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The outputs consist of the machine-held forms of :-

a) all screen formats,
b) completed blocks,
c) connected links, and,
d) designated named paths.

Authoring may commence at any point after Stage 5 has been completed, although the longer this is delayed the more refined will be the structure. The process of authoring will, like the work of subject and domain investigation, suggest new connections and alternative organisations of material, especially if there is any re-interation through from Stage 4. Any changes may be checked against the designed structures and then incorporated or not.

Conclusions

From a general point of view the test application of the design method showed that it can be applied successfully. It provides very useful reference points during the investigatory and authoring activities that form the kernel of the process. In particular it safeguards against the premature or random accretion of linkages.

As it stands the method gives only token recognition to the iterative nature of the authoring process and its combination with the earlier stages of investigation and application modelling. The effect of this on each intervening stage needs to be examined. The characteristics of the test domain suggest that the results may be more generally valid and other subjects should be tested. The current method also has an inherent bias towards explanatory subjects involving either the creation or the recreation of subjects within a clearly structured domain. Further development work would be facilitated by the construction of a graphically based tool that simplifies and accelerates the necessary diagram making and checks the consistecy of the structures produced.

From the particular viewpoint of art history further testing of the full method might usefully concentrate on material from a much wider range of period and school. In its simplest form the design method may be used as general guidance, a checklist of actions, for those who might wish to develop their own experimental applications. A general case has been made for hypertext as a new multi-dimensional medium for communication which is particularly suitable for the presentation of entities with complex structures of form or meaning, in a sense a new means of contributing to their *rinascita* in a technological rather than Albertian context.

Acknowledgements

The authors would like to thank their colleagues and students for their suggestions and comments on the work reported above. Stephen Morris would like to thank the SERC for their support.

OUTPUT *from stage*	**INPUT** *to stage*								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1. Problem analysis and definition									
a) preliminary subject definition			•						
b) preliminary use and user definition		•							
c) constraints of cost, time etc.		•					•		
d) test criteria									•
e) lacks multi-dimensional character {• return to spec.}									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
2. User specification									
a) knowledge of subject					•	•			
b) knowledge of computers								•	
c) type of use					•	•	•	•	
d) frequency of use					•	•	•	•	
e) personal characteristics								•	
f) environment of use								•	
3. Subject and domain investigation									
a) contents for outline structure				•					
b) contents for domain structure				•					
c) contents for application structure					•				
d) contents for authoring									•
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
4. Modelling of domain structure									
a) domain structure diagram					•				
5. Modelling of application structure									
a) application structure diagram						•	•	•	•
6. Modelling of path structure									
a) path structure diagram(s)							•	•	•
7. Choice of implementation software								•	•
8. Design of carrier format and interface									
a) block formats									•
b) link and navigation system design									•
9. Authoring									

Figure 10 : Summary of outputs and inputs for stages of method

This includes both the manner in which the links will be manifested within blocks and any diagrams included to enable users easily to locate themselves within the structure.

The principle inputs come from Stage 2 (b - f) in the form of information about the users, from Stage 6 in the form of the link structure which may be reproduced in some form as a 'navigation' aid and from Stage 7 in the form of information about how the software will allow blocks and links to be represented.

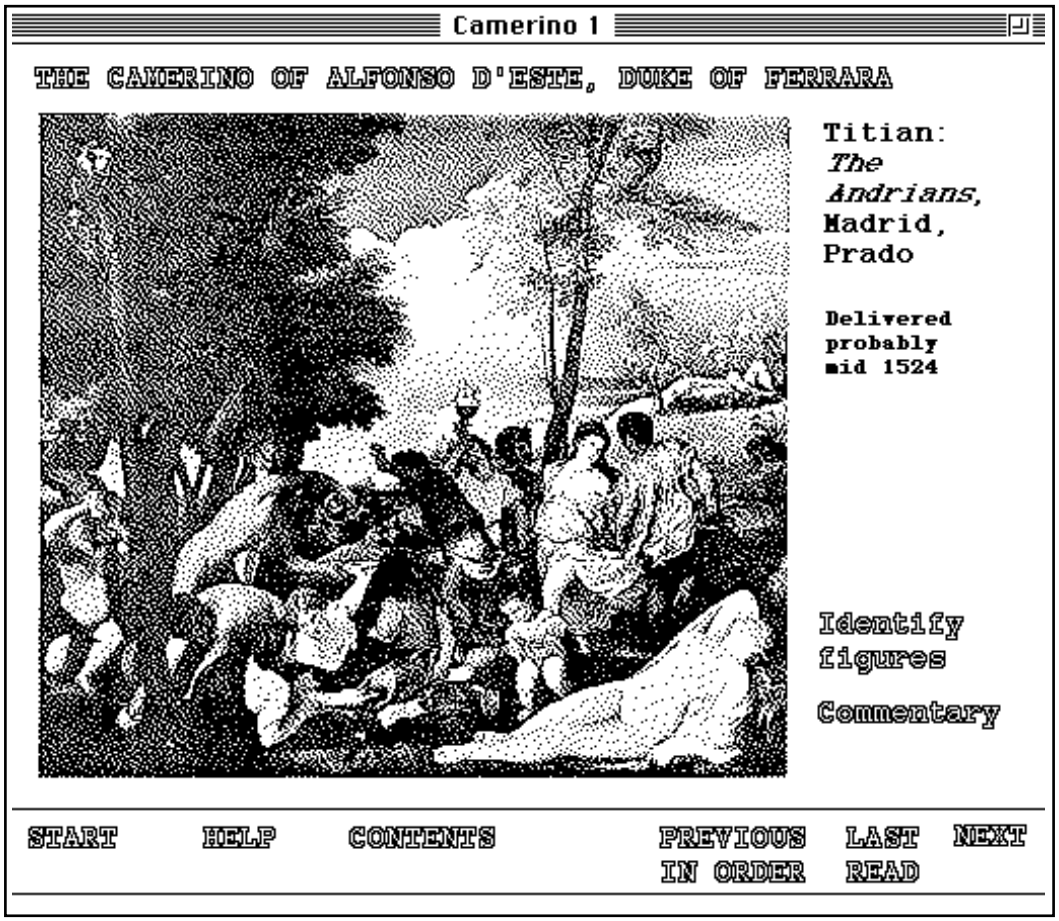

Figure 9 : Initial format for 'Probables' image card in Application 3

Stage 9 : Authoring

The objective of this final stage is to create the application in its final form. The major inputs to this stage come from Stage 3 which provides the content for the blocks identified as part of the application structure, from Stage 5 which provides the structure itself and from Stage 8 which produced the block and navigation designs.

