

Title

**A user-centered design method for organizational web sites:
Task Driven Web Site Design Method**

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Abstract

This work proposes the Task Driven Web Site Design Method to assist the development of web sites of large non-profit organizations, the so-called organizational web sites. To create user-friendly web sites, the several tasks of different types of users, interacting with the web site, are identified and utilized as a continuous thread through the entire design process. This design method is further characterized by the separation of the information analysis from the specification of the navigation structure as well as from the design of the user interface. The development of an academic web site shows the subsequent phases and their activities.

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1 Introduction

1.1 Formulation of the problem

Few events in the history of computing have wrought as profound an influence on society as the advent and growth of the World Wide Web. As a consequence of this popularity, large companies, organizations and academic institutions hush to make their presence on this unique forum, taking every chance to address a new audience or enlarge their present public. However for large organizations, the development of a user-friendly web site structure can be a hard challenge.

Some divisions of a large organization may already have started the development of an own web site, where they present their information and address their audiences. As divisions in an organization always strive to evolve a distinguishable identity, they all opt for various design styles, what seriously influence the coherence of the whole web site. Web sites, which structure appears chaotic and illogical, will damage the image of the institution in the eyes of the outside world. The management of the organization, unconsciously ignorant to these efforts, is not going to take unpopular and unpleasant measures to force these divisions to redesign their web sites.

As a many-used solution, the different developed web sites of the diverse divisions are put together in a web site with an organization chart based structure. This approach is not the proper method from a usability point of view : if there are a considerable number of divisions and their naming is based on insider's functionalities, an external user will not be able to find the specific division who is responsible for answering services in response to his information demand.

E.g., in a web site at the corporate level, for example, one can see groupings such as marketing, sales, customer support and human resources. How do the customers visiting this web site know where to go for technical information about a product they just purchased?

A similar situation occurs with more official institutions, like musea, universities, administrative and government services. In university web sites, prospective students may have no idea where to look for information about the specific procedures and their preferred sequence in the enrolment process or researchers can't locate a desired research group, starting from the list of the names of the faculties of the universities.

Citizens, taxpayers and all sorts of government constituents and special interest groups are crying out for increased government accountability and transparency. Many administrative web sites are centered on the administration's organizational chart. In such sites a citizen has to know that the deliverance of a passport depends on a particular office which is more or less hidden in the organization, or how does he know which procedures and in what order, he has to be followed to obtain a construction permission.

In developing web sites with a certain official character, e.g. universities, non-profit organizations and governments, the web site's usability is perhaps even more important than in case of more commercial-inspired web sites.

The focus here is not on attracting the greatest possible number of persons to visit the site, but to offer a clear, logic, and easy-to-use structure to present the correct and necessary information without risking to lose the visitors in insignificant details or links which can distract the visitor's attention.

1.2 Objective

The examples given illustrate the need for a more user-friendly approach, which accommodates the requirements of the public more adequate.

Instead of a having a web site structure based on the organization's divisions where their naming may only be familiar to insiders, the information presented in the web site must be easily and uncomplicatedly accessible by the users.

The sub sites, created by the diverse divisions, are a way of handling the complexity of the large amount of information provided by such an organization. It is now the challenge to integrate these existing sub sites into a coherent and logical structure that is easy for the users to understand.

To assist the designers to handle this challenge, a method must be provided to guide them in the development process of more user-friendly web sites.

1.3 Approach

To attack the problem of the web sites of large organizations, a systematic design method, called Task driven WSDM, is proposed for the development of a user-centered and modular web site structure. This design method mainly aims at creating web sites, whom structure feels more logical and natural to their specific audiences by paying more attention to the users' requirements and the way they will interact with the web site.

The modular character lies in the recognition of the sub sites of the different organization departments as modules through the phases of the process.

In the subsequent phases: the Conceptual Modeling, the Navigational Modeling and the Presentational Modelling, the responsibilities, accessibility and presentational issues of the several sub sites are determined and developed.

The integration process for the individual sub sites, is based upon the specific tasks that the user wants to accomplish with the different organization's divisions being involved. These tasks are specified early in the design effort and used throughout the subsequent phases of the development process.

Applying a user-centered approach, the design process starts with the identification of the different audiences to form audience classes. These audience classes are characterized by the different tasks they have to fulfill.

The focus in the Audience Modeling lies on the determination and the definition of the tasks that different audience classes want to fulfill while interacting with the web site. These tasks can be considered as a blend of the functional and informational requirements, gathered in the Audience Modeling of the original Web Site Design Method.

The design method is further evolved around the three dimensions that characterize a web site: these are the content, the navigational structure and the presentation. By treating these aspects separately in successive steps, the designer can concentrate better on each aspect. This separation also enhances the creation of web sites, which are easier to extend and to maintain.

The Conceptual Modeling describes the relevant information related to the specific tasks of the audience classes. The responsibilities of the individual divisions of the organizations are recognized and related to these tasks in the Sub Site Modeling sub-phase.

In the Navigational Modeling, the possible paths that can be traversed by the members of an audience class are built using the concepts of themes, scenarios and tracks. Themes are narrative descriptions of surfing patterns and strategies throughout the information, performed by the web site visitors. These themes are graphically translated to scenarios, which are combined into the navigation tracks. The different audience tracks are put together in the navigation schema of the web site.

As distinct from the WSDM, the Navigational Modeling phase is more detached from the Conceptual Modeling in the Task Driven WSDM approach. The new concepts of scenarios and scenes are introduced to assist in the construction of the several tracks while the concepts of collection structures and menus help to create clear graphical representations of the divers navigation tracks.

While the Navigational Modeling shows how members of the audience classes navigate through the available information, the Presentational Modeling describes how this information is presented to the user. In the Task Driven WSDM, the Presentational Modeling takes a more practical approach comparing to the Implementation Design phase of WSDM. Presentation mock-ups are used to define the layout of the web pages.

A presentation mock-up can be considered as a sketch of a specific web page and focuses on the structural organization of the presentation and not on the physical appearance in terms of special fonts, formats, colors, etc.

These last issues are left to the implementation phase.

1.4 Overview of the thesis

Section 2 introduces organizational web sites and unveils the particular difficulties and problems, which are related to their development. In section 3 the need for a systematic, well-structured design methodology is clarified. Further it shows a short summary of the Web Site Design Method (WSDM), which uses a user-centered approach. Then, it presents the proposed extension and describes into detail its phases to manage the development of user-friendly organizational web sites.

The activities in the subsequent phases of the task driven WSDM approach are reported in the next four sections, each time illustrated with a case study of the design of a university web site. Section 4 describes the audience modeling phase, which identifies and classifies the different users into audience classes. In section 5, the Conceptual Modeling is described that summarizes the relevant information for each audience class and reveals the responsibilities of each division in the organization. The Navigation modeling phase is discussed in section 6. Section 7 shows the Presentational Modeling. Section 8 concludes this work.

2 Organizational web sites

After introducing the concept of organizational web sites, this section continues with an enumeration of the typical difficulties that designers have when developing such web sites.

The amount of information related with a large organization and their activities, could be enormous, which makes it difficult to handle and manage it. A lot of deficiencies, experienced on the Web, are therefore caused by maintenance problems.

Most of these organizational web sites reflect unquestionably the internal hierarchy of the institution or company, representing its composition in several specific divisions. The cause and the consequences using an organizational chart as the basic structure of a web site are shown in the next subsection.

The usability of a web site can be interpreted as the visitor's ability to use this site and to access its content in the most effective way. The fifth subsection enumerates a few problems, which can affect the usability of an organizational web site.

2.1 The Web's shift

Within a short period, the Internet and World Wide Web have become ubiquitous in everyday life, surpassing all other technological developments. Through its life story the Web has experienced a complete shift in its reason of existence. It was originally designed as an information medium for distributed science research teams (Berners-Lee et al. 1994). But currently, the dominant use of the Web is quite differently than the purpose for which it was originally conceived.

The World Wide Web (WWW or just 'the Web') has become the global communication medium for delivering information and services. The nature of the offered information has outstripped the scientific subjects and this medium has infused itself into our mainstream culture and social life - for this purpose it has been called social hypertext (Erickson 1996). For the first time, millions of individuals are able to exploit an enormous amount of linked information in a distributed fashion.

These new ways to access and disseminate information have appropriated this immense popularity by its low barrier of entry and a whole range of inventions in the advancing technology of the computer networking and Internet branch. The web has evolved to a medium for personal expression and a conduit for a commercial revolution.

2.2 Organizational web sites

As companies, organizations and academic institutions realize the benefits that stem from the globally interconnected network, they exploit this infrastructure for a variety of purposes to provide their audiences and users with information and services.

By categorizing web sites by their author's identity, one can define the following term.

Organizational web sites refer to a collection of WWW pages that are created for and maintained by a particular organization.

An organizational website can therefore be considered as the virtual representation on the Internet of a corporation or an organization. It is typically a large website that contains a wide variety of information about or related to that organization.

Examples include company and university sites, the site of a professional group and of any society or organization.

Some of these sites provide little more than basic publicly available marketing and PR information about the organization or institution, while others provide detailed technical and support information, as well as links to related sites and services, which are of interest to potential users. Many organizational sites include extensive materials relating to subject areas of interest to these users. Often organizational sites include personal home pages, which are created and maintained by individuals working or associated with the concerned organization.

2.3 Maintenance web site deficiencies

Although HTML editing is not a difficult task, there are many factors, which can affect the web development process and in the end effect of the web presentation.

Web sites have an inherently dynamic nature. Their content and their corresponding structural organization may be changed continuously. Therefore the maintenance of a web site is more important than in the case of the design of conventional software applications.

Maintenance for web sites can be generally described as any development activity performed to modify or fix the web site after it has been completed or reached some milestone, such as its first major release.

This maintenance must be executed on a regular base. However, the sources as well as the subject areas of the information strongly influence the need for updating.

While it is usually not necessary to maintain information about an organization on a very frequent basis, such as daily or weekly, it is essential that the user can determine when the materials were last updated in order to estimate their likely accuracy.

In the following paragraphs a few maintenance difficulties are enumerated and described into further detail.

2.3.1 Accuracy difficulty

Accuracy generally refers to the factual accuracy or correctness of a piece of information. Individuals access the home page of a particular organization because they are interested in the facts relating to it, such as an address or a phone number. When they experience that some of the presented information on the web site is incorrect, they will question the other content as well and feel less sure to depend on that information. Therefore, it is essential that basic formal information pertaining to the organization (e.g. phone numbers, addresses, opening times) be represented accurately.

2.3.2 Obsolescence difficulty

The obsolescence of a website relates to how up-to-date the displayed information is. Just like the accuracy, the obsolescence plays a central role in the web use as an information source, as there is a general perception that the Internet provides access to the most current information possible. Obsolescence is an important consideration because outdated information can become useless, as well as inaccurate or misleading.

2.3.3 Scalability difficulty

Websites exhibit the remarkable tendency to grow in time with a speed not comparable with any product of nature. A small site, consisting of only a few pages, can be quickly and easily written by hand and without investing great programming effort. Keeping the site up to date and consistent in regard to content and layout, however, can appear manageable in the beginning but tends to get almost impossible when the web site grows larger.

The term scalability is used to indicate that no one exactly knows which content will be included in the future, so the site needs to be flexible to house unknown amounts and types of information. Ideally, the structure of the website will accommodate change and growth over time without being crushed under the enormous weight of its content.

Besides these sad to say almost classical web site deficiencies, the construction of a large, organizational web site can suffer from other problems. The next section describes the most important points on which the designers have to pay attention to when developing an organizational web site.

2.4 Organizational chart based web site structure

There exists a considerable danger that the structure of an organizational web site overly mirrors the way the organization is structured. So basically the entire web site represents the organizational chart in a digital form.

Such a web site can show a clear, well-defined structure, which is very understandable and usable for insiders, but a visitor, who is out of touch with this hierarchical organization, will meet annoying problems to find the desired information. Most of the time, the user is completely unknown with the divisions of the organizations and the services for which they are responsible. Users, should not have to care about how the organization is internally structured. The internauts want information to be made accessible the way they think, not the way the organization or corporation have it in mind.

Because of the inherent power of information organization in forming understanding and opinion, the process of establishing a structure for web sites can involve a strong undercurrent of politics. Politics exist in every organization and can play an important role in its everyday management. Individuals and departments constantly position for power or respect.

There is also a strong assertiveness to manifest their individual importance and indispensability for the prosperity of the organization. It may be even taken as an offence to some parties if the site structure will not centralize their role in the World Wide Web representation of the organization with for instance a striking link on the home page.

As mentioned above, an organization can be constructed of several sub-organizations or departments, which in turn are responsible for the fulfillment of several different activities. A multinational company, for example, consists of several departments: product department, financial department, marketing department, human resources, ... The reason for this division of the entire organization into smaller units is a widely and traditionally applied approach for an efficient and effective dealing of their businesses. The power of a corporation lies in its ability to leverage the sum of its independently working units while laboring to keep those units from completely splitting apart. Web designers often make the erroneous step to mimic this concept into a web design by distributing the responsibility for the site creation to the divisions and departments without any common agreement about this creation.

When each department of the organization, independently, creates a web site, which appropriately presents their activities, the chance exists that a complete farrago will rise. Not only the content of the web sites of the different departments will differ, also their structure and presentation can be handled in various ways.

The diversity of the activities of a large organization like a university or a multinational doesn't make the task to create a coherent web site structure easier. This lack of coherence can have severe consequences as coherence is recognized as a positive influence (Thüring et al. 1991) to the comprehension of hypermedia documents, which are, for instance, web pages.

It must be admitted that a web site development based on the organizational chart is the easiest and less painful way to create a site blueprint for a web site architecture. While the construction of another information structure has to take some effort and research for the design team, the organization chart is a specification known from the early start of a web site design project.

The management of the organization is often convinced that this information is sufficiently important to deal with the rest of the world. Sometimes they will not dither to point out the design team the use of the organizational chart as web site structure, while referring to the countless examples, experienced on the web.

2.5 Web site usability problems

In the beginning of its history, the Web was mainly used by academicians and computer professionals. Following the expansive growth from research labs to general use, the profile of the web public is continue moving towards a closer match with the population at large.

Surveys as the GVU's annual WWW User Survey (GVU) have shown such a shift from the professional often academic web users to a much more social and cultural mix. The people of this latter group are less familiar with computer related concepts and habits.

As more people have access to the web, the demand for quality and user-friendly web sites increases. It becomes necessary to provide for users' needs, expectations and preferences for different interaction styles and modalities.

2.5.1 Ad hoc web site design

After an organization has decided to launch a web site, the focus of the design especially lies on the graphical presentation of the single web pages.

Linking these single pages as need arises ultimately results in a web site.

However, web site development involves more than the creation of an appropriate graphic design, the choice of an attractive interface and the production of correct HTML-coding.

These building processes deal mainly with the visual contents and presentation while paying little attention to other important issues for the usability of the web site such as the information organization and the navigational structure.

The consequences of these practices in designing web sites are well known and can be experienced while spending some time on the web. The appearance of these deficiencies is an embarrassing situation as web users mostly take note when things don't work properly: obscure labels, huge download times, exaggerated scrolling, striking typos, out of date information and broken links, while the consequence of a good web site design seems to be transparent and thus invisible for the users.

2.5.2 Designer-centeredness

Some designers take the opportunity to showcase their imposing skills and talents in their work by implementing superfluous whistles and bells. In order to build catchy web representations, designers and developers focus their energy mostly on the graphical issues. Blinded by excitement, professional designers make heavily overuse of the newest technical and graphical opportunities of hasty-outdated web technology. Designers often try to attract users by bragging about use of the latest web technology. This may attract a few nerds, but mainstream users will care more about useful content and the ability to offer good services to their needs.

While at first these persuasion techniques may work, they may also cancel each other out or leave the user feeling oversimulated and annoyed. In fact, over time a user will become accustomed to any extra stimulation, and the attention-grabbing techniques lose their power. This is a known phenomenon from cognitive science called sensory adaptation (Coe 1996).

It is no shame to create gorgeous looking web pages that evoke positive artistic feelings, as long as the design pays attention to the different needs of the intended audience. Most people visit websites to retrieve a particular piece of information or to accomplish some task. Though sites with attractive design may entice visitors initially, it is the information and functionality that guarantees the longevity of the site.

2.5.3 Organization-centeredness

For certain organizations, especially those with commercial objectives, an efficient and good- looking web site is of vital interest to attract and keep the masses. Such organizations realize that frustrated and discontented visitors will end up at the site of one of their competitors.

Other organizations consider their web presentation more as an additional medium for spreading information.

A museum web site, which forgets to annotate the opening hours or a web site of a university professor who doesn't announce the hour and place of his courses are typical examples. People, who don't find the desired information, will not always have the possibility to look somewhere else on the web for a more satisfying quest. They will have to fall back on the more traditional communication media like a telephone call or even have to risk a fruitless transfer.

Managing this monopoly of information endows such organizations with some flavor of power. Such organizations behave themselves annoyingly elevated that they expect that anybody is knowledgeable about the important things of the organization.

For most people who are experts on something, it's awfully hard to remember how it was like not to know it.

(Wurman et al. 1996) called this experience: "the disease of familiarity".

The same goes for a designer of a web site. The designer knows exactly how it works, since he was involved in the process of the design from the start.

Since designers are privy to the inner workings, they may not have any knowledge of the existence of these intricacies. The designers' own in-depth knowledge of their site can make it difficult to understand a visitor's perspective.

Sometimes, visitors are shackled off by an altruistic or a self-perspective tone that a web site is spreading. When the design is extremely influenced by the viewpoint of insiders from the organization, the language on the web site can appear interlarded with too much jargon and specific terms and visitors will meet difficulties to have a grip on it. Visitors, who are not familiar with this style, will be distracted and felt provoked by this inappropriate tone. No doubt that they will feel strange and will miss the real information inside.

2.5.4 Hierarchical structure of information

The above contemplations about a organizational chart based web site structure must not be misunderstood as the conclusion to never use an hierarchy for the construction of the organization of information. It is a common technique for web designers to apply hierarchies for the classification of information. People are skilled to continually practice this form of information organization in real life.

They construct hierarchies to reveal the relative importance of the specific parts of information and to manage huge amounts of data for convenience.

So, hierarchies are widely used and most of the people are familiar with them and talented in finding successfully information in their structure. Many authors, among them Nielsen (Nielsen 1993), argue for using a hierarchical organization for web sites, unless the information clearly lends itself to another type of organization.

Consequently, the design of a website may make use of a hierarchical structure, but this structure must be adapted adequately to the needs and the tasks of the specific audiences.

A web surfer doesn't care about the specific organization structure.

Whatever organization one chooses, it is imperative that it is clearly communicated to the user and that the user feels comfortable with this choice.

2.5.5 Disorientation

(Conklin 1987) has described the disorientation problem as not knowing where you are in the information space or not knowing how to access something you believe exists there. He also argued that the disorientation problem might in fact ultimately limit the usefulness of a web site.

Disorientation is the tendency to lose one's sense of location and direction while navigating the hyperspace (this term originates from early hypertext literature and refers to hypertext space). (Nielsen 1990) sums up disorientation with the following quote: "The jumping metaphor leaves the user with no context as to where they are in hyperspace." Browsing through non-linear networks, like web sites, often leaves people with a general feeling of disorientation, being lost in an enormous labyrinth, or of losing context.

In fact, disorientation is the consequence of another phenomenon: cognitive overhead. Cognitive overhead is the additional effort and concentration necessary to maintain several tasks or trails at one time. Cognitive overhead also occurs in everyday life as the underlying cause of car accidents while drivers are busy while calling with their mobile telephone. They are wholly absorbed in their conversation they become totally unable to concentrate on their main task.

