Structural Distinctions Between Hypermedia Storage and Presentation

Lloyd Rutledge, Lynda Hardman, Jacco van Ossenbruggen* and Dick C.A. Bulterman

CWI
P.O. Box 94079
1090 GB Amsterdam, The Netherlands
+31 (20) 592 41 27
{lloyd,lynda,dcab}@cwi.nl
http://www.cwi.nl/~{lloyd,lynda,dcab}
*Vrije Universiteit
Dept. of Math. and Computer Science
De Boelelaan 1081
1081 HV Amsterdam, The Netherlands
+31 (20) 444 77 81
jrvosse@cs.vu.nl
http://www.cs.vu.nl/~jrvosse/

Abstract

In order to facilitate adaptability of hypermedia documents a distinction is often made between the underlying conceptual structure of a document and the structure of its presentation. This distinction enables greater variety in how a presentation can be adapted to best convey these underlying concepts in a given situation. What is often confusing for those applying this distinction is that although both levels of structure often share similar components: transformation form the storage of a document to its presentation sometimes occurs directly between these similar components and sometimes does not. These similarities typically fall in the categories of space, time and relationships between document portions. This paper identifies some primary similarities between the structure of hypermedia storage and presentation. It also explores how the transformation from storage to presentation often does not follow these similarities. This discussion is illustrated with the Fiets hypermedia application, which addresses the issues of storage, presentation and transformation using public domain formats and tools. The intention is to help authors who separate storage from presentation to better understand this distinction.

Keywords

Hypermedia, storage, generation, presentation, HyTime, DSSSL, SMIL.

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Introduction

The World Wide Web offers the promise, and more and more the reality, of a widely distributed and widely accessible electronic publication of related hypermedia data. In order for this data to be applicable to a wide variety of presentation styles, circumstances and future technology changes, it must be stored in a presentation independent format that does not prescribe aspects of its presentation. In order for such data to be presented, a mechanism must exist that can process it to generate a presentation appropriate for a given situation.

This involves a hypermedia environment working on three levels. The first is the long term storage of the documents. The second is the processing of the documents for presentation. The third is the presentation of the documents. Authors using such environments are concerned about the structure of documents as they are stored and as they are presented. The structure of hypermedia presentations typically involves timing, spatial layout on a screen, and the user activation of presentation portions for navigation. The structure of hypermedia storage often falls in similar categories. Events can be represented as occurring at certain times. Also, spatial relationships, both abstract and specific, can exist between document objects. Finally, document objects have relations with other document objects.

A collection of standard formats assists in defining these three layers of hypermedia. The ISO standard HyTime (Hypermedia/Time-based Structuring Language) specifies the representation of hypermedia documents in a presentation independent format [ISO97][DeRose]. HyTime is defined as a subset of Standard Generalized Markup Language (SGML) [ISO85][Goldfarb], which defines the structure of electronic documents in general. The ISO standard DSSSL (Document Style Semantics and Specification Language) encodes the transformation between storage and presentation [ISO96]. DSSSL defines the transformation of SGML documents into formats that present them. Thus, DSSSL systems can accept HyTime as input. The use of DSSSL with HyTime was recently made easier with the release of the second edition of HyTime, which contains new facilities for use with DSSSL.

SMIL (Synchronized Multimedia Markup Language, pronounced "smile") is a new public domain format for final-form hypermedia presentations distributed on the Web [W3C98]. With W3C's promotion and the public domain SMIL browsers to be released with its version 1.0 publication, it is expected that SMIL will be a widely-used means of distributing published hypermedia. We have developed a public domain tool that plays SMIL documents called GRiNS (A GRaphical INterface for creating and playing SMIL documents) [Bulterman]. SMIL is defined as a subset of SGML. Thus, DSSSL can encode transformations that output SMIL. These standards can be used together to create an environment that processes documents from stored hypermedia data into final presentations.