implementations. Inputs come from the Stage 2 specifications of type and frequency of use and from the application and path structures

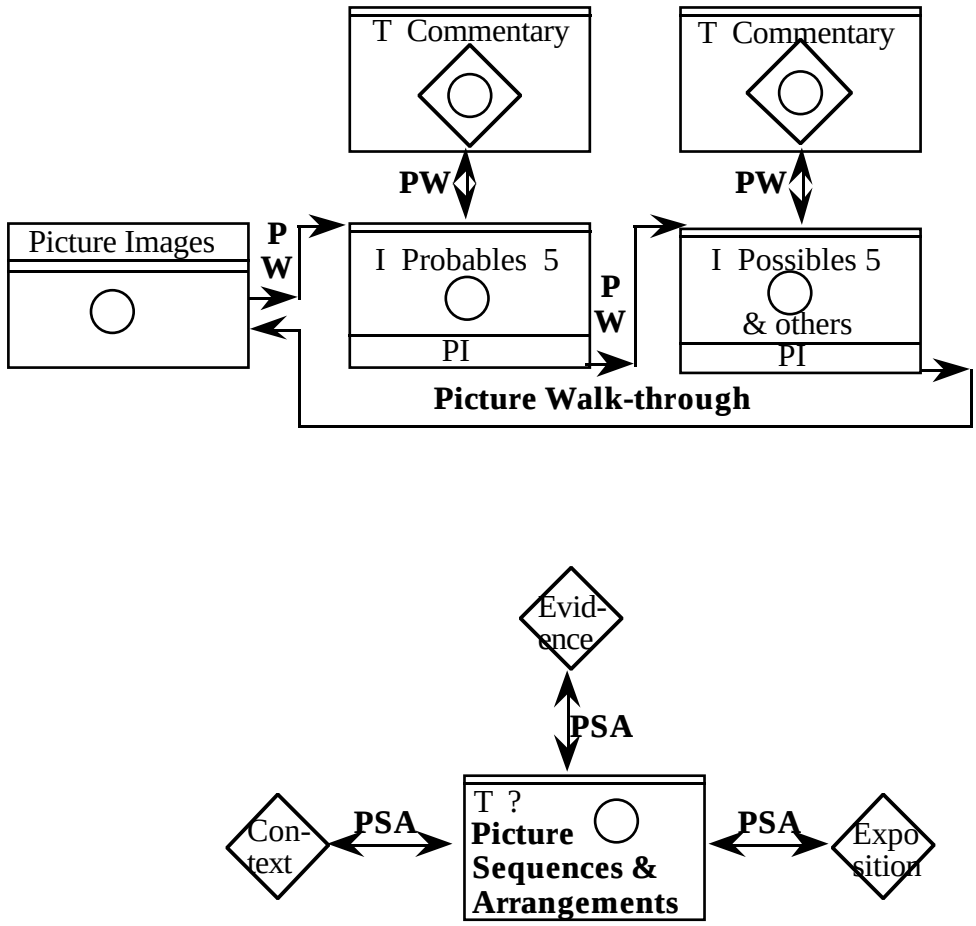

Figure 8 : Application 3 Stage 6 : Sample Path Structure Diagrams

Stage 8 : Design of Carrier Format and Interface

The objective of this eighth stage is to design the interface elements of the application to complement the database elements whose design was the end-product of Stage 5. This design has two major parts in its output :-

a) the display formats to be used for the presentation of each part of the database content of the application, and the carrier formats for each medium and type of block involved, and,
b) the display format for all the elements of the interface which perform in some way as the means for guiding the user through the database and the explanatory material, the 'navigation' system.

structure including explicit links and paths, it may be necessary to re-iterate Stages 4, 5 and 6 as additional information becomes available from the continuation of investigations in Stage 3.

The main output on completion of this stage, or of its re-iteration, will be a comprehensive diagram showing blocks and implicit links within the domain structure. Production begins with the identification of blocks, followed by the identification of the implicit links between them. This process is similar to that used for the identification of entities and relationships for relational databases.

Stage 5 : Modelling of Application Structure

The objective of this fifth stage is to prepare a comprehensive model of the structure to be made explicit in the application. The output from Stage 4, in the form of the domain structure, provides the essential input. The process involved has three parts :-

a) selection of those blocks that are to be included and, wherever possible, the decomposition of multiple blocks into their constituent individual blocks,
b) selection of the links that will be explicit, and,
c) choice of those links that will become blocks in their own right, the exegetic link blocks, because of the need for explicit explanation of the nature and significance of the link.

These choices are made on the basis of a combination of the understanding gained from the continuing work of Stage 3 with the selection criteria implicit in the expected level of user knowledge provided in Stage 2. The notation provides the format for the diagram that forms the output.

At this juncture it may be necessary to sub-divide diagrams, whilst ensuring that intermediary links are displayed. The exact positions of all embedded links within individual blocks still cannot be shown. Also embedded links within multiple blocks may remain, although a possible source of confusion, if they are to form part of a path specified in the next stage.

Stage 6 : Modelling of Path Framework

The objective of this sixth stage is to identify and name any specific paths through the application structure, making use of the notation provided. The nature of the paths will be determined by the requirements made by the specification of uses from Stage (a), (c) and (d). The essential input is the application structure diagram produced in Stage 5. The output consists of a diagram for each designated path; the only essential form of cross-referencing required is provide by the inclusion of all intersecting path names.

Stage 7 : Choice of Implementation Software

The objective of this seventh stage is to identify the type of software that will be most suitable for the application. The essential elements for consideration are :-

a) the nature of the nodes available and whether these will accommodate the types of blocks required and the media to be used,
b) the nature of the links that may be constructed, in particular whether they can be embedded within nodes as well as acting as external connections between them,
c) the availability of facilities particularly appropriate to the application, for example a path building tool if there are to be extended chains of links, and,
d) the flexibility offered for the design of the user interface.

