1, GETBLO	PAGE
XR	WKREG2, WKREG2	ZERO WORK
XR	WKREG1, WKREG1	REGS
IC	WKREG1, PAGENO	GET SECTN NO(12) OF ORIGINAL
A	WKREG1, APAGETAB	PAGE, ALSO SECTN NO OF NEW PAGE
IC	WKREG2, 0(WKREG1)	+1: INDICATES FREE LIST NOT EMPTY
LA	WKREG2, 1(WKREG2)	
SLL	1, 12	ISOLATE PAGE NO
SRL	1, 24	OF NEW PAGE
A	1, APAGETAB	
STC	WKREG2, 0(1)	ENTRY FOR NEW PAGE IN PAGETAB
E	GETBCLI	

M SOURCE

*INPUT PARAMETERS
 *VALADD CONTAINS THE REQUIRED NOTION'S ADDRESS
 *ATADD CONTAINS THE ADDRESS OF THE VALUE CELL POINTING TO THE LIST TO
 *BE SEARCHED.
 *OUTPUT PARAMETERS
 *VALADD CONTAINS THE ADDRESS OF THE CELL CONTAINING THE REQUIRED NOTION
 *OR 'LSTPT' IF THE SEARCH HAS FAILED
 *C(ATADD) MAY BE CHANGED DURING ROUTINE.
 *DESCRIPTION: FNDVALSU ROUTINE
 *THE VALUE LIST INDICATED IS SCANNED CELL BY CELL TO SEE IF THE NOTION
 *SPECIFIED IN VALADD IS PRESENT. IF IT IS, THE ADDRESS OF THE CELL THAT
 *CONTAINS IT IS RETURNED TO THE CALLING ROUTINE. IF THE SCAN FAILS THE
 *ROUTINE CHECKS VALADD TO SEE IF AN EMPTY CELL IS REQUIRED. IF SO THE
 *GETBLK ROUTINE IS CALLED TO ALLOCATE A NEW BLOCK WHICH IS CHAINED TO
 *THE EXISTING ONE BEFORE THE ADDRESS OF THE 1ST CELL IN THE NEW BLOCK
 *IS PASSED BACK TO THE CALLING ROUTINE OTHERWISE THE ROUTINE RETURNS
 *'LSTPT' TO INDICATE FAILURE.
 *CALLS: GETPLK
 *CALLED BY: SIMCREN, SIMCRER, SIMSUPR, SIMTAV, SIMLAT
 FNDVALSU STM 10,11,FNDVSAVE WORK REGS
 L 10,0(ATADD) START OF VALUE LIST

 ST VALADD,VALZONE STOCK ADDRESS OF NOTION REQUIRED
 LA 10,4(10) SKIP COUNTER CELL
 LA 11,3 LOOP CONTROL
 FNDVCOMP CLC 1(3,10),VALZONE+1 VALUE REQUIRED?(IGNORE FLAGS)
 BE FNDVFND YES->FNDVFND
 LA 10,4(10) NEXT CELL
 BCT 11,FNDVCOMP
 CLC 0(4,10),LSTPT END OF LIST?
 PE FNDVFAIL YES->FNDVFAIL
 L 10,0(10) ADDRESS OF NEXT BLOCK
 LA 11,4 LOOP CONTROL
 B FNDVCOMP
 FNDVFAIL C VALADD,EMPTY EMPTY CELL REQUIRED?

 BE FNDVGBLK YES->FNDVGBLK
 L VALADD,LSTPT REPORT FAILURE
 FNDVEXIT LM 10,11,FNDVSAVE RESTORE WORK REGS
 BR LINK EXIT
 FNDVFND LP VALADD,10 ADDR OF CELL CONTAINING VALUE REQ
 B FNDVEXIT
 FNDVGBLK GBLCK FNDVSAVE+8,10,ATADD,VALADD
 *SET UP PARAMETERS AND CALL GETELK ROUTINE
 B FNDVEXIT

M SOURCE

*INPUT PARAMETERS
 *ROOTAD CONTAINS START ADDRESS OF NOTION CONCERNED
 *NATADD CONTAINS ADDRESS OF NOTION WHICH IS NATURE OF ATTRIBUTE WANTED
 *OUTPUT PARAMETERS
 *ATADD CONTAINS ADDRESS OF VALUE CELL OF ATTRIBUTE FOUND OR 'LSTPT' IF
 *SEARCH FAILED
 *ROOTAD, NATADD UNCHANGED
 *IF NATURE OF ATTRIBUTE WANTED WAS SPECIAL, THE ADDRESS OF THAT ATTRIBUTE
 *IN THE ROOT NOTION IS RETURNED IN ADDSAVE.
 *DESCRIPTION: FNDATSUB ROUTINE
 *AFTER MASKING THE FLAG BITS IN NATADD, THE ROUTINE TESTS TO SEE IF THE
 *ATTRIBUTE REQUIRED IS ONE OF THE SPECIAL ONES, IF SO THE VALUE CELL OF
 *THE ATTRIBUTE IS TESTED, IF IT IS EMPTY THE ROUTINE REPORTS FAILURE,
 *OTHERWISE IT RETURNS THE VALUE CELL'S ADDRESS IN ATADD.
 *WHEN THE ATTRIBUTE REQUIRED IS NOT A SPECIAL ONE THE ATTRIBUTE BLOCKS
 *ARE SCANNED UNTIL AN ATTRIBUTE IS FOUND WITH THE GIVEN NATURE (IN WHICH
 *CASE THE ADDRESS OF THE CORRESPONDING VALUE CELL IS RETURNED) OR THE
 *END OF THE NOTION IS REACHED. IF THIS HAPPENS NATADD IS TESTED TO SEE
 *IF AN EMPTY ATTRIBUTE IS REQUIRED IN WHICH CASE THE GETBLK ROUTINE IS
 *CALLED AND AN EXTRA BLOCK IS ADDED TO THE NOTION, THE ADDRESS OF AN
 *EMPTY VALUE CELL IS THEN RETURNED TO THE CALLING ROUTINE, OTHERWISE THE
 *ROUTINE REPORTS FAILURE.
 *CALLS: GETBLK
 *CALLED BY: SIMCREN, SIMCRER, SIMSUP, SIMSUPR, SIMTMV, SIMPEP
 FNDATSUB STM 10, 11, FNDASAVE SAVE WORK REG CONTENTS
 *NOTE: SAVE AREA=3 WORDS, 1 WORD NEEDED IN ROUTINE