The issues discussed in this paper are illustrated with an example hypermedia application about the city of Amsterdam, The Netherlands, and is called Fiets (Foundation for Interactive Electronic Touring Systems, or fiets {pronounced "feets"}, the Dutch word for "bicycle" and generally the preferred means of personal transportation in Amsterdam) [Rutledge98][CWIb]. Fiets provides geographic and historic information about Amsterdam.

This paper starts with a general discussion of the structural distinctions. This discussion is done in terms of the Fiets application. Then the roles various standards play in encoding the structure of storage and presentation, and the transformation between them, are described.

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The Structural Distinctions

Hypermedia has typically been modeled in terms of its presentation. The resulting structure usually represents the timing of the media object presentations, the spatial layout of the visual media object displays, and the point-and-click navigational interface for the user. However, there is often a discernible structure to the concepts being conveyed by the presentation, and there can often be more than one means of using hypermedia presentation structure to convey these concepts and their underlying structure. Because of this, it is often beneficial for an author to model a document in terms of such an underlying conceptual structure and handle the mapping of this structure to the final presentation as a separate task.

What often confuses the separation between the underlying conceptual structure of a document and the structure of its presentation is the similarities that exist between these two. Time is an important aspect of hypermedia presentation, but it also often an underlying concept used frequently in documents, such as documents regarding history. Spatial structure is an important aspect of hypermedia presentation because it applies to screen display layout, but space can also be an underlying concept of a document, such as when the document refers to geographic locations. The navigational point-and-click structure of a hypermedia presentation is commonly referred to as hyperlinking, but this term can also be used to refer to any type of semantic relationship that exists between two components of a document. The underlying structure of any document can consist of many such semantic hyperlinks.

This section explores the differences between time, space and hyperlinks in storage and presentation by providing examples of when these corresponding components are mapped directly to one another and when they are not. The temporal structure of a document may have a direct mapping to the temporal structure of its presentation, but this is not always so. It could instead map to spatial or navigational presentation structure. Also, its mapping to the presentation structure may be altogether indirect or nonexistent. It is hoped that by exploring the mappings among these corresponding structures that the distinction between storage and presentation will be better understood and the potentials of maintaining such a distinction better utilized.

The Fiets application is used as an example to illustrate these structural distinctions. Fiets stores the locations on the Web of a large number of media objects about Amsterdam. It also encodes a semantic relational structure in which these media objects exist. These media objects include images such as paintings by Dutch masters, photographs of Amsterdam buildings and neighborhoods, old paintings and engravings of buildings and neighborhoods as they once appeared, videos and sound clips of modern Amsterdam life, and text descriptions of each of these. Fiets conveys such an underlying conceptual structure: the structure of Amsterdam and its history. Amsterdam as a city has geographic structure: its buildings have locations, as does the city itself. With its history, Amsterdam has a temporal structure: events important to Amsterdam occurred on particular dates in the past. Further, Amsterdam has a structure consisting of semantic relationships. For example, a painting is related to its painter, title, year of creation, and, if it is a portrait, who is represented in it, along with their names, life spans, and addresses when living in Amsterdam. An address, in turn, is associated with a building, its architect, year of construction and who lived in it during various periods of history.

The next subsection describes the storage structure of Fiets documents. The combinations used in Fiets transformations between the main structural components of storage and presentation are charted in Table 1. Each combination is discussed in detail in the subsections below.