In the context of web surfing, cognitive overhead is the extra positional and routing information that a web site visitor must maintain over and above his exploring movements.

A clear presentation of all the available information will notably enhance the web surfer to find the information easily and quickly without getting lost in chaotic hyper textual webs.

3 Web site design

The first section clarifies the need for a systematic, well-structured design method for the development of web sites. In the next section, the phases of the design process are introduced. Section 3 describes the Web Site Design Method (WSDM).

The last section presents a short overview of the Task Driven WSDM approach.

3.1 The need for systematic web site design

A single website may have to fulfill many roles ranging from information delivery to interactive services for suiting the needs and wants of diverse groups.

The many requirements for web sites, the number of concerned parties and the pace at which websites must be developed make web site design a challenging endeavour.

As already pointed out in the previous section, web site development is mostly carried out without following a well-defined process. Web developers often use ad hoc, hacker-type approaches. Most developers delve directly into the implementation phase paying minimal attention to requirements acquisition and specification and going through a very informal design phase (if any at all). They place too much emphasis on how pages must look, and not on their content, purpose, functionality and the user's experience.

Experiences have revealed that these ad hoc practices fail when used to develop large-scale websites: in the related discipline of hypermedia design, it leads to inconsistent design (Garzotto et al. 1995) and the possibility of errors and omissions (Botafogo et al.1992) (Brown 1990).

Many researchers((Goedefroy et al. 1998), (Lowe 1999) and (Powell et al. 1998)) have argued that web system development has been ended up in a similar crisis that occurred in software development in the 1970s. To overcome this crisis, they propose that more disciplined development methodologies must be utilized to minimize problems and provide a framework that designers can follow.

Design methods, coming from other information technology like software engineering can be applied to web site development to bring the chaotic process under control.

The need for a systematic, well-structured design method is consequently recognized. While structured design and development methodologies are widely accepted in conventional software engineering and database design practices, in the case of the development of web sites such an approach is not a common practice.

The findings of a recent study (Lang et al. 2000) have revealed that practitioners of web-based system development are not accustomed to apply multimedia development methodologies.

Some of the main reasons for this phenomenon may be hidden in the characteristics of the Web itself. It may be argued that the World Wide Web's brilliant success has been derived in part from its global scale and its simple access to information. The basic implementation model for the web was chosen to be simple for publishing by research teams. Later however this simplicity has been seen as major drawback from the hypertext theory point of view (Ladd et al. 1997): authors are tempted to immediately start with the low-level technologies, without any planning. The use of practice-oriented technology is not guided by a systematic methodology that provides the website developers with a higher level of their creations.

The frantic rush to be present on the web can be considered as another reason for developing without planning. Web publishing projects are therefore characterized by limited time and budget boundaries.

3.2 The phases of a design method

Design methods can be interpreted as an answer to the need for a more systematic design. (Nanard et al. 1995) defined a design method as a recipe that guides someone along a development task by specifying an ordered series of design stages.

To clarify the problem of web site design in more detail (Florescu et al. 1998) has summed up the specific tasks, which must be performed during the creation of a web site:

- 1 Selecting the data that will be displayed at the site: the so-called conceptual modeling.
- 2 Designing the site's structure or the navigation modeling.
- 3 Designing the visual presentation of the pages.

(Koch 1999), (Rossi et al. 2000) and (Schwabe et al. 1995) argued that the separation of the information analysis from the specification of the navigation space structure as well as from the design of the user interface yields certain benefits for the web site design.

From an architectural point of view, separating conceptual, navigational and presentational activities helps to produce sites that are easier to extend, maintain and redesign.

It would be, for example, possible to render different presentations for one and the same conceptual model. An existing web site can be dressed up with a new look and feel by changing only the presentational dimension.

Web documents are very redundant data-sources since the same piece of information can occur at several pages and traversed by several different access paths.

In the content dimension on the contrary, redundancy can be eliminated by means of normalization techniques to avoid inconsistencies and update problems.

Another benefit is that this approach enhances the designer to concentrate at one aspect of the web site design at a time.

3.3 The Web Site Design Method (WSDM)

This section briefly overviews the Web Site Design Method (shortly WSDM). More detailed information can be found in (De Troyer et al. 1998), (Goedefroy et al. 1998), (De Troyer 1998), (De Troyer 2001) and (Casteleyn et al. 2001). The present status of further research about WSDM can also be consulted on the WSDM web site: <http://wsgm.vub.ac.be>.

WSDM clearly differs from the more traditional web site development methods by applying an audience-driven approach. Instead of applying a data-driven approach for the development of a web presentation, like most other methods, the starting point for the design of a web site is the audience and their needs and behaviors. The requirements of the different types of users play a central role through the whole development process. In this way, WSDM acknowledged the fact that web sites usually have different types of visitors that may have different needs.

The method consists of the following phases: Audience Modeling, Conceptual Design, Implementation Design and Implementation. The figure 1 clearly shows a schematic overview of these subsequent phases and their composition in sub-phases.

Before the actual design can start, it is a common usage to formulate a mission statement for the web site. The mission statement must clarify the vision for the website, balancing the needs of its sponsoring organization and the needs of its audiences. This mission statement expresses the purpose and the subject of the web site and declares the target audience. It can be used when designers need to take decisions or as a basis for the evaluation of the success of the web site.

The next phase is the Audience Modeling, which comprises of two sub phases: the Audience Classification and the Audience Class Characterization. In the Audience Classification, potential users or visitors are identified and classified into different audience classes. An audience class consists of users with the same information and functional requirements. The target audience mentioned in the mission statement gives a rough indication for these audience classes, but this need to be further refined.

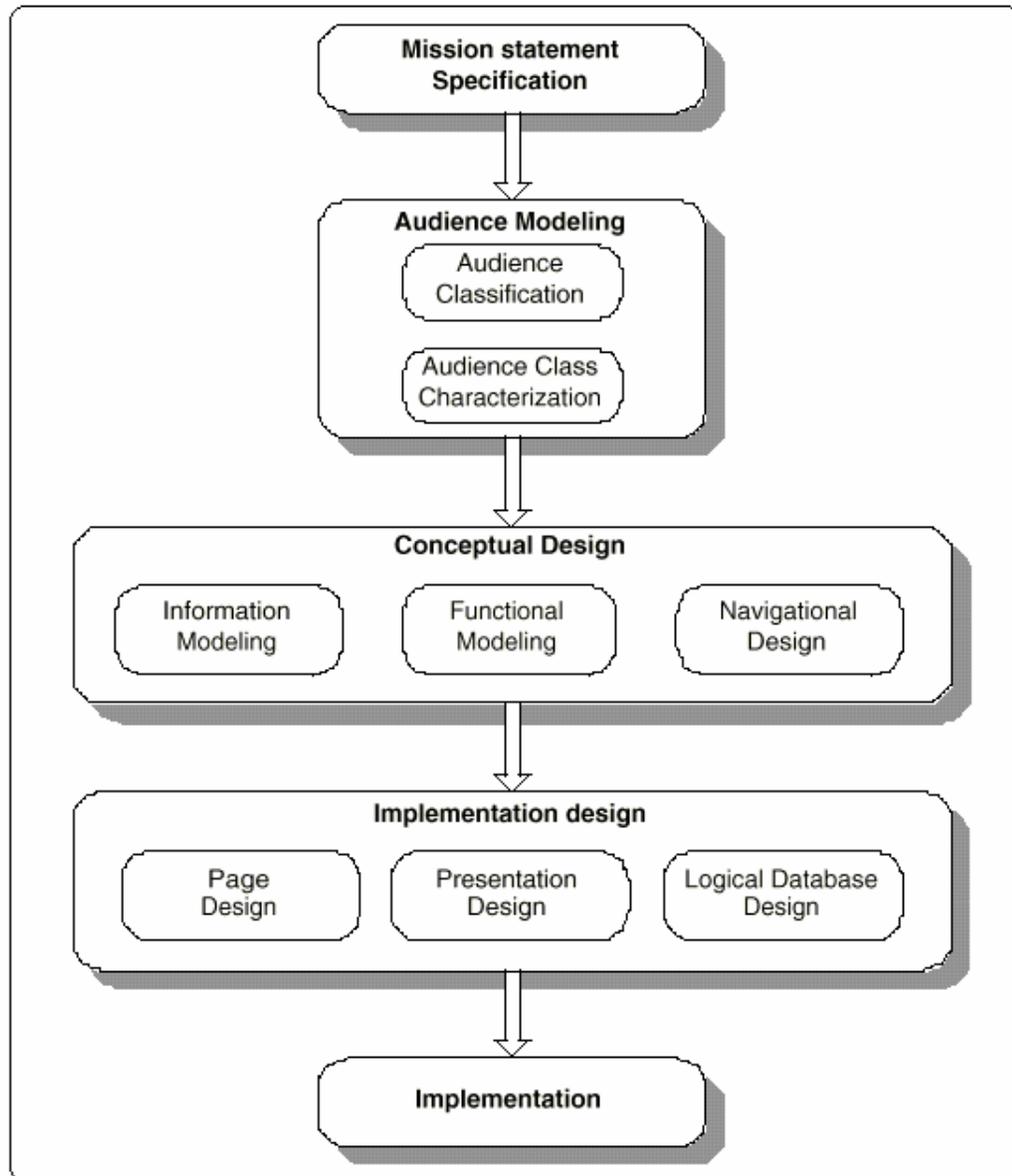


Figure 1: Overview of the WSDM process.

To determine more specific audience groups, WSDM further prescribes to explore the activities of the organization or their business, which the web site should support. The people involved in these activities can be candidates for new audience classes.

In the second sub-phase, the so-called Audience Class Characterization, the identified audience classes are further detailed with characteristics. A more detailed analysis is performed to build up the characteristics and the requirements for each audience class. The result of the Audience Modeling is a set of audience classes together with an informal description of their requirements: information and functional as well as navigational and the usability requirements, and their characteristics.

If within one audience class, members have different characteristics, the audience class is divided into so-called variants that group members of the same class with the same characteristics.

After the Audience Modeling, the Conceptual Design of the site is performed. The Conceptual Design phase is divided in three steps: Information Modeling, Functional Modeling and Navigation Design.

During Information Modeling, information chunks, which model the information requirements of the different audience classes, are created. By linking together these information chunks into a single information model, the business information model takes shape. This business information model describes the available information of the web site, independently of any particular use.

In the Functional Modeling phase, functional chunks are created to describe the functionality needed for the different audience classes.

The Navigation Design models how the members from the different audience classes will be able to navigate through the available information on the site. For each audience class or variant a navigation track is created. The navigational requirements, collected in the Audience Modeling, are taken into consideration in this step.

The navigation model of the site composes all constructed navigation tracks.

The Conceptual Modeling results in a conceptual model of the web site, which is an integration of the information chunks and functional chunks in the navigation model.

During the Implementation Design phase, the page structure as well as the 'look and feel' of the web site is developed. This stage aims to create a consistent, pleasing and efficient 'look and feel' for the conceptual design made in the previous phase by considering the usability requirements and characteristics of the specific audience classes.

The grouping of information in pages or the design page structure starts from the navigational model. A user should not be overwhelmed by an exaggerated amount of information on a page. In addition, a superfluous information flood will cause long download time. On the other hand, too little information on a page may force the user to "click" too much.

If a database will be used to maintain the information provided by the web site (or parts of it) then the Implementation Design phase will additionally include the Logical Design of this database. The logical database schema can be derived from the business information model, which is built during the Conceptual Modeling.

In the last phase, Implementation, the actual realization of the web site is performed using the chosen implementation environment. For web sites, this means that the implementation model must be converted into a set of files containing HTML source code.

3.4 Overview of Task Driven WSDM

First, a global overview of the method is described, while the following chapters show the subsequent phases into more detail. The process is showed in the figure 2 below.

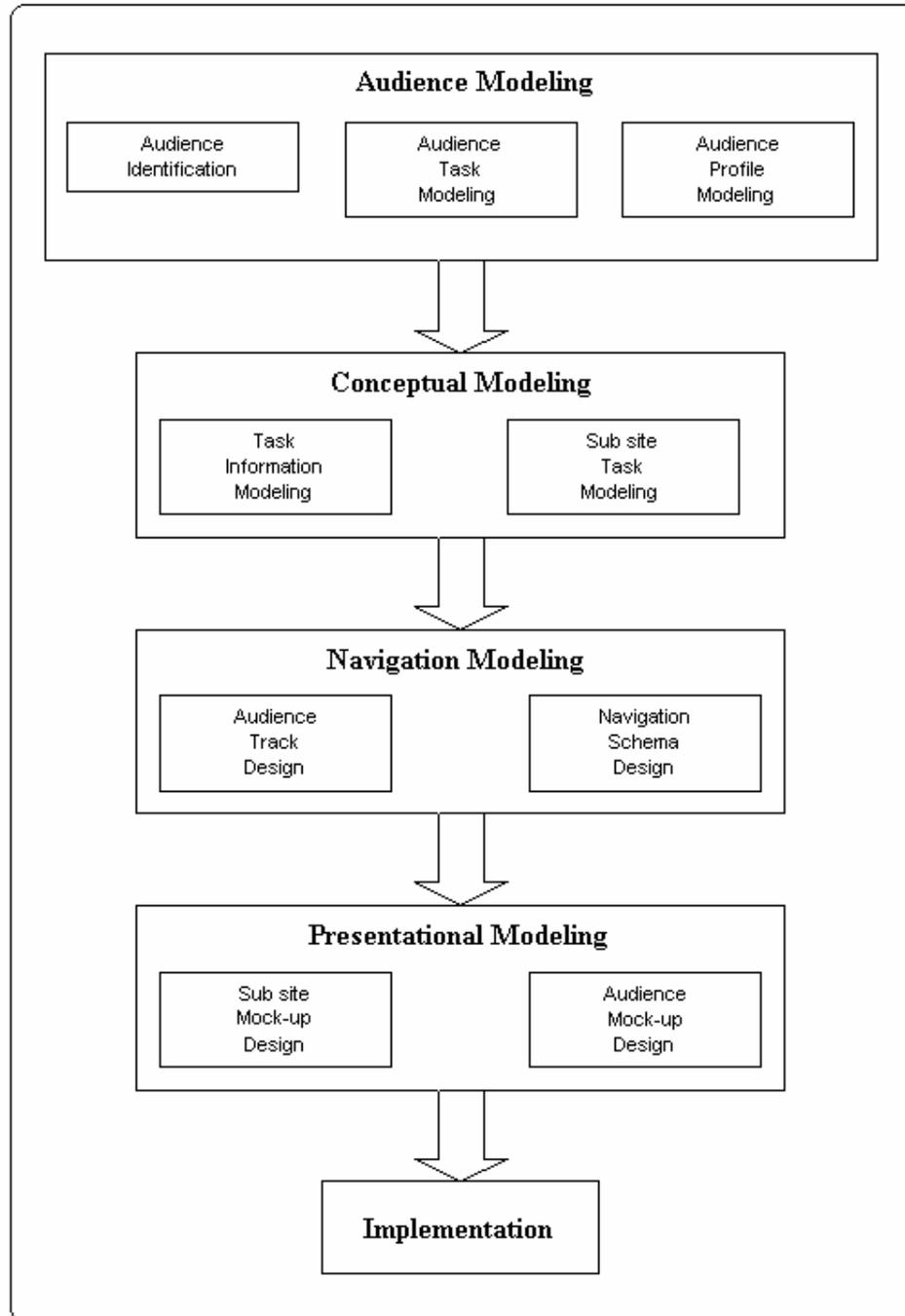


Figure 2: Overview of the Task Driven WSDM process.

The method starts with an Audience Modeling phase, which consists of three sub-phases: the Audience Identification, the Audience Tasks Modeling and the Audience Profile Modeling.

In the Audience Identification, the intended users of the web site are identified and analyzed and further divided into different audience classes. An audience class can be considered as a group of web site visitors, which have the fulfillment of the same tasks in common.

In the Audience Task Modeling, the most relevant tasks of each audience class are identified and described. A task can be considered as an activity where the user interacts with the web site to acquire some information. For the members of each audience class, a set of tasks they would like to fulfill can be collected.

In the Audience Profile Modeling, the characteristics of the audience classes are further elaborated in specific audience profiles. An audience profile summarizes the different properties, besides the tasks, of an audience. This profile enumerates characteristics, which can play an important role in the design of the web site and defines requirements for navigation and presentation.

The next phase is the Conceptual Modeling, which constitutes of the following sub-phases: the Task Information Modeling and the Sub Site Task Modeling.

In the Task Information Modeling a conceptual model is built for each task.

A task conceptual model contains all relevant objects and their relations for the fulfillment of the task. Further, an audience conceptual model is brought about by merging the different task conceptual models of the specific audience class.

The Sub Site Task Modeling phase analyses the responsible tasks of the different sub-organizations of the main organization and associates them with the tasks of the identified audience tasks.

The Navigation Modeling constitutes of two sub-phases: the Audience Navigation Design and the Navigation Schema Design. In the Audience Navigation Design, different audience tracks are constructed which correspond to the possible navigation paths members of an audience class can traverse. These audience tracks are combined to form the navigation schema for the web site in the Navigation Schema Design.

The Presentational Modeling consists of two sub-phases : the Sub Site Mock-up Design and the Audience Mock-up Design. The concept of mock-ups is used to describe the look and feel of the different types of web pages, which are the basis of the final web site.

The final phase, the implementation creates the actual web site by means of the constructs provided by the chosen implementation technology.

4 Audience modeling

The first section emphasizes the benefits of a user-centered approach. Section 2 defines the Audience Modeling phase in the Task Driven WSDM approach, illustrated with the case study of the design of a university web site.

4.1 User-centered design

The starting point of a website development process is a kind of a chicken-and-egg dilemma. To define all relevant information, the designers need to know who all the possible users are and what their wants and needs might be. But to figure out who the users are, they have to know what kind of information the website must offer.

The first approach might concentrate on answering the question "Who are the users?" while the other approach might focus on the question, "What information should the web site contain?" These two approaches are known as user-centered and information-centered, respectively.

In a user-centered approach, the first step is to identify the different user groups. The next is to determine the type of information each group might want and the type of action they might take. The user plays a central role and its demands and expectations must be considered in the development of the website.

The usability problems, mentioned earlier, have shown to the designers the benefits for a more user-centered approach. The immense popularity of the World Wide Web and its role as a global communication medium has enhanced this effect. As the web grows through time, the fraction of computer-experienced people will further decrease and as a consequence the group of computer novices will enlarge.

The early involvement of users has the potential for preventing serious mistakes when designing. Indeed, it compels designers to think in terms of utility and usability. Benefits of the user-centered approach are mainly related to time and cost saving during development, completeness of system functionality, repair effort saving, as well as user satisfaction (Nielsen 1993). It is acknowledged that approximately 60-80% of interaction difficulties, including lack of facilities and usability problems, are due to poor or inadequate requirement specifications (Petrelli et al. 1999). Even if late evaluations are useful to assess the usability of final systems, it is unrealistic to expect that their results bring about a complete redesign.

User-centered design can further be split into two approaches based on the relative engagement and influence of users on the final design.

Consultative design leaves decision-making power to technicians: users are simply sources of information with little to no direct influence. Designers turn to users to test their ideas and receive specific hints on the system being developed.

On the opposite, Cooperative design strongly involves selected users giving them the possibility of affecting the final system. Users have an active role: they have to understand problems and to propose solutions. A big effort is needed to create a common background, as well as to organize and lead design sessions.

