The *Pausanian* Notation: a method for representing the structure and the content of a hyperdocument

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ABSTRACT

This paper introduces a new approach for improving hypermedia design, by providing the author with a tool to visualise, examine, and analyse the structure of documents containing hypermedia links. Our proposal is a new representation method the purpose of which is *not to* show the document structure in graphical form in order to enable the users to know where they are, where they can go next, or to give an overview of their environment [12]. The purpose of our representation method is to depict *what options the users are about to be offered*, so that the author can examine the structure in order to better guide them around the information space. Our representation is shown in the form of a map consisting of a proposed classification of elements that define the composition of a hyperdocument. To extract and classify those attributes we have analysed in detail all three dimensions of the hypermedia cube: internal dynamics, external visual appearance and content synthesis.

After introducing our diagrammatic notation we give a brief example of how it could be applied to an existing hypermedia application. In the boundaries of this paper, we include the part of the method which represents the structure of just one hypermedia document and its linked branches. The paper concludes with, a brief description of how the method is applied to represent groups of hypermedia documents, and a discussion of our plans for future work.

KEYWORDS: Hypermedia design, authoring tools, representation methods, hypermedia maps, navigation, hypermedia writing.

1.0 INTRODUCTION

Models or methodologies such as OOHDM [30], RMM [17] and HDM, [10] have been applied very successfully in the process of hypermedia application design by expressing in a non-ambiguous way [28] the relationships among the interconnected objects. Their success solved many design problems and proved formally the need of structuring the design process.

Two-dimensional, three-dimensional, *n*-dimensional, hierarchical and non-hierarchical structure representations of hypermedia networks, have been the subject of much research, as well as commercial products for many years. Generally, their main goal has been to provide 'the user' with a tool which will solve problems such as disorientation and being lost in hyperspace.

However, the questions we need to ask but which have not yet been suitably answered are: "what causes disorientation? why are users allowed to become lost in the hyperspace; why do we still, and how long we will be designing applications with navigational errors?" The hypermedia field has produced some excellent representations -in the forms of overview diagrams or maps- but, 'to tell a multitude of little white lies; they suppress the truth to help the user see what needs to be seen' [23]. Most of those maps have been 'system-generated means of reader orientation' [20].

2.0 THE PAUSANIAN NOTATION APPROACH

The need for another approach to the representation of hypermedia networks derived from our research and the development of the Pausanias 2000, a hypermedia library for the ancient Hellenic World (The Attica Region) based on the Microcosm hypermedia system [8]. The application at its prototype stage, includes 140 content categories, including links between 300 text documents, 2000 pictures, 250 region maps, 3D graphics in a VR environment, video and sound sequences etc. As authors, during implementation, we felt that we needed a tool which would allow us, to keep track of, and control the entire structure. A way to achieve this, is obviously to be able to visualise the hyperdocuments. Having examined current representation methods [5,7,9,11,12,13,18,22,24,25, 27,29,32] we realised that the majority, if not all of them, are implemented as an aid to users rather than the authors.

By combining the philosophies of a design model with an overview diagram we began to develop a representation method, that is a tool for helping *the author*, to improve the overall structure of the hypermedia application, and to avoid inconsistencies and navigational errors that confuse the user. The Pausanian method is a diagrammatic notation for representing the static and dynamic properties of a single or a collection of hypermedia documents in order to help the author to visualise the structure they are creating. It employs a wide range of shapes and symbols based on the characteristics that make up the structure of a document containing hypermedia links (figures 1a,1b). With a clear diagrammatic representation and an overall picture of the different issues concerned with the design of the hypermedia application, the author can save considerable

amount of design time by evaluating or examining the prototype in order to minimise the amount of serious navigational and interaction errors that often occur [26].

The name Pausanian derives from Pausanias, a Greek historian, traveller, and geographer. During the 2nd century AD *he was travelling* around Greece and *describing* all the sites and monuments *he was seeing*. His work was called the "Description of Greece" which gives a detailed account of the monuments of art and of the legends *connected with them.*

The Pausanian notation is divided into two main sections. The first section represents one hypermedia document, and the second one represents a group of selected hypermedia documents. To visualise the structure of one hypermedia document we distinguish those elements that, we believe, characterise it (aspects of interest). These elements are drawn diagrammatically in what we call the "Pausanian Map for representing the structure of a single hypermedia document". To visualise the structure of a group of hypemedia documents, we define a set of variables (variables of interest) which are statistically represented in what we call the "Pausanian Charts for representing the structure of a group of hypermedia documents".