These criteria apply equally to purpose-written software as to proprietary hypertext

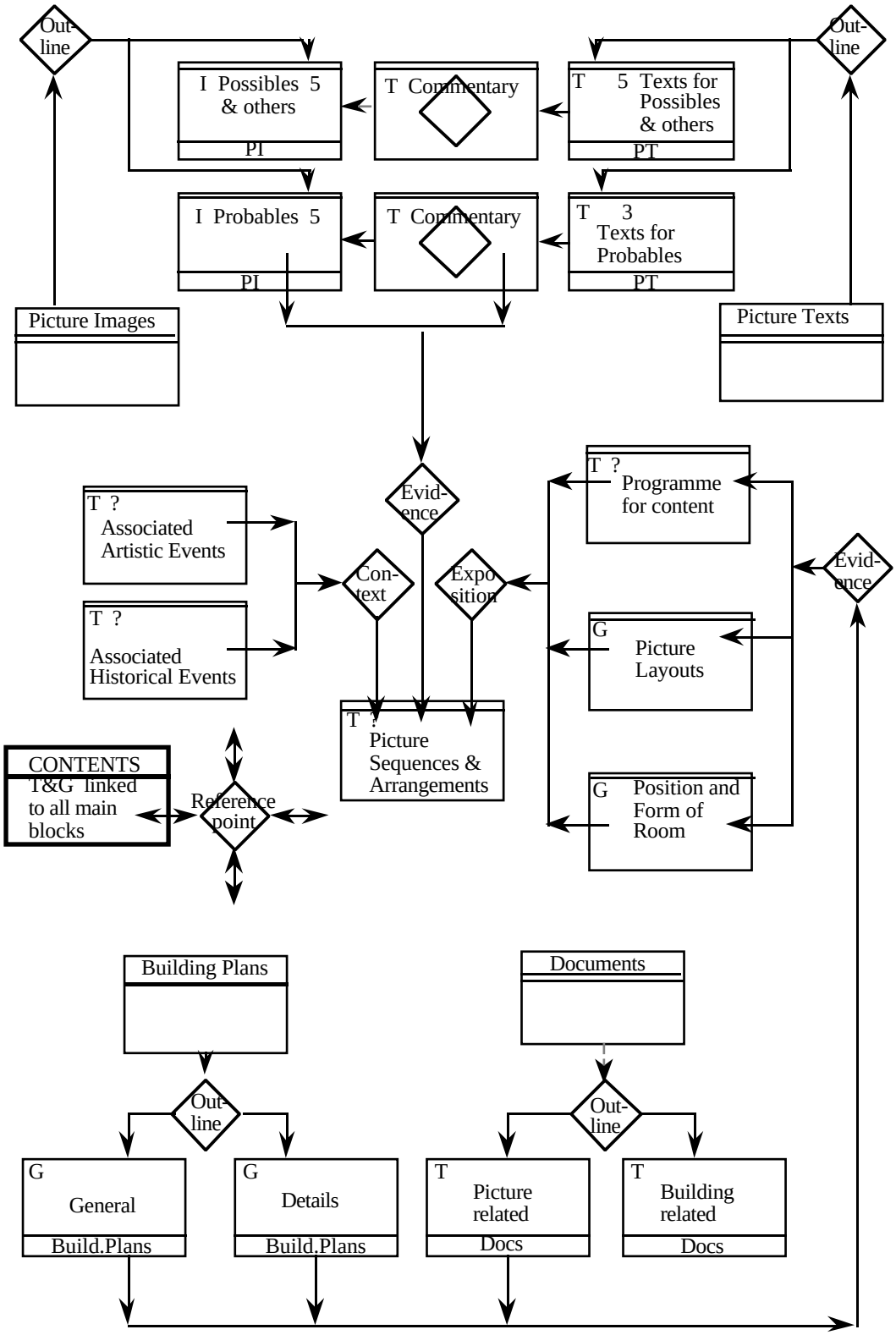

Figure 7 : Application 3 Stage 5 : Main Application Structure Diagram

d) a statement of the criteria by which the application will be judged satisfactory, and by whom.

In particular circumstances the output may merely consist of advice that the subject matter does not have sufficient multi-dimensional characteristics to justify the complications of an application in hypertext.

Stage 2 : User Specification

The objective of this second stage is to clarify the definition of the potential users of the application and the uses that they may make of it. The initial input is provided by Stage 1 (b).

The basic elements of the output are detailed statements about :-

a) user knowledge of the subject matter, measured on some arbitrary scale or related to specific aspects of the domain,
b) user knowledge of computers and hypertext, in particular experience with likely hardware,
c) types of expected use, in particular related to the nature of the application as hypertext and the possibilities for browsing, searching, writing or some form of planned learning,
d) frequency of use, especially to estimate increased familiarity of frequent users,
e) personal characteristics of users, including factors such as position within the organisation for which the application is intended, and,
f) the environment of use, including cultural as well as physical factors.

Stage 3 : Subject and Domain Investigation

The objective of this third stage is to provide the raw material from which the final content of the application will be distilled. The process involved is a repeating cycle of information gathering, analysis and conclusion. Stage 1 (a) provides the first essential input in the form of the preliminary definition of subject matter.

This stage provides outputs which will principally :-

a) act as an intermediary stage prior to the modelling of the domain structure, in the form of an outline structure without any regular format or standard notation,
b) determine which parts may be made explicit in some form, and,
c) provide the actual contents for the authoring stage in the form of text, graphics, images, or any other medium that is to be included.

As these contents suggest, this stage may run concurrently with the remaining stages providing different input for each. In a more refined method this third stage might therefore be subdivided and the inputs and outputs for each be made more specific.

Stage 4 : Modelling of Domain Structure

The objective of this fourth stage is to translate the subject content, as initially provided via Stage 3 (a), into a model of the domain structure that is closely related to a form in which it may be reproduced by software. This can be achieved using the type of standard format and notation described above.