	N	NATADD, MASK	MASK FLAG BITS
	C	NATADD, =A(ARG4)	ATTR REQUIRED ONE OF SPECIAL ATTR?
	BNH	FNDASPEC	YES->FNDASPEC
	LA	11, 36(ROOTAD)	POINTER CELL OF 2ND BLOCK
FNDALoop	LA	10, 2	LOOP CONTROL
	CLC	0(4, 11), LSTPT	END OF NOTION?
	BE	FNDAFAIL	YES->FNDAFAIL
	L	11, 0(11)	ADDRESS OF NEXT BLOCK
FNDACOMP	L	WKREG1, 0(11)	NATURE OF ATTR
	N	WKREG1, MASK	MASK FLAGS
	CR	NATADD, WKREG1	NATURE OF ATTR REQUIRED?
	BE	FNDAFND	YES->FNDAFND
	LA	11, 8(11)	NEXT ATTRIBUTE
	BCT	10, FNDACOMP	
	B	FNDALoop	
FNDAFND	LA	ATADD, 4(11)	ADDRESS OF VALUE CELL OF ATTRIBUTE
FNDAEXIT	LM	10, 11, FNDASAVE	RESTORE WORK REGS
	BR	LINK	EXIT
FNDAFAIL	C	NATADD, EMPTYMSK	EMPTY ATTRIBUTE REQUIRED?
	BE	FNDAGPLK	YES->FNDAGPLK
FNDANOAT	L	ATADD, LSTPT	REPORT FAILURE
	B	FNDAEXIT	
FNDASPEC	LR	10, NATADD	NATURE OF ATTRIBUTE REQUIRED
	LA	11, SPATTAB	TABLE-SPECIAL ATTRIBUTE ADDRESSES

M SOURCE

FNDAC	C	10,0(11)	ATTRIBUTE WANTED?
	BE	FNDAOFFS	YES
	LA	11,4(11)	NO:NEXT ATTRIBUTE
	B	FNDAC	
FNDAOFFS	S	11,=A(SPATTAB)	TABLE
	LA	11,4(11)	ADDRESS
	C	11,=F'16'	INTO
	BL	FNDATEST	OFFSET
	LA	11,4(11)	IN ROOT NOTION
FNDATEST	AR	11,ROOTAD	ADD ROOT NOTION ADDRESS
	ST	11,ADDSAVE	SAVE ADDR OF SPECIAL ATTRIBUTE
	CLC	0(4,11),EMPTY	ATTRIBUTE EXISTS?
	BE	FNDANCAT	NO->FNDANCAT
	LR	ATADD,11	ADDRESS OF VALUE CELL OF ATTRIBUTE
	B	FNDALXIT	
FNDAGBLK	GBLCK	FNDASAVE+8,11,RCOTAD,ATADD	
*ALLOCATE	EMPTY	BLOCK,CHAIN TO END	OF NOTION,RETURN ADDRESS OF BLOCK
	LA	ATADD,4(ATADD)	ADDRESS OF VALUE CELL
	D	FNDALXIT	

M SOURCE

*INPUT PARAMETERS
 *ROOTAD CONTAINS ADDRESS OF BEGINNING OF VALUE LIST
 *NOTSTEND CONTAINS ADDRESS OF CURRENT POSITION IN NOTSTACK
 *SW INDICATES THAT THE LIST BELONGS TO AN OCCDE ATTRIBUTE IF SET TO X'01
 *IT IS SET TO X'00' OTHERWISE
 *OUTPUT PARAMETERS
 *NOTSTEND CONTAINS (UPDATED) POSITION IN NOTSTACK
 *SW IS RESET TO X'00'
 *DESCRIPTION:RETVLST ROUTINE
 *AFTER INITIALISATION OF REGISTERS ETC;THE BLOCKS OF THE VALUE LIST ARE
 *SCANNED CELL BY CELL.AN EMPTY CELL IS SKIPPED.WITH A NON-EMPTY CELL
 *THE REFERENCE COUNTER OF THE NOTION REFERRED TO IN THE CELL IS
 *DECREMENTED.IF IT BECOMES ZERO THE NOTION IS ADDED TO THE STACK OF
 *NOTIONS (NOTSTACK) THAT NO LONGER EXIST AND WHOSE SPACE ALLOCATION CAN
 *BE RETURNED TO THE FREE LIST.IF THE CELL BELONGS TO AN 'OCCDE' VALUE
 *LIST IT IS TESTED FOR A BASIC ACTION OCCURRENCE IN WHICH CASE THE CELL
 *IS SKIPPED
 *AT THE END OF A BLOCK THE ROUTINE TESTS FOR THE END OF THE LIST.IF NOT
 *THE END IT TESTS WHETHER THE FOLLOWING BLOCK IS IN THE SAME PAGE AS THE
 *PREVIOUS ONES,IN WHICH CASE IT CARRIES ON WITH THE NEXT ONE.IF NOT,THE
 *PREVIOUS BLOCKS (ALL IN THE SAME PAGE) ARE RETURNED TO THE FREE LIST
 *OF THE PAGE BY THE RETBLK ROUTINE:BEFORE THE NEXT BLOCK IS DEALT WITH.
 *AT THE END OF THE VALUE LIST THE REMAINING BLOCKS ARE RETURNED TO THE
 *FREE LIST BEFORE EXIT FROM THE ROUTINE.
 *CALLS:RETVLST
 *CALLED BY:RETNOTSP
 RETVALST STM 8,11,PETVSAVE SAVE WORK REG CONTENTS
 CLI SW,X'01' OCCDE LIST?

*SW IS SET TO X'01' IF THE VALUE LIST BELONGS TO THE OCCDE ATTRIBUTE,TO
 *X'00' OTHERWISE

	BNE	RETVLA	NO->RETVLA
	MVI	SW,X'00'	RESET INDICATOR
	MVI	RETVSW+1,X'00'	BRANCH TO NOP
RETVLA	LA	11,4(ROOTAD)	ADDRESS OF 1ST CELL
	L	10,NOTSTEND	CURRENT POSITION IN STACK
	PAGNO	ROOTAD,PAGENO	INITIALISE CURRENT PAGE NO
	LA	9,3	LOOP CONTROL:3 CELLS IN 1ST BLOCK

*TREATMENT OF A BLOCK

RETVSW	B	RETVCELL	SWITCH
		TSTFLAG (BASIC,0(11),RETVNEXT)	
RETVCELL	CLC	0(4,11),EMPTY	CELL EMPTY
	BE	RETVNEXT	YES->
		TSTFLAG (OBJUN,0(11),RETVNEXT)	
		DECRF 11,RETVNEXT	

