# Development of multiple media documents

S.J. Morris,  A.C.W. Finkelstein

Imperial College,
Department of Computing,
180 Queen's Gate,
London SW7 2BZ, UK

Abstract:       Development of documents in multiple media involves activities in three different fields, the technical, the discoursive and the procedural.  The major development problems of artifact complexity, cognitive processes, design basis and working context are located where these fields overlap.  Pending the emergence of a unified approach to design, any method must allow for development at the three levels of discourse structure, media disposition and composition, and presentation.  Related work concerned with generalised discourse structures, structured documents, production methods for existing multiple media artifacts, and hypertext design offer some partial forms of assistance at different levels.  Desirable characteristics of a multimedia design method will include three phases of production, a variety of possible actions with media elements, an underlying discoursive structure, and explicit comparates for review.

Keywords:       multimedia document, design method, discourse

## 1      Introduction

The accelerating pace at which new multimedia systems and software become available might suggest that many problems in this field are now solved.  Removal of technological constraints on the use of multiple media in single artifacts or documents has indeed expanded their potential use greatly, but not without generating a new set of questions and issues.  Such areas of uncertainty centre around the problems of how best to develop new multiple media artifacts in a multimedia computer environment.  Multiplication of the number of media brings with it novel characteristics as well as a new technical scale.  An understanding of these characteristics will be an essential constituent of good design methods for these new means of preparing and communicating information.  This paper will draw boundaries around the overlapping fields of activity involved, outline the major development problems, suggest a model for development activities, describe existing partial solutions and related work, and offer some conclusions about what characteristics a general method might have.

## 2    *Fields of Activity*

A variety of specific problems and general issues condition any type of methodical development of computer based documents incorporating multiple media.  Such problems and issues are ill-defined and straddle the boundaries of three different fields of activity, the technical, the discoursive and the procedural;  these fields already exist in their own right and offer a variety of insights.  We now delineate these fields and set problem definition in a suitable context.

The technical field is the field of the machine.  It incorporates the translation of individual media from analogue to digital form, their creation and manipulation in digital form, their subsequent storage, retrieval and eventual display, and the capabilities required for their transmission elsewhere.  This field also encompasses the integration of separate media with each other and the mechanics of manipulation and interaction with any user.  The development of hardware and software platforms for multimedia systems forms much of the activity.  Such work is only a subsidiary concern of our work because our principal intent is to provide practical guidance to augment existing design techniques within the software engineering discipline.

In the discoursive field the activities of the human communicator as message generator or receiver are paramount.  The nature of the document as a communicative object, as something that is a vehicle for human thought, is the concern of this field.  The definition of discourse may be traditional, by the OED a treatment of a subject in which it is handled or discussed at length.  From such a pragmatic definition flows the segregation of discourse, by convention and long practice, into a number of modes: narrative, description, argumentation, exposition and other, always less used, forms such as lyric poetry (Chatman, 1990).  This categorisation in effect provides an abstract division according to general purpose.  Production of a discourse in the modes of argument or exposition will involve the use of language, whether in verbal or other forms, so as to persuade or influence others.  Hence both these modes employ the techniques of suasion that properly constitute rhetoric. The definition of discourse may alternatively be in a more abstract form based on studies derived from linguistics and its semiological extensions.  Discourse becomes any valid sequence of statements in their context and discourse analysis becomes a method for analysing the structure of texts or utterances longer than a sentence, taking into account both their linguistic content and their sociolinguistic context (Polanyi, 1987).

In the procedural field the human designer is the principal participant.  Its concern is the design activity itself, its constituent parts, their order of production and the context within which the activity takes place.  This field impinges closely on the discoursive field because it incorporates theoretical and practical analyses of the manner in which all forms of discourse are comprehended and produced.  Related material also comes from the field of software engineering, in the form of software and interface design methods and method engineering research.
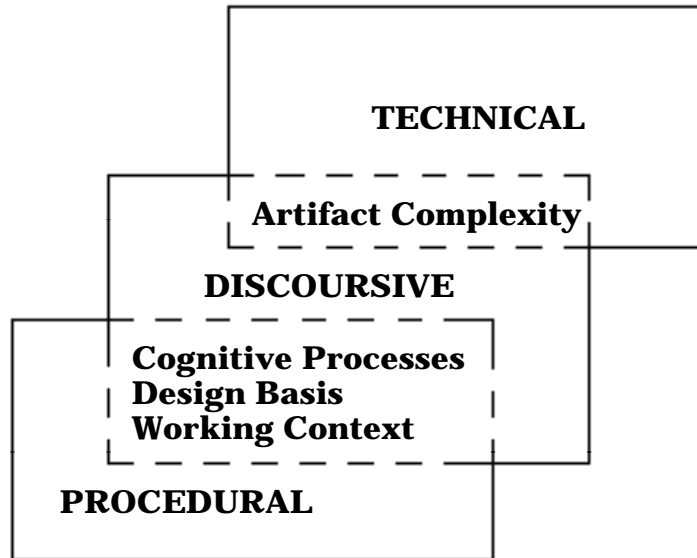
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                    TECHNICAL