The minimum requirement is a complete set of blocks, even if the specific size of some multiple blocks may not yet be determined, with the implicit links between thm. The level of detail should be determined by the level of development of the application. It is assumed that, following the completion of the next two stages and the production of a draft application

Interface

Given a potentially highly complex database and the possibility of creating a large number of different paths through it, the means provided for a user to gain access to this database, its interface, becomes a critical feature. Its importance is enhanced by the prospect of hypertext readers including those who are infrequent or non-specilist users whether by chance or intent, for example the casual museum visitor or the expert already pre-occupied with his or her own field.

The traditional physical form of the printed book provides many visual and even tactile clues to the position of the reader within the text and a variety of methods for finding the location, or absence, of any particular element of possible subject matter. Hypertext does not automatically provide any such clues although particular implementations may include facilities designed to meet a limited set of needs. Also the physical characteristics of the screen display used, in terms of size, proportion and colours, will have as powerful an effect on the reaction of the viewer as do the same characteristic of a printed book.

It is not the intention here to discuss the many issues involved with interface design. Works such as those of Sutcliffe (1988) and Shneiderman (1987) provide wide-ranging reviews. The most important principle to note is the need to take a user-centred approach that is based on a well understood user model or profile. Some details of the possible constituents of such a model are provided in Stage 2 of the method that follows.

6. Design Method

The emphasis of the method is upon structure and for this reason there is a close relationship with the notation proposed in the previous chapter. The tripartite division in the hierarchy of links is paralleled in the fourth, fifth and sixth stages of the method. Also the preparation of a user specification forms an essential early stage.

This method was tested using the Camerino of Alphonso D'Este as the subject matter for an application in Hypercard. The results for each stage were documented and small parts are reproduced here: from Stage 5 an initial application structure diagram (Figure 7), from Stage 6 a sample path structure diagram (Figure 8) and from Stage 8 a preliminary format design (Figure 9)

A summary of the outputs and inputs for each stage appears as Figure 10.

Stage 1 : Problem Analysis and Definition

The general objective of this stage is to provide a definition of the essential features of the proposed application in terms of its subject matter, its possible users and the environment within which it will operate. This may be information already available in the form of written specification; if not, the inputs will come from any combination of written proposals or statements of requirements and any material gathered directly from those commissioning the application.

The outputs will be :-

a) a preliminary definition of the subject matter and media involved,
b) a description of users and uses expected, in sufficient detail to begin a full user specification in Stage 2,
c) a statement of constraints in terms of time, cost, software and hardware as a basis for the choice of implementation method in Stage 7, and,

b) those links that may be used for a controlled or directed path through a structure.

The latter type (b) consist of what are here called ‘chained links’ or ‘paths’. The notation (Figure 6) uses a representation in which all the relevant blocks are represented with the addition of a small circle. This notation is intentionally similar to that used for the flow control models known as Petri nets. A summary consideration of this form of abstract virtual machine is given by Davis (1990).

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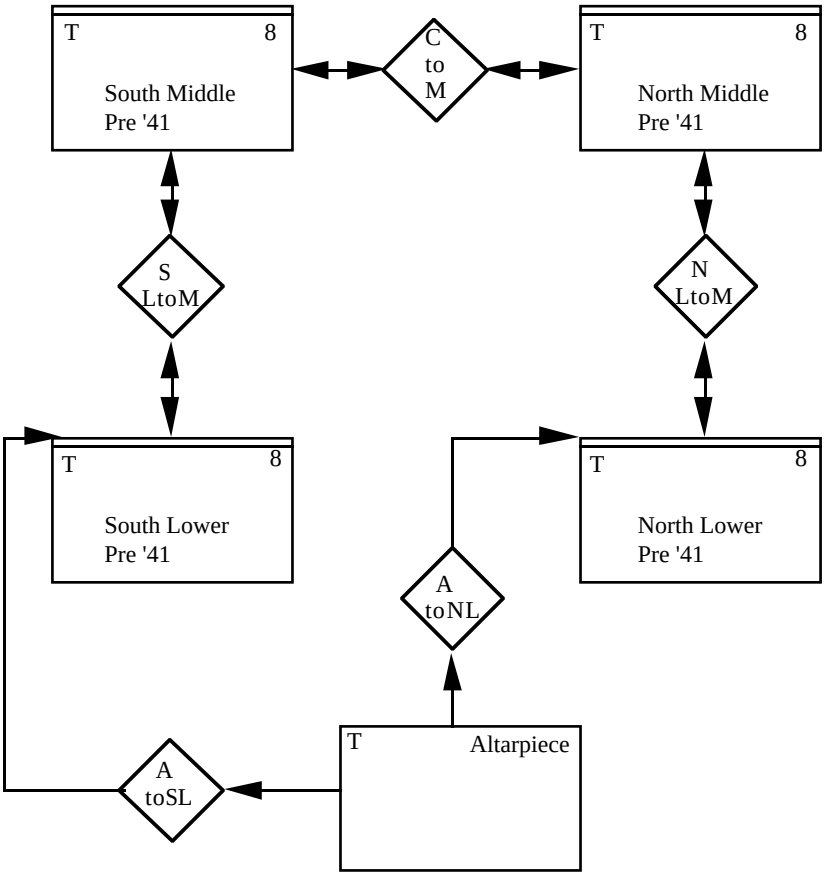