3.0 ASPECTS OF INTEREST

We call the characteristic elements that define the structure of a hypermedia document and are appropriate to the hypermedia author's interest, the *aspects of interest*. The aspects of interest within a hyperdocument structure are classified into three main categories: The *'endogenous'*, which include aspects that characterise the internal structure or dynamics of the hypermedia document, the *'exogenous'* which contain aspects that define its visual appearance and the *'auctorial'* category which is concerned with aspects of interest on the content's structure and composition. All aspects of interest are assigned with attributes graphically represented in the Pausanian map. Authors are provided with the pre-defined attributes, but there are cases where they are also given the opportunity to include their own.

3.1 ENDOGENOUS ASPECTS OF INTEREST

The representation of the endogenous aspects of interest, on the Pausanian map, produces an 'x-ray' that depicts the internal structure and dynamics of a hypermedia document. By examining the map, the author can clearly perceive all objects that comprise the structure as well as the dynamics effecting it. At the top level we classify the endogenous aspects of interest as: types of nodes, types of links, types of anchors, location of anchors, status of traversal, status of direction and depth of path.

Each endogenous aspect of interest is characterised with a set of *attributes* acting as identification marks on the Pausanian Map. The classification of attributes for the *endogenous aspects of interest* is as follows:

3.1.1 Type of Node

The 'type of node' justifies its role as an aspect of interest to the hypermedia author, because it defines the identity of all the different objects that comprise the structure of a hypermedia application i.e. text, picture, sound etc. Each type of node together with its attributes will be represented in the Pausanian map so that the author will be able to clearly distinguish all information units and the way they are presented to the user. Since the Pausanian notation is currently implemented on Microcosm based hypermedia applications, eight categories have been assigned, as the types of nodes that can be currently viewed in Microcosm: Text, Graphic, Audio, Video, Animation, Graphic Menu, HTML(any HTML document, viewed by the Microcosm's Web viewer), VR (any virtual reality objects) viewed by the Microcosm's 3D viewer, External Object (any independent application linked with Microcosm). Since each type of node has different characteristics (in terms of comprising the structure of a hyperdocument), it has been assigned with attributes which identify it as an aspect of interest to the hypermedia author.

Type of Node: TEXT

Type of TEXT: includes Core Document, Section, Supplement, Question - Answer (attrb - Interactive, Passive), Table (attrb - Dimensions), List-menu, Footnote, Reference, Glossary, Dictionary, Bibliography, Combination of (Type of Text + Type of Text), other by the author.

Type of Node: GRAPHIC

The type of node *graphic* is given two sets of attributes, one that identifies what type of graphic it is and another one that defines the semantic relation between the graphic and its source, when the graphic is a picture and serves as a destination node.

Type of Graphic: includes Picture, Diagram, Graph-Chart, Graphic Combination.

Status of Semantic Relation when the graphic serves as a destination node includes: Explanatory, Decorative, Allegorical [2].

Each of the types of graphic attributes are given an additional identification mark which represents on the Pausanian Map the case of any text accompanying the graphic.

The type of node: AUDIO

The attributes that define an audio node and are appropriate to the hypermedia author's interest include: the type of audio, which reveals the content of the particular audio file. For example, Verbal description, Music, Composite: the length of the sequence which represents the total playing time of the audio file; and the status of the audio player's (viewer) controls, which show whether they are available or not to the user while they are listening to audio information.

The type of node: VIDEO, ANIMATION

The attributes that define kinetic information [19] such as video and animation and are appropriate to the author's

interest include: the length of the sequence which represents the total playing time of a video or animation information unit; the status of the video and animation player's (viewer) controls, which show whether they are available or not to the user while viewing the particular video or animation; and the status of interaction, which represents whether a sequence is interactive or passive.

The type of node External Object is assigned two attributes: the type of External Object which states its identity e.g. 'database', and the status of interaction representing whether that particular external object allows user interaction or appears passive. Attributes for the types of node Graphic Form- Menu, HTML and VR are under research.

3.1.2 Types of Links

One of the most important elements in the structure of a hypermedia document, is the different types of links provided by the hypermedia system. Microcosm includes, four associative types of links, one visible (button link - highlighted anchor) and three invisible (specific, local and generic - their anchors are not highlighted). At this point we do not consider other dynamically generated types of links (i.e. Microcosm's *compute links*).

Button

A link from a **visible** anchor in a source node to a specific location in a target document. It is used in situations where the link should be obvious and the author wishes to indicate visibly its presence: for example a link from the anchor **the first Athenian Coin**, to the associated picture of the actual coin.

Specific

A link from an invisible anchor in a source node to a specific location on the target document. It is used in situations where the link provides detailed information about a particular subject 'not strictly related' to the overall content of 'the source node' but directly related to its anchor. Authors would use the specific link when they wish to offer the particular information but also allow the users to study the content without interrupting their cohesion; for example a link from a reference: Aristotle's description of King Archon's role, to the actual document is referred to as Aristotle's work "Athenaion Politeia" line 57. The user has already read the text block in the source node where the author discusses the King in ancient Athens and if they wish to examine the actual reference they can trace a question (select the text block and ask Micrososm to 'show' the link connected to that phrase) and follow the link to the Aristotle's work.