         ┌ ─ ─ ─ ─ ─ ─ ─ ─ ┐
           Artifact Complexity
         └ ─ ─ ─ ─ ─ ─ ─ ─ ┘

              DISCOURSIVE

         ┌ ─ ─ ─ ─ ─ ─ ─ ┐
           Cognitive Processes
           Design Basis
           Working Context
         └ ─ ─ ─ ─ ─ ─ ─ ┘

            PROCEDURAL
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***Figure 1***        *Overlapping fields of activity and the associated development problems*


## 3      Major Development Problems

We will now consider the major problems of multiple media document development, located where the fields of activity overlap (Figure 1).  The complexity of the final artifact constitutes a group of problems combining technical and discoursive issues: diversity of media, differentiation between temporal and spatial media, links within and between media, levels of interactivity, and technical handling.  The overlap between the discoursive and procedural fields is the general location of the other three major problems:  understanding of the comprehension and production processes, the choice between strategy or structure as the basis for design, and the working context.

### 3.1     Artifact complexity

The overlap between the technical and discoursive fields is the general location of the first major development problem, which is the potential complexity of the final artifact.  The potential complexity of the final artifact has been apparent for a long period in those works which, although not computer based, incorporated multiple media in a single object.

### 3.1.1   Diversity of media

All the traditional media persist in the computer environment, with some additions.  In combination these media, the intermediate agencies between creator and user and between communicator and receiver, have a diversity that is both a technical and a discoursive issue.

In the technical arena the media consist of:

*text* - all forms of written language;

*graphics* - vector based or bilevel representation of any image of a type otherwise drawn with a pen or a similar instrument;

*image* - any multilevel or bitmap based image;

*sound* - all audio signals;

*video* - linear sequences of graphics or images that provide the illusion of motion when displayed in rapid succession (usually in excess of twenty five images per second);

*numeric data* - all forms including mathematical symbols;

*database entities and attributes* (in general sense);  and

*hypertext* and *hypermedia* - a problematic media type consisting of linked elements of other types.

In the arena of discourse, and particularly where linguistic analysis has been applied, conglomerations of heterogeneous codes displace media. The categorisation of media now becomes one of :

*text* - written 'natural' language in any form;

*graphics* - a two dimensional representation of information using signs from a monosemic system whose meanings are specified or are known beforehand, or from a notation in the strict sense (Goodman, 1969);

*image* - a visual representation whose interpretation involves polysemic elements whose meanings are deduced from the collection in which they appear (Bertin, 1983), alternatively one that indicates nothing other than itself as its own 'pseudo-presence' (Metz, 1974);

*video* or *moving pictures* - sequences of graphics or images in animated form as defined technically;

*speech* - spoken natural language;

*sound* - the remainder of any sound track including music and real noises proper to their sources;  and

*other sign systems* - numbers and mathematical symbols, computer languages and database entities.

It is essential to distinguish between separate systems of signs used for communication.  From the practical point of view such discrimination should allow the document producer to avoid the use of more than one language at the same time and protect the user from the resulting confusion.

