Cooperating on Architectural Analyses

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As part of a fourth semester architectural design studio, students perform an analysis of selected precedents according to various criteria. For this purpose, they are provided with a web-based environment for the storage and management of their analyses. In this way, , and By integrating the analysis results into a common, extensible, library, the students are able to benefit from a collaboration with peers, and draw upon each others' results for comparisons and relationships between different design aspects or buildings. In order to support this integration and strengthen the collaboration, we are developing organization and presentation tools that are integrated within the web-based environment. In this paper, we describe the context as provided by the design studio course, reflect on the advantages of a web-based repository for managing design and analysis information, describe the techniques we are developing to improve this process, and present the implementation of the resulting tools within the web-based environment.

Keywords: Architectural analysis; design studio; types; precedent-based learning; information structures.

Introduction

At our faculty, a three + two year bachelor and masters program is being implemented instead of a five year program. Additionally, a system of five periods of each eight weeks per year is being replaced by a semester-based system. As part of this substantial curriculum review, the role of ICT (Information and Communication Technology) in the design studio is being reassessed. In this paper, we focus on the fourth semester design studio which will be held each semester from the fall semester of this year on for about 350 students per year, and describe one particular aspect of this role we are developing for this semester.

The central design theme of this studio is a small public building. In the progress of the studio, the students will first perform an analysis of select-ed precedents according to various criteria. Given a relatively complex functional program, they will then design and work out the materialization of their building, while documenting their entire design process. The documentation of this design process is stored, managed, organized, and presented in an integrated document management communication environment (Stouffs et al., 2002).

We will provide the students with a web-based environment for the storage and management of their analysis, and tools to perform this analysis. In this way, the students will benefit from a collaboration with peers, and by integrating the analysis results into a common, extensible, library, they will be able to draw upon other results for comparisons and relationships between different aspects or buildings. Within this context, we are develop-

ing tools that are integrated within a presentation environment for analyses. In this paper, we present the context as provided by the design studio course, reflect on the advantages of a web-based repository for managing design and analysis information, outline an information model for design document representation, and describe the various design precedent analysis tools under development.

Educational value

The main purpose of design precedent analyses as part of architectural education is to teach students design principles using existing examples. While practitioners can rely on their own and their colleagues' experience in the process of a new design, students can only draw upon documented examples of success and failure from known architects (Akin et al., 1997). Especially in the early stages of design, it is common practice for architecture students to collect information on prominent buildings relevant to their design task. Precedents as finished and complete design objects contain knowledge of design. A study of such precedents can yield, among others, heuristics used by the designer, design principles for various purposes and situations, and prototypes from building typologies.

In the context of design studio projects, case studies are commonly presented in the form of collages on paper, or as hyper-documents. By integrating the respective results into a common library, students can draw upon others' results for comparisons and relationships between different aspects or buildings. There have been attempts at collecting and organizing these results into computational environments (e.g., Madrazo and Weder, 2001; Madrazo, 2000) as a collection of categorized and hyperlinked documents. The EDAT example (Akin et al., 1997) additionally offers the students a tool to present their work in the design studio and is extendable in different ways, e.g., for carrying out performance analyses on the stored test cases.

The major innovation of such web-based environments and tools is the flexibility these provide with respect to the composition and relatedness of the design analysis information structure. This flexibility applies when integrating new and additional information into the repository and relating this to the existing information in this repository. It also applies when searching for and retrieving information according to concepts of interest. If, instead, the information were statically represented, these advantages would not apply.

There may be many different reasons for retrieving information on precedents in an electronic environment. Given a group of precedents of a specific building type, e.g., theaters, one may be interested in a particular theater hall because the works of that particular architect are of interest. Or, one may want to look at all foyers in order to get an overview of different circulation schemes used in theaters. Alternatively, one may want to deduce rules of thumb about designing theater halls with good acoustics by looking at theater halls that are considered to be examples of good acoustics. Such cases can be enumerated for pages.