*DECREASE REFERENCE COUNT,IF 0 ADD NOTION TO STACK

RETVNEXT	LA	11,4(11)	ADDRESS OF NEXT CELL
	BCT	9,RETVSW	

*END OF BLOCK/END OF VALUE LIST

	CLC	0(4,11),LSTPT	END OF LIST?
	BE	RETVTERM	YES->RETVTERM
		CPAGE 11,PAGENO,RETVSAME,RETVSAVE+16	

M SOURCE

*IF BLOCK NOT IN SAME PAGE RETURN PRECEDING BLOCKS TO FREE LIST
 *OTHERWISE->RETVSAME

LR	11,ROOTAD	START ADDRESS
PAGNO	ROOTAD,PAGENO	NEW CURRENT PAGE NO
B	RETVSAME+4	
RETVSAME	L 11,0(11)	ADDRESS OF NEXT BLOCK
LA	9,4	4 CELLS/BLOCK:LOOP CONTROL
B	RETVSW	
*END OF VALUE LIST		
RETVTERM	ST LINK,PETVSAVE+16	RETURN
BAL	LINK,PETBLK	LAST BLOCKS
L	LINK,PETVSAVE+16	TO FREE LIST
ST	10,NOTSTEND	CURRENT POSITION IN STACK
MVI	RETVSW+1,X'FO'	BRANCH:SKIP BASIC ACTION TEST
LM	8,11,PETVSAVE	RESTORE REFS
BR	LINK	EXIT

M SOURCE

*INPUT PARAMETERS

*ROOTAD CONTAINS THE START ADDRESS OF THE NOTION WHOSE SPACE ALLOCATION
*IS TO BE RETURNED TO THE FREE LIST

*OUTPUT PARAMETERS

*NONE

*DESCRIPTION:PETNOTSB ROUTINE

*THE ROUTINE SCANS THE NOTION CHECKING THE CONTENTS OF EACH CELL.WHERE
*THE CELL REFERS TO A NOTION,THE REFERENCE COUNT OF THIS NOTION IS
*DECREMENTED.WHERE THE CELL POINTS TO A LIST OF VALUES,THE RETVALST
*ROUTINE IS CALLED TO REMOVE THE VALUE LIST.AN EMPTY CELL OR AN 'OCCDE'
*CELL CONTAINING A BASIC ACTION REFERENCE IS SKIPPED.WHEN,AT THE END OF
*A BLOCK,THE ROUTINE DETECTS A CHANGE OF PAGE FOR THE NEXT BLOCK IT
*CALLS THE RETBLK ROUTINE TO REMOVE THE BLOCKS ALREADY SCANNED BEFORE
*CONTINUING WITH THE NEXT BLOCK.AT THE END OF THE NOTION IT CALLS THE
*RETBK ROUTINE TO REMOVE THE REMAINING BLOCKS OF THE NOTION.
*EACH TIME A REFERENCE COUNT IS DECREMENTED TO 0 THE ADDRESS OF THE
*NOTION IS ADDED TO A STACK OF SUCH NOTIONS,THE ROUTINE CHECKS THIS
*STACK WHEN IT HAS FINISHED WITH 1 NOTION AND REMOVES,IN TURN,EACH
*NOTION ON THE STACK UNTIL IT IS EMPTY.'SPECIAL' NOTIONS ON THE STACK
*ARE NOT REMOVED FROM THE GRAPH.

*CALLS:RETVALST,RETBK

*CALLED BY:SIMSUP,SIMSUPR,SIMREP

*INITIALISATION

RETNOTSB STM 8,11,RETNSAVE SAVE WORK REG CONTENTS

*NOTE:SAVE AREA=6 WORDS,2 WORDS NEEDED FOR STORAGE BY ROUTINE

L 10,=A(NOTSTACK) INITIALISE NOTION STACK

MVC 0(4,10),=F'0' AND POINTER

RETNEEG PAGNO ROOTAD,PGNUMB INITIALISE PAGE NO

LA 11,4(ROOTAD) START OF SCAN

*REMOVE NAME BLOCK IF NOTION NAMED

NAMBLK ROOTAD,RETN10C,KEY,DICT,RETNSAVE+16

*TREATMENT OF 1ST TWO BLOCKS

RETN10C LA 8,2 2 BLOCKS,LOOP CONTROL

LA 9,3 3 CELLS IN 1ST BLOCK,LOOP CONTROL

*OCCDE CELL

TSLIST 11,,RETN1EA OCCDE LIST?

MVI SW,X'01' YES,SET FLAG

RETN1LST RETVC RETNSAVE+16,0,11 CALL RETVALST

R RETN1SKP

RETN1EA TSTFLAG (BASIC,0(11),RETN1SKP) IF BASIC ACT OCC->SKIP

RETN1EMP CLC 0(4,11),EMPTY CELL EMPTY?