### 3.1.2   Differentiation between temporal and spatial media

The need to differentiate between temporal and spatial media adds a further dimension to the complexity of the final artifact.  Text and image exemplify two important classes distinguished by their perceptual characteristics.  Text controls temporally its reception by its audience; it is clear to the reader where to start and to stop (Chatman, 1990).  This temporal characteristic carries with it a necessary linear structuring.  Language is used linearly because each word or cluster of words stands for an intellectual concept and such concepts can only be combined in succession (Arnheim, 1970).  Images on the other hand do not regulate the temporal flow or spatial direction of audience perception;  they present themselves simultaneously in their entirety.  The general distinction between the visual arts as essentially spatial and the verbal arts as temporal goes back to the late eighteenth century (Lessing, 1984).  However, while single images and graphics may in practice be presented in their entirety and be considered theoretically as an aesthetic totality, it is not altogether certain that the reading of text and the scanning of pictures differ radically in perceptual terms (Kolers, 1977).

Notwithstanding such caveats, the dichotomies of the temporal and the spatial and of the linear and the non-linear remain;  they will exert a powerful complicating influence on multimedia documents and they will constitute an essential consideration in their design and structure.

### 3.1.3   Links within and between media

Complexity involves not only the combination of many and different elements, but also their connection in a manner that is not easily disentangled or analysed.  Problems of juxtaposition and interrelation of different media have existed for as long as technical production methods have allowed the incorporation of more than one medium in a single document;  the oldest examples are illustrated books.  Such problems are merely compounded in computer based documents which may, if required, call upon the full range of available technical media.  This important quantitative difference is accompanied by an essential qualitative difference brought about by the ability to link media elements of the same or different kinds.  The first exploitations of this linking ability form the existing body of hypertexts.  A variety of link types exist in various hypertext implementations.  The detailed nature of hypertext links is not immediately relevant in this context;  most recent ideas are unified in the 'link component' concept of the Dexter Hypertext Reference Model (Halasz & Schwartz, 1990; Grønbaek, 1992).

### 3.1.4   A continuum of interactivity

The availability of links connecting parts of a multimedia document opens the way for new relationships between the document and its user.  A continuum of potential accessibility to the user best describes the theoretical relationship between multimedia and hypermedia.  At one extreme is

a multimedia document with 'closed access', where the user is a passive receiver and cannot interact in any way other than to interrupt attention or withdraw it. Such documents already exist in the form of commercial video presentations. At the other extreme is a hypermedia document with 'open access' allowing a completely free passage within and between all media elements. Such documents are unlikely to be constructed, except in the form of descriptive multimedia databases, because of the 'navigation' and 'cognitive overload' problems already identified with hypertexts (Conklin, 1987). Between these two extremes are the degrees of 'restricted access' implied in the number of alternative paths that are available between the nodes containing text or any other type of media element.

### 3.1.5 Technical handling problems

Outstanding technical problems still inhibit any systematic document development. Source material exists in a variety of non-digital forms; the required amounts of digital data strain current storage and compression technologies; partial methods of media integration are offered in different commercial products and experimental systems. These problems add further constraints to the task rather than form part of its essential definition and there is a body of relevant literature (Davies & Nicol, 1991; Williams et al., 1991).

### 3.2 Discourse comprehension and production processes

The second major problem area related to document development is the general understanding of the comprehension and production processes involved. Ideally there should be a firm foundation for any design method constructed from an understanding of the cognitive processes involved in the production and comprehension of each discursive medium. Some components of such an understanding already exist, although few are directly applicable and most work concentrates on the single medium of text.

In one general model (Flowers & Hayes, 1980) the long term memory of the writer, the task environment and the writing process itself are interconnected sub-domains of the overall task. Such a model supports a variety of general strategies, although none is implicit in the model itself. A more recent model provides a closer relationship between its own structure and possible production strategies (Sharples & Pemberton, 1988; 1990); it combines 'representational items' with 'representational structures' in a matrix form. Transitions from cell to cell in different sequences suggest alternative writing strategies.

This relationship between model and production strategy, although associated in this work with a confined segment of media, indicates an important general element of any overall document development method.

*3.3      Strategy or structure as design basis*

The third main development problem concerns the nature of the design philosophy that will underlie any method.  The first alternative is a descriptive approach based on some form of static structure; the second is an approach which is more dynamic and process orientated and which employs in some way strategies for action on the part of the producer or on the part of the person attempting  comprehension.  The first approach is well developed in software engineering as well as in the fields of linguistics and psychology;  the second exists only within discourse analysis.