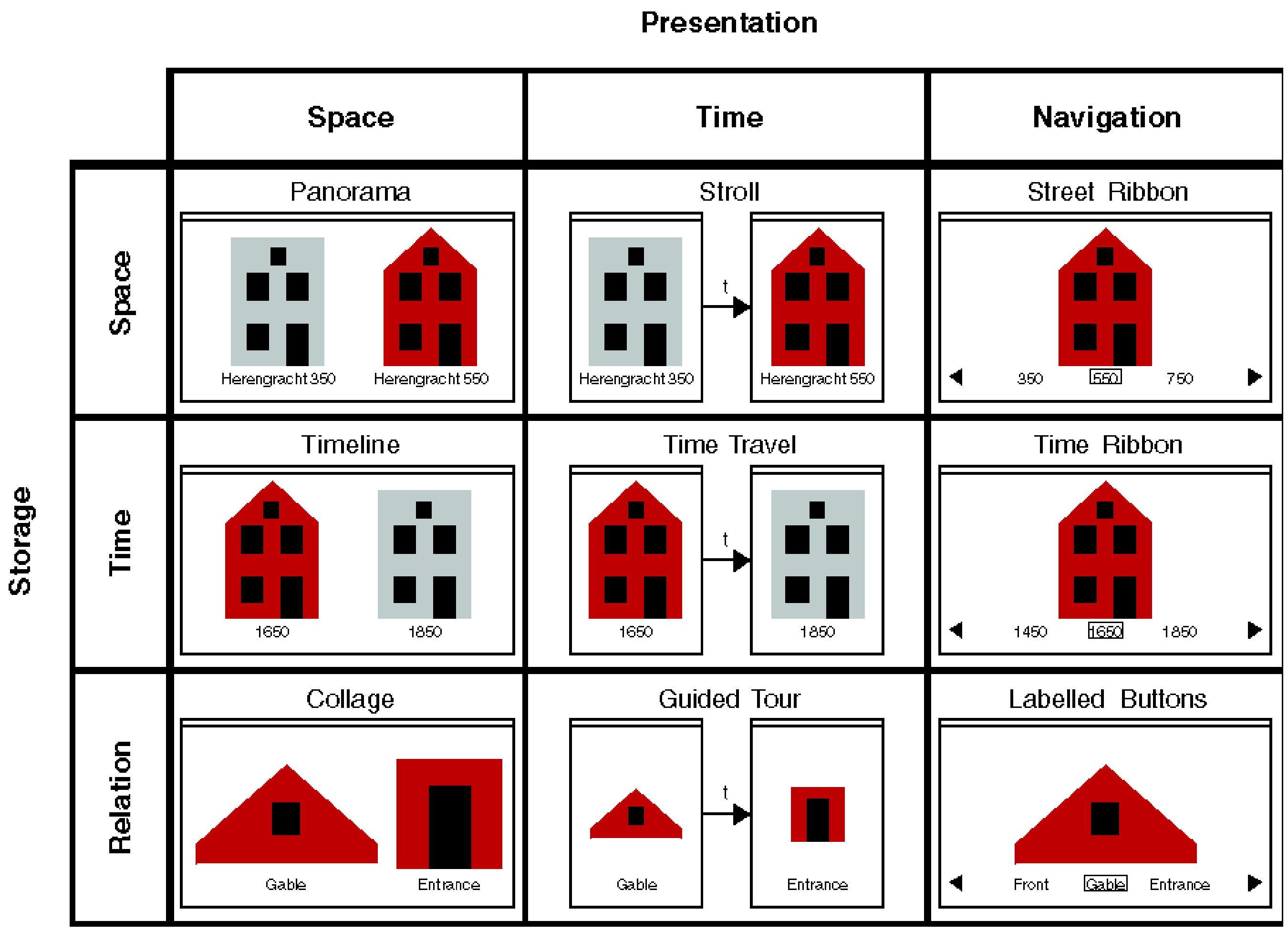

Table 1. Fiets Structural Transformation Combinations

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Storage Structure of Fiets

Figure 1 provides an illustration of the spatial and temporal storage structure of Fiets. This figure shows front view images of three houses along the Herengracht, one of Amsterdam's streets. Also represented is where these buildings lie in spatial structure, in terms of street number, and where they lie in temporal structure, in terms of years.