Figure 5 : Notation of relationships shown in Figure 1

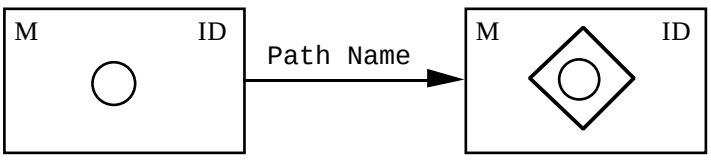

Figure 6 : Notation for chained links or paths

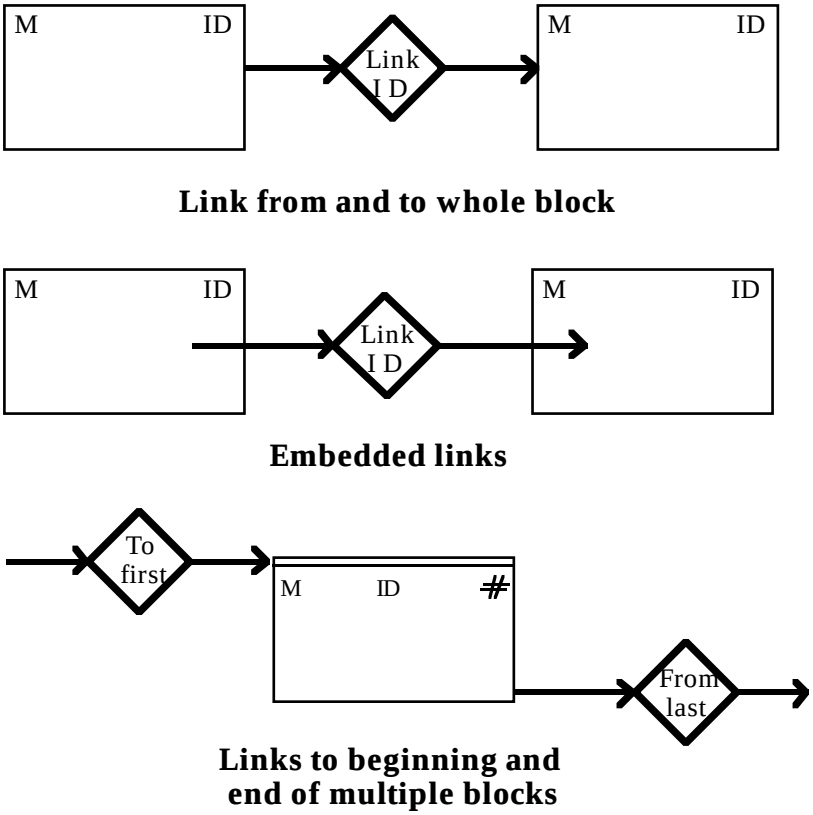

Figure 4 : Notations for links to and from whole blocks, for 'embedded' links, and for links to extremities of multiple blocks

Whilst the content of the subject domain may have been modelled accurately, this will in no way guarantee that it will be understood in its form or content. Any explanation, argument or narrative required to explain the transition from one block to the next must be included explicitly. In cases where a very high level of user knowledge of the subject is expected such material may form the major part of the application, exposition of a line of argument being the principal objective. In this process an existing explicit link, which would already have been identified as an essential relationship both within the domain and within the application, is transformed into a block in its own right. This takes the form of an 'exegetic link block'.

Paths

In some circumstances, for example in any form of application where a guided reading is required, it will be necessary to join links in the form of a chain or path to ensure that the contents are read and assimilated in a particular order. There is a general need therefore to distinguish between :-

a) series of explicit links which will always be available for browsing, and,

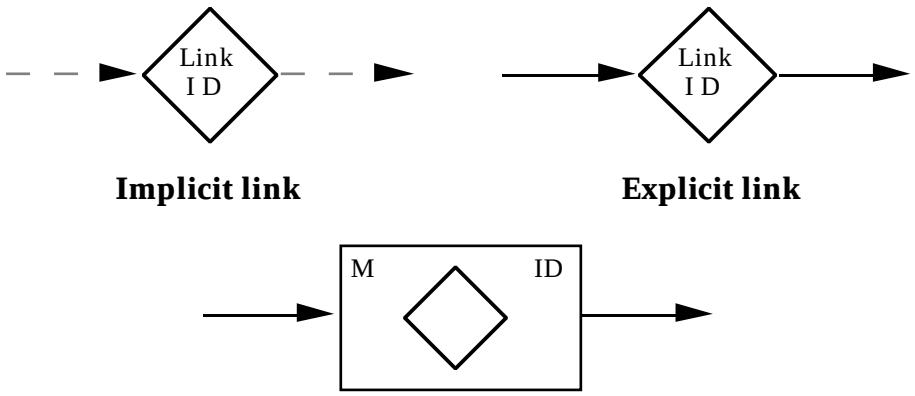

Figure 3 : Notation for basic links

Any bidirectional links must be identified explicitly. This is necessary to avoid confusion between links identified by the design process and those that may coincidentally be facilitiated by any particular hypertext implementation. Hypercard provides for continuous backtracking through previously viewed cards. Storyspace has only a limited facility to return down the most recent link, but no further unless a specific links happens to be available.

Explicit links

Implicit links identified within the subject domain are the essential foundation for the explicit links that will appear in the application itself. Blocks that are to form part of the explicit structure must not be left unattached without any explicit links available to the reader. This is the immediate impression given by some initial Storyspace displays, especially if the viewer is not familiar with the hierarchical structure and the means of passing through it. This problem implies the need for some kind of overall structure from which all links may originate.

Creation of explicit links will form the framework for any paths that a reader may follow. Any structure must be easily assimulated either because of it has a regular pattern or because it has a clear relation to a subject structure with which the reader can be expected to be familiar. Reader disorientation results from the lack of clear structure or the absence of any clear indication of the origin or destination of links. In the lower levels of a Storyspace application this can occur rapidly, particularly because all link names cannot be displayed simultaneously on its network diagrams. So long as its stacks are not too large Hypercard suffers less from this problem of disorientation because of the ease wth which it is possible to use standard commands to move ‘up’ and ‘down’ a stack in order.

All the general needs identified during the preparation of the first two, exploratory applications can be met using a four part classification of blocks. The four classes are 'single blocks', 'multiple blocks', 'supra-blocks' and 'sub-blocks'. The notations proposed are shown in Figure 2. The 'single block' represents a unique entity that has no subsidiary parts. In its notation the letter in the upper left corner signifies the medium (**T**ext, **G**raphics, **I**mages, **A**udio and **V**ideo). In an initial general design such a block might represent a substantial part of an application design, at the final detailed stage a single screen display.

The 'multiple block' represents a collection of single blocks with common characteristics of form or content. Its identifier is common to all its constituent blocks as part of the identifier of each. Such blocks will provide another representation for use in early design stages when the specific number of blocks required to contain the information about a particular entity or subject may not be known. At the stage of detailed design it will identify blocks that share a common display design.

The 'supra-block' provides the means to represent the root of an hierarchical 'tree' structure and the 'sub-blocks' represents a 'leaf' in any such structure.