For web site design, Cooperative design will emerge some paradoxes in the group of selected collaborated users, which can seriously obstruct the development process. Especially, in the field of the presentation, many proclaimed argumentations are sometimes diametrically opposed.

To reach a consensus for these acknowledged issues can be a hard challenge and will sometimes introduce effects, which can affect the overall usability quality.

For the design of kiosk web sites the consultative approach is preferable because the web universal access may lead to a faceless and diffuse audience, which are characterized by their diverse purposes to visit a particular web site.

But this can be no excuse for designers to ignore the audience as an unmanageably broad spectrum. Understanding the specific concerns of different types of users can help in building a site that is responsive to their concerns.

After all, the crux of a kiosk web site is to provide information.

4.2 Audience Modeling phase

4.2.1 Audience Identification

In the first phase of the Audience Modeling, the specific visitors of the particular website must be identified and classified.

(Shneiderman 1997) emphasized the importance of knowing who the users of the site will be to be able to make informed design decisions. Other researchers made the role of the users also clear in their writings. Users are the most important part of any interactive computer system because the computer system is there to serve users and support their tasks. And web sites can be considered as computer systems with interacting users.

So, the starting point for the design of a new website is the identification of the people for which the web site is created. After all, there is no point in building a web site if you don't have an audience.

There is nothing wrong with self-expression, but most designers sometimes seem to forget that websites are initially created for satisfying their visitors. Designers often design for themselves (see section 2.5.2 Designer centeredness) unless they are trained to realize that people are diverse, and that end-users are unlikely to be like them (Landauer 1995).

The designer must have the reflex to put himself into the shoes of the intended users.

So the most widely preached and important design principle is to understand who your users are and what they want to do.

Due to the popularity of the web, there are so many users with so many different purposes. Think of the people who aim to arrive on a university web site home page.

There will be potential students: post-18, mature students, part-time, full-time.

There will be enrolled students: also characterized in different categories, classified according aspects like department, discipline, year etc. There will be academic people who want to investigate the current results in a specific research domain.

There may be commercial users also interested in research progresses for evaluating their economic feasibility. There may be job applicants, checking the department's research and teaching vacancies or looking for more administrative jobs.

And the list can be continued.

Taking into account all these different people and their needs will result in a serious agony for the designer. In fact, it is not quite as bad as it seems - often it is possible to identify the most significant user groups and to design the site to funnel the different types of users to different areas. As it seems an unfeasible job to design the web site customized for each individual user, the design can be organized for a group of visitors, characterized with similar properties.

There are plenty of possibilities for dividing the different potential visitors of a web site in specific groups. E.g. one can categorize web users by investigating the web navigation strategies they use. The researchers Catledge and Pitkow (Catledge et al. 1995) for example, characterized users' browsing strategies on the web by analyzing the logged data of user-generated events in a particular browser. They divide the users into three categories - serendipitous browsers, general-purpose browsers and searchers - by analyzing the relationship between the average frequency of page visits and the average path length per site per visit.

A choice for categorizing the audience of the particular web site must be made.

Focusing on the user, it seems natural to divide the entire audience of a web site in the role they play when visiting the site.

Several authors have considered the relationship between the type of task being performed and the way that information is structured in a hypertext system ((Mohageg 1992), (Wright et al. 1989), (Rada et al. 1992)).

They all stressed the need for the information in the hypertext to be structured in such a way that it supports users' tasks.

Knowing the user's tasks is essential for the designer to construct user interfaces adequately reflecting the tasks' properties. (Bomsdorf et al. 1998) (Guell et al. 2000) has reported the usefulness of tasks in the elicitation of the requirements for the design of a large web site. The following definition will capture this approach and forms the basis for the Audience Modeling phase.

An *audience class* is a group of potential visitors that are characterized by the same tasks, while interacting with the specific web site.

Taking the tasks as a starting point for the identification of these audience classes, how does a designer actually begin with this job? Most of the times, the organization has a good view on the different groups who are visiting their web site for information or services. The activities of the organization that are related to the purpose and the subject of the web site can help identifying the different audience classes. Groups can be recognized by the typical interactions they perform while visiting the web site.

There is no need to wage a life-and-death struggle to capture all the audience classes in this phase. In the next sub-phase of the Audience Modeling, the Audience Task Modeling, the different identified audience classes become related with their most relevant tasks, which they will like to fulfill. In this way, the Audience Task Modeling functions as a completion and as an evaluation of the results built in the identification phase.

Corrections on the constructed audience classes can be made to achieve a more representative audience classification. Constructed audience classes can be divided in smaller ones and new audience groups can be recognized.

4.2.2 Academic site design example

As a running example to illustrate the Task Driven WSDM approach in this work, an academic web site for a fictive university is built from scratch.

The web site of a university functions as an information billboard for the entire university community. Announcing information for their enrolled students to assist them during their studies is just one of its objectives. It also hopes to influence the choice of prospective students to become enrolled by presenting a professional looking prospectus, including numerous interesting study programs with efficient supervising and brilliant perspectives. As well as its educational purpose, research activities and results are divulged to be a useful resource for other interested researchers or to tempt sponsors for important investments.

By presenting its established know-how, a university aims to radiate an unstained and renowned identity.

Due to its respectful reputation, the web site of a university has to provide clean and clear information to its audiences.

Taking into account this statement of intent, several audience classes can be identified. The most relevant audience classes are shown in the understanding table.

| |
|----------------------|
| Enrolled students |
| Prospective students |
| Former students |
| Professors |
| Course assistants |
| Administrative staff |
| Technical staff |
| Internal researcher |
| External researcher |
| Research sponsor |
| Job searchers |

Table 1: Relevant audience classes of a university web site.

There are no bones broken when the designers forget an audience group in this phase of the design. During the following sub-phases of the Audience Modeling, new audience classes will be recognized and can be added to this provisional collection.

4.2.3 Audience Task Modeling

In this phase, the most relevant tasks of each audience class are identified and described. A task can be considered as an activity where the user interacts with the web site to acquire some information.

The practical approach for this phase is to build a list of tasks a specific audience group wants to fulfill. For situations, where designers may have difficulty to identify the most relevant tasks for an audience class, one can make use of the purpose and the subject of the web site and the activities of the organization.

This phase does not aim to catch the complete and full specification of a task, salted with all details. During the following phase, the Conceptual Modeling, each task can be further specified and the information related with each task will be studied in depth.

The Audience Task Identification complements and extends the previous phase by evaluating the constructed audience groups and by adding more descriptions about the most relevant tasks for each audience class.

The close interaction between the Audience Task Identification and the Audience Task Modeling incites the application of multiple iterations for an obvious and representative blueprint of the expected public of the web site.

While other methods based on user tasks like the User Task Analysis (Hackos et al. 1998) applies a formal methodology to define a complete classification of the task into sub-tasks and the description of the relevant environment issues, this more informal approach emphasizes the association of the most relevant tasks with each audience class.

4.2.4 Academic site design example

The running example of the academic web site as an example of the design of an organizational web site is too large to discuss in detail in this work. Therefore only parts are elaborated through the different steps of the method.

The following tables specify the most relevant tasks for a few audience classes.

| |
|---|
| Examine specific information about a course in the study program |
| Search email-address of a course assistant of a specific course |
| Examine information about course material at the campus shop |
| Search a comfortable housing |
| Look for study advice |
| Find information about the acquisition of a student grant |
| Look for information about obtaining a doctor’s degree, post graduate programs, etc |
| Find information about a student job |
| Find information about the university library |
| Find information concerning the restaurant |
| Look for information about proposition subjects across research groups |
| Find information about cultural, sport and student-like activities and events |

Table 2: Tasks of the audience class enrolled students.

| |
|---|
| Examine the offered study programs |
| Looking for information about a specific study program and its prerequisites |
| Examine some general information concerning the university |
| Find information about the introduction days |
| Examine accessibility and parking facilities |
| Find information about the enrolment procedure |
| Look for information about housing |
| Find information for study choice advice |
| Find information for the acquisition of a student grant |
| Find information about cultural, sport and student-like activities and events |

Table 3: Tasks of the audience class prospective students.

| |
|---|
| Contact campus shop for new publications of course material |
| Find information about education program projects, evaluation, etc |
| Contact personnel department |
| Ask assistance to fix/substitute a broken projector |
| Find general information about research and development |
| Find information for computing architecture facilities |
| Find information for reservation of classrooms and other facilities |
| Find information about getting reimbursed for travel expenses |
| Find information about the university library |
| Examine information concerning the restaurant |

Table 4: Tasks of the audience class professors.

| |
|---|
| Contact campus shop for new publications of course material |
| Contact personnel department |
| Find information for reservation of classrooms and other facilities |
| Find information for computing architecture facilities |
| Find information about the university library |
| Examine information concerning the restaurant |

Table 5: Tasks of the audience class course assistants.

| |
|---|
| Find information for the presentation of new research projects |
| Find information about reservation and use of infrastructure and facilities |
| Find information for computing architecture facilities |
| Find information for canvassing new researchers |
| Find information for refunding of expenses and budget |
| Find general information about research and development |
| Contact Medical department for check-up or an emergency |
| Contact an environmental coordinator |
| Find information about the university library |
| Examine information about publications in campus shop |
| Examine information concerning the restaurant |

Table 6: Tasks of the audience class internal researcher.

| |
|--|
| Find information of a specific research group, research subject, researcher ... |
| Examine research results of a specific research group, research subject, researcher, ... |
| Contact spokesman of a research group |
| Contact researcher |
| Find information about a workshop or conference, located at university |
| Find information about university library |
| Examine information about publications in campus shop |
| Examine accessibility and parking facilities |
| Examine information concerning the restaurant |

Table 7: Tasks of the audience class external researcher.

| |
|---|
| Examine research results of a specific research group, research subject, researcher ... |
| Contact spokesman of a research group |
| Search information about sponsoring |
| Contact spokesman of the financial department |
| Examine some general information concerning the university |
| Examine accessibility and parking facilities |

Table 8: Tasks of the audience class research sponsor.

| |
|---|
| Examine vacancies with their requirements, criteria for selection, job descriptions ... |
| Contact for more information about the offered vacancies |
| Examine accessibility and parking facilities when a job interview has to be done |
| Examine some general information concerning the university |

Table 9: Tasks of the audience class job searchers.

An analysis of these audience classes and their most relevant tasks show that some tasks occur frequently. That sets one thinking, that only one design will be necessary for such a task. However, the eyes of a prospective student went differently through the presentation of the general information about the university than these of an external researcher or a job applicant.

4.2.5 Audience Profile Modeling

When designing a web site, a primary concern is the comfort and satisfaction of the audience. Web sites are about providing some service to some audience. If designers lose track of this device then they will not be able to create an effective web site.

The description of an audience contains certainly the resources that the majority of the audience has to access the web site. Cutting edge web sites may be cool and hip but they exclude many users who lack the software or hardware to view them. Turnaround of new computer technologies currently runs about two years for seventy-five percent (75%) of users to adapt a new technology. In this world of fast changing technology, one can assume that the resources available to half an audience is at least a year out of date, two years out of date for a quarter of the audience, and even further out of date for smaller segments, some of whom will never take efforts to update but stodgily stick with whatever they first acquired.

This may seem a far-fetched requirement for an audience while designing a web site. (Fleming et al. 1998) reported that the messages, which announce the lack of an additional plug-in for the browser software are experienced by web surfers as one of the most disturbing annoyances. For web sites of important organizations and institutions, like musea, universities and high schools and government services, where the information can be essential for their "customers", a universal access for all interesting web surfers should be strived for.

Another item, which is otherwise related with the previous one, is the experience of the web surfers with computer and Internet concepts: (Nielsen 1993) reported that the web site visitors can be classified in a range from novices with minimal computer and internet experience and expert users with extensive experience.

While novices need easy to navigate routes, where each step along the way is as simple as possible, experts prefer speed to simplicity and would rather deal with a huge menu of over a hundred alphabetized choices than short menus that require stepping through more than one page to get to their destination quickly.

According to (Nielsen 1993), the experience with the information domain also influences the way people view to a web site. Users completely ignorant with the domain may need additional descriptions to clarify domain-dependent terms while users knowledgeable with the organization or the subject may find these descriptions annoying and gushing.

Other characteristic, useful for the design process, can include: age, educational and intellectual abilities, gender, geographic location, language, etc. The choice for mentioning specific characteristics can also be influenced by the type of the organization, their businesses and their target audiences.

By creating audience profiles, where the most important characteristics of each audience class are summarized, the designers are equipped with a clear image of the different requirements of the specific audiences. These profiles will demonstrate their usefulness for the further stages of the design process.

4.2.6 Academic site design example

The creation of the audience profiles for the different audience classes of the university web site is rather straightforward.

The important characteristics of an audience class are summarized in a table.

In the table 10, the audience profile of the audience class of the prospective students is shown. Only the information, necessary for the design process, has been taken up. One can also find an item in the table "Possible types", which introduces different subgroups for the audience class.

In fact, there may be some discussion to consider these groups as audience classes. The details of their performed activities can be different in some cases, but their tasks are basically similar.

By organizing the process by specific types of users, the boundaries between the different user groups must be sufficiently clear.

Otherwise, the process will get bogged down in a great number of categories, only differing in small details.

Users also don't like this sophisticated organizing into groups because this makes them doubt in which specific category they belong and that they may miss important information by "pigeon-holing" themselves.

| | |
|--------------------------------------|---|
| Audience profile | |
| Audience class | Prospective students |
| Computer experience | Rather familiar, depends on the previous studies, ... |
| Internet experience | Rather experienced, depends on the previous studies, ... |
| Knowledge about university | Low, out of touch with specific university terms, procedures, departments, etc. |
| Possible types | Students looking for a regular study program, evening classes, ... Foreign students, Students from other universities, etc. |
| Age | 18+ |
| Educational / intellectual abilities | Sufficient level to start a university study, depends on the type, |
| Language | Native language, sufficient knowledge of English |

Table 10: Audience profile of the audience class prospective students.

5 Conceptual modeling

The relevance of the conceptual modeling in the development of web sites, and more generally, in design methods for hypermedia systems has been acknowledged. Beginning the design with a conceptual model when developing a web site is considered to be the state of the art for most hypermedia design methods (see, for example (Isakowitz et al.1995) (Garzotto et al. 1993) and (Schwabe et al. 1996)).

The first section presents the background and benefits of conceptual modeling. In the following section, the Conceptual Modeling phase in the Task Driven WSDM approach is described. The university web site design case study illustrates the divers aspects in this phase into more detail.

5.1 The use of conceptual modeling

The use of conceptual modeling is well known in the database field, where it is used both to develop new applications and to document existing ones.

Given the fact that web sites essentially provide access to complex structures of information, it is natural to apply techniques from database systems to the process of building and maintaining web sites. (Florescu et al. 1998) identified web site creation and management as data-management problems that can benefit from database technologies.

The application of the conceptual modeling proves their usefulness during the whole development cycle in the context of the design of web sites. Conceptual models can be used as a means to structure, understand, communicate, model, and, ideally, formalize the part of the information domain that is to be presented on the web. (Mylopoulos 1998) (Wand et al. 1995))

It helps the designers to increase their understanding of the systems to be built and is the first step towards a formal representation of the web site. It keeps the design of the web site at the heart of the available information, to force the developer to deeply analyze the conceptual issues, before addressing low-level concepts as links and layout. By documenting the requirements and design decisions it serves in a beneficial way as the basis for implementation.

In (Truex et al. 1998), the importance of the conceptual models is emphasized to enable adopting the systems to changing needs, supporting the focus on modeling regarding the further development.

The application of a conceptual modeling phase in web site design yields benefits and avoids the maintenance-related problems.

However, the use of a conceptual model also forces the designers to a data-driven approach i.e. the design is based on the available information. This design method starts with the modeling of the information domain and creates then a web site structure by means of views on this information. Such an approach may lead to usability problems. The designers must constantly pay attention for which the web site is meant and this must be the starting point for the development process.

5.2 Conceptual Modeling phase

This section describes the Conceptual Modeling phase of the proposed method, which constitutes of the following sub-phases: the Information Task Modeling and the Sub Site Task Modeling. While in the Audience Modeling, the emphasis lies on the identification of the different audience classes and their tasks, the Conceptual Modeling focuses on the specifications of the different tasks. The first sub-phase of the Conceptual Modeling, the Information Task Modeling elaborates the description of the information related with these tasks.

For each task, all the information, which is relevant enough to be present in the web site is modeled in task conceptual models. Next, for each audience, these constructed task conceptual models are merged into an audience class conceptual model, which summarize all information relevant to a specific audience class.

By associating the diverse tasks to a specific department of the organization, the designer gets a clear image of the responsibilities of each department. The Sub Site Task Modeling also points out which audience classes may need to make use of the offered services and know-how of a specific department of the organization. This approach already introduces a gradual clue for the next phase, the Navigation Modeling and also introduces some kind of evaluation of the existing sub sites.

5.2.1 Information Task Modeling

After identifying the most relevant tasks for a specific audience class in the Audience Modeling, this phase will analyze and describe these different tasks into more detail.

This Conceptual Modeling phase enhances the clear identification of the information, which is related to the audience classes and their tasks. During this phase, the designer acquires a complete picture of the information domain of the web site. It generates crucial insights and understanding which can be useful throughout the further phases of the design.

For each audience class, an audience conceptual model is built.

This audience conceptual model embodies the information, which plays an important role in the diverse tasks of a specific audience class. The building process of the audience conceptual model evolves gradually by adding successively the objects and the relations between these objects dealing with each particular task.

For each task the audience class is involved in, a specific task conceptual model is constructed of the objects and the relations between the objects. It includes all the concepts that are relevant for the task and for the audience that have been identified.

Then, the task conceptual models of a specific audience class are in turn merged into a single model: the audience conceptual model. In this way, the audience conceptual model comprises the conceptual models belonging to all the tasks of a specific audience class.

The mechanisms of this growing audience conceptual model have many interesting advantages. By emphasizing a conceptual model on a simple task, one gets better insight in the specific needs of the audience to fulfill the task optimally. Details of objects and their relations are easier to understand and to analyze when focusing on a small part of an information domain.

Another advantage lies in the documentation effect during maintenance.

If someone wonders in retrospect why a specific object or relation is included in the conceptual model, the different task conceptual model can be consulted. In this way one can understand precisely and eventually evaluate the reason for the specific item.

From the aspect of redesign and maintenance, this mechanism makes it easier for the designer. When after some time, the designer reveals that an important task is forgotten, an additional task conceptual model of the task can be made and this can be merged into the existing audience conceptual model. In this way, the greatest part of the Conceptual Modeling phase work remains unchanged: all the task conceptual models can be maintained and the audience conceptual model is slightly changed with the new task fitting into it.

This approach even allows the addition of a new audience class. In this way, the design of the web site can be developed incrementally, where each step introduces another audience class. The redesign of an existing web site can also be neatly executed. When the original design has forgotten a sufficient important enough audience group during the Audience Modeling, or when a web site will attract a new public because it has undergone a change of purpose, the conceptual models of the original audience classes (if necessary) can be maintained.

For the notations of the task conceptual models and the audience conceptual models, designers can make use of different techniques. They can use well-known object-oriented techniques like OMT (Rumbaugh et al. 1991) or UML (Booch et al. 1999), or database techniques like E-R (Chen 1976) based. The character and nature of the information domain and their objects can influence the choice of the used notation.

The Task Driven WSDM doesn't prescribe any notation technique as an optimal solution, so designers have the opportunity to take the notation with which they feel most comfortable with.