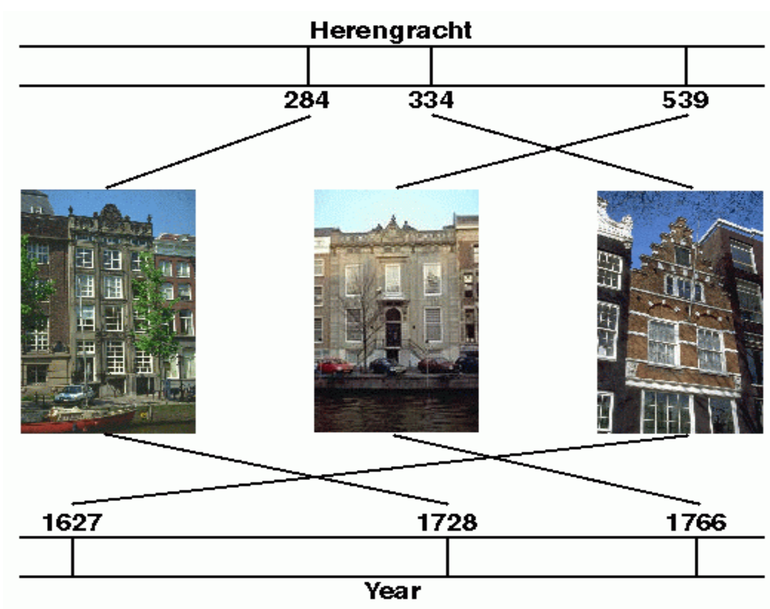

Figure 1. Fiets Spatial and Temporal Storage Structure

Both these types of measure are too abstract to immediately apply to a presentation. Street number is a particularly abstract type of spatial measure, but it does denote a type of measurement in space that has meaning in certain contexts. The unit of "year" has a more tangible meaning, but hardly represents the temporal scope of hypermedia presentations. Use of these units of measure do not apply directly to presentations but can provide information that has impact on the presentation of hypermedia storage data.

Figure 2 provides an illustration of the storage relational structure of Fiets. This shows two types of relations applied to the building at Herengracht 284. The detail relation is a directional relation. It associates a portion of one image with another image that is a detail of it. The building images relation is a multi-endpoint relation. It associates a collection of images for a building with each other and gives each image a role name. The three roles shown here are front view, which gives the full front view of the building, gable, which shows a close-up of the building's gable, and entrance, which shows a close-up of the building's entrance.

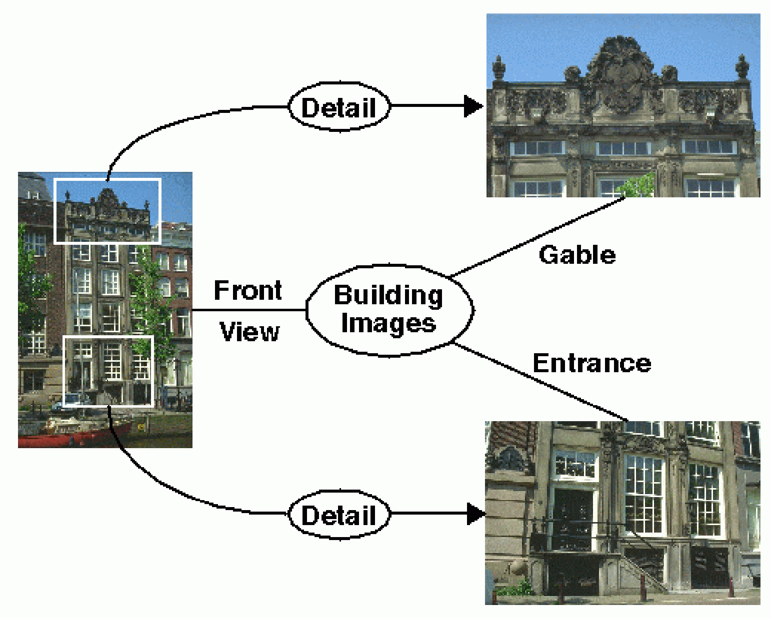

Figure 2. Fiets Relational Storage Structure

These two types of relations are not necessarily navigational in nature. They can transform relatively directly to navigation, as some of the following discussion will show, but the information in these relations also transforms to non-navigational aspects of a presentation as well.