BE RETN1SKP YES

DECRF 11,RETN1SKP DECREASE REF COUNT

RETN1OBJ TSTFLAG (OBJUN,0(11),RETN1SKP) IF OBJ OF UN ->SKIP

TSLIST 11,RETN1LST,RETN1EMP IF LIST->RETN1LST,ELSE->RETN1SKP

RETN1SKP LA 11,4(11) NEXT CELL

BCT 9,RETN1OBJ

L 11,0(11) ADDR NEXT BLOCK

LA 9,4 LOOP CONTROL:4 CELLS/BLOCK

BCT 8,RETN1OBJ

M SOURCE

	LA	11,36(ROOTAD)	PTR CELL TO REST OF NOTION
	B	RETNPTR	
*ORDINARY BLOCK			
RETNVAL	B	RETNNAT	SWITCH
		TSLIST 11,,RETNOBJ	LIST?NO->RETNOBJ
	MVI	SW,X'00'	NOT OCCDE LIST
	RETVC	RETNSAVE+16,0,11	CALL RETVALST
	B	PETNSKIP	
RETNOBJ		TSTFLAG (OPJUN,0(11),RETNSKIP)	IF OBJ OF UN->SKIP
RETNNAT	CLC	0(4,11),EMPTY	CELL EMPTY?
	BE	RETNSKIP	YES->SKIP
	DECRF	11,RETNSKIP	DECREASE REF COUNT
RETNSKIP	LA	11,4(11)	NEXT CELL
	XI	RETNVAL+1,X'F0'	FLIP SWITCH
	PCT	9,RETNVAL	
RETNPTR	CLC	0(4,11),LSTPT	END OF NOTION?
	BE	RETNTERM	YES
	CPAGE	11,PGNUMB,RETNSAME,RETNSAVE+16	
*IF CHANGE OF PAGE RETURN PREVIOUS BLOCKS TO FREE LIST			
	LR	11,ROOTAD	NEXT BLOCK
	PAGNO	ROOTAD,PGNUMB	CURRENT PAGE NO
	B	RETNSAME+4	SKIP UPDATE
RETNSAME	L	11,0(11)	NEXT BLOCK
	LA	9,4	LOOP CONTROL:4 CELLS/BLOCK
	B	RETNVAL	LOOP
*END OF NOTION			
RETNTERM	ST	LINK,RETNSAVE+16	SAVE CURRENT RETURN ADDRESS
	BAL	LINK,PETBLK	RETURN LAST BLOCKS TO FREE LIST
	L	LINK,RETNSAVE+16	
	CLC	HOTSTACK,=F'0'	STACK OF NOTIONS EMPTY?
	BNE	RETNOTST	NO->RETNOTST
	LM	8,11,RETNSAVE	WORK REGS
	BR	LINK	EXIT
RETNOTST	SH	10,=H'4'	REMOVE TOP
	L	ROOTAD,0(10)	ENTRY OF STACK
	MVC	0(4,10),=F'0'	REINITIALISE STACK
	LA	ROOTAD,0(ROOTAD)	REMOVE FLAG BITS
	C	ROOTAD,=A(ARG4)	DO NOT REMOVE
	BNH	RETNOTST	'SPECIAL' NOTIONS
	B	RETNBEG	

SOURCE

*INPUT PARAMETERS
 *ROOTAD CONTAINS ADDRESS OF NOTION
 *OUTPUT PARAMETERS
 *ATADD CONTAINS ADDRESS OF VALUE CELL OF ATTRIBUTE CHOSEN
 *NATADD CONTAINS ADDRESS OF NOTION WHICH IS NATURE OF ATTRIBUTE CHOSEN
 *ROOTAD IS UNCHANGED
 *DESCRIPTION:CHRATSUB ROUTINE
 *THE NOTION INVOLVED IS SCANNED TO DISCOVER IF IT HAS ANY ATTRIBUTES,
 *(IF NOT THEN 'NIL' IS RETURNED TO THE CALLING ROUTINE);B)COUNT THE NO
 *OF POSSIBLE ATTRIBUTES.AS SOON AS AN ATTRIBUTE IS FOUND SCAN A) IS
 *ABANDONED.WHEN THE END OF THE NOTION IS REACHED THE TASK CPU TIME IS
 *OBTAINED AND DIVIDED BY THE COUNT OF SCAN B) THIS PRODUCES A 'RANDOM' NO
 *WHICH IS USED TO PICK OUT AN ATTRIBUTE OF THE NOTION,(IF THE ATTRIBUTE
 *IS ONE OF THE SPECIAL ONES A DIFFERENT TECHNIQUE IS USED),IF THE ATTR
 *IS NON-EMPTY ITS VALUE CELL ADDRESS AND NATURE ARE PASSED BACK TO THE
 *CALLING ROUTINE.OTHERWISE A NEW 'RANDOM' NO IS GENERATED,ETC.IF, AFTER
 *3 NOS HAVE BEEN GENERATED,AN ATTRIBUTE HAS NOT BEEN FOUND THE FSTATSUP
 *ROUTINE IS CALLED TO SEARCH SYSTEMATICALLY FOR ONE
 *CALLS:FSTATSUP(2 ENTRY POINTS)
 *CALLED BY:SIMLAT

CHRATSUB	STM	8,11,CHRASAVE	SAVE WORK REG CONTENTS
*NOTE:SAVE AREA=5 WORDS,1 WORD NEEDED IN ROUTINE			
	LA	NATADD,3	INIT TRY COUNT
	XR	8,8	INITIALISE ATTR COUNT
	LR	11,ROOTAD	START ADDRESS OF NOTION
	LA	9,2	LOOP
CHRATEST	LA	10,3	CONTROLS
	LA	11,4(11)	NEXT CELL
	CLC	0(4,11),EMPTY	EMPTY?
	BNE	CHRAEMP	NO->CHRANLMP
	BCT	10,CHRATEST	
	LA	11,4(11)	POINTER CELL
	LA	10,4	LOOP CONTROL
	BCT	9,CHRATEST	
	LA	8,7	ATTRIBUTE COUNT:7 SPECIAL ATTR
CHRAEND	CLC	0(4,11),LSTPT	END OF NOTION?
	BE	CHRALNPT	YES->CHRAEMP
	L	11,0(11)	ADDRESS OF NEXT BLOCK
	LA	10,4	LOOP CONTROL
CHRATST	CLC	0(4,11),EMPTY	CELL EMPTY?
	BNE	CHRAEMP	NO->CHRANLMP
	LA	11,4(11)	NEXT CELL
	BCT	10,CHRATST	
	LA	8,2(8)	ATTR COUNT:+2 ATTR/BLOCK
	B	CHRAEND	
CHRAEMP	L	NATADD,EMPTY	RETURN NIL AS NATURE AND
	LR	ATADD,NATADD	ADDRESS OF ATTR (NO ATTR)
	LM	8,11,CHRASAVE	RESTORE PEGS
	BR	LINK	EXIT
CHRANLMP	LTR	8,8	NON-EMPTY ATTRIBUTE IN 1ST 2 BLOCKS?