Local

A link from an invisible anchor(s) in a source document to a specific location in a target document. When a phrase or word has been linked as a local link, all occurrences of this particular anchor in the source node are linked to the same destination node. It is used to ensure that users can only reach certain documents by careful research, or to avoid presenting them with inappropriate information. Suppose the word *harbour* in a text node about the ancient harbour of Piraeus, is selected as the source anchor and a link is made to a picture painting of the ancient harbour. If the link type *local* is selected when the link is made 'all' occurrences of the word *harbour* 'in the source document only' are linked to that painting.

Generic

A link from an invisible anchor to a specific location in a target document. When an anchored piece of text has been linked as a generic link, all occurrences of this anchor in any document throughout the application, are linked to the same destination node. It is used in situations where the link should be available 'throughout the application': for example a link from the word '*archon*' to its explanation in the ancient Greek-English dictionary.

Sequential

Another type of link included in the Pausanian notation is the sequential link. It is represented on the Pausanian map when a visible anchor (anchored text, anchored graphic object, or anchored graphic selection) leads the user to a single linear path of related nodes. It is therefore a navigational rather than an associative link. The hypertext author uses such links when he wishes to guide readers into a logical path in order to achieve a specific objective. A source node can include visible and invisible links as well as a sequential link(s) defining guided tours specifically created by the author. Sequential links provide a more limited version of what is available within the structure of the particular node [15]. That linear-logical path consists of nodes including a few or no button, specific or local links, only anchors indicating 'go to Next' and 'go to Previous' nodes. In the case when there is a sequential link starting a linear path from a graphic type of node, then only the maximum depth of path will be represented on the map. (for the aspect of interest *depth of path* see later).

Three other attributes attached to each type of link are the Status of Traversal, Status of Direction and Target at the Destination document:

3.1.3 Status of Traversal

One to One

The source anchor leads the user to only one destination node.

One to Many (Indirect)

The source anchor leads the user to a choice of destination nodes, e.g. the source node is about the ancient Greek philosophers and in the fourth paragraph the name **Plato** is a visible anchor linked to a choice of three different destinations: a document about his life, a picture of a statue and another document about his works.

One to Many (Direct)

By following the source anchor the user is lead directly to more than one destination nodes, e.g. the source node is about Daily life in Athens at the 5th century BC; a visible source anchor is the words **women's embellishment**. If the user follows the link, three nodes will appear: a picture of a

vase painting showing such scenes as friends preparing a bride for her wedding, a picture of a vase painting showing women applying perfume to themselves, and the third, a text node discussing embellishment in ancient Athenian Society.

3.1.4 Status of Direction

One way Link

The source anchor leads the user to a destination node from where they cannot return automatically, to the document of departure.

Bi-directional Link

The source anchor leads the user to a destination node, from where they can 'reverse the link', or in other words return to the node of departure. In Microcosm this occurs either, when both the source and the destination node stay active on the screen so that the user can jump from B back to A, or when, the destination document has replaced the source node (in Microcosm terminology: the viewer starts unlocked) but includes an anchor that connects back to it.

The 'target' at the destination node is an attribute mostly used in situations where the destination is a text type of node. It represents the location within a text node, where the link points to: e.g. specific location, beginning of document. For example a link from the source anchor 'W. Thomson' to the specific location of a bibliographical reference in the bibliography type of text node.

3.1.5 Types of Anchors

The aspect of interest 'Types of Anchors' is represented on the Pausanian map, in order to show what part of a node is linked to other information units.

Anchored Text

Any piece of text serving as a mark, emphasising (visible), or containing (invisible) a connection with another information unit: for example the visible anchor 'Democracy' which links to a text node about the Constitution in Ancient Athens.

Anchored Graphic Object

Any graphic element serving as a link to another information unit: for example a navigation sign on the map of the Acropolis, a sound icon at the end of a text node which links to a musical reconstruction from the Orchestra in the Athenian Agora.

Anchored Graphic Selection

A link made on a particular selection within a picture or a graphic e.g. a link made on an ancient wine cup (being part of a picture presenting six red-figure wine cups) connecting to another picture consisting of the bottom of that cup which depicts an ancient potter sitting at his wheel, the speed of which he controls with his knee and above him on a shelf there are some of his pots.

All three types of anchors are attached to another set of attributes that represent the destination flag which is any possible indication at the source anchor for the type of the destination node.