In the audience conceptual model, where the different task conceptual models are put together, the use of abstraction can avoid a chaotic cluttering of the information. When, for instance, the objects and relationships between them of a particular task are very specific for each task and have no interdependence with each other, it is not necessary to construct a summarizing model with fully details of these objects and relationships. In that case, the audience conceptual model will not be a useful tool in the design process. The independent task conceptual model can then better be represented by an abstract sub system notation in the audience conceptual model, which refers to the specific task conceptual model where the detailed issues of a task can be viewed.

5.2.2 Academic site design example

For the case study of the university web site, we make use of an ORM-based notation. It is important to have some forms for presenting the objects, which correspond with pieces of information and the relationships between them.

In this notation, ellipses are used to represent objects and the relations correspond to the rectangles composed into boxes, each box connects with a line to the related object. Further, a specification/generalization mechanism and an abstraction mechanism can avoid cluttering in the diagrams and keep them clear for analysis. The specification/generalization relation is graphically represented by a solid arrow between the specific objects; an icon representing a kind of network abstracts another conceptual model. These notations are presented in the following figure 3.

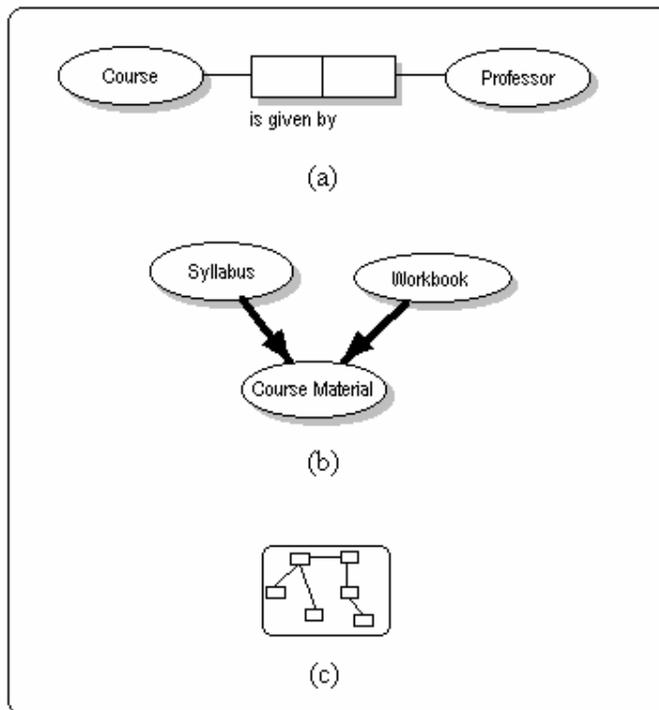
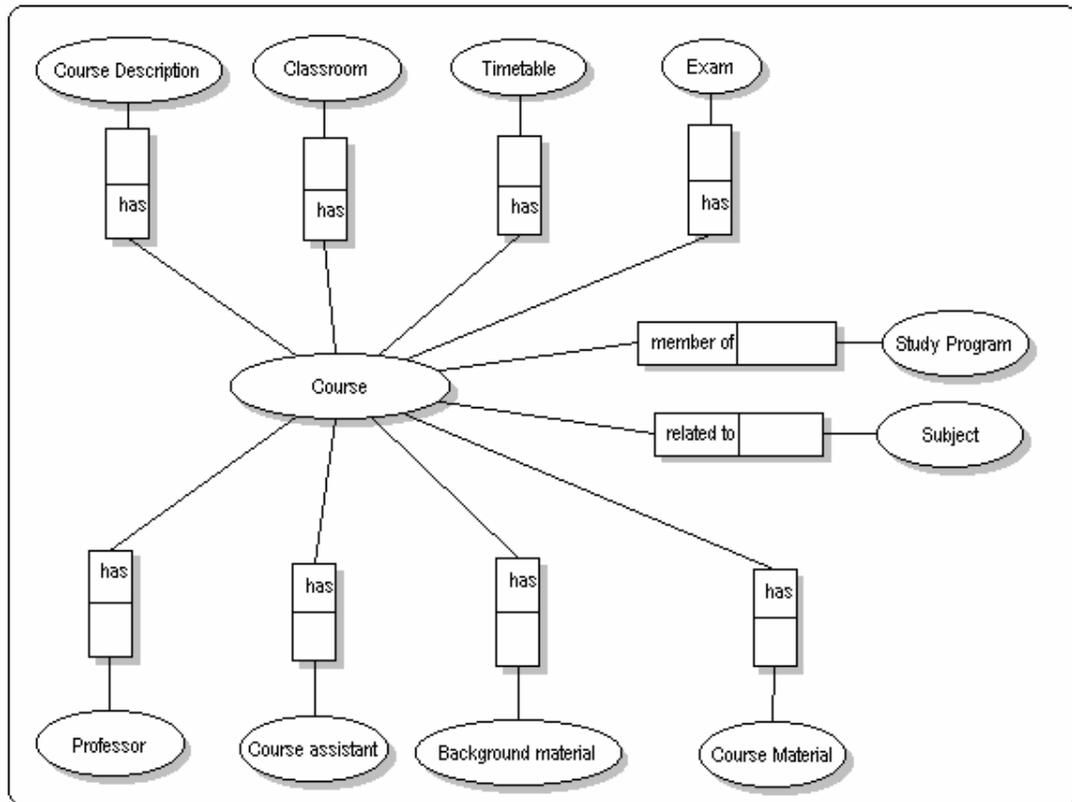


Figure 3: Notation items used in the information modeling((a) Objects and their relationship (b) Specification/generalization relation (c) Abstraction icon).

The number of tasks of the audience class of the enrolled students is too numerous to put them all in this work. Therefore, this section will only show the construction of the few representative task conceptual models and presents the resulting audience conceptual model.

In the figure 4, the conceptual model of the task "Examine specific information about a course in the study program" is shown.



*Figure 4: Task conceptual model of the task
"Examine specific information about a course in the study program".*

One can see that only the most relevant information, related with the task, is inserted into the diagram. Another task for a student is to get in contact with a course assistant of a specific course. The diagram for this task is shown in the figure 5.

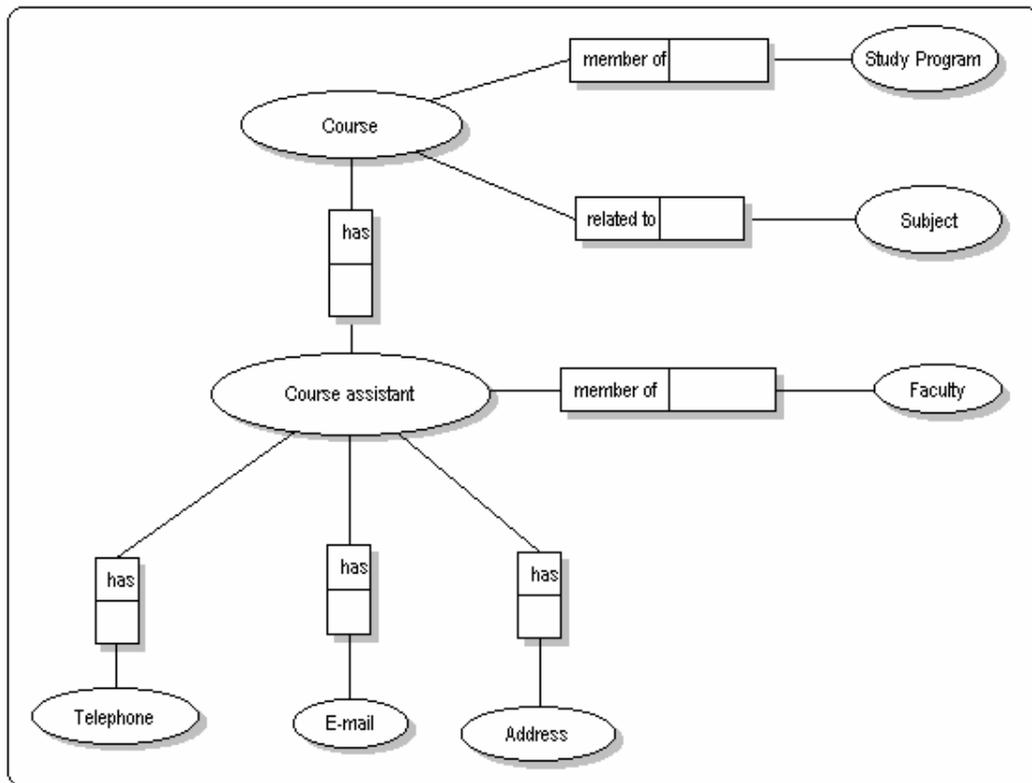


Figure 5: Task conceptual model of the task "Search email-address of course assistant of a specific course".

One may argue that the e-mail addresses of a course assistant are also interesting course information for an enrolled student. That's true, but the main purpose for the construction of the task conceptual models is the presentation of the information only related to a specific task. In this way, the designer is concentrated on the specific information needed for a particular task. In the summarizing audience conceptual model, this information will be related and put together.

The following diagram 6 shows the task conceptual model of "Examine information about course material".

It includes an interesting feature for the generalization/specification concept for objects. Course material can take many different forms: a syllabus written by the course professor, a book used in the lessons or related with one of the subjects of the course or some software tool, needed in practices. This is represented in the diagram by registering that the course material follows some subtype relationship of these instances.

The diagram 6 shows also an example of the abstraction of subsystem, which is too elaborated to specify into detail. Some of the course materials can be for sale in the campus shop or for loan in the university library. This information is useful for students to get that material so it is included into the diagram. However, because it is also related to other tasks, like visiting the campus shop or searching a specific item in the library, which are specified in other conceptual models, the choice is made to abstract the campus shop and the library.

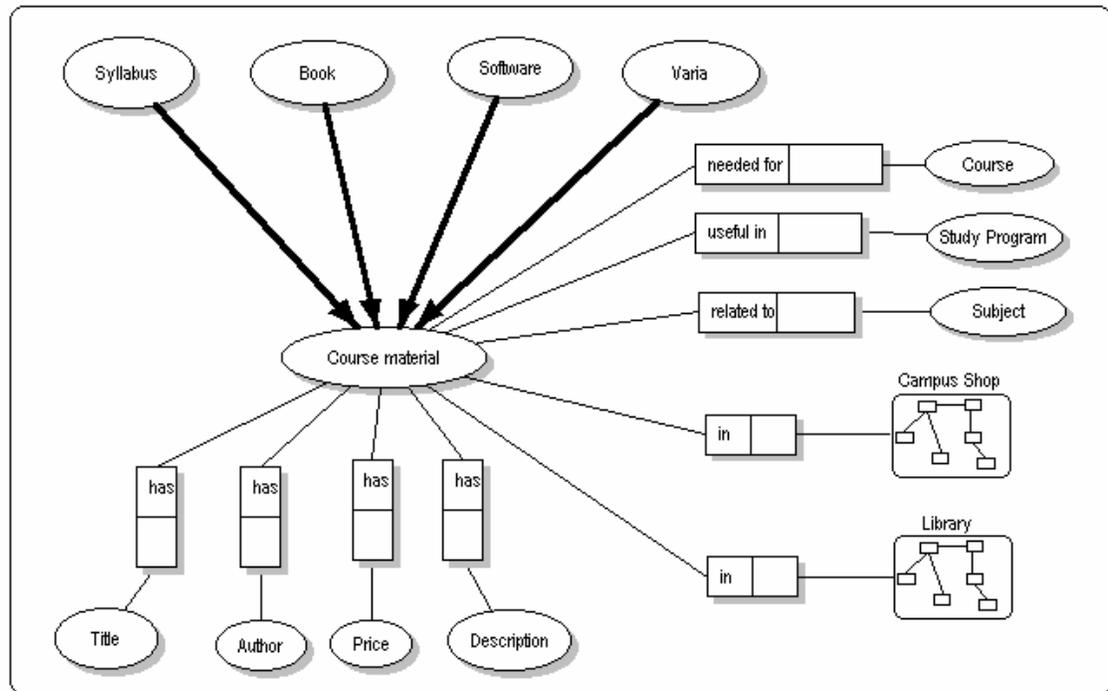


Figure 6: Task conceptual model of the task "Examine information about course material".

After the construction of the specific task conceptual models for the most relevant tasks of a particular audience, they can be combined into an audience conceptual model. Again the mechanism of abstract systems can be used to preserve a clear picture. The figure 8 shows the conceptual model of the student audience class, which is created with an intermediate step: figure 7 shows the conceptual model of the task related with the educational duties of a student while figure 8 abstracts this model as "Study Information" and presents the audience conceptual model of the enrolled student audience class.

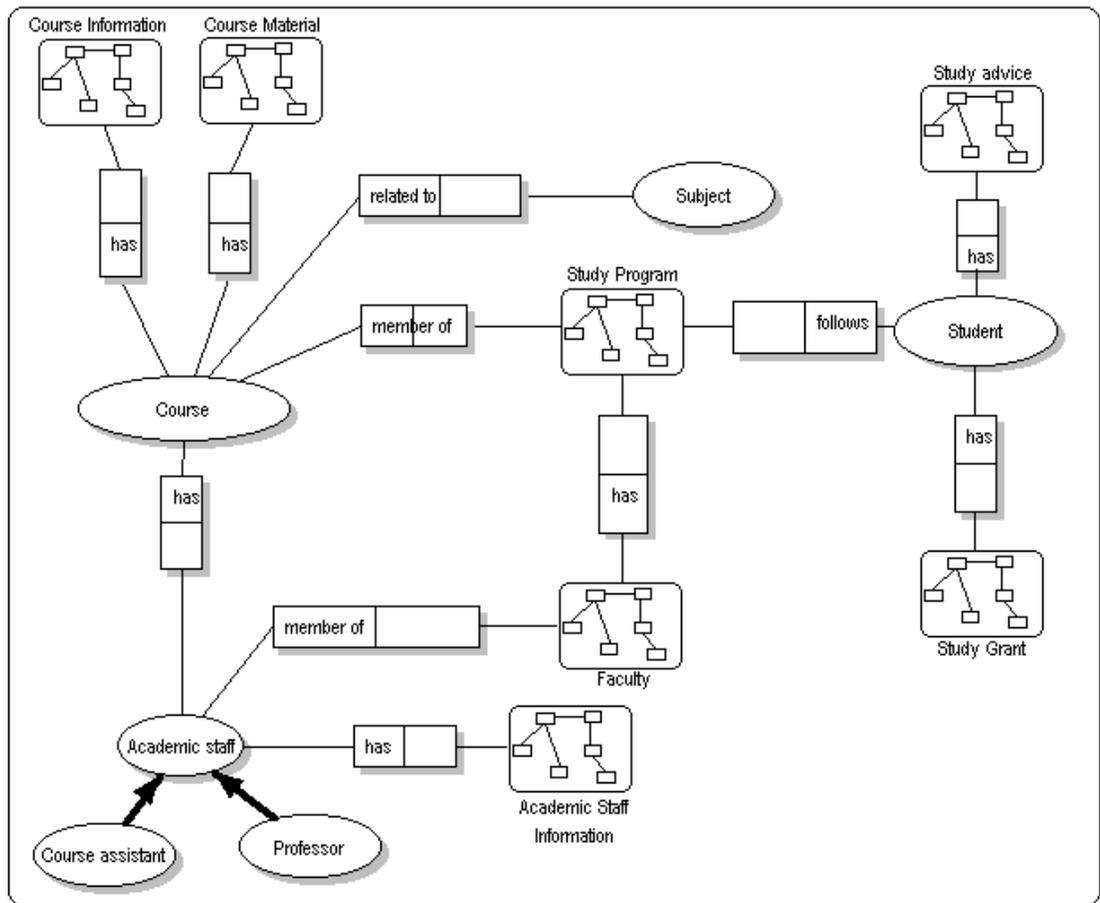


Figure 7: Abstract task conceptual model of all tasks related with study activities of the student audience class.

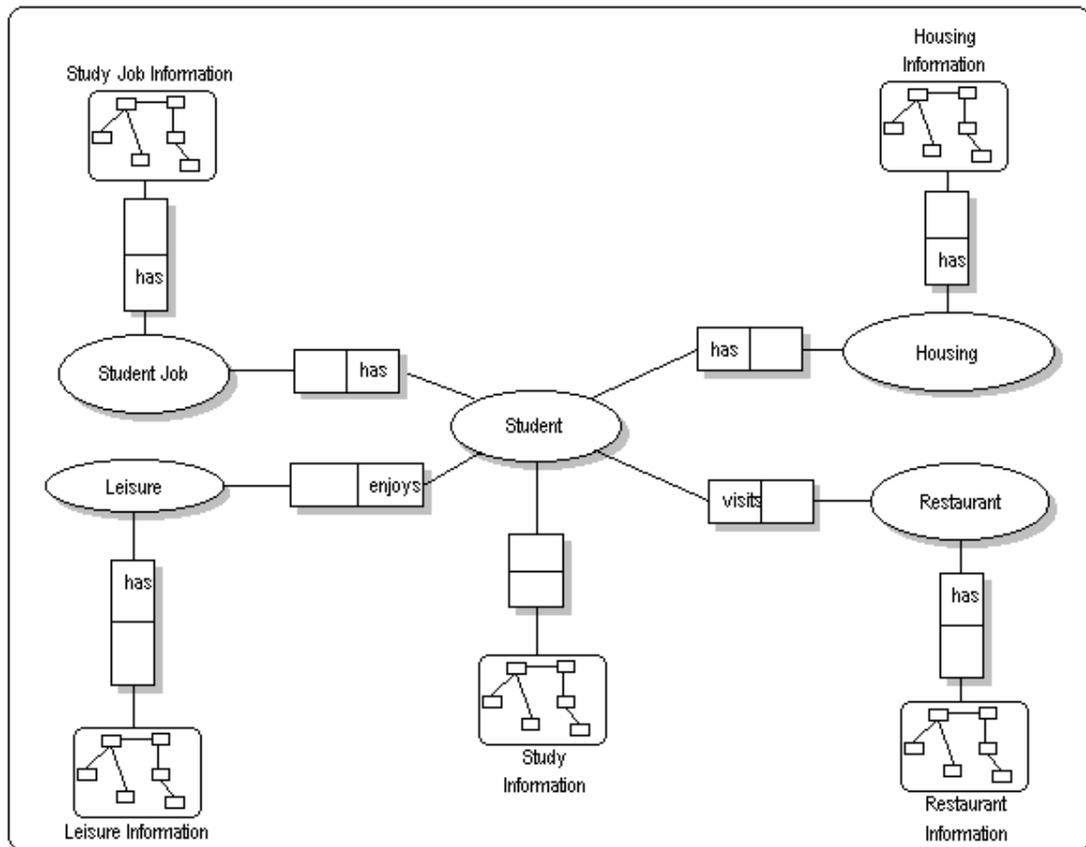


Figure 8: Audience conceptual model of the enrolled students.

5.2.3 Sub Site Task Identification

During this phase, the different tasks of a department of the organization are analyzed and associated with the divers identified audience classes. To achieve this, the designer can apply two approaches, depending on the starting point: the tasks of the audience classes or the offered services of the different departments.

When the budget and the time scheme permit it, it is advised to make use of both mechanisms because they complement each other. Applying both methods can even bring advantage to the organization itself and their success on the web.

The first approach is rather straightforward when the Audience Modeling has resulted in a clear view concerning the different audiences and their tasks.

This step includes mainly delegating the tasks to the specific departments of the organization. For each audience group, their tasks are related with the department(s), which is responsible for the fulfillment of these tasks.