SOURCE

	BNZ	CHRACONT	YES->CHRACONT
	MH	10,=H'4'	MOVE TO POINTER
	AR	11,10	CELL OF CURRENT BLOCK
	LA	8,2(8)	ATTR COUNT:+2 ATTR/BLOCK
CHRACLC	CLC	0(4,11),LSTPT	END OF NOTION?
	BE	CHPAGEN	YES->CHPAGEN
	L	11,0(11)	MOVE TO POINTER
	LA	11,16(11)	CELL OF NEXT BLOCK
	LA	8,2(8)	ATTR COUNT:+2 ATTR/BLOCK
	B	CHRACLC	
CHRACONT	LA	11,36(ROOTAD)	POINTER CELL OF 2ND BLOCK
	LA	8,7	ATTR COUNT:+7 SPECIAL ATTR
	B	CHRACLC	
CHRAGEN	TMODE	TASKINFO	TASK INFORMATION
	L	10,TASKINFO+24	CPU TIME
	SRDA	10,32	INITIALISE FOR DIVISION
	DP	10,8	DIVIDE BY NO OF ATTRIBUTES
	LA	10,1(10)	REMAINDER BETWEEN 1 & NO OF ATTR
	C	10,=F'7'	SPECIAL ATTR?
	BNH	CHRASPEC	YES->CHRASPEC
	S	10,=F'8'	-(NO OF SPEC ATTR +1)
	LA	9,36(POCTAD)	GET ADDRESS OF
	L	9,0(9)	3RD BLOCK
	SRDA	10,32	INITIALISE FOR DIVISION
	D	10,=F'2'	DIVIDE BY NO OF ATTR/BLOCK
	LTR	11,11	SKIP 0 BLOCKS?
	BZ	CHRAMVE	YES->CHRAMVE
CHRASKIP	LA	9,16(9)	SKIP TO
	L	9,0(9)	BLOCK
	BCT	11,CHRASKIP	CHOSEN
CHRAMVE	MH	10,=H'8'	OFFSET TO CHOSEN ATTR
	AR	9,10	ADDRESS OF CHOSEN ATTR
	CLC	0(4,9),EMPTY	CELL EMPTY?
	BE	CHRARETR	YES->CHRARETR
	LA	ATADD,4(9)	ADDR OF VALUE CELL OF CHOSEN ATTR
	L	NATADD,0(9)	NATURE OF CHOSEN ATTR
	LM	8,11,CHRASAVE	RESTORE REGS
	BR	LINK	EXIT
CHRARETR	BCT	NATADD,CHRAGEN	UP TO 3 TRIES
	ST	LINK,CHRASAVE+16	SAVE CURRENT RETURN ADDRESS
	SR	9,10	ADDRESS OF LAST
	LR	11,9	BLOCK TRIED
	BAL	LINK,FSTATSUB	CALL ROUTINE TO SCAN NOTION AND
*RETURN	ADDRESS	OF FIRST NON-EMPTY	ATTRIBUTE IN REG 11
CHRARET	LR	ATADD,11	ADDRESS OF ATTRIBUTE
	L	LINK,CHRASAVE+16	RESTORE RETURN ADDRESS
	LM	8,11,CHRASAVE	RESTORE REGS
	BR	LINK	EXIT

M SOURCE

CHRASPEC	LR	11,10	NO OF ATTR CHOSEN
	MH	11,=H*4'	CONVERT TO
	CH	11,=H*16'	OFFSET IN NOTION
	FL	CHRALDAT	TO ATTRIBUTE
	AH	11,=H*4'	CHOSEN
CHRALDAT	AP	11,ROCTAD	ADDR OF ATTR CHOSEN
	CLC	0(4,11),EMPTY	ATTR EXISTS?
	RNE	CHRALNAT	YES->CHRALNAT
	ECT	NATADD,CHRAGEN	UP TO 3 TRIES
	STM	8,10,FSTASAVE	INITIALISE FOR
	LA	0,1	FSTATSUB,FSTAREG ENTRY POINT
	LR	11,ROCTAD	PARAM FOR FSTATSUB
	ST	LINK,CHRASAVE+16	SAVE CURRENT RETURN ADDRESS
	DAL	LINK,FSTAREG	CALL ROUTINE TO SCAN FOR 1ST NON-
		*EMPTY ATTRIBUTE,RETURNING ADDRESS	IN REG 11

	B	CHPARET	
CHRALNAT	LR	ATADD,11	ADDR OF ATTR
	RCTR	10,0	CALCULATE OFFSET
	MH	10,=H*4'	IN SPATTAB FOR
	A	10,=A(SFATTAD)	ADDRESS OF
	L	NATADD,0(10)	NATURE OF ATTR
	LM	8,11,CHRASAVE	RESTORE REGS
	ER	LINK	EXIT

* SOURCE

*ERROR MESSAGE OUTPUT, FROM ERRCALL MACRO

WRGOUT WRGOUT (1)
ERR TERM0WRPAPAM DS A OPTION CODE AND MESSAGE ADDRESS
DS C RESERVED
DC AL3(ERR) ERROR EXIT

*IOAREA FOR DICTIONARY

INARLA DS 0F
DS UCL12
DC CL8

DATA DS CL4

*SAVE AREAS FOR REGISTERS IN ROUTINE NAMED

REPSAVE DS 2F

*SAVE AREAS NEVER USED SIMULTANEOUSLY WITH REPSAVE

COMPSAVE EQU REPSAVE

CRENSAVE EQU REPSAVE

CPERSAVE EQU REPSAVE

IFOUSAVL EQU REPSAVE

LATSAVE EQU REPSAVE

SUCCSAVE EQU REPSAVE

SUPSAVE EQU REPSAVE

SUPPSAVE EQU REPSAVE

TMVSAVE EQU REPSAVE

RETHSAVE DS 6F

*SAVE AREAS NEVER USED SIMULTANEOUSLY WITH RETNSAVE

GETSAVE EQU RETNSAVE

PARLSAVE EQU RETNSAVE

FANSAVE EQU RETNSAVE

CHRSAVE EQU RETNSAVE

TSTSAVE EQU RETNSAVE

RETVSAVE DS 6F

*SAVE AREAS NEVER USED SIMULTANEOUSLY WITH RETVSAVE

ENDASAVE EQU RETVSAVE

ENDVSAVE EQU RETVSAVE

FSTASAVE EQU RETVSAVE

FSTVSAVE EQU RETVSAVE

PITSAVE DS 2F

*SAVE AREAS FOR 3-GRAPH CELL CONTENTS

NATSAVE DS F

VALSAVE DS F

ADDSAVE DS F

VALZONE DS F

*ARGUMENTS USED IN SIMULATION ROUTINES

FSTARC DS F

SNDARG DS F

THDARG DS F

FTHARG DS F

*TABLE OF ADDRESSES OF SPECIAL NOTIONS

* SOURCE

SPATTAB DC A(OCCDF)
 DC A(SUC1)
 DC A(SUC2)
 DC A(ARG1)
 DC A(ARG2)
 DC A(ARG3)
 DC A(ARG4)

*TABLE OF BASIC ACTION SIMULATION ROUTINES

SIMTAB DC A(SIMCOMP)
 DC A(SIMCPEN)
 DC A(SIMIFOU)
 DC A(SIMLAT)
 DC A(SIMREP)
 DC A(SIMSUP)
 DC A(SIMSUP)
 DC A(SIMSUPR)
 DC A(SIMTMV)
 DC A(SIMCRER)
 DC A(#ATHALT)

I/O HALT POINT ENTRY

TASKINFO DS CL28
 *SPECIAL CELL VALUES IN 3-GRAPH
 EMPTY DC X'FFFFFFF'
 LSTPT DC X'FFFFFFF'