Destination Flag

The destination flag will be shown on the Pausanian map when a source anchor is accompanied by any indication of its destination e.g. an icon: a video camera icon situated next to an anchor showing that the destination node is a video sequence; or any other way of indicating the destination such as a label appearing after a mouse action: a label stating 'animation' which appears when the mouse is over an anchor; or a link preview: where the source anchor includes a preview of the destination node such as the node type and a name such as a title or a brief summary of the content.

3.1.6 The Location of Anchors

The aspect of interest 'location of anchors' includes attributes that show in the map, the exact position of each anchor in the source document: Paragraph No. Beginning of Document, Middle of Document, End of Document. It is a very important aspect of interest because it shows clearly, the frequency or concentration of links within a document.

3.1.7 The Depth of Path

The Depth of Path is an aspect of interest represented on the Pausanian Map in the form of steps. Those steps are the attributes that identify the depth of the linking path, from the "surface" of the hypermedia document (the source anchor) to its "bed" (the last linked destination node). For example: [anchor A1] in node A linked to Node B (1st Step) [anchor B3] in node B linked to node F (2nd Step) [anchor F3] in node F linked to node L (3rd Step), [anchor A2] etc.

The Pausanian Map includes a visual representation of links traversed up to the fourth step. If a linking path "pulls" the user further than the fourth step, then only the location of that last destination node is shown but not the representation of its attributes.

3.2 EXOGENOUS ASPECTS OF INTEREST

The second category of aspects of interest to the hypermedia author is the exogenous. The *exogenous* aspects of interest define the visual appearance, of a hypermedia document:

Length of Document: Scrolling document (more than one screen page), Non-Scrolling document (one screen page). If the document is scrolling, it is represented in the Pausanian Map by the number of pages. Further attributes that are being considered include: Width of Text Block, Alignment of Text Block, and Number of Fonts used in the Document.

3.3. AUCTORIAL ASPECTS OF INTEREST

The final category of the aspects of interest to the hypermedia author, is the auctorial[1]. The *auctorial* aspects of interest are concerned with the content's structure and

[1] . We use the name *Auctorial* from the Latin word auctor which is the origin of the word author. What we mean by auctorial is, anything to do with the actual writer who writes his ideas in the form of hypermedia (presented in an electronic medium) and not in a linear way as the traditional author of the printed book.

composition. We have classified these as: the status of association, the arrangement of cognitive layers, the content kermatism and the level of content fragmentation.

3.3.1 The Status of Association

A very important aspect of interest for the hypermedia author is the association between the source anchor and the destination text node. The Pausanian notation includes eight different attributes which define the status of the association. These attributes are offered as predefined to the author, (as well as to the content expert or the evaluation team) of the application. As well as the *status of association* we are considering including in the notation, Trigg's links taxonomy [31] which is a very explicit classification of attributes defining the semantic relation between nodes.

Consecutive Association

A consecutive association is the smooth content transition from the source node to the destination document. For example, the source node is about sculpture in ancient Greece and it discusses the different types of Korai (female standing figures) The third paragraph of the document *explains briefly their characteristic elements and the differences between the Kore of the 6th century BC and the Kore sculptured in the 7th century BC.* Within this paragraph there are two button links (visible) one on the anchor: 'Kore of the 6th century' and another on the anchor: 'Kore of the 7th century'. Both anchors lead the user to documents which *discuss in detail the characteristics of each statue.* If the user chooses to follow the link and read these documents they can easily compare their characteristics because *the source document has already prepared them by introducing the subject.*

Therefore there has been a smooth transition from the destination nodes to the source node and vice versa. The content of the destination document succeeds the source node.

Renaissance Association

Authors create a renaissance relation between two nodes, when they make a link to a document, that *'revives' the user's enthusiasm for learning more information about the corresponding subject.* For example, the source document discusses the sculpture of the Parthenon where the author talks about its frieze and metopai. In the text block discussing the frieze of the Parthenon, the author has made a link on the word 'frieze' that connects to a detailed document containing a description. The same strategy has been chosen for the word 'metopai'. Both anchors are visible (button) links. Since the source document is about 'the sculpture of Parthenon' and includes links to information about the main architectural elements of the temple, it is building a renaissance relation where the author inclines the reader's mood to learn more about the anchored subjects.

The distinction between the two examples given for the attributes of content relevance: renaissance relation and consecutive relation, is that in the renaissance relation, the destination nodes consist of information about different subjects that comprise the theme: Sculpture of Parthenon. (the user follows the link in order to learn more about the source subject), whereas in the consecutive relation the destination nodes consist of information on the same subjects (statues of Korai) but in different chronological periods. (the user-reader *compares* the information in the destination node, to the source node-a smooth transition from A to B)

Umbilical-Cord Association

An Umbilical-Cord relation is created when the destination node(s) complements the content of the source node. For example, the source document discusses the columns (kiones) of temples built in the Archaic period. The second paragraph of the text explains that the ancient temple's columns consist of parts such as the stylobate, the krepidoma, the capital and the entablature. All these words have been anchored by the hypermedia author as visible links, leading the user to destination nodes containing the description of each part and its corresponding location on the column of an archaic temple. Since the destination documents complete the subject about the structure of columns in the archaic temples, they create an umbilical-cord relation between the source node and its target document(s).