The second approach starts from the departments of the organization.

The departments have usually a clear insight to the services they offer, so designers can therefore easily derive the tasks for which these services are meant. Here the challenge for the designer is to relate the different offered services to the tasks of the audience classes. In this way, tasks, which are not recognized during the Audience Task Modeling phase in the Audience Modeling, would come to light.

There exists a danger in this second mechanism that the emphasis on the users is dropped and shifted towards a more department-oriented, and thus organization-centered approach.

Both mechanisms can be applied separately or they can be combined.

When the department of an organization already has a web presentation, the offered services, which are relevant for the audience and for which the department is responsible must be clearly recognizable on the web site.

Comparing the tasks of the audiences with the offered services of a specific department can show gaps between the functionalities of the web sites and the needs of the audience. The possible functionalities that a web site offers to their audience and the tasks of that audience must be in balance. This analyze can reveal shortages in the functionality of the web site but can sometimes indicate missing links in the structure of a department for an adequately dealing with the audiences' tasks.

Such analysis can also point the designers to new opportunities for obtaining users' satisfaction.

5.2.4 Academic site design example

To illustrate the first approach, the tasks of an internal researcher are associated with the specific departments, which are responsible for the support of these tasks.

| | |
|--|---|
| Find information for the presentation of new research projects | <ul style="list-style-type: none"> • Faculty • Research & development department • Research group • University management |
| Find information about the reservation and use of infrastructures and facilities | <ul style="list-style-type: none"> • Class room management service • Faculty |
| Find information for computing architecture facilities | <ul style="list-style-type: none"> • Computing services |
| Find information for canvassing new researchers | <ul style="list-style-type: none"> • Financial department • Personal department • Research & development department |
| Find information for refunding of expenses and budget | <ul style="list-style-type: none"> • Financial department • Research & development department • University management |
| Find general information about Research and development | <ul style="list-style-type: none"> • Research group • Research & development department |
| Contact Medical department for check-up or an emergency | <ul style="list-style-type: none"> • Medical department • Personal department |
| Contact an environmental coordinator | <ul style="list-style-type: none"> • Environmental services |
| Find information about the university library | <ul style="list-style-type: none"> • University library |
| Examine information about publications in campus shop | <ul style="list-style-type: none"> • Campus shop |
| Examine information concerning the restaurant | <ul style="list-style-type: none"> • Restaurant |

Table 11: Task - responsible department list of the audience class of internal researchers.

In this way, the designer builds a global overview of the different departments of the university where the members of a specific audience class can make use of. The access to these departments must be made very logical and easy to use by the particular audience class. Due to this, it will be a basic help for the next navigation phase.

The tasks, where multiple departments are involved, merit more attention. By performing such a task, the members of an audience class must have a clear picture of which departments are responsible for what parts of the task and in which sequence these specific parts of the task must be fulfilled. If a user is informed about this, the fulfillment of such a task will be more efficient and effective. It will also endow the university with a transparent view of its activities and every day management.

The second approach in the sub site task design looks at the responsible activities of the specific departments from the angle of the audience classes. All tasks, which can be offered to a particular audience class, are collected in a sub site task card. In the table 12, the tasks of the enrolment services to the audience class of the prospective students is shown.

| | |
|----------------|--|
| Audience class | Prospective students |
| Department | Enrolment service |
| Tasks | Find openings hours and dates |
| | Find location for enrolment |
| | Find location of secretary of enrolment service (not necessary the same as the location for the enrolment) |
| | Contact enrolment service (email - phone - address) |
| | Find required documents and study certificates for enrolment |
| | Find information about enrolment for entrance examination |
| | Find enrolment fees and means of payment |
| | Find receiving of a student card and certificates |
| | Find offered types of enrolment |
| | Change enrolment |
| | Find information about study grant |
| | Find closure of enrolment period |

Table 12: Sub site task card of the enrolment service for the prospective students.

The contents of a card for a department can be evaluated by the responsible persons of the department. This interaction may reveal new tasks to be offered by the specific department and tasks that are already offered by the department, but are not recognized by the design team.

The analysis of the different divisions of an organization may also introduce other important issues for the construction of a website. Suppose that there is a hospital located at the campus, which has a close relationship with the university.

While the students and the academic staff of some medical faculty can make use of the hospital's infrastructure for practices and research activities, the hospital also takes care of patients, which in fact is its main purpose.

During the Audience Modeling phase, we did not identify the audience that comes to the university web site to search for information about the academic hospital. The hospital may have an own web site, which provides the necessary information to their visitors. However, someone, who knows the strong relationship between university and hospital, and doesn't know the specific URL of the hospital, can have a look at the university web site.

The designer can support this by adding a new audience class with their specific tasks. This will draw his attention not to forget to include in the final web site a link to the web site of the academic hospital to support this audience group.

6 Navigational modeling

Web design, as (Garzotto et al 1993) had put it very appropriately, comprises structuring of a complex information domain and making it clear and accessible to users. Several studies((Elm et al. 1985) (Thüring et al, 1995) and (Edwards et al. 1989)) showed that it will be beneficial for the information-seeking process to have a clear organization of the information and try to convey it to the user. The first sub-section handles the structuring of the information while the next will discuss the activities of the Navigation Modeling phase of the Task Driven WSDM.

6.1 Structure of information

Large web sites offer so much information that an adequate structure becomes immensely necessary. Without a solid and logical organizational foundation, a user will not be able to locate any information even if it is reachable after only a couple mouse clicks.

According to (Rosenfeld et al. 1998), web-based organization systems are based upon two essential concepts : organization schemes and organization structures which are defined in the next paragraphs.

6.1.1 Organization schemes

Organization schemes define shared characteristics of content items and influence the logical grouping of these items. Two types of organization schemes exist : exact and ambiguous.

In exact organization schemes, the information is divided into different well-designed and mutually exclusive sections. This system enhances the known-item searching : the user has a very clear need and understands the information retrieval method. A few examples are given in the table 13 below.

| Basis of the scheme | Example |
|---------------------|---|
| Alphabetical | Looking up a known name in the white pages phone book |
| Chronological | Searching for an article with a specific date in a list of articles ordered by their releasing date |
| Geographical | Locating a street on a map of a city centre |

Table 13: Examples of known-item searching in an exact organization scheme.

When the desired information is vague and ill-formed or when the user can only describe it in the right context, another form of information retrieval seems necessary.

Ambiguous schemes divide information into categories that defy exact definition. Browsing these different categories is more exploratory and interactive and allows the user to apply recognition skills to match target concepts rather than recalling specific items. Examples are illustrated in the table 14 below.

| Basis of the scheme | Example |
|---------------------|---|
| Topical | Overviewing the available keywords in a library search. |
| Task oriented | Looking in a list of processes, functions, tasks for the operation of a machine |

Table 14: Examples of browsing in an ambiguous organization scheme.

Working with hybrid schemes can mislead the mental model built by the web user. Items of different organization schemes will undermine the assumption how the user interprets the ordering of information. To retain the integrity of each scheme, it is recommendable to present them separately.

As web users apply both browsing and known-item searching, a usable web site must provide both mechanisms for their visitors.

6.1.2 Organization structures

Organization structures define the type of relationships between content items and their groups and introduce the primary ways in which users can navigate.

The linear form is the most familiar organization structure mechanism in traditional documentation. The linear style of organization provides a great deal of predictability in that the designer knows exactly where the user will go next.

The introduced lack of interactivity and flexibility can bring the user a feeling of indoctrination and loss of freedom. As flexibility and interactivity are the main properties for the web user today, the linear mode is not the ideal method for the presentation and browsing of information on the Internet.

Hierarchies order information moving from the most general items down through increasingly specific ones. Relationships based on hierarchical sectioning are ubiquitous in life.

However the application of hierarchies exposes also a few drawbacks.

The names on the different levels must be meaningful to facilitate effective routing of the users to the desired information.

Another controversial issue is the right balance between breadth and depth in hierarchies. Designers might be tempted to expose all information at once, but users may feel overwhelmed when confronted with all options.

However, providing fewer choices and hiding the information deep within the hierarchy may frustrate the user looking for a particular item. An ideal balance must be searched between the wide and narrow hierarchy.

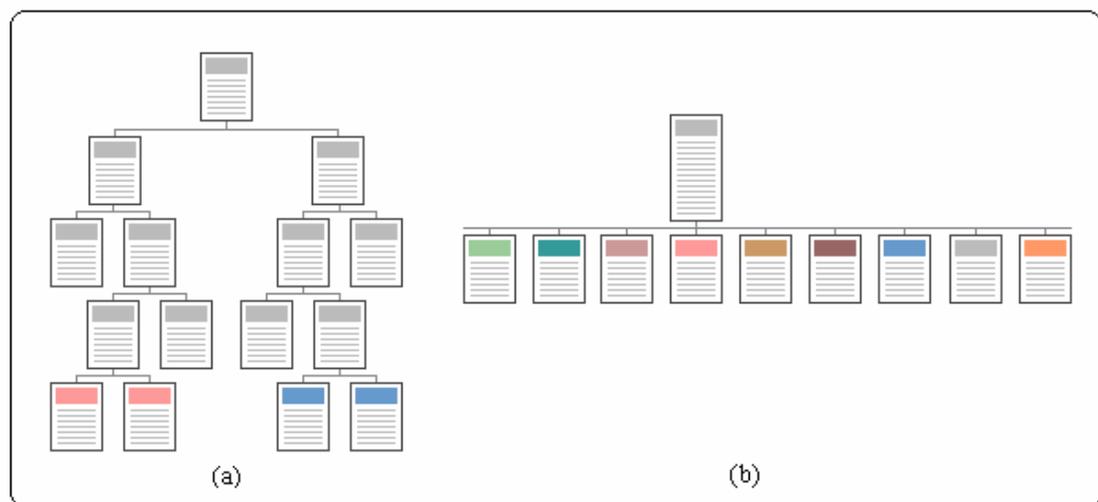


Figure 9: Unbalanced hierarchies((a) Narrow hierarchy (b) Broad hierarchy).

Hierarchies cannot always be fully exclusive or inclusive. Thus some documents may show up in multiple categories. Then the problem arises where to put these things, which don't belong to any specific, already created category.

They are naturally too different to put in one single category and they are mostly with too many to devote a separate category for each of them.

These situations are mostly resolved by introducing additional links, but this may undermine the main structure. When too many cross links, skip-aheads and other augmentations are made to a structured documentation collection, after all the web site will become unclear and confusing to the user.

The benefit of a less structured structure is that it provides a great deal of flexibility, while others might argue that the introduced complexity and confusion structure may cause the user to lose focus and make it difficult for a participant to form a mental map of the site. The ideal way exists in a complementary balance between flexibility and guidance.

6.1.3 User-centered structuring

If anything is clear about the structuring of information in web sites, it is that there is no single best way to take : different types of web sites seem to demand different approaches to organization. Consequently, depending on the type of content and the user's mode of consumption, different structuring mechanisms should be used so that users don't get lost and can navigate the presented information quickly and logically. It is the designer's responsibility to structure the information in a way that will make it most useful to the user. The users should not be hampered by the information design of the site, neither should they be overwhelmed by it.

So whatever structure one chooses, it is imperative that it is clearly communicated to the user and stays consequent throughout the site. When confronted with a new complex information system, users build mental models. They use these models to assess relations among topics and to guess where to find things they haven't seen before. Therefore, a logical site structure must match the users' expectations and must allow them to make easily predictions about where to find the desired information. Consistent methods of displaying information permit users to extend their knowledge from familiar pages to unfamiliar ones.

6.2 Navigation Modeling phase

The Navigational Modeling is a crucial aspect in the design of usable web sites. Building a navigation model is not only helpful for the documentation of the web site structure; it also allows a more structured increase in navigability for the audiences. In the Navigation Modeling phase the structure of the web site is developed. It describes how the members from the different audience classes will be able to navigate through the site. The Navigation Modeling constitutes of two sub-phases: the Audience Navigation Design and the Navigation Schema Design.

In the Audience Navigation Design, different task navigation tracks are constructed for each audience class. A task navigation track shows the different routes through the information to achieve a specific task.

An audience navigation track shows for each member of the audience class the possible navigation paths by combining the task navigation tracks. These audience tracks are combined to form the navigation schema for the web site.

6.2.1 Audience Navigation Design

For the construction of the individual task navigation tracks, the contents of the several task conceptual models are used together with *themes*.

A theme can be considered as a description in a narrative way of the navigational activities performed by the members of an audience class.

It takes into account the navigational patterns and strategies, performed by the audience class, and different aspects of the task, including the purpose, the means, the goal and the circumstances. Shortly, it summarizes the context of the task into more detail.

For each task of an audience class, different themes are collected which form a basis for the further development of the *navigational scenarios*.

These navigational scenarios describe how a member of an audience class experiences the different objects belonging to a task conceptual model while navigating through them, according to the narrative specifications of the themes.

A scenario forms a solution to the problem described in the theme and helps building the navigation structure of the task navigation model.

A scenario constitutes of components, links and collection structures to present graphically the navigation paths traversing by the members of the audience class.

A component represents an object, which has his origin in the conceptual models. Links are used to connect components and to extend the navigational opportunities across the several objects.

To group components, collection structures are used. These collection structures may be formed in different ways, according to the needs and tasks of the audience.

Therefore the definition of the properties of these collection structures can be done by the designer, anticipating the different situations occurring in the tasks.

A task navigation track can then be constructed as the combination of these navigational scenarios.

In the second sub-phase of the Navigation Modeling, these task navigation tracks are further combined into an audience navigation track.

6.2.2 Academic site design example

To illustrate the process of the Audience Navigation Design, the following example describes the construction of a task navigation track for the audience class of the external researchers. Consider the task of an external researcher, which wants to find some information on a specific research topic. For this task, one can imagine a few themes, corresponding with the actions of the following three researchers.

The first external researcher assumes that the research group, which deals with the specific research topic, is part of a department or a faculty of the university. The problem is that he has no clear idea to which specific department the research group belongs. Of course, he can scan the list of all departments and faculties (if this is available) and select the most plausible one. But sometimes the naming of the departments will not help much.

Another researcher has been able to memorize the name of the research group.

A third one is looking for the research result of a specific member of a research group, knowing only the name of this particular researcher.

These are several themes, which describe in more detail the specific differences that may occur in a task.

All these themes give a good insight into the needs and behaviors of the audience and the contexts of their tasks. These detailed descriptions of the tasks will help the designer in the construction of the scenarios of the audience class of the external researchers.

To construct the respective scenarios for these three themes, the task conceptual model functions as an elementary tool to present a complete understanding of the objects and relations, concerning this task. This task conceptual model is shown in the figure 10.

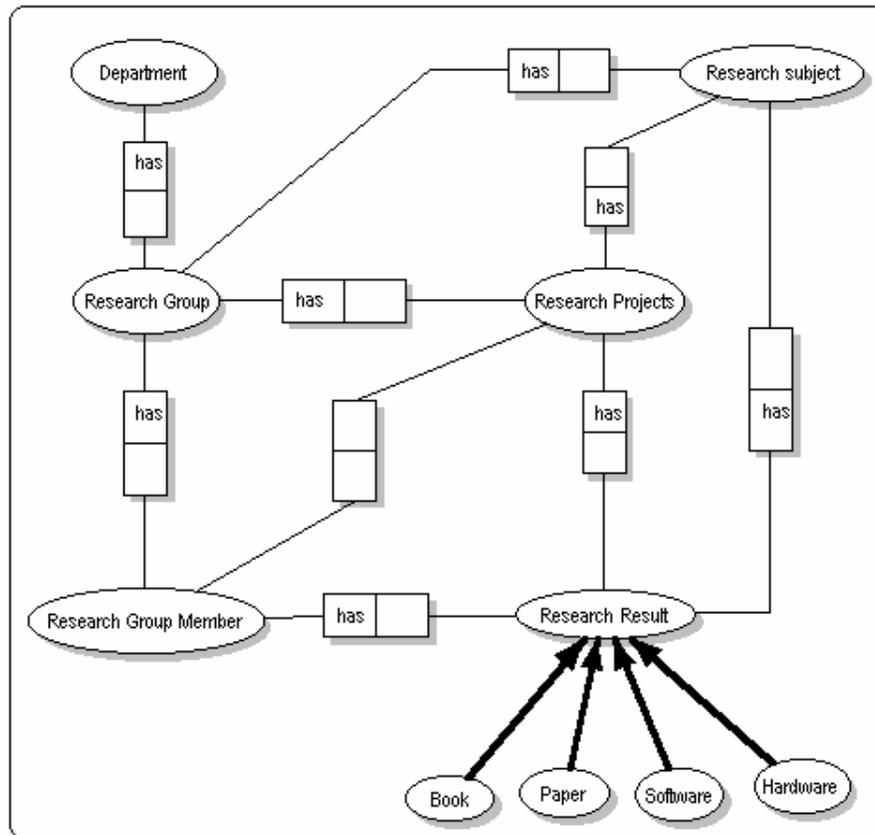


Figure 10: Task conceptual model of the task "Examine research results of a specific research group, research subject, researcher" for the audience class of the external researchers.

The external researcher of the first theme starts his quest with a specific research subject. If all the research subjects, which are related to the work of the different research groups on the university, are arranged on the basis of some logical order, together with the name and link to their specific research group(s), the researcher can simply browse through this list to find the specific subject and its research group. The figure 11 shows this navigation strategy graphically.

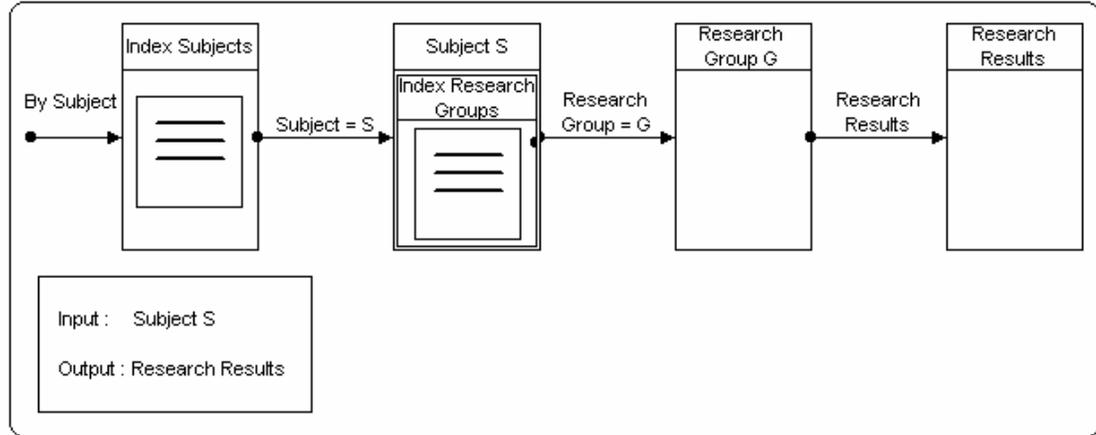


Figure 11: Task scenario of theme "Search research results from research subject".

The first link leads to an index collection structure, which groups all research subjects. By selecting a specific research subject, say subject S, the user follows the second link to a component, which handles all information related to the subject S, including an index of all the research groups working at this subject.

Following the third link brings the user to the desired research group, where one of the links will lead him to the research results part. Additional information can be also included in the diagrams to have a clear documented description of a scenario. In these scenario diagrams, the specific input and output are written down for a patent specification of the situation.

The researcher from the second theme knows the name of the specific research group and will be helped by providing a list of all research groups of the university. This scenario is shown in the figure 12.