ZONE FOR TMODE SYSTEM MACRO

FPLSTAD DS OF
 DC XL4'FFU'

*MASKS IN CONNECTION WITH FLAG BITS

EMPTYMSK DS OF
 DC X'00FFFFFF'

MASK DS OF
 DC X'00FFFFFF'

NOTSTACK DS 10F
 *

STACK FOR ACTIONS NO LONGER REFERENCED

NOTSTEND DC A(NOTSTACK)
 STACK DC 50X'FFFFFFF'

STACK FOR PARALLEL SUCCESSOR ACTIONS

STCKPTR DC A(STACK)
 *EXTRN ADDRESSES
 APAGETAB DC A(PAGETAB)
 *WORK ZONES

TSTPTR DS F
 TTTAB DC 256X'00'

M SOURCE

VALFND	DC	X'0C'
SW	DC	X'00'
SAVE	DC	X'00'
PCNUMB	DS	C
PAGENO	DS	C
NOFLCKS	DS	C
INDIC	DS	C
WORK	DS	C
DWORD	DS	00
	DC	PL8'0'
*MESSAGES TO USER		
RLPLY	DC	CL12'
ASK	DC	X'0035404001'
	DC	'PLEASE GIVE NAME OF FIRST ACTION TO BE SIMULATED'
ERRMESS2	DC	X'002B404000'
	DC	'AN ACCESSED NOTION IS COMPLETELY EMPTY'
ERRMESS3	DC	X'003D404000'
	DC	'REQM NOT CARRIED OUT, FURTHER EXPANSION IMPOSSIBLE'
ERRMESS4	DC	X'002C404000'
	DC	'NOT ENOUGH ROOM LEFT IN SUCCESSOR STACK'
MLSS	DC	X'0039404000'
	DC	'STACK OF NOTIONS TO BE RETURNED TO FREE LIST IS FULL'
ERRM10	DC	X'002A404000'
	DC	'ERROR IN PARAMETERS TO TSTELK ROUTINE'
END		SIMULATE

M SOURCE

```

TITLE '3-GRAPH INPUT/OUTPUT ROUTINES'
#USERINT CSUCT
FRINT NOGEM
EXTRN NEXTACT AFTER HALT POINT RESUME AT NEXTACT
EXTRN SPATTAB SPECIAL ATTRIBUTE NATURE ADDRESSES
EXTRN FNDATSUB, BASE FOR GETATTR MACRO
ENTRY #ATHALT ENTRY WHEN HALT POINT REACHED
ENTRY #RDATA IORETURN AFTER ERROR MESSAGES

*
BR1 EQU 3 BASE REGISTER
BR2 EQU 4 SIMULATOR BASE REGISTER (GETATTR)
WREG1 EQU 14 SHORT TLRM
WREG2 EQU 15 WORK REGISTERS
CURRADD EQU 12 CURRENT POSITION IN 3-GRAPH
ATADD EQU 5 ATTRIBUTE ADDRESSES
NATADD EQU 6 NATURE OF ATTRIBUTE (GETATTR)
ROOTAD EQU 7 ROOT OF ATTRIBUTE (GETATTR)
PTR EQU 6 CURRENT POSITION IN OUTPUT LINE
LENG EQU 7 LENGTH OF NEXT ITEM IN OUTPUT LINE
VALITP EQU 11 POSITION IN VALUE LIST
LINK EQU 13 LINKS BETWEEN ROUTINES
INDEX EQU 10 INDEX REGISTER
TRUE EQU X'01' BOOLEAN 'TRUE'
LIST EQU X'40' VALUE LIST FLAGS
BASIC EQU X'80' BASIC ACTION OCCURRENCE
NAMFL EQU X'80' NAMED NOTION FLAGS
USING #USERINT, 15 STANDARD LINKAGE
STM 13, 11, #SAVEREG SAVE USER REGISTERS EXCEPT 12
(CURRADD)
*
LA BR1, #RDATA NEW
USING #RDATA, BR1 BASE
DROF 15 REGISTER
*REQUEST INSTRUCTION FROM USER
#RDATA MVI #REQDATA, ' ' REINITIALISE
MVC #REQDATA+1(21), #REQDATA ZONE
RDATA #REQUEST, #RDALPR, 26

```

M SOURCE

```

*
*ANALYSE INSTRUCTION
*
#INSCHK  CLC  #REQDATA(3),='AT '  AT?
          BNE  #INSEP              NO->
          FNDNAME #REQDATA+3,#NOTION,#TRTTAB
*NAME OF NOTION ISOLATED AND STORED IN #NOTION
          LA   INDEX,4
          B    #INSTAB(INDEX)      BRANCH TO AT ROUTINE
*
#INSEP   CLC  #REQDATA(3),='ER '  ER?
          BNE  #INSRES            NO->
          FNDNAME #REQDATA+3,#NOTION,#TRTTAB
*ISOLATE NOTION NAME AND STORE IN #NOTION
          LA   INDEX,8
          B    #INSTAB(INDEX)      BRANCH TO ER ROUTINE
*
#INSRES  CLI  #REQDATA,'R'        R?
          BNE  #INSD              NO->
          LA   INDEX,12
          B    #INSTAB(INDEX)      BRANCH TO R ROUTINE
*
#INSD    CLC  #REQDATA(2),='D '  D?
          BNE  #INSERR            NO->ERROR
          FNDNAME #REQDATA+2,#ROOT,#TRTTAB
*ISOLATE NAME OF NOTION AND STORE IN #ROOT
*REG 1 CONTAINS LENGTH OF NAME STORED IN #ROOT
          A    1,=#A(#REQDATA+3)  ADDRESS END OF NAME
          CLC  0(4,1),=' OF '     2ND TYPE OF D?
          LA   INDEX,16
          BNE  #INSTAB(INDEX)      NO->BRANCH TO D ROUTINE
          MVC  #NATURE,#RCOT       YES, SWITCH 1ST NOTION NAME TO
                                   #NATURE
*
*ISOLATE 2ND NOTION NAME AND RETURN IN #ROOT
#DISPAT  FNDNAME 4(1),#ROOT,#TRTTAB
          LA   INDEX,20
          B    #INSTAB(INDEX)      BRANCH TO DISPLAY ATTR ROUTINE
*
*ERROR ROUTINES
#PDAERR  L    WREG1,='F'-12'      -12
          AR   WREG1,15           +ERROR CODE
          BZ   #PDAERR1          =0->READ TRUNCATION
          ERRCALL #RDAM2         OTHER ERROR CODES
*
#PDAERR1 WRRR #RDAM1             ERROR MESSAGE AND RETURN TO #RDATA
*ERROR IN USER INSTRUCTION
#INSERR  WRRR #ANALERR          ERROR MESSAGE AND RETURN TO #RDATA
*
*BRANCH ADDRESSES TO OUTPUT ROUTINES
*
#INSTAB  NOP  *                MINIMUM OFFSET=4
          B    #SETHALT          SET HALT POINT
          B    #BRANCH           BRANCH TO NOTION GIVEN
          B    #RESUME           RESUME SIMULATION
          B    #PRINT            PRINT NOTION
          B    #PRINTF           PRINT ATTRIBUTE