In the descriptive approach the structure of the end-product acts as a guide for the relationship between the parts of the method.  A layered model may define the product structure;  the associated method comprises a set of stages arranged in a sequence corresponding, at least in part, to the ordering of the layers.  Models of language and the use of language, both in linguistics and psychology, account for linguistic objects in terms of the 'levels' of morphonology, syntax, semantics and the pragmatics of composition.  Comprehension is understood to take place in stages corresponding to these levels.  Such layers or levels of abstraction do not necessarily dictate an order of generation, but do fix a relationship that precludes simultaneous instantiation of elements at different levels.  In software engineering parallels with the linguistic models are clearest where similar terminology is used in 'linguistic' models, as in the Command Language Grammar (CLG) representation for user interfaces in interactive systems (Moran, 1981).  CLG addresses the problem that systems may be designed without a conceptual model in mind, but assumes explicitly that the model of the designer and the model of the user are essentially identical.

Only in part of the field of discourse analysis has there been any attempt to combine an understanding of both the comprehension and production of discourse, even if the bias is heavily on the former (van Dijk & Kintsch, 1983).  An approach called 'strategical' because of its more dynamic and process orientated characteristics replaces the earlier predominantly 'structural' approach.  Strategies are concerned with the establishment of local and global coherence in a 'textbase', the semantic representation of the input discourse.  Emphasis is upon the continual feedback between less and more complex units composed of the semantic 'propositions' which define the textbase, and upon the non-sequential growth of these units.  A set of 'propositional strategies' enables the construction of propositions themselves;  'local coherence strategies' establish meaningful connections between successive sentences in the discourse, and 'macrostrategies' provide 'macropropositions'.  Such macropropositions may themselves be connected to form a 'macrostructure' of the text, a theoretical account of its gist, theme or topic. There are also 'schematic strategies' because many discourse types exhibit a schematic structure based on convention, a 'superstructure' which organises global content.

The link which allows the use of such an approach for the study of production, as opposed to

comprehension, is the assumption that language users do not plausibly have two completely different and independent systems of strategies for production and understanding.  However the production process cannot simply be a reversal of the process of comprehension because the initial data and goals of the speaker or writer and of the listener are different and they remain different through subsequent stages (*ibid*).

The nature of the multiple media document as a computer based artifact suggests that a descriptive structural approach would provide a suitable basis for design.  On the other hand, the nature of the document as discourse and the lessons of discourse analysis would support the more process orientated strategic approach.

*3.4     The working context of development*

The fourth major development problem is the lack of a clear overall working context for multiple media document development.  The number and variety of persons and skills involved in related activities, particularly in parts of book publishing and the whole of film making, even if drastically reduced in scale, suggest a complex situation.  Such diversity is associated with interwoven organisational and collaborative arrangements.  The assumption must be that individual authorship may not be the norm, especially for commercial products.  The role of the author may be held jointly by two or more collaborators, possibly with the different skills associated with different media, and the work of the author or authors may be mediated within an hierarchical organisational structure.  Working relationships of a cooperative or collaborative nature in writing, which assume a joint responsibility and division of tasks and labour, are already the subject for study and a framework for research exists (Sharples et al., 1991).  Work is mediated if a person or persons comes between the principal producer and the final product in a relationship in which the mediator may predetermine or amend its form or content.  Mediated working arrangements are as common as collaborations and may be more appropriate where production activities require the deployment and direction of diverse skills.

The processes of review, revision and editing are essential and closely related parts of any mediated activity.  These processes are also an integral part of the individual act of writing and the study of this act has identified important characteristics.  The review process is akin to revision in that both may be distinguished from text generation by the fact that they involve some explicit process of comparison, generally between some segment of text and some representation of knowledge, intention or assignment;  the result is some attempt to change the text (Bartlett, 1982).  The comparate, that with which something is compared, is the essential prerequisite for any form of review or editing.  It has an important role in a whole range of editing process, including traditional publishing (Butcher, 1975; Chicago, 1982) and film production (Reisz & Millar, 1968), and a variety of software engineering techniques including 'document inspection' (Fagan,1986) and  'critiquing' (Silverman, 1992).

The conclusion is that, whether as a collaborative or mediated activity, multimedia design will incorporate implicitly, but preferably explicitly, comparates that will facilitate review, revision and editing. This will provide an essential element of a satisfactory working context. Other issues, such as the combination of different skills required by different media, remain open.