Information retrieval actions within precedent-based learning environments generally fit one of the following two categories. Firstly, one may want to retrieve a specific known document that resides in the repository. Secondly, one may want to retrieve all information or documents pertaining to a certain concept or topic, including links to other related documents. Such an overview of relevant documents may provide the necessary information in order to establish or verify a certain design aspect. The possibility of interpreting the entire document structure seeking information related to a concept of interest is an important requirement in such an environment.

The use of an extensive library by a collection

of students requires a flexible and extensible model for relating and integrating the various contributions. Specifically, there is a need for an information organization that enables a user to access information independently of the individual viewpoints of the authors of the information space. Targeting a largely unfamiliar audience, the indeterminacy of viewpoints provides the possibility to anticipate individual requests from the audience. Unexpected viewpoints derived from the information can also invoke new interpretations of existing information, which in turn can lead to creative discoveries.

Flexible information model

Web-based environments for precedent-based learning generally use an abstraction model or a document-based model. They use collections of abstractions for representing, storing and presenting design information. Each abstraction expresses a different aspect of the design object, such as form, function, acoustics, structure, process, space, and organizational relationships (Schmitt, 1993: 39). Abstractions are expressed as documents of various formats, e.g., drawings, diagrams, 3D models, images, simulations, and texts. Such computational environments treat the individual abstractions as entities or objects that are organized and related according to various categories and attributes. The purpose is to offer a flexible organizational framework and enable easy indexing and retrieval of documents.

In general, information retrieval in such environments is based on keyword searches. Documents are indexed such that each document is represented by a set of keywords. This indexing can be done manually or automatically.

Instead of a list of categories or keywords, we introduce a keyword hierarchy, which provides an outline for organizing and categorizing information. The semantic relationships in this hierarchy can be derived from the internal relationships of a system of architectural types (Tunçer et al., 2001). A type in this context is a conceptual object that represents the characteristics of a group of similar objects. Such a keyword hierarchy provides users with a structure to (collectively) categorize their contributions.

The keyword hierarchy defines the context for the organization of documents. In order to more accurately organize the design information within the abstractions in coordination with the keyword hierarchy, documents can be interpreted and broken up into their components. Such a decomposition offers the possibility to relate parts of documents through the keyword hierarchy, which makes documents inherently related by content. In a similar vein, information from a number of existing documents can be composed into a new "document" and placed into the document structure, retaining all relationships to the original documents.

The separation of syntax (document structure) and semantics (keyword hierarchy) ensures extensibility and flexibility of the overall representation and avoids the imposition of a fixed frame of reference. The semantics can easily be altered at any time without requiring an adaptation of the syntactic structure. Users can alter either the decomposition or the categorization without affecting the other. Furthermore, the user has full control on the effective positioning of any document within the categorical organization, by selecting either or both the number of keywords assigned and the level of decomposition. This flexibility avoids a rigorous and tedious process when using an application of this methodology.

Semantic maps

When keywords are organized in a structure, these are more easily visualized and conceptualized, facilitating a conceptual organization of documents with respect to this semantic structure. Visualizations of semantic structures are denoted

semantic maps. Semantic map displays support users' searching and browsing activities. In particular, effective visualizations allow efficient and fast access to data, and provide a better overview of data entities (Papanikolaou, 2001). The organization of these visualizations helps users to learn (and memorize) the contents of the map (Lin, 1995). This allows users to locate information faster and more easily, especially over time. Such visualizations also allow users to quickly identify a starting point, because they give the users a sense of spatial location. They also allow users to identify the relative distance between information entities providing feedback on the relatedness of these entities. In this way, visualizations can guide the user to zones or nodes of interest, serve to determine activity centers, and highlight issues that may be of interest (Stouffs, 2001). Visualizations that facilitate visual exploration and manipulation support the process of relating appropriate keywords to document entities and components. For example, a hierarchical structure of keywords allows for an effective overview of the entire structure in a single view that can be used when assigning keywords to documents and when creating new keywords within this structure.