```


* SOURCE

```

*
*PRINT ATTRIBUTE ROUTINE
*USER GIVES D <NOTION NAME1> OF <NOTION NAME2>
*ANALYSIS PROVIDES NAME OF ROOT NOTION (NOTION NAME2) IN #ROOT AND NAME
*OF NATURE NOTION (NOTION NAME1) IN #NATURE
*ROUTINE OUTPUTS THE PCOT,NATUPE AND ALL VALUES OF THE GIVEN ATTRIBUTE,
*THEN RETURNS TO #RDATA FOR FURTHER INSTRUCTION
*
#PRATTTR GETADD #ROOT,#ROOTADD,#NOFIND
      GETADD #NATURE,#NATADDR,#NOFIND
*GET ADDRESSES OF ROOT AND NATURE NOTIONS IN #ROOTADD AND #NATADDR RESP
      GETATTR #ROOTADD,#NATADDR,ATADD
*FIND ATTRIBUTE ASKED FOR
      C      ATADD,LSTPT          ATTR EXISTS?
      BE     #NOATTR           NO->
*INITIALISE OUTPUT ZONE POINTERS
      LA     PTR,#OUTZONE        POSITION AND
      LA     LENG,8              LENGTH OF 1ST NAME
      PUTNAM PTR,#ROOT,LENG
*PUTS NAME OF ROOT NOTION IN OUTPUT ZONE
      PUTNAM PTR,#NATURE,LENG
*PUTS NAME OF NATURE NOTION IN OUTPUT ZONE
      TSLIST ATADD,#VALST        LIST OF VALUES->#VALST
*ONE VALUE ONLY
      GETNAM ATADD,#NOTION,NIL
*GETS NAME OF VALUE NOTION IN #NOTION
      PUTNAM PTR,#NOTION,LENG
*PUTS NAME OF VALUE NOTION IN OUTPUT ZONE
      PUTLINE #OUTLINE,PTR,#TERMD
*WRITE LINE TO SYSOUT FILE
      B      #RDATA              LOOP
*VALUE LIST
#VALST  L      VALPTR,0(ATADD)   START OF LIST
      BAL     LINK,#NEXTVAL      ROUTINE TO OUTPUT VALUE LIST
      B      #RDATA              LOOP
*NO ATTRIBUTE
#NOATTR WRERR #NOATTRM         ERROR MESSAGE AND RETURN TO #RDATA

```

M SOURCE

```

*
*PRINT NOTION ROUTINE
*USER GIVES D <NOTION NAME>
*ANALYSIS GIVES NAME OF ROOT NOTION IN #ROOT
*ROUTINE OUTPUTS ALL NON-EMPTY ATTRIBUTES OF THE NOTION THEN RETURNS TO
*#RDATA FOR FURTHER INSTRUCTION
*
#PRINT GETADD #ROOT,#ROOTADD,#NOFIND
*GET ADDRESS OF ROOT NOTION IN #ROOTADD
    LA    LENG,8          INITIALISE OUTPUT
    LA    PTR,#OUTZONE    ZONE POINTERS
    PUTNAM PTR,#ROOT,LENG
*PUTS NAME OF ROOT NOTION IN OUTPUT ZONE
*
*INITIALIZATION FOR OUTPUT OF SPECIAL ATTRIBUTES
    L     ATADD,#ROOTADD    ADDR OF
    LA    ATADD,4(ATADD)    OCCDE CELL
    L     8,=(SPATTAB)      1ST ENTRY IN SPATTAB
    LA    9,3                LOOP CONTROL:3 CELLS IN 1ST BLOCK
    LA    10,2               LOOP CONTROL:2 SPEC ATTR BLOCKS
#SPATLO OUTATT ATADD,#NXTCEL,#SPLIST,SPEC,8
*OUTPUT SPECIAL ATTRIBUTE AT ATADD,IF NONE->#NXTCEL,IF LIST->#SPLIST

    LA    PTR,9(PTR)        REINITIALISE POINTER IN OUTPUT ZONE
#NXTCEL LA    ATADD,4(ATADD) NEXT CELL
    LA    8,4(B)           NEXT ENTRY IN SPATTAB
    ECT   9,#SPATLO
*END OF A BLOCK
    L     ATADD,0(ATADD)    NEXT BLOCK
    LA    0,4              LOOP CONTROL:4 CELLS IN 2ND BLOCK
    ECT   10,#SPATLO
*END OF SPECIAL ATTRIBUTES
    C     ATADD,LSTPT      END OF NOTION?
    BE    #ENENOT         YES->
    B     #ATTR           NO->CONTINUE
*SPECIAL ATTRIBUTE VALUE LIST
#SPLIST L     VALPTR,C(ATADD) START OF LIST
    LAL   LINK,#NEXTVAL   ROUTINE TO OUTPUT VALUE LIST
    B     #NXTCEL         NEXT CELL
*
*OTHER ATTRIBUTES OF ROOT NOTION
*
#ATTR   LA    9,2          LOOP CONTROL:2 ATTR/BLOCK
*                               ATADD ASSUMED OK
#NEXTATT OUTATT ATADD,#SKIPATT,#LISTV,NORM
*OUTPUT NEXT ATTRIBUTE,IF EMPTY->#SKIPATT,IF LIST->#LISTV
    LA    PTR,9(PTR)        REINITIALISE POINTER
    LA    ATADD,4(ATADD)    NEXT ATTRIBUTE
    ECT   9,#NEXTATT
*END OF BLOCK