Implicit Links

In traditional printed text all links connecting ideas, arguments or narrative sections are embedded within the written material, incorporated explicitly or implcitly according to the style and ability of the author. The modularisation implicit in hypertext requires that links between blocks should be explicit, even if this only takes the form of the ordering of a Hypercard stack. The proliferation of links and the entanglements that can easily be created have often been noted and illustrated. A summary of this problem and related issues is provided by Conklin (1987). From the perspective of the design process there is the equally important, and closely related, problem of the explicit creation of links too early in the process before the full structure has been realised.

The different types of link required for a design method together form an hierarchy with four levels. At the highest level are all the links that are implicit in the domain stucture of a subject, for example every link of content or position between the scenes that have at some time formed part of the Sustine Chapel decorations. At the second level some, or all, of these links may be made explicit within the structure of an application. These explicit links that have, or are given, an explanatory function may then be transformed into blocks in their own right, forming the exegetic link blocks in the third level. At the lowest level chained series of blocks become the framework of paths through the application structure.

The initial need is to identify those links that are implicit in the subject matter, at the same time as identifying those discrete blocks into which it may be decomposed. This places the emphasis on the structure of the subject domain and the need for an accurate, if partial, reconstruction of its form.

These implicit links within the subject domain require their own notation, which can be borrowed from the standard entity relationship model, shown in Figure 3. Each link must be named. Within multiple blocks there is an implicit link between each member with a common name. Storyspace provides a powerful facility for giving the same name to a series of links.

A link may go to or from a whole block, i.e. be accessible from any part of it, or to or from some part of it in the form of an 'embedded link' (see Figure 4). Links to or from a multiple block as a whole are taken to mean a link to or from each individual member block. In the special cases of links to the first or from the last members of a multiple block a variation of the notation is needed. Figure 5 shows the notation in practice modelling the structure illustrated in Figure 1.

Blocks

The concept of the defined section or block has far greater significance within hypertext than within traditional text. Hypertext is fundamentally different because its structure demands the strict modularisation of ideas. This modularisation is the pre-requisite for the creation of links, providing their explicit origins and destinations. In turn the links facilitate the creation of non-linear structures. As a result of this modularisation the identification of the constituent parts of any subject, in the form of component parts or blocks of some kind becomes an essential initial stage in the design process. This identification also provides indications of any underlying structure within the subject domain.

The idea of a block that can be identified individually is analagous with the definition of an entity in a relational database as anything that can be distictly identified in th real world. Such entities clearly exist in any abstraction of the form or content of the works that make up the decorations of the Sistine Chapel, the subject of the first exploratory application. Modelled using Storyspace each section of the decoration, for example each scene from the series from the life of Christ on the middle section of the north wall, was allocated a block, in Storyspace called a 'writing space', and was given a named link to the next in its particular series. Each writing space may itself contain further writing spaces, which may be further subdivided to create ever deeper hierarchical structures.

Hypercard, used for the second exploratory application on the subject of the Maestà, uses the metaphors of the 'card' and the 'stack', each of the former corresponding to a single block of text, graphics or imported image, or some combination thereof. The only implicit structure is the order of the stack. In both these applications, developed without any design guidance, an hierarchical structure emerged. In both applications certain blocks also shared the characteristic that they only existed in the abstract sense of being formed from the multiple combination of some kind of sub-block.

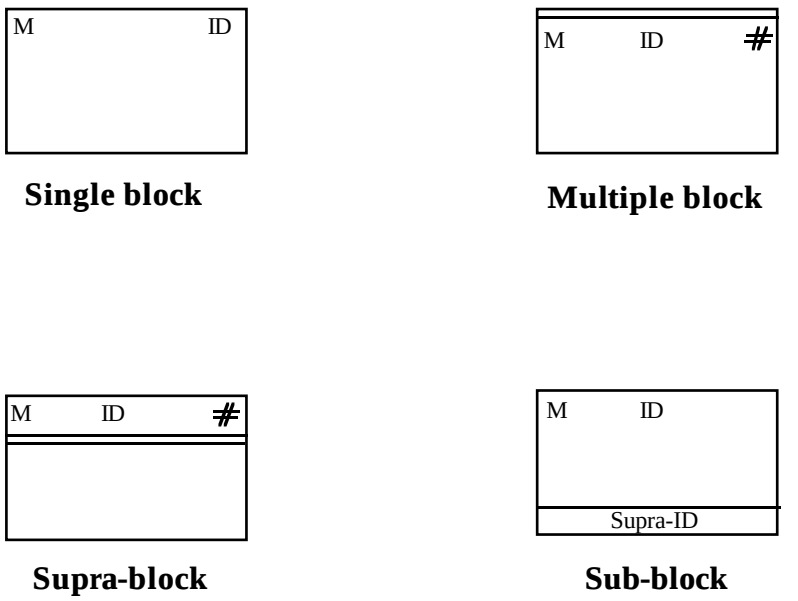

Figure 2 : Notation for basic blocks

and with those of the tapestries designed for the floor level. In the case of the Camerino the later pictures have clear and explicit content which can be associated directly with the pictorial forms. This issue and related problems are discussed in the work edited by Cavalli-Bjorkman (1987).

5. Components of Hypertext Designs

Within the multi-dimensional context outlined above it is possible to identify the major components of any hypertext system and to propose a notation to represent these components in the design process. An abstract notation is required as a transitional stage between subject matter, the domain of the application, and a form that may be expressed directly by software. The notation has to be sufficiently flexible to meet the general needs of any initial design process as well as the detailed requirements of specifications for system implementation. Art historians acting solely in the role of software client may understandably be reluctant to assimilate the details of any software design notation that might only be used by specialists. They are include here as much to illustrate the view of hypertext structure that is taken as to be part of detailed practical guidance.