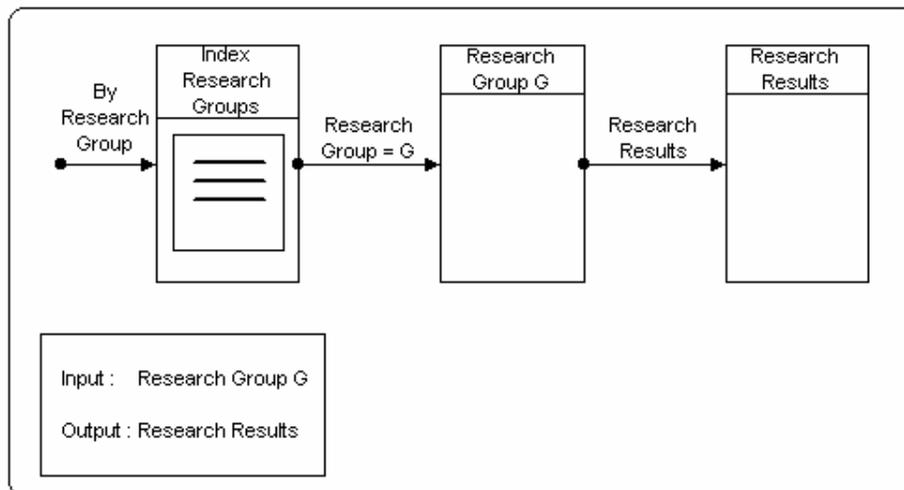


Figure 12: Task scenario of theme "Search research results from research group".

The third researcher has the name of a specific researcher to start his search operation. The figure 13 below presents this scenario.

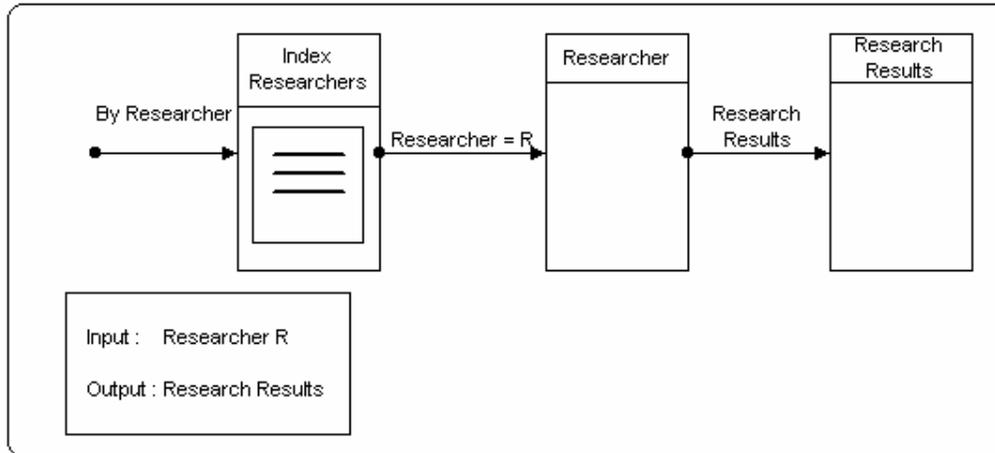


Figure 13: Task scenario of the theme "Search research results from researcher".

By merging the different scenarios, the task navigation track takes shape. It summarizes the navigational scenarios of each task of the external researchers and combines them together to formalize all possible navigation opportunities.

In the case of the external researcher audience class, a task navigation track is built which comprises all scenarios concerning task "Examine research results of a specific research group, research subject, researcher ..." for the audience class of the external researchers.

This task navigation track is shown in the figure 14 below.

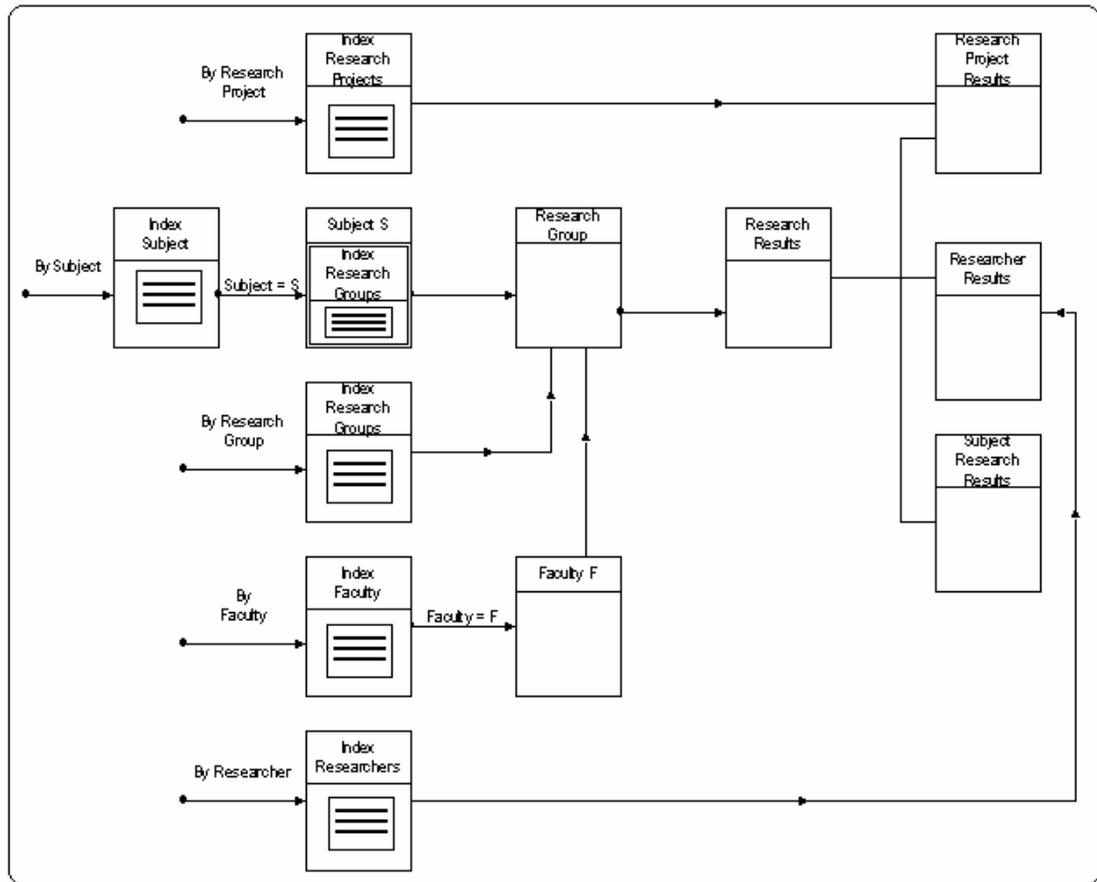


Figure 14: Task navigation track for "Examine research results of a specific research group, research subject, researcher ..." for the audience class of the external researchers.

To provide an easy access to the different task scenarios, one can make use of an additional structure to group the different start positions of these scenarios. A menu can be considered as a composite object, which contains a fixed number of menu items. These menu items can correspond with the different scenario options. The figure 15 shows the use of menus for the task navigation track of figure 14.

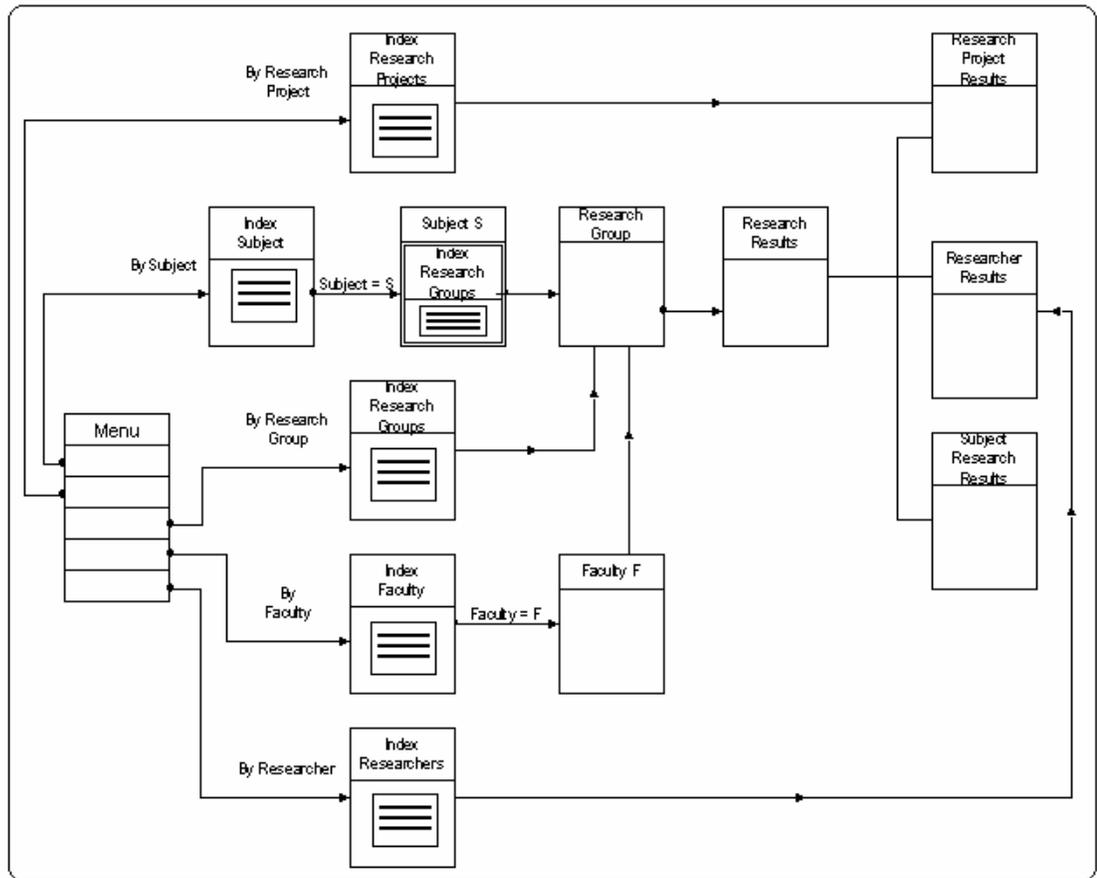


Figure 15: Task navigation track of Figure 14 equipped with menus.

When the different task navigation tracks are built, they can be put together into an audience navigational track for all the specific tasks of one specific audience.

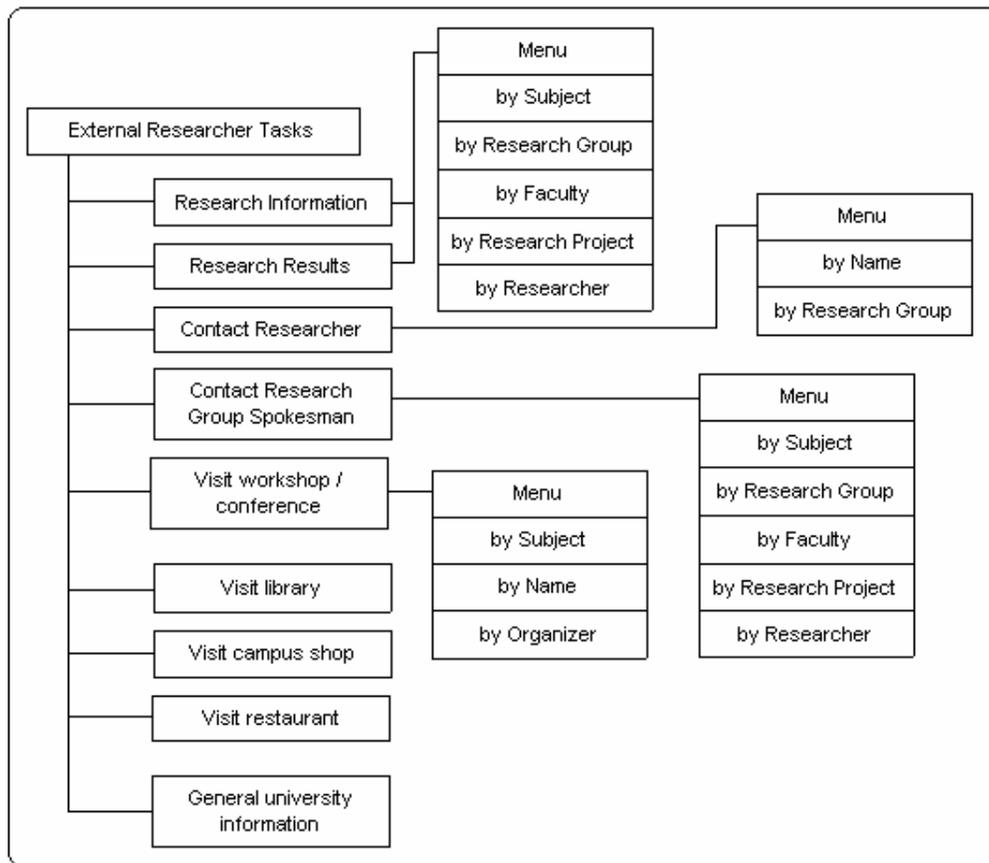


Figure 16: Audience navigation track of the audience class of external researcher.

In the figure 16 of the audience navigation track of the external researchers, the tasks that are related to a single division are not elaborated.

The next phase, the Presentational Modeling constructs for each of these divisions a web page model, or mock-up, which anticipates the information requirements of the specific audience class.

6.2.3 Navigation Schema Design

In this phase the navigation schema for the web site is built with the audience navigation tracks from the Audience Track Design phase. To combine the different audience tracks, the concept of a menu is utilized again for canalizing the access of the different user groups.

The main menu of the web site will be based on the different audience classes. When the number of audience classes is too large, decisions have to be taken how the ordering of these audience groups will be managed.

Audience classes, which have common requirements, can be grouped in a single collection, but this may not degrade a class in favor of other classes of the collection. Designers must consider retaining the different audience classes and their characteristics, identified in the Audience Modeling. To anticipate an easy access to the different divisions of an organization by people who know exactly the name of the specific division, an organizational menu must still be provided.

The analysis of the different audience classes, profiles, tasks and conceptual models, constructed in the previous phases, can reveal similarities, which can assist the development of such a menu. In any case, this menu may never be the main navigation scheme for the entire web site, it must mainly play a role for providing shortcuts to frequent visitors.

As well as the needs and wants of the identified audience classes, the web site has to accommodate the requirements of accidental passer-byes, by providing some general information. The information must be presented in a form, understandable by all visitors, and thus by all audience classes.

6.2.4 Academic site design example

In the design of the university web site, there were 11 different audience classes at the start. By introducing the term academic staff for the audience classes professors and course assistants and the term non-academic staff for the audience classes of administrative members and technical members, the number is decreased to 9.

Analyzing the audience classes and their tasks, one can notice the bipartite objective of the university. A part of the audience is focused on the educational aspects while the others are interested in the research aspect. Therefore it would be logical to base the audience menu on these aspects. The figure 17 introduces the menu for this planning.

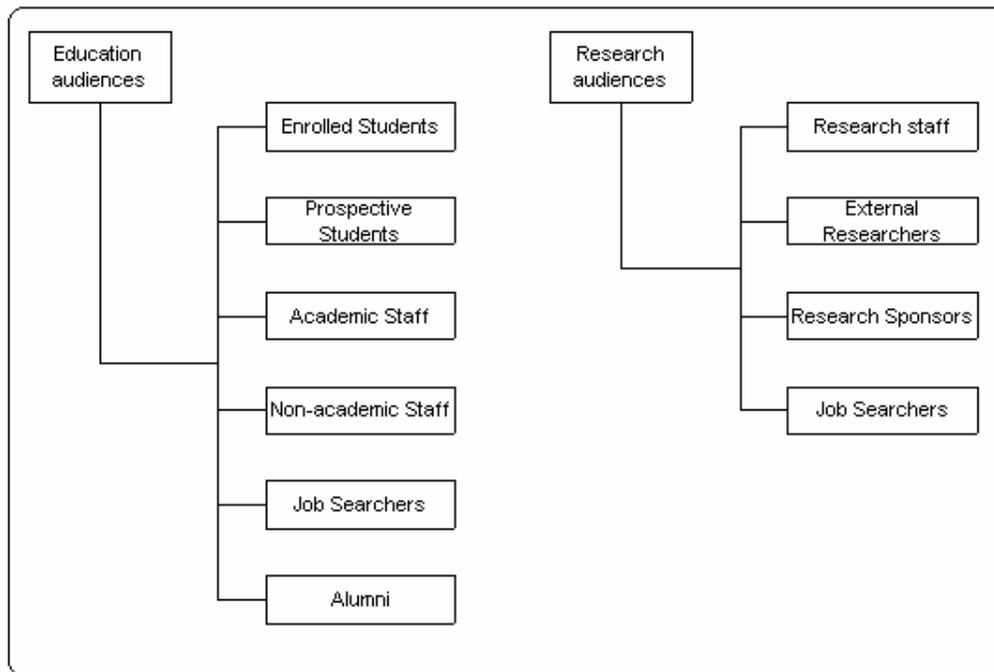


Figure 17: Audiences of a university web site.

This division also classifies the job searchers by the kind of job they are looking for. The upper layer can further be completed with the university library (an important facility for many audience classes and visitors), general information about the university and an overview of university faculties, facilities, services and activities.

7 Presentational modeling

In this section, the development of the look and feel of a web site is discussed. The section starts with a few presentational guidelines that should assist designers to create user-friendly presentation interfaces for their web sites. The second subsection attaches importance to the cause and effect of the independence of web pages into a web site. The third subsection describes the activities in the presentational modeling phase in the Task Driven WSDM approach.

7.1 Presentational guidelines

In traditional media, the content and its presentation are intimately bound, forming a strong collaboration for a successful communication. It is the clue to tie together the stories being told with how they are being presented in such a fundamental way as to achieve something greater than the sum of its parts. The web too is a close interplay of structured content and visual presentation.

7.1.1 The need for a clear visual lay out

Web users looking for information are impatient. They want to get their answers immediately and do not want to be slowed down by "cool" features, mission statements, or self-promoting grandstanding. People spend far less time looking at pages than with classical, printed media. (Veen 2001) argued that people are not busy poring over each page, reading every bit of finely crafted text and weighing their options before deciding to follow an interesting-looking link. Instead they glance hastily to the page, scan some text and click on the first link that catch their interest or vaguely resembles the thing they are looking for. Therefore it is important to make a page's presentation and its content easy to grasp in a hurry.

The layout of a page should tell the reader where to look, what is important and where to start reading. The appearance of things on a page have to portray clearly and accurately the relationships between the specific things on the page. It must be clear for anyone, which objects are related and which objects are parts of other objects.

Breaking up pages in clearly defined areas and relating these parts according to their logical relations will assist the user in a better understanding of the available content.

The most important information must be placed in a prominent spot and emphasized by some graphical or visual clues like larger or bolder font, a distinguishable color or set off by more white space surrounding it. Things that are logically related must also be visually related. Grouping them can effectively do this.

The experience of the traditional publishing world concludes that a clear visual appearance saves work for their readers by organizing and prioritizing the offered information, which can be considered as a form of pre-processing it.

7.1.2 Benefits of consistency and conventions

Just as with the concepts of content and navigation, consistency is also an important issue in the layout of web sites. Another used term for developing a consistent look and feel is *branding*.

Branding stands for creating a unique character or style for a web site, which makes it easily recognizable. When a site is well branded, visitors immediately realize if they are still on the specific site or if they have already left it. This may seem a triviality while navigating but a web surfer unconsciously takes advantage of this feeling.