Subversive Association

Hypermedia authors build a subversive relation when they connect two documents, and the destination document subverts the content of its source. For example the case where the source document is about the Parthenon's Frieze and its sculptured decor which represents the Panathenaic Procession. In the entire text the author concentrates on the interpretation of the sculptured representation and maintains the most popular theory which is *the procession that accompanies the presentation of the robe of the Goddess Athena.* In the middle of this document, the author reports that there is another interpretation for the decor of the frieze, but it is not accepted by the experts. The words 'another interpretation' are visible links connecting to the text reporting this alternative explanation which however subverts the globally accepted theory in the source document. In this case the author has created a subversive relation between the source and the destination node.

Intrusive Association

An intrusive relation is created when the destination document suddenly disrupts the coherence of the content. For example, the source document discusses the most famous ancient Greek sculptor Feidias and his master work on the gold statue of Zeus sculptured for the temple of Zeus in Olympia. The author has chosen the words 'temple of Zeus in Olympia' (which are situated at the first paragraph of the source document) to be a visible anchor (button link) from which the user 'is given the opportunity' to follow the link and learn more information about this famous temple. The destination document happens to be extremely informative as two pages description of the temple including information about its architectural elements, the

east and west metopies and what they represent (the labors of Heracles). All the main characteristic elements of the temple are visible anchors (15 button links) linking to other documents with more detailed information for each part of the temple i.e. its columns. The user started to learn about the sculptor Feidias and his master work the gold statue of Zeus and ended up reading very detailed information about the temple of Zeus where the statue was situated, having previously passed from a text about the representation on the decor of the west frieze. In this case the destination document has suddenly interrupted the reader from the content of the source document and created an intrusive association.

Magnetic Association

The characteristics of a magnetic relation could be the same as the renaissance relation with the difference that the former brings possible danger. Let us take the same example as in the renaissance relation where the source document discusses the Pheidias' sculptures of the Parthenon, specifically the gold statue of the goddess Athena. Somewhere in the middle of the description the author refers to Pheidias' students who contributed in the construction of that most important temple of the ancient Hellenic civilisation. The words 'Pheidias' students' are visible anchors linking to documents of detailed information about each student. In this case the author has roused the reader's interest (magnetised) to learn about a subject completely different from the initial content. It is not a renaissance relation because there hasn't been any positive transition and the visible anchor leads the reader to a completely different context from the one in the source node.

Association of Superiority

A relation of superiority is created when the destination node is full of information and overwhelms the source document. For example the source document is about ceramic vase painting in the 7th century BC, and discusses the Attic workshops and the technique for applying the decoration of the vases. In the third paragraph of the document the author reports a later technique (applied in the 6th century BC), which was one of the two most common in the Attic workshops: the black-figure painting (the second most common technique was the red-figure painting). The author explains that all vase-painting in the 6th century was based on the black-figure technique. The words 'black-figure' technique are a visible anchor, which leads the reader to a document containing a well composed detailed description on the actual technique, including information about different painters and their vase paintings. In this case the author by providing a visible link to such important and detailed information, overwhelms the content of the source document.

Association of Discontinuity

Content discontinuity is created when there is no relation between the destination document and its source. For example, suppose the source document is about 'the temple of Poseidon in Sounion'. In the second paragraph of that document there is a very brief reference to the columns of the Parthenon. The words 'columns of the Parthenon' are anchored as a visible link connecting to the document consisting of general information about the Parthenon. Since the source document is the temple of Poseidon and the destination node is about the Parthenon, there is no continuity in the content. If the destination document was about the columns of the Parthenon then there would be some continuity but not as much as in the umbilical-cord relation.

Each of the above attributes are represented in the Pausanian map together with another attribute which states if the destination node has been composed by the same or different author.

3.3.2 The Arrangement of Cognitive Layers

Hypermedia authors, build cognitive jumps in order to offer the user what he anticipates from possible questions. They offer the reader, anticipated solutions to possible questions which arise, while reading the source document. We call these cognitive jumps the *layers* which are created by the reader's transition from the informative source document to the destination node which focuses attention to a particular point of information. The author invents cognitive solutions that comprise the necessary channels to enable the reader to attain their anticipated target. In some cases the author's intention to offer the anticipated, could be perceived by the reader as "a present". However, there are times when the readers get exactly what they expect, but there are also other times where they are given little or nothing that would meet their expectation. The hypermedia author is obliged to know his readers very well and plays the role of an *augur* who knows both, the person who is asking for an oracle as well as their problem. In other words, the reader and what they anticipate from the content in a source document, and the provided linked information. The cognitive channels or *layers* created by the author, resemble the oracles given by the augur (author) to the applicant (user).