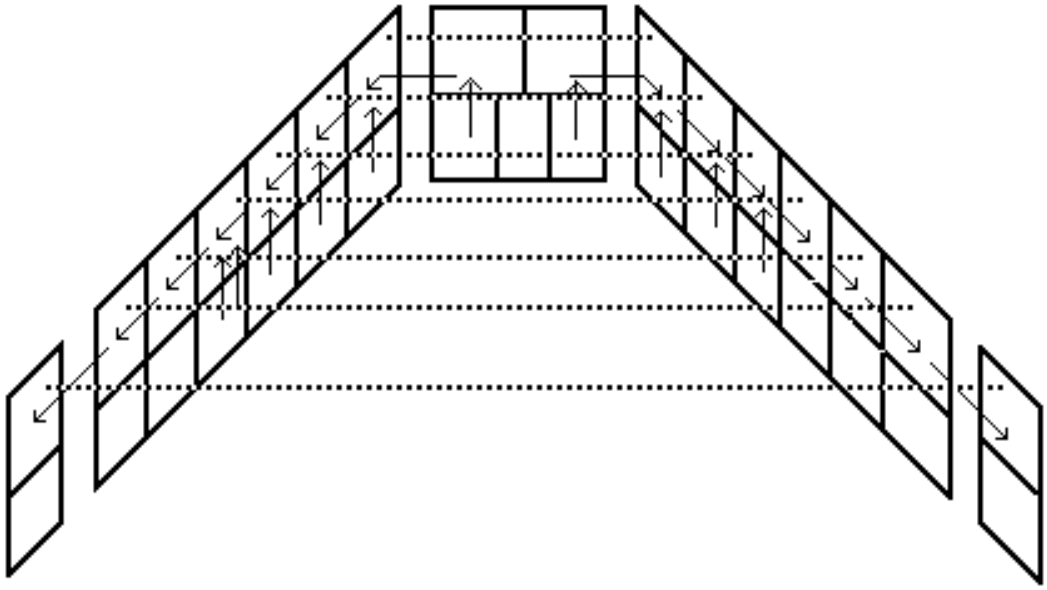

Figure 1 : Informal diagram showing relationship between picture cycles on middle and lower levels of Sistine Chapel walls

The essential nature of hypertext lies in its dual character as both a peculiar type of database and as a special form of human computer interface. As an interface it is influenced most strongly by the potential users and by the software and hardware available. As a database it shares some of the characteristics of conventional text. The only two basic components are the ‘block’ and the ‘link’. These are analagous to the standard divisions of text into separate parts such as paragraphs or chapters and to the variety of stylistic and formal devices that may be used by an author to present a narrative or argument.

nodes in a screen window and support standard window operations. Windows should contain any number of 'link icons' to other nodes; these are 'buttons' in the case of Hypercard and links without specific form in Storyspace. Both implementations allow the creation of new nodes. Both allow for 'browsing' within the database by following links and opening windows to nodes or by keyword searching. Only Storyspace allows 'navigation' from node to node via links that can be displayed automatically as a network.

The method set out in Section 6 was developed in a three stage process. The objective of the first stage was to clarify the general characteristics of hypertext by using one implementation, Storyspace, to create a reference application with an art historical subject. In the second stage it was possible to extend the investigations to consider possible hypertext design components whilst using a second implementation, Hypercard, to prepare a second application with a similar subject. The purpose of the third stage was to prepare a draft design method and then to test it by preparing a third application. Results of this test provide illustrations in Section 6.

4. Art History Seen As Hypertext

In a figurative as well as an actual sense the reconstruction of works of art is an essential task of the art historian. This is a challenge with many aspects, not least that of communicating its results. There are many examples of works with complex internal relationships of layout and composition, with the added dimension of narrative or manifest content and with an interplay between all these elements. Yet the historian is generally restricted to a single-dimensional linear text as a channel for the communication of his or her work, albeit with a small measure of 'width'provided by footnotes, 'height' by illustrations and 'depth' by appendices and similar conjuncts. The degree to which the basic dimension may be extended is restricted physically. In addition the number of effective links that can be made with other elements besides the main text is constrained by the skill and resources of layout designers.

All such restrictions are relaxed in hypertext. Its advantages come to the fore with the need to simulate complex forms, whether for their own sake or as part of a line of argument. Its disadvantages stem from its essential capacity to provide links to and from almost any location within any medium; the structures created may have little coherence in their form and as a result hamper rather than improve understanding. Whether hypertext may provide any improvement for the exposition of argument is not a question addressed here; its problem-solving potential is already the subject of study (reference ?).

The three subjects chosen for the three test experimental and test applications exemplify some of the opportunities and problems. The subjects were the Sistine Chapel, the Maestà altarpiece by Duccio and the Camerino of Alphonso D'Este.

The internal structure of the Maestà is particularly interesting according to White (1979), because the design of its back face suggests that Duccio was thinking in terms of building into his design a series of major, alternative pathways. White hypothesizes that the twenty six scenes from Christ's Passion on the rear face can be viewed in two different orders, in their chronological sequence as presented in the New Testament or in a regular, but non-linear, sequence which has a pattern in what would have ben the normal and expected form.

Work on the Sistine Chapel was mainly restricted to study of the fresco cycles on the middle sections of the walls, based around the work presented by Chastel (1986). These frescoes follow linear sequences, but on one side reverse the conventional left to right flow. They also use the convention known as continuous narrative by which scenes taking place at different times and in different locations but with common participants are depicted in the same pictorial space. Figure 1 shows an informal diagram drawn to show the linkages of content between these scenes

'Length' is used in the same conventional sense as that normally applied to text in any form. It is the only measure commonly used whether the units are words, chapters, pages or some other division. This convention is an indicator of the nature of text as a strictly linear sequence.

'Width' is suggested as a dimension to indicate the number of paths that a reader or viewer may take in addition to a straightforward linear sequence. To a limited extent the use of footnotes can be said to 'widen' a text to a limited degree. Hypertext implementations that offer facilities to attach links to and from any part of a text, or to other elements of another medium, will allow the creation of chained series of links to a limit only dictated by storage or procesing capacity.

'Height' is proposed as a measure of the number of different media that are incorporated. Such a measurement may be confused by problems of media definition. There are obvious examples such as pictographs or calligraphy that might be classified according to their context as either text or image. In other cases there are mixtures created within a single medium of reproduction, the most common being text combined with pictures or graphics on a printed page or on a screen display. In such cases the predominant medium must be defined in relation to the subject matter, perforce a subjective judgement.

'Depth' may be employed as a dimension indicating size in terms of the number of independent entities in each identified medium, for example the number of separate text documents.

'Participance' is a term coined in order to take account of the collaborative aspects of some systems and also possibly their combination with expert systems.