When the layout of the pages stays more or less the same and the web site is consistently implemented, the mental model, developed by the user while navigating can be maintained and eventually completed.

This does not mean that all the pages of a site have to be identical but they should all bear a clear resemblance to each other while every introduced difference has a reason.

Every publishing medium develops conventions and continues to refine them and to develop new ones over time. Well-applied conventions make it easier for users and create a sense of familiarity among them. Although the web technology is very young, it has already create a lot of conventions where web surfers often unconsciously make use of: many people know the meaning of words like FAQ, Help, Home etc, and they have a rather clear suspicion what they would find after following the link "about us".

Designers are often reluctant to take advantage of consistency and conventions, forcing a conflict by their nature of creativity, but the benefits are well-proven as they introduce no or perhaps a little learning curve for new visitors.

7.1.3 Minimizing noise

When a web page layout is very busy, i.e. when everything on the page is clamoring for attention, visitors may feel overwhelmed and have no clear idea where to start reading. Users have varying tolerances for complexity and distractions: some people will make no problem of busy web pages and background noise, but many do.

Another source of noise may be the art of writing, utilized on the web. According to (Veen 2001) and (Nielsen 1993) sentences should contain no unnecessary words and a paragraph no unnecessary sentences, for the same reason that a drawing should have no unnecessary lines and a machine no unnecessary parts.

The variety of access interfaces of several browsers, which are not under control of the designers, has to be taken also into consideration in order to provide an adequate user interface to most frequent users. This particular problem is mainly typical to Web-based systems, and it is subject to a continuous evolution of the available interfaces. Using the latest and greatest things before it is even out of beta is a sure way to discourage users: if their system crashes while visiting your site, many of them will not come back when experiencing these troubles. Unless the concerning web site is positioned in the business of selling Internet products or services, it is better to wait until some experience has been gained with respect to the appropriate ways of using new techniques.

Unfortunately, the selection of an appropriate site layout can be difficult because it begins to intersect with matters of personal taste. For example, people are always arguing and complaining about graphic design on the web being both dull and excessive. Therefore an ideal layout that suits every user perfectly, may be an utopia for the design team.

7.2 Web page design

Web sites do not tend to exhibit the same degree of control over user navigation as traditional software, which make their design difficult because different user paths must be anticipated and accommodated. Users seldom follow the traffic patterns that designers intended. Users may end up at a page in a way that the designer never has in mind. For example, surfers often don't enter through the front door of a web site i.e. the home page, but rather come tumbling in from all directions. Search engines, bookmarks, URLs passed from friends, links from other sites - these are just a few ways users find their way to a particular page on a given site.

Each page must be developed if it is an isolated one that contains all the necessary site-specific navigational information to orient the visitor. It is essential that a user immediately can discern the following items on each web page: the current location, a link to the start position i.e. the Home page, the utilities and the different access possibilities to the available information.

The current location allows a user to be able to infer his present location and orientation in the web site structure. With a successful recovery of the current position, a web surfer can answer precisely and undoubtedly the following questions: Where am I? Which way am I facing? Each web page should clearly demonstrate its position in the whole of the web site.

Providing a link to the home page of the site is an essential issue for users because they will not always enter a web site at the home page. It offers a feeling of reassurance to lost users that they can always start over the navigation process: it is like pressing a reset button. (Hardman 1989) notes that many users return frequently to the start screen, suggesting that the desire to get back to a known place outweighs the effort involved to work out a route which will take them from where they are to where they want to go.

The type of the offered utilities strongly depends on the specific information domain to which the web site is related. They often include: search possibility, contact information, members dictionaries, help facility, detailed site map, etc. Placing these items delicately but obviously on each page, users will not have to direct to a specific page to make use of them.

The access possibilities represent the links to the main sections of the site. The labels of these sections can be considered as the primary navigation tool but do in fact more than that. When done effectively, it also acts as free advertising for the content of the site and presents a clear communication of the site's structure that will help develop the user's mental model of the web site.

7.3 Presentational Modeling phase

This phase embodies the development of the presentational issues of the web site. While the Navigational Modeling shows how to navigate through the navigation schema, this phase describes how the information within the navigation schema is presented to the user.

7.3.1 Audience Mock-up Design

When the presentational design phase is reached, the designer has already defined the items of the information domain that are relevant for the members of the audience class. It is also determined how these items should be organized according to the user's profile and tasks.

Now, it is time to decide how all this information must be presented on the different pages of the web site.

This is done with the construction of presentation models that shows the web site and page layout. A presentation model focuses on the structural organization of the presentation and not on the physical appearance in terms of special formats, colors, etc. These issues are left to the implementation phase where these specific issues take shape. However, the layout of the elements, gathered in the presentation model, may provide hints, for example, about the position and the size of these elements relative to each other.

By grouping the specific components, collections, links and menus from the navigational audience tracks, mock-ups of the final web pages can be constructed. The designer can start to make a page for each component, collection or menu but that would not lead to a user-friendly solution. Indeed, pages would be created that contain very little information, forcing web surfers to constantly click for further viewing any interesting things.

Of course there are many possibilities to construct the presentation mock-ups for a given navigational schema model. In any case it is essential to define a presentational mock-up, dedicated to each audience class that comprises the most relevant tasks and the links to the most accessed departments. This audience mock-up can be considered as the starting point for all the audience tracks of a particular audience.

7.3.2 Academic web site example

The figure 18 on the next page shows the audience mock-up of the audience class of the external researchers.

This presentation sketch makes use of a three panel lay-out where the following areas can be distinguished : an organization bar at the top, a navigation bar at the left of the page and a content canvas, taking the rest of the space.

The organization bar presents the site identity, which consists of the name of the organization and eventually the logo. Also a collection of different utilities is offered to assist users in frequent tasks, including: a search facility, location descriptions, site-maps, helps, contacts, etc. Every page of the web site should have a similar organization bar with a consistent look and placing of its elements to generate an instant confirmation to visitors that they are still visiting the same web site.

The navigation bar at the left of the page functions as a navigation tool and as a description of all the available information.

They provide for frequent visitors shortcuts to particular parts of the web site.

All the interesting information is offered in the remaining space, the content canvas.

Here it is divided into two panes.

The first area is dedicated to the different tasks of the audience class of the external researchers.

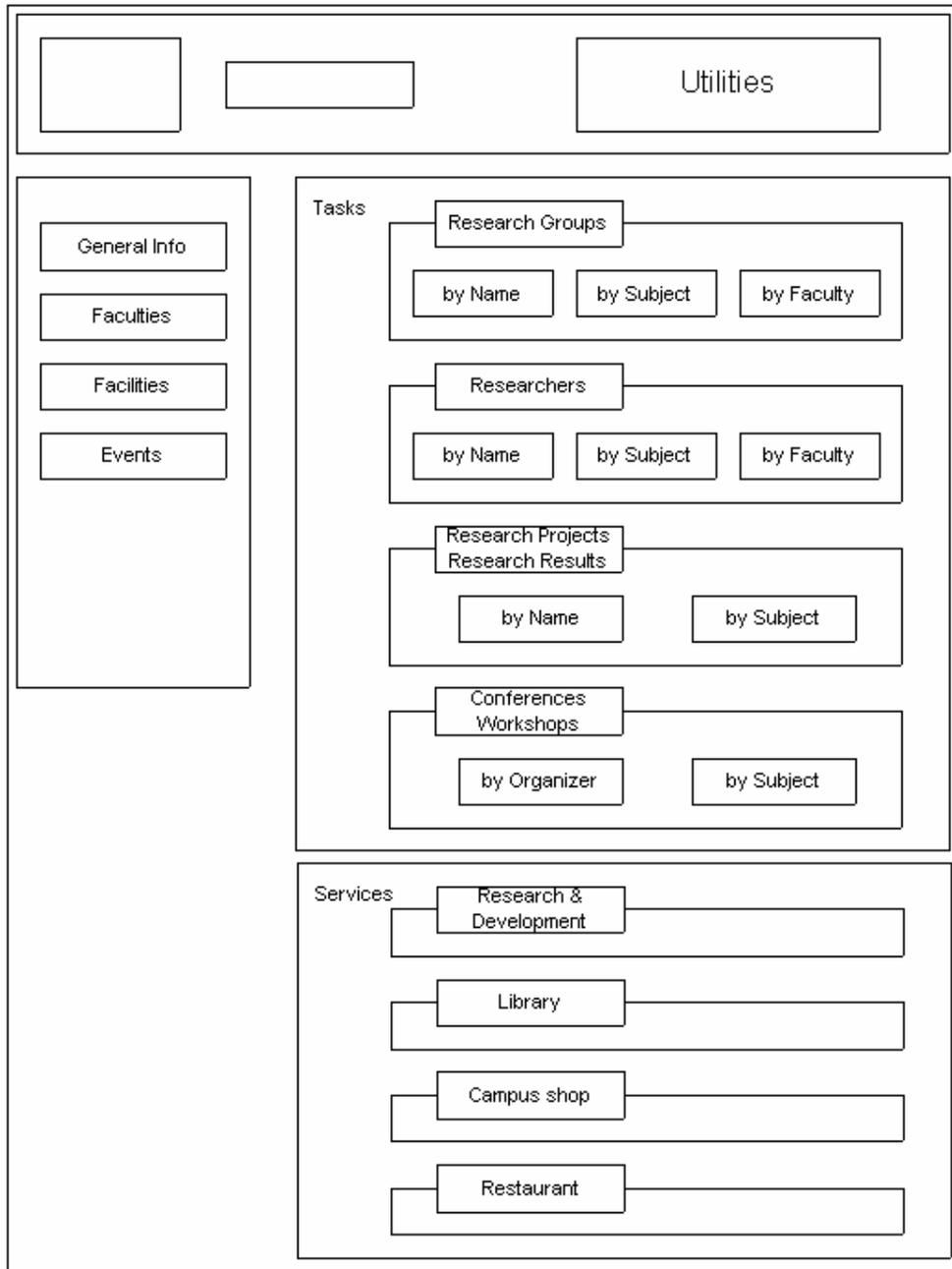


Figure 18: Audience mock-up of the external researchers.

Because this group of web site visitors is mostly unfamiliar with the exact structure of the web site, the different interesting items related with research are equipped with many access possibilities to facilitate navigation.

The second pane introduces different divisions and services of the university, for which the audience class of the external researchers is a target group or on the other side, the external researchers may be interested in these services.

The presentation sketch only gives the items that the web pages must include and their relative positions while their forms, sizes and layout are illustrative and determined in the implementation phase.

7.3.3 Sub Site Mock-up Design

To integrate a sub site of an individual division in the organization, a mock-up presents the most important information about the division, adjusted to the requirements of the interested audience class and further provides links to the specific sub site.

In this way, an intermediate layer above the different sub sites of the organization bridges the gap between the organization and its division.

Every division's mock-up is tuned to a specific audience class, to suit in the audience track. This avoids that the members of an audience class are confronted to needless information, intended for other audience groups.

When a division of the organization doesn't have a sub site on the web, still it is useful to create a specific mock-up, which will result in a single web page.

This page can present necessary contact and location information for the audiences. Such a web page takes care of a clean finish of the audience track to which this division is related.

This mechanism allows that the sub sites can apply a different style and have been integrated into the organizational web site.

7.3.4 Academic web site example

For the presentation mock-ups of the sub sites of the university web site, the organization and navigation bar is maintained.

The top of the content canvas shows a heading that specifies the name of the division of the organization together with frequent consulted and important information as location, contact, openings hours and news.

There is also an indication for which audience group the information is meant. In the figure 19 a sub site mock-up of a specific research group for the audience class of the external researcher is shown.

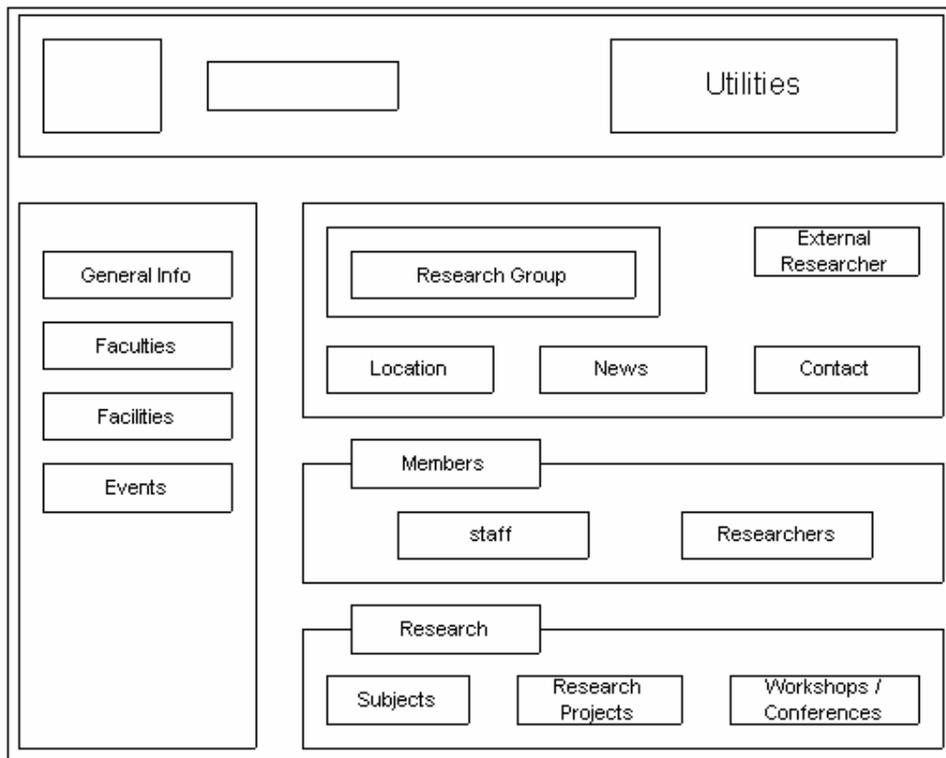


Figure 19 : Sub site mock-up for a research group for the external researchers.

The remaining space of the canvas can be used to present the information for this audience class. This information depends on the particular audience group and will be different for different audience classes.

The figure 20 shows the sub site mock-up for the same research group for the audience class of the enrolled students.

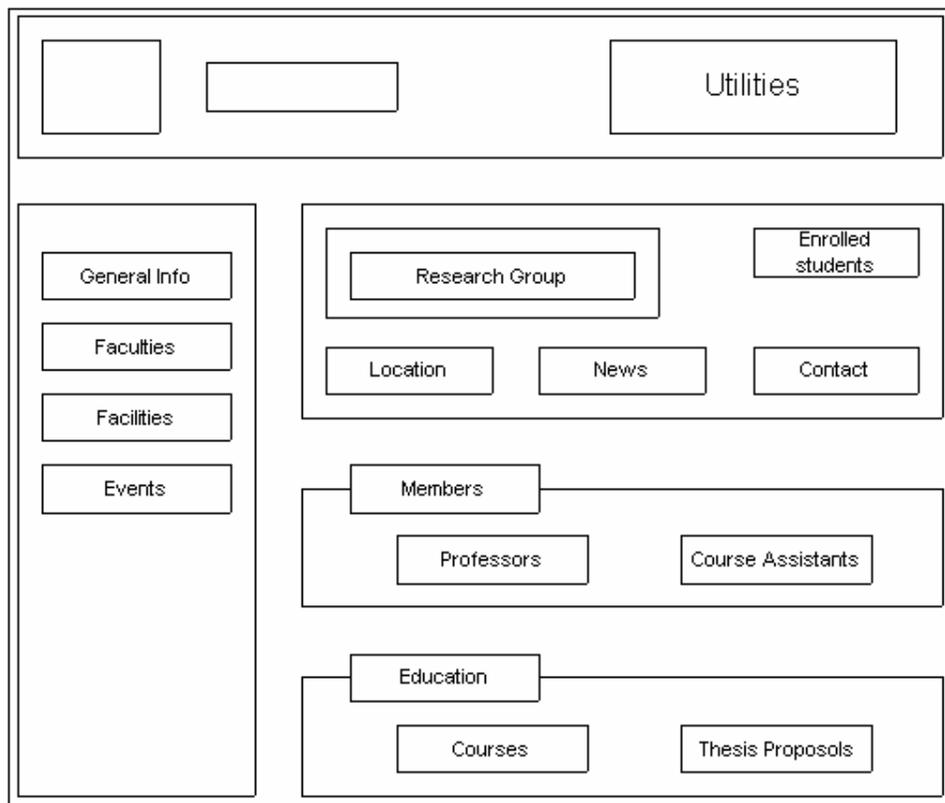


Figure 20 : Sub site mock-up of research group for enrolled students.

Instead of the research projects and results which are not directly relevant for enrolled students, the information of the courses which are organized by the professors of the research group, is given together with other information about the educational functions of the research group.

When someone selects the specific sub site from the navigation bar, a general web page of the division must appear.

Therefore a general sub site mock-up is developed, where all relevant information of the particular division is presented.

However this information will not be as elaborated as on the specific sub site mock-ups for particular audience groups to avoid an overwhelming plethora of data.

The indication of the specific audience group, for which the sub site is meant, is substituted by the whole range of audience classes that have an own adapted version of the sub site at their disposal.

Figure 21 shows such a general sub site mock-up of the research group.

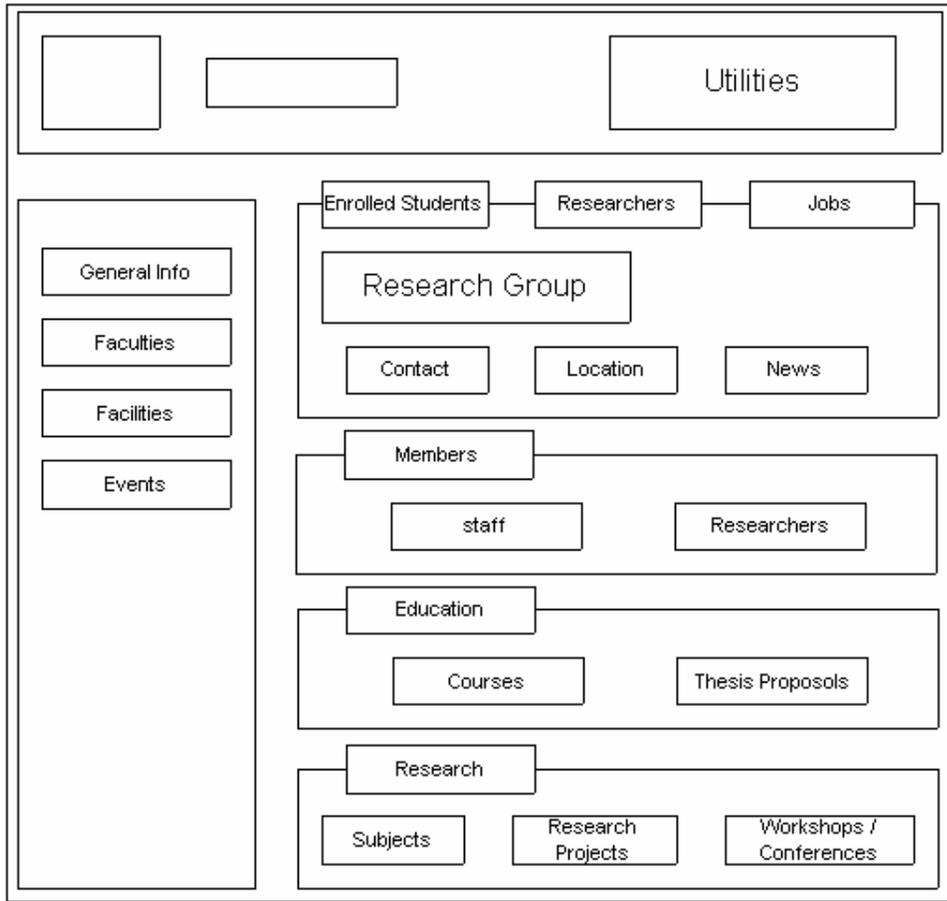


Figure 21: General sub site mock-up for a research group.