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Space to Space

An example of transformation in the Fiets application from spatial storage structure to spatial layout in a presentation is the generation of a panorama of a collection of buildings along a street. In a panorama, multiple buildings along one street are shown simultaneously, arranged on the screen, in order of street number.

The spatial storage structure used represents at what number a building is located along a particular street. A street and the buildings along it make up an abstract, one-dimensional space. This maps to the spatial structure of the screen display layout. All the buildings along one street are shown on the screen together. Where they are placed on the screen depends on where they lie along the street because the street number order is maintained. Houses lower in number appear to the left and houses higher in number appear to the right.

<-- The Structural Distinctions

Time to Time

An example of time to time transformation in the Fiets application is the generation of a time travel. A time travel shows, in sequence, images of buildings that were built at different points in history. These images are shown in chronological order, giving the user a sense of how the architecture of Amsterdam buildings changed over time. The temporal storage structure used is based on the year of a building's construction. The temporal presentation structure it maps to is the order along the presentation timeline in which the image for each building is displayed.

<-- The Structural Distinctions

Relation to Navigation

Relation to navigation transformation is exemplified in Fiets with labelled buttons. Much information about a particular building is represented in storage structure with relations. These relations associate a building with information about it. Figure 2 shows relations in Fiets that convey information for images regarding a particular building. Storage relational information associates a building with images of its full front, its gable and its entrance. In a relation to navigation transformation, this information would translate to navigation choices provided to the user.

Figure 3 shows the screen display for an example of a relation to navigation transformation. Here, during the display for a building, the labels "front view", "gable" and "entrance" appear. The user can click on one of these to see the corresponding image. The information for making this presentation comes from a relation of type "building images", illustrated in Figure 2. The labels are generated from the storage relational information on the role each member of the relation plays in the relationship represented. What is presented when activating a label is determined by storage information on what the endpoint of that role is in the relation.

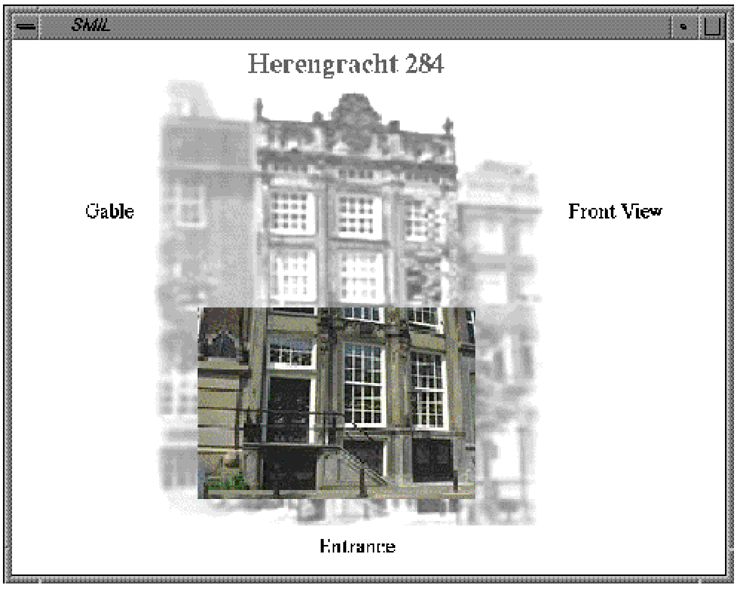

Figure 3. Result of Relation to Navigation Transformation

Other types of storage relation types exist in Fiets as well. Some associate a building with information including its architect, its inhabitants and its interior layout. When a building is being introduced, with one or more images of its exterior, text labels can appear titled "architect", "inhabitants" and "interior". The user can click on one of these labels to access the corresponding information about the building.