Design studio application

We developed a first prototype for the presentation of architectural analyses on the web in order to illustrate the presented techniques (Tunçer et al., 2001). Ottoman Mosques served as a case study for this work. XML was adopted as a common syntax for the representation of document structures and their integration into a single information structure. Based on its results, we are currently developing various tools for the construction and presentation of a body of architectural analyses in the context of a design studio.

This fourth semester design studio will be offered to about 350 students. The central design theme of this studio is a "small public building",

this year, a small theater. The students will be given a relatively complex functional program and will be requested to design and work out the materialization of this theater.

The students will begin the studio by analyzing selected precedents (historical and contemporary) of the relevant building type with respect to various criteria (composition, program, construction, context, type, etc) and from structural, formal, and functional points of view. Documentation of these precedents is presented to the students in the form of drawings, pictures, and texts. Until now, such documentation was commonly provided in the form of a book. In this studio, instead, this documentation will be available on the web within the same environment that the students will use for the presentation of their own analysis results. The result will be a common library such that students, in later design activities, can draw upon other students' results for comparisons and relationships between different aspects or buildings.

We are developing tools to create the keyword hierarchy, and view it as a semantic map; to intuitively decompose documents and relate them with keywords; to generate pages to draw sections and views on a plan, relate the respective documents, and then to generate web pages from these, as entry pages to analyses; and to draw areas on plans, sections, and elevations, color them, and link them to the appropriate keywords. These and other tools are integrated within a presentation environment for analyses. The user interface provides views for individual documents and all their related documents at one glance, and visual overviews of the entire document and keyword structures and their links. The students will be provided with a keyword hierarchy corresponding to a system of architectural types as a structure to hook up their contributions. In general, and depending on their knowledge of the domain, students can collaboratively define or extend this structure.

The functionality of the underlying environment is, mainly, the storage and management of work documents, a powerful and flexible organization for information and documents, the presentation of work, both internal to the project and externally to a broader public, and the integration of communication with document management. Applications of this functionality are the submission and management of digital products in the context of digital lab sessions, information and document management in the context of a design studio with the purpose of creating a digital log corresponding to the design process, the creation of a digital portfolio by the students, and the application presented here.

Representation

The content to the system is provided as a number of abstractions from selected precedents and a keyword hierarchy. Abstractions may be decomposed into constituent entities, in correspondence to the adopted keyword structure. Abstractions in the form of images can be broken up into smaller images using an image processing application. Currently, we consider only text and image abstractions. The result is a document hierarchy, with the top-level elements corresponding to the various abstractions. The keyword hierarchy depicts the semantic structure for this document hierarchy, with each document entity assigned at least one keyword from the keyword hierarchy. The keyword hierarchy itself can be imported from an external source or collaboratively composed by the authors of the analysis. Both the keyword hierarchy and the collection of abstractions can serve as access points into the analysis. Both are recursively defined.

In this organization of keywords and documents, various kinds of document relationships can be distinguished. Documents and document components are initially related by the abstraction hierarchy these belong to. By assigning keywords to documents, documents that share the same keyword are implicitly related. The keyword hierarchy further relates documents; these relationships are derived from the nesting of the respective keywords in the keyword hierarchy. Additionally, explicit relationships can be specified between documents.