## 4     Development at three levels

As an initial step towards a comprehensive solution to the problems of multimedia document development, we propose a model of development activities with three layers or levels.
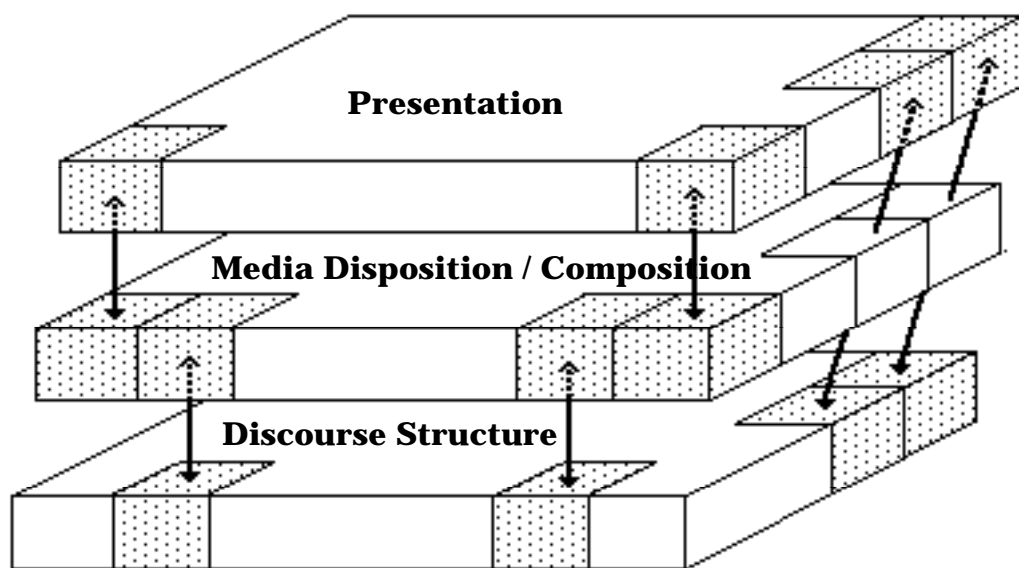


**Figure 2**        *Three levels for multimedia document development*


Pending the emergence of any such unified approach to design, any method must allow development to take place on at least three different levels. These are the levels of discourse structure, media disposition and composition, and presentation. Each may have its own design rules and its own representations. There may also be intermediate representations. Work may progress sequentially, simultaneously (as illustrated in Figure 2) or in some set of temporal combinations according to the method proposed. The overall objective is to make as explicit as possible, to the producer and to collaborators or mediators, the transformation of the abstract communicative object into the communicative artifact realised before the user.

*4.1     Level of discourse structure*

The level of discourse structure is the most abstract.  It will contain three general types of discourse: description, argument and narrative.  The other modes mentioned earlier are of less importance in this context.  Description renders explicitly the essential properties of an object for their own sake.  Implicit description may take place within any other type of discourse as a subsidiary activity, for example in moving pictures where the primary focus of attention may frequently be elsewhere (Chatman, 1990).  This is one example of the ability of media to perform two or more representational functions at one time.

For the purpose of discourse, argument is defined as any process of reasoning intended to establish or subvert a position.  Although this would encompass formal types of argument based on mathematics and formal logic, the emphasis here will be on the informal types commonly used in general intercourse (Perelman & Olbrechts-Tyteca, 1968).  Argument and exposition have an indistinct boundary;  the latter subsumes the former.  Argument presupposes a difference of opinion, while exposition merely requires an absence or confusion of opinion, whose clarification implies an argument in favour of its own preferability (Chatman, 1990).

Narrative is a sequence of events characterised by plot, character and setting.  It is unique among discourse types in having a 'doubly temporal logic' (*ibid*) entailing both an 'external' movement through time, the duration of presentation, and also an 'internal' progression, the duration of the sequence of events that constitutes the plot.  Chatman also emphasises the importance of double functions not only of media but also of discourse types, which may form an underlying structure or an overriding surface representation, for example the surface narrative form of fables or of television commercials which present arguments in clear stages.

*4.2     Level of media disposition and composition*

At this level the choice, disposition and composition of individual media elements take place.  Choice concerns the selection of the medium to be employed as the vehicle for each element of the discourse structure at each stage of its development.  This must recognise the close existing relationship between certain media and standard discourse types, born out of the dominant historical position of text and the more recent cultural influence of moving pictures.  It also involves the issue of whether there is to be a dominant media type for the principal discourse elements, with subsidiary media for any subordinate parts.  This is the basic issue of disposition.