8 Conclusions

As a consequence of the World Wide Web's immense popularity, most companies, organizations and academic institutions rush to make their presence on this unique forum to promote their information and reputation to a new audience or to deliver additional services to their present public. Most of their constructed web sites unquestionably reflect the internal hierarchy of the organizations, based on the organizational chart with their divisions.

This organization-centered approach together with the large amounts of information causes many maintenance and tedious usability problems.

A respected organization is in honor bound to defend its reputation by making a clear presentation on the Web. Chaotic created web sites will damage the image of the institution in the eyes of the outside world.

The use of an accurate development method seems to be indispensable for an efficient management of the huge amounts of information concerning a large organization, and the catering of this information to the interested web visitors.

Many of the applied design methods often stress the central position of data and neglect the comfort of their potential web site visitors.

On the contrary, the Web Site Design Method (WSDM) utilizes a user-centered approach. The starting point of this method is the identification of the different user types and their needs and requirements. In this work, an extension of the Web Site Development Method (WSDM): Task Driven WSDM is proposed to assist designers in the construction of large, organizational web sites.

In this extension, groups of users are classified according to their tasks, when interacting with the web site. The web site must be carefully constructed to satisfy the diverse audiences in finding information and accomplishing their tasks.

The several tasks of each audience class function as a continuous thread through the entire design process. They assist in classifying the different audience classes by definition. The most relevant content for publishing is determined from the information necessary to fulfill the users' tasks. Even, the fundamental organizing and navigational principles are based on these tasks.

Task Driven WSDM makes a clear distinction between the conceptual design of the information domain, the design of the navigational structure and the visual representation of the information to according to the three dimensions of web sites: content, structure and presentation.

Treating conceptual, navigational and interface design as separate activities allow us to concentrate on different concerns one at a time.

As a consequence, more modular and reusable designs take shape, which can be applied more flexibly by the developers.

The method starts with an Audience Modeling phase, where different audience classes are identified. An audience class is characterized by the same tasks they want to fulfill. These tasks can be considered as activities where a member of an audience class interacts with the web site to acquire some information.

Audience profiles further describe the qualities of the diverse audience classes into more details. These profiles can assist the designers in taking difficult design decisions in further stages of the development process.

In the Conceptual Modeling phase, which aims to define the content of the web site, the most relevant information, related to the tasks, is selected.

In the Information Task Modeling, for each task a conceptual model is built to present the designers a clear view on the necessary information. The created task conceptual models of a specific audience class are further composed to an audience conceptual model, which summarizes all information for the specific audience. A gradually growing audience conceptual model introduces many benefits.

By creating conceptual models for a simple task firstly, a better insight will be formed in the specific needs of the audience to fulfill this task optimally.

When focusing on a small part of an information domain, one can more adequate analyze details of objects and their relationships. From the aspect of redesign and maintenance, this mechanism makes it easier for the designer.

The task conceptual models can be used as documents to store design decisions about specific object or their relationships. It gently forces the possibility for an incremental design process, where each step new tasks can be analyzed and developed.

The task driven WSDM puts no pressure on the choice of the notation techniques to register the conceptual models. Designers may select the notation, with which they feel most comfortable. The character and nature of the information domain and their objects can influence their choice.

The second stage, the Sub Site Task Modeling associates tasks to the departments of the organization to show the responsibilities of each department to the designers.

For this modeling step, the designer can choose between approaches, depending on the angle of the starting point: the tasks of the audience classes or the offered services of the specific organization's divisions. The first approach includes mainly delegating the audience tasks to the specific divisions of the organization. For each audience group, these tasks are related with the division, which is related with the fulfillment of the task. The second approach takes the view that the departments mostly have a clear view on their offered services, so designers can therefore easily derive the tasks for which these services are meant.

In this way, this approach can be considered as an evaluation on the collection of the audience tasks, which are collected during the Audience Task Modeling phase.

Comparing the tasks of the audience classes with the offered services of a specific department can reveal gaps between the functionalities of the web sites and the needs of their audience. The functionalities offered by a web site to their audience and the tasks of that audience must be in ideal balance. The analysis of this balance can reveal shortages in the functionality of a web site and can point the designers to new opportunities for the users' comfort and satisfaction.

The Navigational Modeling phase is a crucial aspect in the design of usable web sites as it aims to generate an increase in navigability for the audiences.

In this phase the structure of the web site is developed which describes how the members from the different audience classes will be able to navigate through the available information.

In the first sub-phase of the Navigation Modeling, different task navigation tracks are constructed for each audience class. A task navigation track shows the different routes through the information to achieve a specific task.

The individual task navigation tracks are built on base of themes, which are narrative descriptions of the navigational activities performed by the members of an audience class. These themes take into account the relevant aspects of the task and specify the different searching and browsing strategies that members of an audience class may follow to reach their goal.

For each theme, a scenario, which can be considered as the solution to the problem given in this theme, graphically describes how a member of an audience class experiences the different objects belonging to a task conceptual model while navigating through them, according to the narrative specifications of the theme.

A scenario comprises several elements, such as components, links and collection structures to present graphically the navigation paths traversing by the members of the audience class. A component represents an object, which has his origin in the conceptual models while links are used to connect components and to extend the navigational opportunities across the several objects.

Collection structures, grouping several components, may be formed in different ways, according to the needs and tasks of the audience.

Designers can equip these collection structures with specialized properties and requirements, anticipating on different situations occurring in the tasks.

A task navigation track combines these navigational scenarios, using the concept of a menu. A menu is as a composite object, containing a fixed number of menu items. These menu items correspond with the different scenario options, where they represent the divers access possibilities to the components.

By combining the different task navigation tracks into an audience navigation track, the possible paths throughout the web site for the member of an audience class are determined.

These audience tracks are then combined to form the navigational schema for the web site. The main structure of the web site will be based on the different audience classes. Audience classes, which have similar requirements, can be grouped in a single collection, but this may not degrade audience classes in favor of other classes of the collection. Designers must stay attentive to retain the different audience classes and their characteristics, identified in the Audience Modeling phase.

To anticipate an easy access to the different divisions of an organization by people who know exactly the name of the division, an organizational menu must also be built. In this way, shortcuts are provided for the frequent visitors of the web site.

While the navigational design phase constructs the navigational possibilities through the available information in the web site, the presentational modeling describes how this information is presented to the user. Presentation models are used to show the web site and page layout. They focus on the structural organization of the presentation and not on the physical appearance in terms of special formats, colors, etc.

By grouping the specific components, collections, links and menus from the navigational audience tracks, sketches, so-called mock-ups, of the final web pages can be constructed. Of course there are many possibilities to build these presentation mock-ups for a given navigational schema model. In this work, the use of two essential presentational mock-ups is proposed: the audience and the sub site mock-ups.

An audience mock-up is dedicated to a specific audience class and comprises the most relevant tasks and the links to the most accessed departments. Such an audience mock-up can be considered as the starting point for all the audience tracks of the particular audience.

To integrate the sub sites of individual divisions of the organization, a sub site mock-up presents the most important information about these divisions, adjusted to the requirements of their interested audiences and provide links to the specific sub sites. Every sub site mock-up is tuned to a specific audience class, to suit in the audience track. This avoids that the members of an audience class are confronted to needless information, intended for other audience groups. A compact and concise general version of the sub site mock-up can be easily reached and links further to the versions, specific for particular audience classes.

An intermediate layer of web pages, constructed out of these sub site mock-ups, situated above the different sub sites bridges the gap between the organization and its division. When a division of the organization doesn't have a sub site on the web, still it is useful to create a specific mock-up, which will result in a single web page. This page can present necessary contact and location information for the audiences. Such a web page takes care of a clean finish of the audience track to which this division is related.

This mechanism allows that the sub sites apply a different style and are integrated into the organization web site.

References

(Berners-Lee et al. 1994)

Berners-Lee, T., Cailliau, R., Luotonen, A., Nielsen, H.F., Secret, A.(1994),
"The World-Wide Web",
Communications of the ACM, Vol. 37, No. 8, Aug. 1994, pp. 76-82.

(Bomsdorf et al. 1998)

Bomsdorf, B., Szwillus, G.(1998),
"From Task to Dialogue: Task-Based User Interface Design",
SIGCHI Bulletin, October 1998.

(Botafogo et al. 1992)

Botafogo, R.A., Rivlin, F., Shneiderman, B.(1992),
"Structural analysis of hypertext: Identifying hierarchies and useful metrics",
ACM Trans. Information Systems 10, 2(1992). pp. 142-180.

(Booch et al. 1999)

Booch, G., Rumbaugh, J., & Jacobson, I.(1999),
"The Unified Modeling Language: A User Guide",
Addison Wesley.

(Brown 1990)

Brown, P. J. (1990),
"Assessing the quality of hypertext documents" ,
Hypertext: Concepts, Systems and Applications; Proceedings of the European
Conference on Hypertext, 1-12, Cambridge University Press, Cambridge, UK.

(Casteleyn et al. 2001)

Casteleyn, S., De Troyer, O.(2001),
"The Conference Review System with WSDM",
In IWOST 2001, <http://www.dsic.upv.es/~west2001/iwwost01/>, Valencia, Spain
(2001).

(Catledge et al. 1995)

Catledge, L.D., Pitkow, J.E.(1995),
"Characterizing browsing strategies in the world wide web",
In Computer Systems and ISDN Systems: Proceeding of the Third International World
Wide Web Conference, 10-14 April, Darmstadt, Germany, volume 27, pp. 1065-1073,
(1995).

(Chen 1976)

Chen, P.P.(1976),
"The Entity-Relationship Model: Towards a Unified View of Data",
ACM Transactions on Database Systems, Vol 1 no 1, 1976, pp. 471-522.

(Coe 1996)

Coe, M.(1996),
"Human factors for technical communicators",
John Wiley & Sons, New York, 1996.

(Conklin 1987)

Conklin, J.(1987),
"Hypertext: An introduction and survey",
In Computer, IEEE Computing Society, 20 :9(September), pp. 17-41.

(De Troyer et al. 1998)

De Troyer, O., Leune, C.(1998),
"WSDM: A User-Centered Design Method for Web Sites",
In Computer Networks and ISDN systems, Proceedings of the 7th International World
Wide Web Conference, Elsevier (1998) pp. 85 - 94.

(De Troyer 1998)

De Troyer, O.M.F.(1998),
"Designing Well-Structured Web Site: Lessons to be Learned from Database Schema
Methodology",
In Proceedings of the ER'98 Conference, Lecture Notes in Computer Science (LNCS),
Springer-Verlag (1998).

(De Troyer 2001)

De Troyer, O.(2001),
"Audience-driven web design",
In Information modelling in the new millennium, IDEA GroupPublishing, ISBN 1-
878289-77-2 (2001).

(Erickson 1996)

Erickson, T.(1996),
"The World-Wide-Web as social hypertext",
In Communications of the ACM, Jan. 1996 Vol. 39(1), pp. 15-17.

(Edwards et al.1989)

Edwards, D.M., Hardman, L.(1989),
"Lost in Hyperspace: Cognitive Mapping and Navigation in a Hypertext Environment",
In: R. McAleese (Ed.). Hypertext: theory into practice, pp.105–125. Oxford: Intellect
Limited.

(Elm et al. 1985)

Elm, W. C., Woods, D. D.(1985),
"Getting lost: A case study in user interface design",
In Proceedings of the Human Factors Society, pp. 927–931, Baltimore, Maryland. The
Human Factors Society.

(Fleming et al. 1998)

Fleming, J.(1998),
"Web Navigation: Designing the User Experience",
O'Reilly and Associates, Sebastopol, CA, 1998,

(Florescu et al. 1998)

Florescu, D., Levy, A., Mendelzon, A.(1998)
"Database Techniques for the World Wide Web: A Survey",
ACM SIGMOD Record, Vol. 27, No. 3, Sept. 1998.

(Garzotto et al. 1993)

Garzotto, F., Paolini, P., Schwabe, D.(1993),
"HDM - A Model-Based Approach to Hypertext Application Design",
In ACM Transactions on Information Systems 11(1): 1-26.

(Garzotto et al. 1995)

Garzotto, F., Mainetti, L. and Paolini, P.(1995),
"Hypermedia Application Design: A Structured Approach",
In Designing User Interfaces for Hypermedia, W. Schuler, J., Hannemann, and N.
Streitz, Eds. Springer Verlag, 1995.

(Goedefroy et al. 1998)

Goedefroy, W., Meersman, R., De Troyer, O.(1998),
"UR-WSDM: Adding User Requirement Granularity to Model Web Based Information
Systems",
In Proceedings of 1st Workshop on Hypermedia Development, Pittsburgh, USA (1998).

(GVU)

GVU's WWW User Surveys
http://www.cc.gatech.edu/gvu/web_surveys/

(Guell et al 2000)

Guell, N., Schwabe, D., Vilain, P.(2000),
"Modeling Interactions and Navigation in Web Applications",
Lecture Notes in Computer Science 1921, Proceedings of the World Wild Web and
Conceptual Modeling 2000 Workshop, ER Conference, Springer, Salt Lake City (2000).

(Hackos et al. 1998)

Hackos, J.T., Redish, J.C.(1998),
"User and Task Analysis for Interface Design",
John Wiley and Sons, New York, 1998.

(Hardman 1989)

Hardman, L.(1989),
"Evaluating the usability of the Glasgow Online hypertext",
Hypermedia, 1, pp. 34-63.

(Isakowitz et al.1995)

Isakowitz, T., Stohr, E. Balasubramanian, P(1995),
"A Methodology for the Design of Structured Hypermedia Applications",
In Communications of the ACM, 38(8), pp. 34-44, 1995.

(Koch 1999)

Koch N.(1999),
"A comparative study of methods for hypermedia development"
Technical Report 9901, Ludwig-Maximilians-University Munich (1999).

(Ladd et al. 1997)

Ladd, B. C., Capps, M. V., Stotts, D. S. (1997),
"The world wide web: What cost simplicity?",
In Proceedings of the Eighth ACM Conference on Hypertext: Hypertext 97,
Southampton, UK. ACM Press (1997).

(Landauer 1995)

Landauer, T. (1995),
"The trouble with computers: Usefulness, usability and productivity",
MIT Press.

(Lang et al. 2001)

Lang M., Barry C.(2001),
"Techniques and methodologies for multimedia systems development : a survey of
industrial practice",
In proceedings of "Realigning Research and Practice in Information Systems
Development: The Social and Organizational Perspective", by the International
Federation for Information Processing (IFIP), eds.Nancy L. Russo, Brian Fitzgerald and
Janice I. DeGross, Boise, Idaho, USA, July 2001.

(Lowe 1999)

Lowe, D. (1999),
"Engineering the Web - Web development methodologies: Help or hindrance?",
In WebNet Journal. July-Sept. 1999

(Mohageg 1992)

Mohageg, M. F.: (1992),
"The influence of hypertext linking structures on the efficiency of information retrieval",
In Human Factors, 34, pp. 351-367.

(Mylopoulous 1998)

Mylopoulous, J. (1998),
"Information modeling in the time of the revolution",
In Information Systems 23(3/4), pp.127-155.

- (Nanard et al. 1995)
Nanard, J. and Nanard, M. (1995),
"Hypertext design environments and the hypertext design process",
Communication of the ACM, August 1995, Vol 38 (8), pp. 49-56.
- (Nielsen 1990)
Nielsen, J. (1990),
"Hypertext and Hypermedia",
San Diego, CA, Academic Press.
- (Nielsen 1993)
Nielsen, J.(1993),
"Usability Engineering",
Academic Press, 1993.
- (Petrelli et al. 1999)
Petrelli, D., De Angeli, A., Convertino, G.,
A user-centered approach to user modeling,
In Proceedings of the Seventh International Conference, UM'99, pp. 255-264
- (Powell et al. 1998)
Powell, T.A., Jones, D.L., Cutts, D.C.(1998),
"Web site Engineering, beyond web page design",
Prentice Hall, New York,1998.
- (Rada et al. 1992)
Rada, R., Murphy, C. (1992),
"Searching versus browsing in hypertext",
In Hypermedia, 4, pp. 1-31.
- (Rosenfeld et al. 1998)
Rosenfeld, L., Morville, P.(1998),
"Information Architecture for the world wide web"
O'Reilly & Associates, Sebastopol
- (Rossi et al 2000)
Rossi, G., Schwabe, D., Lyardet, F. (2000),
"Web Applications Models are More than Conceptual Models",
In Proceedings of ER'99 (Paris, France, November 1999), Springer, 239-252.
- (Rumbaugh et al. 1991)
Rumbaugh, J., Blaha, M., Premerlani, W., Eddy F., Lorensen W.(1991),
"Object Oriented Modeling and Design",
Prentice Hall Inc. 1991.

(Schwabe et al. 1995)
Schwabe, D.; Rossi, G.(1995),
"Building Hypermedia Applications as Navigational Views of Information Models".
Proceedings of the 28th Hawaii International Conference on Systems Science, Maui,
Jan,
1995.
Also Technical Report MCC 41-94, Departamento de Informática, PUC-Rio.

(Schwabe et al. 1996)
Schwabe, D., Rossi, G., Barbosa, S(1996),
"Systematic Hypermedia Design with OOHDM",
In Proceedings of the Seventh ACM International Conference on Hypertext
(Hypertext '96), Washington DC, ACM 1996.

(Shneiderman 1997)
Shneiderman, B.(1997),
"Designing information-abundant web sites: issues and recommendations",
In International Journal of Human-Computer Studies (1997) 47, pp. 5-29.

(Thüring et al. 1991)
Thüring, M., Haake, J.M., Hannemann, J.(1991),
"What's ELIZA doing in the Chinese Room? Incoherent hyperdocuments – and how to
avoid them",
In Proceedings of the 3rd ACM Conference on Hypertext (Hypertext '91), pp. 161–177,
San Antonio, Texas, December 15–18, 1991.

(Thüring et al, 1995)
Thüring, M., Hannemann, J., Haake, J.M.(1995),
"Hypermedia and Cognition: Designing for Comprehension",
In Communications of the ACM, 38(8), pp. 57-66.

(Truex et al. 1998)
Truex, D. P., Baskerville, R. (1998),
"Deep structure or emergence theory: Contrasting theoretical foundations for
information systems development",
In Information Systems Journal.

(Veen 2001)
Veen, J.(2001),
"The art and science of web design",
New Riders Indianapolis

(Wand et al. 1995)

Wand, Y., Monarchi, D., Parsons, J.(1995),
"Theoretical foundations for conceptual modelling in information systems
development",
In Decision Support Systems 15(4), pp.285–304.

(Wright et al. 1989)

Wright, P. , Lickorish, A. (1989),
"An empirical comparison of two navigation systems for two hypertexts",
In Proceedings of the Hypertext II Conference. In R.McAleese & C. Green, Eds.
Hypertext: State of the Art. Oxford: Intellect. pp. 84-93.

(Wurman et al. 1996)

Wurman, R.S., Bradford, P.(1996),
"Information Architects",
Zurich, Switzerland, Graphis Press, 1996.