Interface

The interface will allow the user to view both the keyword and document hierarchies and their relationships. These views will include both in-world and out-world views (Papanikolaou and Tunçer, 1999). An in-world view presents a document (or keyword) together with its immediate neighbors within the hierarchy, and displays all other documents that share a keyword with it (figure 1). Such a view allows one to browse the structure, interpret the relationships, and as such lead to interesting out-world views. Out-world views offer an overview of (a part of) the information structure including all its relationships. Such views may be presented as structural maps, providing visual feedback to the users on their traversals and selected views by presenting the location of the currently viewed node within the hierarchy. Such views also give an overview of the scope and depth of the semantic structure guiding the analysis. Figure 2 presents some exemplar out-world views as clickable maps that offer an overview of the entire keyword hierarchy in relationship to the
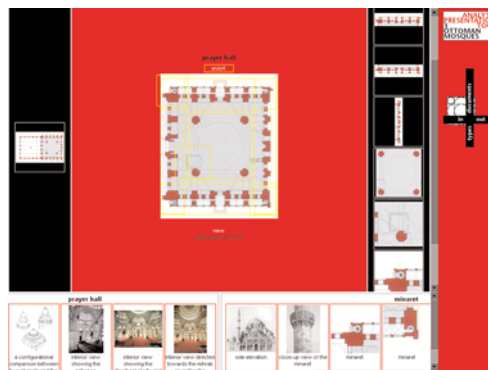

Figure 1. A snapshot of an in-world view from the prototype application. The middle frame contains the currently viewed document. The left frame contains its "parent" document, and the right frame contains its components. The bottom frame contains the document's keywords and all other documents related to these keywords.

Figure 2. Three snapshots from out-world views of the keyword hierarchy. The focus of this figure is on the graphical representation of the structures, not on the keywords themselves.
a) a 2D list view,
b) a 2D dynamic tree view,
*c) a 3D dynamic network view.*

related documents.

While the keywords serve for the most part as binding elements in the structure providing relationships between the documents, when traversing the information structure, the content as available in these documents is the most important aspect. As such, while the document's keyword, and its location in the keyword hierarchy, may be presented as properties of the document, the relationships are specified primarily as document-to-document relationships. This not only ensures that links are presented as shortly as possible, facilitating a swift traversal, but also shifts the focus onto the content, rather than the structure that surrounds it. Keywords further serve a role as index to the information structure.

Tools

We are developing and implementing a number of tools in order to facilitate the development of keyword structures and the decomposition of images and texts, and to construct image maps that can serve as guides into parts of the information space. A first tool serves to create the keyword structure, and view it as a semantic map (figure 2b). This tool extends on an existing freeware application for building up and viewing network structures. Another tool assists the user in the decomposition of image abstractions. Image abstractions are decomposed by selecting rectangular areas from the images (figure 3), select-

ing sets of keywords from the keyword hierarchy (figure 2b), and attaching these to the image components. The same application also offers a tool for adding hotlinks to images, allowing for the development of image maps that can serve as a content map or index to a collection of related documents. The base image may for example constitute a plan of a building; markers can then be positioned on the image and related to the appropriate documents. From this information, a web page is generated containing the respective image map (figure 4). When one moves the mouse pointer over a marker, a preview image of the related document appears. Markers can be clicked to browse to the respective document. Currently we provide for section markers, indicating where on a plan a section is taken, and in which direction (figure 4a), and view markers, defining where a picture or an elevation is taken in relation to the plan (figure 4b). We also intend to implement markers and hotlinks for annotations, and panoramas, and to distinguish markers for elevations and images. Within the same application, another tool serves to draw areas on plans, sections, and elevations, color them, and link them to the appropriate keywords. This composition will be generated as a new collage. When moving the mouse over an area, the related keyword will be shown. Clicking the area will bring up related documents that share the same keyword.
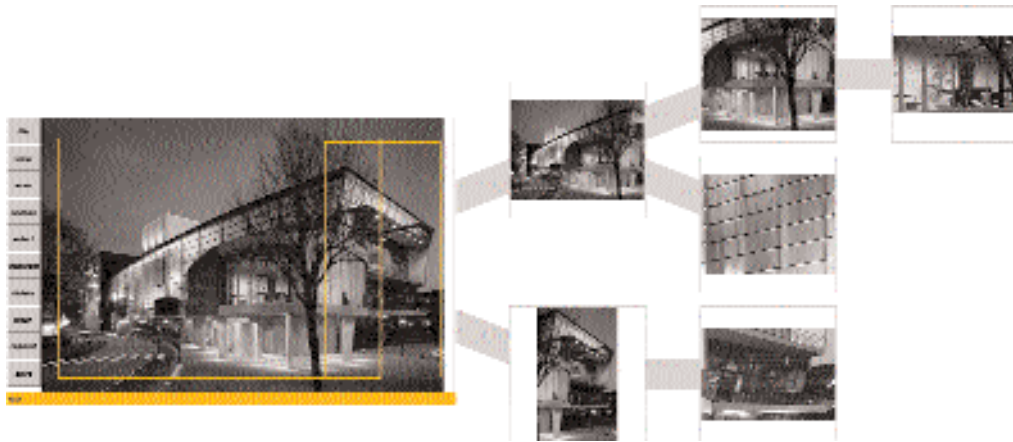
Figure 3. A snapshot from the image decomposition tool showing two rectangular areas drawn on the current image in order to create two image components. Below are the final image components and their compositional relationships.