Within this overall context hypertext can be defined as text having at least the two dimensions of length and width and the potential for the incorporation of all the other three dimensions. Conventional text becomes simply a special case of hypertext in a single dimension, that of length. The integration of conventional text into this scheme provides a point of reference within existing conventions and a starting point for the development of more complex objects.

3. Work Process and Tools Used

The development and testing of the design method presented here have inevitably been influenced by the experimental tools available. Two different hypertext implementations available on Apple Macintosh machines were used, Storyspace (Version 1.03) and Hypercard (Version 2.0). {Macintosh and Hypercard are trademarks of Apple Computer Corporation; Storyspace is a trademark of Eastgate Systems Inc.}

Storyspace is described as a hypertext writing environment - a tool for writers to use while creating and revising their work (Bolter et al. 1991). Hypercard describes itself as an information environment which will (amongst other things). store information - words, charts, pictures, digitised photographs (Apple 1989). Both are essentially single document hypertext systems with substantial capacity in terms of the suggested dimensions of length, width and height. Hypercard provides facilities to make automatic links to other Hypercard files, called 'stacks', so might be considered to offer potential depth. Storyspace offers a facility for the identification of different contributors to a single document, so would support a degree of participance.

The representativeness of these implementations may be gauged by comparison with the features of a somewhat idealised hypertext system (Conklin 1987). Both create a database in the form of a network of textual or graphical blocks or nodes. Both show the contents of such

hypertext and art history is examined briefly in Section 4. What are the problems involved in the design of applications, what are the main elements of a useful approach to such design, and what are the outstanding problems ? Sections 5 and 6 set out the components of hypertext designs and a comprehensive design method. Some conclusions are given in Section 6.

2. A Multi-dimensional Definition of Hypertext

By the definition of the Oxford English Dictionary the prefix 'hyper' is most commonly used in formations where it has the prepositional force of 'over', 'beyond', or 'above' what is denoted by the second element to which it is attached; it is often related to some extension or complication of the object. In such formations it may also signify the higher, or the highest, in some order or degree.

All these connotations may be attached to the terms 'hypertext' or 'hypermedia', although they are not clearly expressed by any of the usual definitions. Most definitions rightly emphasise the machine dependancy of the medium. Conklin (1987) considers that hypertext is, in essence, a combination of natural language text with the computer's capacity for interactive branching or dynamic display of a 'non-linear' text that cannot be printed conveniently on a conventional page. Interactive branching essentially derives from the computer's capacity to store in its memory, and retrieve therefrom, both items of data and pointers to other memory locations from which other data, or pointers, may be accessed. This facilitates the construction of a multiplicity of alternative paths between any set of data blocks of whatever kind; to use an art historical example: different orderings of a set of images, texts with which they may be associated and descriptions of the manner in which these texts are, or are purported to be, represented as the images.

Hypermedia exploits the same machine capabilities and simultaneously allows the incorporation of a full range of media: text, graphics, still images (pictures), moving images (video), sound and speech (audio). Under the title of 'multimedia' this combination is the subject of intense commercial interest. The major design challenge in creating any mixture of such media, simple or complex, is the integration of a variety of elements into a composite and coherent whole.

Other writers have already suggested that any integration of media into a hypertext or hypermedia form will have a multi-dimensional character. In one formulation (Rada 1991) the first dimension is the internal structure of a piece of text or a document; the second is a relationship between texts and along yet another dimension people communicate with each other as they manipulate text.

An alternative view (Halasz 1988) suggests a tripartite division into dimensions according to 'scope' to suggest variation of scale, 'browsing versus authoring' to emphasize the range of passive to active involvement and 'target task domain' to indicate design for specific tasks.

Such definitions do not include all the attributes of multiple media objects. Without these attributes it is not possible to provide any general characterisation or framework for a detailed description or design. Nor is there any suggestion of the measurement of extent without which there can be no comparison of complexity or size.

In an attempt to overcome these problems a physical metaphor is adopted as an aid to the visualisation of such objects. The following dimensions are suggested for any computer-based object incorporating one or more media :- 'length', 'width', 'height', 'depth' and 'participance'. The development of this conception here is only brief because the overall structure of multiple media systems is not the principal subject.

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An Experimental Hypertext Design Method and Applications in the Field of Art History

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Abstract

This article outlines a method to guide and organise the design of hypertext applications. In the absence of any generally accepted definitions, it proposes a framework for computer-based objects that integrate a variety of media. It defines five dimensions that may be used to characterise such objects. Within this mult-dimensional context the basic 'block' and 'link' elements of hypertext are defined and other design components are identified. Some hypertext analogies in the field of art history, used for exploratory and test applications during development work, are described. A design method for hypertext applications in nine stages is set out. It uses the elements identified and reflects the structural relationship between them.

Keywords
Hypertext, definition, design method, art historical analogies

1. Introduction

The general purpose of this article is to outline a method which will guide in a structured manner the design of hypertext applications. No such method exists, nor are there any coherent conceptual models which might provide either an overall context or a useful framework for development.

The work presented here stems from an interest in the general problem of a design method for hypertext. Experience in building even relatively small hypertexts forcefully brings home the problems of undisciplined and unstructured application development. Development in this style appears as dangerous for hypertext as for 'conventional programs.

During the initial stages of this work the field of art history was chosen as one that might provide interesting test material. This proved to be a fruitful choice, not only because of the complex form of scholarly writing dealing with both text and images, but also because of the multi-dimensional relationships of form and content that often constitute its subject matter.

The work used just two of a range of hypertext implementations now available on a variety of machines including the personal computers found on many professional desks. The easy availability of these systems and the opportunities that they offer provide the motivation for considering possible design methods in a context such as art history where computers are becoming increasingly familiar.

There are many competing definitions of hypertext, none wholly adequate. Understanding of its importance is now hampered further by its indestinct boundary with what is commonly called multimedia. In this context a number of questions are outstanding. Is hypertext a valid concept in itself and, if so, how should it be defined ? This issue of definition is considered in Section 2. Is the software now readily available to realise this concept of real value ? Section 3 provides details of two hypertext implementations and explains the manner in which the current work was done. Are there applications in the field of art history ? The relationship between