```


M SOURCE

```

#ENDEL   CLC   0(4,ATADD),LSTPT   END OF NOTION?
          BE   #ENDNOT           YES->#ENDNOT
          L    ATADD,0(ATADD)     NO:ADDRESS OF NEXT BLOCK
          P    #ATTR

*
#SKIPATT LA   ATADD,8(ATADD)     NEXT ATTRIBUTE
          BCT  9,#NLXTATT
          B    #ENDEL

*
*LIST OF VALUES
#LISTV   L    VALDTP,0(ATADD)    START OF LIST
          BAL  LINK,#NEXTVAL     ROUTINE TO OUTPUT VALUE LIST
          LA   ATADD,4(ATADD)     NEXT ATTRIBUTE

          BCT  9,#NEXTATT
          B    #ENDEL

*END OF NOTION
#ENDNOT  CLI  #OUTZONE, ' '     LINE EMPTY?
          BE   #RDATA           YES->EXIT
          PUTLINE #OUTLINE,PTR,#TERMD NO->OUTPUT LINE

          B    #RDATA

```

N SOURCE

```

*INPUT PARAMETERS
*VALPTR CONTAINS START ADDRESS OF VALUE LIST
*PTR INDICATES CURRENT POSITION IN OUTPUT LINE
*OUTPUT PARAMETERS
*PTR IS REINITIALIZED FOR A NEW OUTPUT LINE
*DESCRIPTION: #NEXTVAL ROUTINE
*THE ROUTINE GETS OR CREATES THE NAME FOR EACH ELEMENT IN THE LIST AND
*STORES IT IN THE OUTPUT LINE. WHEN THE LINE IS FULL AND/OR IT REACHES
*THE END OF THE LIST THE ROUTINE OUTPUTS THE CURRENT LINE AND REINITIAL
*IZES THE OUTPUT ZONE.
*CALLS: 0
*CALLED BY: #PRINOT, #PRATTTR
*
#NEXTVAL ST      8, #NEXTSAV      SAVE WORK REGISTER
          LA      8, 3           NO OF CELLS/BLOCK
          LA      VALPTR, 4(VALPTR) NEXT (1ST) VALUE CELL
#TSEMP  CLC      0(4, VALPTR), EMPTY CELL EMPTY?
          BE      #SKIP         YES->#SKIP
          GETNAM VALPTR, #NOTION  NAME OF VALUE NOTION
          LENGTH #NOTION, LENG, #NROOM, #TRTTAE, PTR, #OUTZONE
*CALCULATES LENGTH OF NAME AND SETS #NROOM=1 IF NEW LINE NEEDED
          CLI     #NROOM, TRUE   NO ROOM?
          BE      #PUTL         NONE->
#PUTN   PUTNAM PTR, #NOTION, LENG
*PUTS NAME OF VALUE NOTION IN OUTPUT ZONE
#SKIP   LA      VALPTR, 4(VALPTR) NEXT CELL
          BCT     8, #TSEMP
*END OF BLOCK
          CLC     0(4, VALPTR), LSTPT END OF LIST?
          BE      #ENDOFLS      YES->
          L       VALPTR, 0(VALPTR) NEXT BLOCK
          LA      8, 4           NO OF CELLS/BLOCK
          B       #TSEMP       LOOP
*
#PUTL   PUTLINE #OUTLINE, PTR, #TERM  OUTPUT CURRENT LINE TO SYSOUT
          LA      PTR, 18(PTR)   RESET POINTER PAST ROOT, NATURE POS
          MVI     #NROOM, X'00'  RESET #NROOM
          B       #PUTN
*
#ENDOFLS PUTLINE #OUTLINE, PTR, #TERM  OUTPUT LAST LINE
          LA      PTR, 9(PTR)    PTP TO SKIP ROOT POSITION
          L       8, #NEXTSAV    RESTORE WORK REG
          BR      LINK          EXIT

```

M SOURCE

*SAVE AREAS

#SAVERLG	DS	16F	SIMULATOR REGS SAVE AREA
#NEXTSAV	DS	F	SAVE AREA,#NEXTVAL ROUTINE
#GETSAVE	DS	2F	SAVE AREA,GETATTR MACRO

*INPUT/OUTPUT AREAS

#OUTLINE	DS	0CL120
	DC	X'0000404041'
#OUTZONE	DC	CL115'

#REQUEST	DS	0CL26	INPUT AREA
	DS	CL4	FOR USEP
#REQDATA	DS	CL22	INSTRUCTIONS

*ERROR MESSAGES

#RDAM2	DC	X'0026404000'
	DC	'RDATA ERROR AT #RDATA,TERMINATING'
#RDAM1	DC	X'002F404000'
	DC	'INPUT TRUNCATED,MESSAGE TOO LONG,RE-ENTER'
#RDATM	DC	X'0027404041'
	DC	'ATTRIBUTE REQUESTED DOES NOT EXIST'

#ANALERR	DC	X'0025404000'
	DC	'INSTRUCTION CANNOT BE IDENTIFIED'

*ZONES FOR NOTION NAMES

#NOTION	DC	CL8' '
#PCOT	DC	CL8' '
#NATURE	DC	CL8' '

*ZONES FOR NOTION ADDRESSES

#TEMP	DS	F
#FOOTABL	DS	F
#NATADDR	DS	F

*

#HALTPT	DS	F	SAVEAREA-HALT POINT
#HALT	DC	X'8FC00C28'	HALT POINT INDICATOR
#HALTMS	DC	X'000F404000'	HALT POINT MESSAGE
	DC	'HALT POINT'	

*BASIC ACTION TABLE

#BASACT	DC	'COMP'
	DC	'CREM'
	DC	' '
	DC	'LAT'
	DC	'REF'
	DC	'SUP'
	DC	' '
	DC	'SUPR'
	DC	'TMV'

M SOURCE

```

          DC      'CREK'

          DS      OF
EMPTY    DC      X'FFFFFFF'
LSTPT   DC      X'FFFFFFF'
#NRROOM DC      X'00'                ROOM-IN-LINE INDICATOR

#DWGRD   DS      OD
          DC      PL8'0'

*TRT TABLE FOR ISOLATING NOTION NAMES
#TRTTAB  DC      X'FF'

          DS      CL63
          DC      X'FF'

          DS      CL191
          ORG     #TRTTAB+1          REDEFINE UNUSED PART OF TABLE
*TR TABLE FOR CREATING NAMES
#TAB1    DC      X'FAFFFCFDFF'

          DS      CL41
          DC      '0123456789'

          ORG
*TR TABLE FOR NAMES->ADDRESSES (CETADD)
#TAB2    DC      '0123456789APCDEF'

*OUTPUT MESSAGES, EPICALL & WBERF MACRO CALLS
WROUT   WROUT (1)
LPR     TERMD

WRPARAF DS      A                PARAM LIST FOR WROUT
          DS      C
          DC      AL3(LEFR)
WROUTRET WROUT (1)
          L       #RDATA
#TERMD  TERMD

          END      #USERINT

```