These areas will serve in most cases as functional zone markers.

Conclusions

A web-based environment for managing design and design precedent analysis information facilitates the integration of the analysis results into a common, extensible, library and enables students to draw upon each other's results for comparisons and relationships between different design aspects or buildings. Such an environment, however, requires a flexible information model in order to optimize its effectiveness. A flexible information model as proposed in this paper provides the possibility of interpreting the entire information structure seeking information related to a concept of interest, rather than limiting the retrieval to individual documents. In precedent-based learning, there is a need for an information organization that enables a user to access information independently of the individual viewpoints of the authors of the information space.

We described a design analysis document management environment and built-in tools for organizing and presenting architectural analyses. Next fall will be the first time this environment will be offered to students. Traditionally, students work in groups of 15 during such analysis studies. Since there are about 350 students taking the studio, there will be about 24 groups of students divided over both fall and spring semesters (ratio still unknown). In the first year, we will provide 24 different instances of the design analysis repository for the individual groups. The application to small groups and the repetition over a relatively large number of groups will provide us with extensive evaluation results, which will allow us to better react towards improving the environment and tools in relation to the didactic procedures. In a future version of this course, we will explore the possibility of all 350 students collaborating within the same repository. A next step can be the toolkit's use within an (international) virtual design studio. Technically and from an information-modeling point of view, this is well possible, but the content of the studio is at least as important as the technical capabilities of the system. At the end of the upcoming studio we will ask the students to complete a survey, and we will use the results as guidance for our future developments.
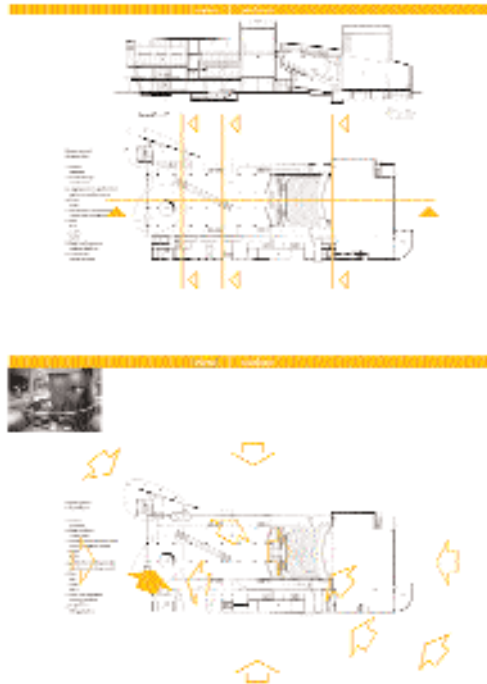
Figure 4. Generated web pages containing image maps that serve as a content map or index to a collection of related documents: a) image map with section markers, b) image map with view markers.

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