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Space to Time

The stroll interface in Fiets exemplifies space to time transformation. A stroll consists of the display of images of the fronts of buildings along a street. These are displayed in sequence, one at a time, in order of street number. This interface gives the user a sense of looking at the buildings while walking, or biking, down the street. Storage structure states the buildings are along the same street and what order they are in along it. The presentation shows these buildings when presenting the street, and shows them in the same order that the storage structure indicates.

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Space to Navigation

Fiets' street ribbon interface is applications of space to navigation transformations. The street ribbon shows all the street numbers for buildings that lie along a particular street and have entries for them in the source document. Clicking on one street number causes images of the building at that address to appear. Storage spatial information, street numbers, is translated to presentation hyperlinks in the form of street number labels whose clicking cause navigation to the display of that building's images.

The street ribbon interface can be similar to the stroll interface. It shows the buildings along a street to the user one at a time. The difference is that, unlike the stroll interface, the pace of this display is determined by user interaction, not by a set duration for displaying each building. The user can cause the next building on the street to be displayed by clicking a "next" button. Of course, a "previous" button could be used as well. The destination of the next and previous button for each building's presentation is determined by the storage spatial information for the buildings.

<-- The Structural Distinctions

Time to Space

The timeline for a building shows the results of time to space transformation. It shows images of buildings from different periods in history on the screen at the same time. The images are placed on the screen in chronological order.

<-- The Structural Distinctions

Time to Navigation

Time to navigation transformation is demonstrated with the time ribbon. It is similar to the street ribbon, but the labels used represent years instead of street addresses. Clicking on a year causes a building built in that year to be displayed. This transformation is similar to that of the street ribbon interface.

Another similarity time to navigation transformations share with space to navigation transformations is the use of the next and previous buttons. Here, building images are shown in the same order generated for the time travel interface, but the pace and direction is determined by user interaction, not the passing of time as in the time travel interface.

<-- The Structural Distinctions

Relation to Space

The transformation from relational to spatial structure is shown in Fiets with the collage. With this, all the images associated with a building through its "building images" relation are shown on the screen at once. Where each image is placed depends on the role it plays in the relation. For example, building fronts may always be displayed along the left, while gables are shown on the upper right and entrances on the lower right. It is the relation-defined role that determines in what portion of the spatial layout an image is displayed.

<-- The Structural Distinctions

Relation to Time

The Fiets application gives an example of the transformation from relational storage structure to temporal presentation structure with its guided tour interface. In a guided tour, different aspects of a building are presented one at a time. The aspect focussed on at each point in such a progression corresponds to a member of a relationship for the building encoded in the storage structure in a relation. For example, a guided tour may start by displaying an image of the building front, followed by a close-up of its gable, followed by a close-up of its entrance.

<-- The Structural Distinctions

Use of Standards and Tools

This section describes how existing public domain standards and tools can be cooperatively applied to addressing the issues of structural distinctions between hypermedia storage and presentation described in this paper. The standards HyTime, DSSSL and SMIL are introduced. Descriptions are provided of how each standard applies to the storage, transformation and presentation of hypermedia.

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HyTime

HyTime is an ISO standard for representing presentation-independent hypermedia data. It is built upon SGML, which provides the basic structuring information that applies to document data in general. HyTime adds more complex structuring constructs and attaches hypermedia semantics to certain patterns of composites of this structure. The basic hypermedia semantics that HyTime represents include hyperlinking, which establishes descriptive relationships between document objects, and scheduling, which puts document objects in coordinate systems that can represent spatial and temporal structure. In Fiets, HyTime hyperlinking constructs are used to represent the relations between stored hypermedia objects. HyTime scheduling constructs are used by Fiets to represent years and street addresses at the storage layer.

HyTime and SGML are meta-languages. They encode not only individual documents but also the document sets to which they belong. A document set is defined by an SGML document type definition (DTD). An individual document conforms to a particular DTD. A DTD defines a specific syntax, in terms of SGML constructs, that its documents must follow. HyTime inherits from SGML the use of DTDs to define individual document sets.