This mechanism of the creation of layers, if they have not been built carefully, will easily miss their target.

The most important concern in that mechanism is *what are the transitions* which create the layers. For example, if the reader studies a document about the Temple of Poseidon and follows a link from the visible anchor 'the statue of Poseidon' to the actual picture of the statue, have they jumped to another layer? Probably not because the destination node is only a static (level of interaction: passive) graphic-picture which complements (explanatory relation) the anchor. Therefore the reader remains at the first layer. For example if a document is about the statue of the eponymous heroes in the Athenian Agora and there is a visible link on the anchor 'the Tribe of Leontis' (defined by the author as a magnetic association) leading to a detailed document about that tribe, then the author has guided the reader to another layer. We are still working on a clear classification of attributes that define these layers, so we have not yet included them as a representation on the map.

3.3.3 The Level of Content Kermatism

The *kermatism* of a hypermedia application is the segmentation and classification of the aggregate content into interrelated atomic subsets each of which comprise an individual subject. For example, the content of Athens in the Years of Perikles divided in chapters and sections such as *The City, its structure and organisation, Social Organisation and day-to-day life, Professions and Finance, The Athenian Constitution, Perikles, his life and mission,* or *a document about the daily life in Ancient Athens and the information linked from anchors located within that source document.* The hypermedia author by segmenting the aggregate content, gives each subset -section or subsection- an entity. They consider it as something discrete or individual within the entity of the aggregate content. However, this does not imply that those subsets do not intersect with each other. In a hypermedia application, they could exist within the content, as self-subsistent or self-created but they can also interrelate (be semantically linked). Some of the subsets, being either chapters sections or subsections, can supplement and complete a notional aggregation. By segmenting the content, authors can offer their best writing capability and meet their targets more easily. One of those targets may be the effective interrelation (linking) of subsets in order to achieve content coherence and comprehension. It is much more likely, that such targets will be met by the kermatism of the content (linked chapters, sections, subsections), rather than it, being a whole single linear unit.

4.0 The Level of content Fragmentation

We describe the *fragmentation of a single hypermedia document*, as all the typographic and conceptual interruptions which lead the user to a path of cognitive jumps. Both the *kermatism* and the *fragmentation* map will help the author to experiment with different strategies in order to see if readership improves or inclines. Unfortunately, due to space limitations we can not include their representations in this paper. (For details of, the Pausanian Kermatism Map, Pausanian Fragmentation Map and Pausanian Generic Links Map see HT'97 poster presentation: The Pausanian Notation [14]).

5.0 THE PAUSANIAN MAP, AN EXAMPLE

The Pausanian Map shown in figure 2, represents the structure of a hypermedia document about "*the statue of the eponymous heroes*" in the Athenian Agora.

From a first glance at the Pausanian Map of this particular document we can clearly see both the *direction* and *distance of movement*. The author has included information guiding the reader along a linking path up to the fourth step. Research studies have shown that if readers are guided along more than four steps there is significant possibility that they will loose track of their current position [16]. If we follow the linking path in reverse (from the fourth step to the first) we can see that the path started from the visible anchor 'the Metroon'. The attributes of the destination node at the second step signify that the author has created an *intrusive* association between the destination node and its source. The hypermedia author *has chosen*, to describe the association between, the source node and its destination, as *intrusive*. By definition, an intrusive association reveals a negative status. However, negative attributes between subsets, would not necessarily be negative for their hypermedia inclusion. This representation on the Pausanian Map, will help the author to visualise the thinking and structure of their ideas in order to examine how well they were composed within the hypermedia context. A suggestion in this particular example would be to avoid linking subsets that are not coherently associated. If the author particularly needs, to provide information about the Metroon, and make it available from that location (1st paragraph of the document, anchor: the Metroon), he could possibly change the selection of the visible ***Button*** type of link and make it, say an invisible *Specific link*. (*A Local type of link* would be a good choice only when the author wishes to make the information available from all the occurrences of the anchor 'Metroon' in that document. However, if the link is described with a negative status of association, a *local type of link* is not recommended).

The representation of the source document's linking structure shows the author that it contains six button links, two specific and one local (six visible and three invisible links). The length of the document is four screen-pages. If we consider its length, in combination with the number of links included, we can observe that there is no great level of fragmentation.