Media disposition at this level implies the formalisation of any hypertextual links at this same level, rather than in the discursive level.  It has yet to be demonstrated that hypertext (and by extension hypermedia) is the priviledged medium of any particular mode of discourse, or that it is in itself a new mode.  In these circumstances it becomes another vehicle for existing forms of

discourse, albeit of a kind with new technological demands and offering new opportunities for expression different from those of existing media. The capacity to provide a chosen degree of 'restricted' or 'open' access may alter discourse in unpredictable ways; in the interim there is a certain need to provide design asistance that will allow the integration of this capacity into existing modes of discourse.

The composition of individual elements takes place at this level, at least in the sense of the creation of their full content. Analyses originating in linguistics would reject any such distinction between form and content on the grounds that the latter must itself have some form of its own. The practical value of the distinction lies in the possible avoidance of fixing prematurely the final representation and in the provision of the essential comparates for any review.

*4.3    Level of presentation*

The level of presentation involves both the design of the appearance of the final artifact and its representation as a computer based object. The design has spatial and semantic aspects. The former involves the elements as displayed individually; the latter incorporates their appearance when involved in the possible combinations allowed by media disposition, plus the representation of the means of 'navigation' or access. The structure of the computer based object, its presentation to the machine, relates both to internal technical factors and to the structure required for transmission to other machines and reproduction by them.

## 5    Partial solutions and related work

At each of the suggested levels of activity some assistance is already available, from generalised discourse structures at the first level, from production methods for existing multiple media artifacts and from design methods for hypertext and hypermedia at the middle level, and from 'structured documents' at the third level. The following sections outline the contributions and their possible value.

*5.1    Composition with generalised discourse structures*

The techniques of classical rhetoric are important in the context of discourse structure because they offer both a comprehensive, staged method and a developed conception of internal structure. Their primary objective is to exert an effect on an audience; as such they can support both argumentative and expository purposes (Corbett, 1990). They thus encompass an important, but incomplete, set of discursive modes. In the classical method the initial need to find arguments to support the assigned case or point of view motivates the first of five main stages, 'discovery' (*inventio*). The selection and organisation of the arguments and ideas takes place in the second stage,

'disposition' (*dispositio*). Its standard six parts provide an ordered internal structure. The third, fourth and fifth stages are style (*elocutio*) which is concerned with the choice of words, their composition in phrases and clauses and the use of figures of speech, memorisation (*memoria*) and delivery (*pronuntiatio*). The general practical value of classical rhetoric as a means of preparing, marshalling and presenting arguments endures, as does its example as a structured method of great sophistication and pervasive influence. One contemporary use of three partial stages in the context of hypertext forms part of the discussion below.

The claim that 'superstructures' may be part of a more general theory of discourse and semantic practices (van Dijk, 1979) is not yet developed. The more limited development of this concept beyond linguistics provides potentially useful frameworks for a variety of both general and specialised discourse types. Graphical representations of knowledge structures already provide the basis of systems such as gIBIS (Conklin & Begeman, 1988). There are also precedents in the 'descriptive' mode of software engineering where an exemplary structure for requirements specification is an important objective for some authors (Heninger et al., 1978).

Long study of the narrative has provided schematic structures for stories such as that provided by van Dijk (van Dijk, 1979). This incorporates five categories of elements: setting, complication, resolution, evaluation, and coda or moral. Together they form an hierarchical structure definable in terms of formation rules which specify the rank and ordering of the categories and which may be recursive . The categories provide the functional slots for the content of the discourse, in this formulation made up of the 'macrostructures' or 'macropropositions' referred to above. Pragmatic structure for reasoning and argumentation (Toulmin, 1958; Perelman & Olbrechts-Tyteca 1968) provide the basis for a similarly constructed arrangement of argument incorporating setting, premises, facts, warrant, backing, and conclusion . The same approach is usable for more specialised activities that are either highly conventionalised, as in the case of scholarly papers , or very general as in the case of newspaper articles (van Dijk, 1979).

These varied conventional discoursive structures offer clear guidelines for document design, at least in single media, which may be more generally applicable.