HyTime also provides for defining properties, which apply semantic labels to composites of SGML and HyTime constructs. This facilitates the querying of the data represented in a document, and thus it facilitates the processing of HyTime documents into documents of other formats, including those for presentation. Typically, many different constructs can be used to represent the same property. In such cases, it is easier to query by the property than by all the possible combinations of constructs that can represent that same property. HyTime constructs for property defining can be used for individual documents, for documents sets, and for architectures. The HyTime property set facility was extended in the second edition of HyTime to be more readily processed by DSSSL style sheets. This facility includes the ability to define new property sets. The HyTime meta-DTD defines properties that are common to all HyTime documents, such as measurement and hyperlinking. The Fiets DTD uses HyTime to define properties that are unique to Fiets, such as street address and front view of a building.

<-- Use of Standards and Tools

DSSSL

DSSSL is a Scheme-like language that describes how an SGML document is transformed into another SGML document or into a non-SGML format. Because HyTime documents are SGML documents, any HyTime document can be transformed by DSSSL. A DSSSL program is typically called a style sheet. The separation of style from structure and content enforced with the distinction between DSSSL and HyTime facilitates the creation of particular styles by the author that can be applied to documents of the same document set.

The design of typical DSSSL usage is shown in Figure 4. This diagram shows how an SGML document is processed with an accompanying style sheet by a DSSSL engine. The DSSSL engine determines the mapping encoded by the style sheet and generates the appropriate transformation of the source document into the presentation format.

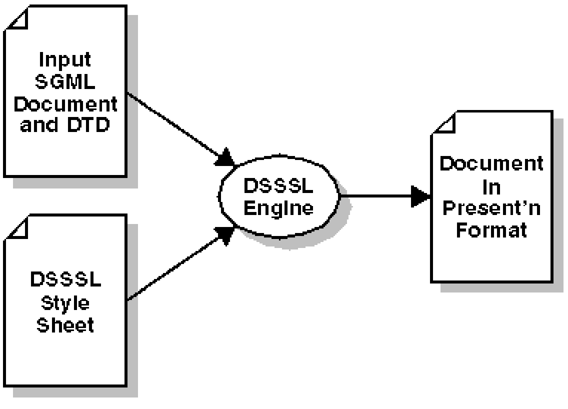

Figure 4. Typical DSSSL Usage

DSSSL is designed to work with HyTime-defined properties, as specified in the HyTime second edition. A style sheet can ask for the property of a document object with one function call, rather than requiring a complex section of code that checks for all the syntax composites that could define that property. No mechanism for recognizing these properties is specified. One possible means for recognizing properties and determining their values is the defining of DSSSL functions that provide access to these properties.

Fiets uses DSSSL to define the transformation of its HyTime-encoding to SMIL presentations. DSSSL functions have been written for Fiets that recognize the properties it uses from the HyTime meta-DTD and the Fiets DTD.

<-- Use of Standards and Tools

SMIL

SMIL is a format representing hypermedia presentations on the Web. It incorporates basic hypermedia principles such as spatial layout, temporal composition, synchronization and navigational hyperlinking. Since SMIL documents are XML documents, they are SGML documents, and thus are readily processed as output, and as input, of DSSSL transformations. SMIL is used to encode the final presentation of Fiets documents. This SMIL code is generated by Fiets from HyTime using DSSSL-encoded transforms.

<-- Use of Standards and Tools

Conclusion

This paper compared the structure of hypermedia storage and presentation. Corresponding constructs between the two structures were identified. These fall in the categories of space, time, and relationships. The transformation from storage to presentation was discussed. How this transformation sometimes maps directly between corresponding constructs and sometimes across corresponding constructs was described. This discussion was held in the context of the Fiets application, which uses the formats HyTime, DSSSL and SMIL for, respectively, hypermedia storage, transformation and presentation.

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