The second paragraph of the document contains two button links one on the anchor 'Kleisthenic Reforms' and another on the anchor 'Citizenship in Athens'. As represented on the map both visible anchors lead the reader to two different Graphic -Menu type of nodes. This means that while the users read the second paragraph of a seven paragraph document, they are "offered" the opportunity to stop themselves from completing the reading of its content and to jump to a graphic-menu that contains links to completely different subjects. Again in this situation the author should either not link visible anchors to graphic menus in the beginning of the document or choose a more appropriate, invisible type of link. It is recommended however that the hypermedia author should not use these links at all, because both the content interruption, and the transition to completely different subjects, could mean the reader looses information taken from the source and become disorientated.

Carrying on the examination of the structure in the fourth and fifth paragraphs respectively, two button links connect to pictures that complete the subject of the paragraph (*explanatory* relation). The visible anchor 'The Eponymous heroes' connects to a picture which is accompanied by text. Undoubtedly, if carefully assigned, that strategy saves, a step and a layer, from *the depth of links*, and *the arrangement of cognitive layers*, respectively. The visible anchor 'preserved today' connects to another picture which is also accompanied by text. The map shows that this picture contains an anchored graphic object that links to a

video sequence. However, this anchored graphic object is not accompanied by a *destination flag*, which means that the reader is not being informed by the author that they should expect *kinetic* information. It is recommended that all anchors connecting to either sound or kinetic information such as animation, video or movement in a VR environment, should be accompanied by a destination flag (i.e. a video camera icon or mouse label) to indicate what type of object is linked to the anchor [19]. Moreover, that video node is relatively long (6':35''). Especially with teaching material the length of video and animation sequences should be restricted in proper length. Such long video nodes (more than 4 minutes) might prevent users for comprehending the content, reduce the concentration and will to study and give much more complex operation of software tools [16].

6.0 VARIABLES OF INTEREST- PAUSANIAN CHARTS

Up to this point in the paper we have introduced how the Pausanian notation could be used to represent a single hypermedia document in order to analyse its functionality or dynamics, and recommend possible improvements or alterations.

As mentioned in the introduction, to visualise *the structure of a group* of hypermedia documents, we have defined a set of variables, (derived from the aspects of interest), which we call the *variables of interest*. These are statistically represented in what we call "*Pausanian Charts* for representing the structure of a group of hypermedia documents" (Figure 3). Such variables include: Total Number of Visible Links, Total number of Generic Links, Maximum Depth of Path started from Visible Links, Maximum Depth of Path started from Generic Links, Concentration of Visible Links, Number of Associations of Discontinuity, Number of Graphic-Picture Nodes, etc. (all variables are applied *per* hypermedia document)

Firstly, the author can select a group of documents for investigation, (i.e. all the text nodes from the chapter Daily Life in the Periklean Athens) , and then choose from our classification of the variables of interest, the ones they would like to represent on the Pausanian Charts, in order to examine their structure. Then a data table is generated and a series of provided types of charts, is recommended. The author can then choose one of the charts from which, the appropriate Pausanian Chart will be drawn, grouping together the selected variables and representing them statistically. By examining the Pausanian Chart, the author can visualise certain issues from the synthesis of all the selected documents, in order to perceive their structure at a glance. If they want to look more closely at a particular point in the chart they could apply the Pausanian Map on that particular node. This aspect of work is still under research.

CONCLUSION AND FUTURE WORK

By proposing the Pausanian notation we argue that it is time to start providing hypermedia authors with tools to help them find the problems inherent in their designs themselves. By no means do we believe that a notation will solve all the problems. What we argue is that by defining the attributes that play a key role in the synthesis of a hypermedia structure and making them visually available to the composers of the application, possible problems and causes can be revealed, and the overall design and the performance of the application can be improved.

In this paper we have introduced the Pausanian notation as well as its main features: the aspects of interest, the Pausanian Map, the variables of interest, and the Pausanian Chart. The major case study being used for evaluating and testing the notation, is *Pausanias 2000, a hypermedia library for the ancient Hellenic World (The Attica Region)*. We are also currently evaluating our method on another six Microcosm and three Storyspace [6] applications. Due to space limitations, we cannot discuss in detail the results of our evaluation however, we have found that our approach has been justified and that, by using the Pausanian Notation, the author can quickly track and correct errors occurring throughout the structure.

Our plans for future work are directed as follows: in the very near future we would like to have completed the classification of *aspects of interest* and *variables of interest* as well as to improve the paper representation of the Pausanian Maps. In parallel, we will be working in the implementation of the Pausanian Notation for representing, examining and analysing the structure of Web based applications. Having achieved that, we will start automating the process of creating the Pausanian maps for Microcosm applications, by adding the appropriate functions to the Microcosm Make-Link feature. The fact that Microcosm keeps all the link information stored in a linkbase file, makes it much easier to extract any information needed for producing the different Pausanian Maps. The implementation of the Pausanian method for representing the structure of a Web application, will be based on WebCosm (the Web version of Microcosm [4]).