*5.2       Production methods for existing multiple media artifacts*

Well developed design procedures already exist which employ staged representations in different single media. Creation of multiple media documents in the form of film and animation has been well established for some time, the design processes are well understood and the stages of production follow clearly defined paths. The controlled transformation and amalgamation of single media elements result in a single artifact integrating at least three media. Filmmakers and animators operating in the dominant narrative mode of their field employ such methods; each displays interesting features of media relationship and ordering (Bloedow, 1991; White, 1986)).

Tables 1 summarise the roles of individual media in the animation process.

***Table 1***        *Media use in animation production*

| Stage of development | Source stage(s) | Media employed | Media for which substitutes | Contribution to final presentation |
|---|---|---|---|---|
| 0  Original conception | - | Speech,Images | Move.Pict.,  Spch.,Snd | To whole (in abstract) |
| 1  Script | 0 | Text | Speech,Sound | To part (dialogue) |
| 2  Storyboard | 0,1 | Images (drawn) | Images (photo.) | To part (images subset) |
| 3  Sound track | 1 | Speech,Sound | None (no substitution) | To part (principal comp) |
| 4  Track breakdown | 3 | Graphics,Text | None (production aid) | None (production aid) |
| 5  Character designs | 1,2 | Images (drawn) | Images (photo.) | To part (images subset) |
| 6  Leica reel | 2,3,4,5 | Moving pictures | Moving pictures | To whole (gen. design) |
| 7  Line tests | 5,6 | Ims.(drawn),Move.Pict. | Moving pictures | To part (full outline) |
| 8  Clean-up | 7 | Images (drawn) | Images (photo.) | To part (final images) |
| 9  Trace and paint | 8 | Images (drawn) | None (no substitution) | To part (final images) |
| 10 Backgrounds | 2 | Images (drawn) | None (no substitution) | To part (final images) |
| 11 Checking | 9,10 | Images (drawn) | None (no substitution) | To part (final images) |
| 12 Final shoot | 11 | Moving pictures | None (no substitution) | To part (final images) |
| 13 Rushes | 12 | Moving pictures | None (no substitution) | To part (final images) |
| 14 Dubbing | 1,3,4 | Speech,Sound | None (no substitution) | To part (fin.soundtrack) |
| 15 Answer print | 13,14 | Move.Pict.,  Spch.,Snd | None (no substitution) | To whole (final artifact) |

Film and animation procedures present special cases whose methods are directly applicable to 'closed access' multiple media documents. More importantly they show the general importance of media substitution, amalgamation and transformation as the means for moving from an underlying discoursive structure to a final presentational form.

*5.3     Hypertext and hypermedia design methods*

There is a sharp contrast between the pragmatic basis of methods established for film production and the theoretical origins of the few methods proposed for hypertext and hypermedia. Currently these are the only alternatives available that might suggest possible design frameworks for multiple media documents. Design at a conceptual level in a system independent manner is one important theme of this work. The description of the 'global' properties of an application, such as its representational structures, navigational patterns, operational semantics, overall visualisation and display aspects, precedes the 'local' creation of individual nodes and their content (Garzotto et al., 1991). This distinction is generalised in the concept of 'authoring-in-the-large' and 'authoring-in-the-small'. This concept provides the basis for an iterative model of hypertext authoring, a seven stage process, advocated in the HYTEA project (Schiff, 1992). The aim of this project is to support the system of choice of the developer rather than to provide a system of its own, the assumption that 'authoring-in-the-large' can be considered and supported somewhat independently of 'authoring-in-the-small'. A similar assumption underlies an alternative nine stage method (Morris & Finkelstein, 1992). This delays authoring of application content until its final stage;  it also requires creation of global models of both the subject domain and, in a subsequent stage, of the application structure.

Both these approaches have their origins in software engineering and echo its terminology (DeKremer & Kron, 1976). An alternative approach takes as its starting point the ideas of local and global coherence from discourse analysis combined with a tripartite structure from classical rhetoric (Thüring et al., 1991). The three parts are 'content', 'structure' and 'organisation' corresponding to 'invention', 'disposition' and 'presentation' (apparently a kind of amalgamation of 'style' and 'delivery'). This approach is the foundation for SEPIA, a 'co-operative hypermedia authoring environment' (Streitz et al., 1992).

Hypertext and hypermedia studies appear to be edging towards design methods that have a diversified rather than monolithic structure, but at present do not offer any comprehensive help.