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Figures 1a, 1b : Examples of symbols used to represent *aspects of interest* and their attributes on the *Pausanian map.*

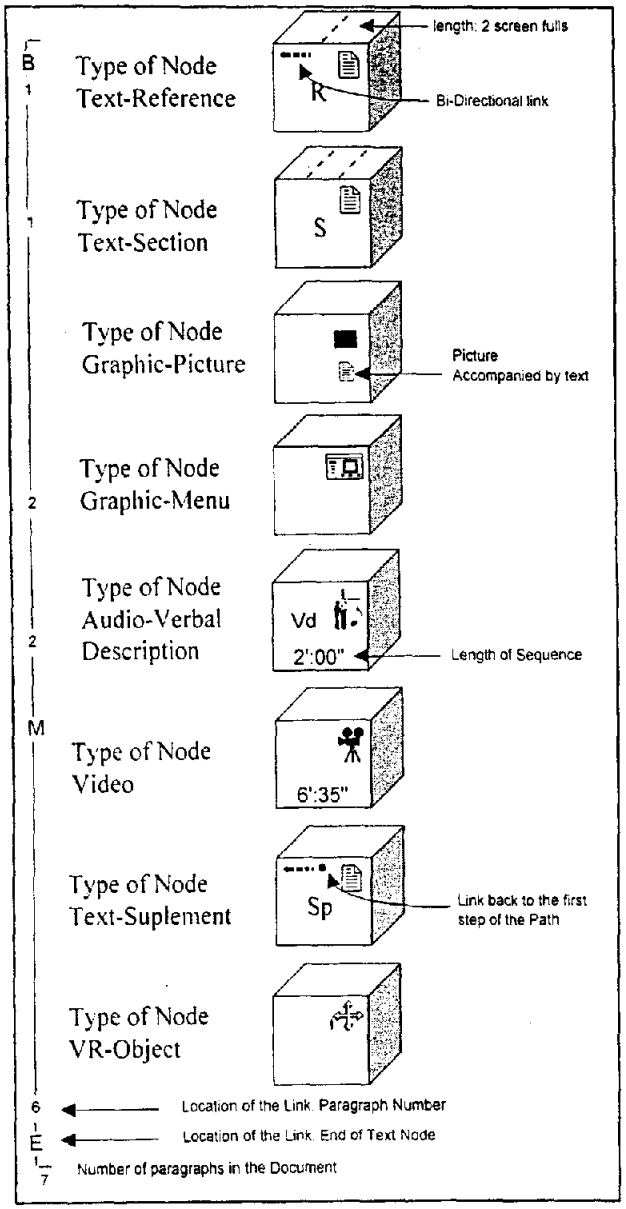

Figure 1a.

[This is a Button Link (Visible)]
[This is a Specific Link(Invisible)]
This is a Local Link (Invisible)

Status of Association

ConA : Consecutive Association
IntrA : Intrusive Association
DisA : Association of Discontinuity
MagA : Stimulant Association
ExpR : Explantory Relation -

Status of Semantic Relation
Graphic-Picture as Destination Node

: Anchored Graphic object
: Destination Flag

dP ⇒

s2: Depth of Path - Second Step

Figure 1b.

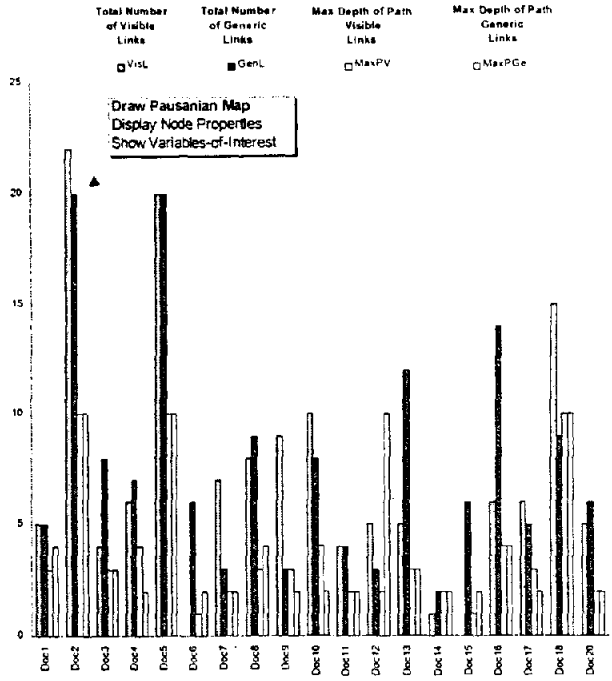

Figure 3 : Example of the Pausanian Chart

Figure 2: Example of the Pausanian Map
Text Node: The Statue of the Eponymous Heroes in the Athenian Agora