*5.4 Presentation via 'structured documents'*

The problems of defining the presentational qualities of the highest level of textual entities, the 'pragmatics' of the layered linguistic model, have received considerable attention because of the increased importance of document portability. This work is a major part of what might be termed the 'artifact driven' approach to document development which began with word processing applications. The fundamental concept is 'mark-up' (Coombs et al., 1987). Originally used only for editing typesetting instructions, it is now employed in a general sense, often in the context of 'structured documents' (André et al., 1989), to refer to any data added to a document to convey information about it in a machine environment.

Products of the artifact orientated 'structured document' approach, such as SGML (Goldfarb, 1990) and by extension Hytime (Newcomb et al., 1991), will increase portability and improve presentational capabilities and thus complement, rather than displace, any design solutions.

## 6 Conclusions

This section summarises the principal points already made and suggests some desirable characteristics of any design method for multimedia documents.

✳ The development of computer based multiple media documents requires a new framework of ideas that will support the merger of concepts from hitherto discrete fields of activity and study. The nature of the document as a communicative object, as a vehicle for human thought, places it within the field of discourse. Any number of diverse media types and elements may act as a carrier for an instance of discourse. The computer environment opens the prospect of maximum diversity and complexity in the final artifact. Thus discoursive issues overlap the technical.

❊ Understanding of the cognitive processes involved in the comprehension and production of discourse would provide important guidance for any design method, but such knowledge is only partial even for single media. The working context for document development is clearer because of experience with existing multiple media enterprises, such as film making, which require the deployment and direction of diverse skills and are essentially mediated activities. The boundaries of development procedure and discourse also cross in all these activities.

❊ The nature of the document as a computer based artifact suggests that a descriptive structural approach would provide a suitable basis for design. On the other hand, the nature of the document as discourse and the lessons of discourse analysis would support a more process orientated strategic approach. The procedures used in existing practical methods for multiple media production suggest a version of the latter in which structure still has an important, but not dominant role.

❊ Pending the emergence of a unified approach to design, any method must allow for development to take place on at least three different levels: discourse structure, media disposition and composition, and presentation. The discourse level provides the opportunity for clear structural definition; the media disposition and composition level will facilitate the maximum use of the multiple media available; the presentational level safeguards the necessity for usability and portability. The overall objective is to make as explicit as possible, to the producer and to collaborators or mediators, the transformation of a representation of the abstract communicative object into the communicative artifact realised before the user.

❊ Existing techniques and studies offer different types of assistance at each level. Classical rhetoric and modern discursive 'superstructures' may give direct guidance at the discourse level. At the presentation level 'structured documents' and 'mark-up' languages will act only as complements to any design method. At the level of media disposition and composition film and animation processes may provide immediate parallels. Hypertext methods do not yet appear sufficiently developed.

It is possible to identify some desirable characteristics of a method for developing multimedia documents.

❊ Existing multiple media methods for film and animation suggest a pragmatic distinction between three general phases of 'pre-production', 'production' and 'post-production'. Although there may be a general correspondence with the three levels of activity identified, elements at any level may be fixed during any phase. This acknowledges the importance of the process orientated approach to comprehension and production, as yet insufficiently developed to provide the basis for a full method.

✳    The method needs to provide for a number of possible actions with media elements.  A version of one element may precis or paraphrase another of the same type.  In a complementary fashion another element may provide an amplified version.  One media type may substitute for another and stand as a preliminary or alternative representation of the same material.  Explicit transformation from one type to another is also required.  Amalgamation of elements of the same or different types will provide the necessary composite whole.  Taken in the order of precis, paraphrase, substitute, transform, amplify and amalgamate these actions might act as the framework for a variety of 'top down' design.

✳    Explicit identification of media substitutes and transformations should facilitate the provision of  explicit comparates essential to the mediated environment that is likely to provide the working context.

✳    Unless the overall objective in particular circumstances is the generation of an experimental form of discourse in hypertext or hypermedia, the method should provide for a particular discourse mode to form the underlying structure.  This mode may have a different mode as an overlying or subsidiary structure.  It may also employ conventional 'superstructures' as guides.  Conventional media associated with common discourse types are likely to dominate at the 'closed' extreme of the interactivity spectrum and hypermedia, in single or multiple dimensions, towards the 'open' extreme.

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