ELSEVIER

Data & Knowledge Engineering 35 (2000) 161–180

DATA & KNOWLEDGE ENGINEERING

www.elsevier.com/locate/datak

The use of metaphorical structures for internet sites

Bernhard Thalheim [a,*], Antje Düsterhöft [b]

[a] *Computer Science Institute, Brandenburg Technical University at Cottbus, P.O. Box 101344, D-03013 Cottbus, Germany*
[b] *Computer Science Department, University of Rostock, Albert-Einstein-Str. 21, D-18051 Rostock, Germany*

Received 31 January 2000; received in revised form 26 June 2000; accepted 26 June 2000

Abstract

Information services, such as regional or tourist information services, are currently developed everywhere. Whenever a site gets very large, providers understand the need for a systematic development. Site development is similar to database co-design, which includes structures, functionality, and interfaces. Additionally, interfaces are even more important for sites and need a very sophisticated support whenever the site is raising to large sites. Metaphorical structures, i.e., metaphors, allegories, metonymies or synecdoches, can be used to help the scanning user understand a page. In general, metaphorical structures have a communicative or cognitive function. For example, many users do not realize that within a computer context a trash can often stand as a metaphor for the action of deleting files. The users can understand content, functionality, and intention intuitively via using such metaphorical structures. Site development can profit from well-integrated metaphorical structures aimed at focus on a deeper context explanation as well as on a more specific navigation and selection. Metaphorical structures for sites can be developed based on linguistic and cognitive research. Stand-alone metaphors have often been used for sites. The power of metaphorical structures can be best exploited if they are used for complex actions and in an integrated way together with structure, functionality, and interfaces. This paper shows how the co-design approach allows for the consistent development of metaphorical structures in an integrated manner.

Keywords: Information systems; Database systems; Internet services; Interaction; Metaphor; Linguistics; Cognition; Natural language

1. Information services

Nowadays, internet is one of the major catchwords in journals and newspapers. However, to become a vital and fruitful source for information presentation, extraction, acquisition, and maintenance, fundamental design concepts are required that are still missing. Web pages are often hard to find and often use very specific graphical representation and inappropriate media objects. They are often designer-centered with a lack of attention to detail and use an inappropriate tone. The 'goodies' of other pages such as big ideas, high utility, simple findability, personalization, and

* Corresponding author. Tel.: +49-355-69-27-00; fax: +49-355-69-27-66.
E-mail addresses: thalheim@informatik.tu-cottbus.de (B. Thalheim), duest@informatik.uni-rostock.de (A. Düsterhöft).

0169-023X/00/$ - see front matter
PII: S0169-023X(00)00037-9

aesthetics are based on a proper conceptual design of the site. It is now observed [39] that web site design includes information design [24], design of functionality [13], and design of presentation [30,31].

The co-design approach [20,35,37,39,40] can be used for design of sophisticated web sites.

Problems of site development. Currently, we can observe an ever-increasing interest in information services for use on the internet. Unfortunately, – except for the co-design approach for developing of information services for the internet, cable nets, and partially [28] – there is no systematic or commonly accepted approach in building these services. Then at least the following problems have to be met:

- Conceptual understanding of information services.
- Integration of different information systems.
- Maintenance of information quality.
- Evaluation of information quality.
- User-adequate presentation of information collections.
- Resource-adequate transmission through networks.

The need for metaphorical structures. Information services intend to meet the needs and expectations of users searching for certain information and services. Most German towns currently have their homepage, and most of them are static. Quality, and especially actuality, cannot be maintained in a simple fashion. The same situation is observed for universities and other sites. Such pages rarely meet all users' needs. For instance, university sites do not properly support either pupils or information brokers. The representation of such pages is oriented to internal needs. External users are not able to capture the content of the pages. The dialogues used for the sites are hard to comprehend. The user intending to look at or scan a page and the user exploring sites are not properly supported. Such users require an intuitive understanding of the 'mission' or the corporate identity of sites. The support for comprehension of the mental model of the page or the site can be based on metaphorical structures.

In summary, metaphorical structure can be used in context of site design for

- supporting the scanning user and
- used as set-up for a story of a site

in order to introduce the content, the style and 'the feeling inside' of a complex web presentation.

Related work: examples of metaphorical structures. Mental models are also used in [36] to define persistent internet-metaphors: digital library, electronic mail, electronic marketplace, and digital world. These metaphors are based on ancient myths and archetypes that have influenced human thinking for thousands of years: keeper of knowledge (the digital library), communicator (electronic mail), the trader (electronic marketplace), and the adventurer (digital world). The internet representation of these metaphors is a matter of common knowledge, but the fact of using metaphors is mostly not known to users. Let us consider the presentation of the German internet mall (www.wn-s.de) shown in Figs. 1 and 2. Internet shopping in that mall is at first an orientation via a map and then a walk through a complex shopping centre. Therefore, the user gets a complete imagination of the actions he/she can do using the site. Real life pictures give that imagination which the user automatically connects with the corresponding (real life) experiences.

Another example, the German public TV develops an electronic program guide based on internet browser metaphors, watches and program journals. This program guide allows the user to

Fig. 1. Area 'Marktplatz Oberlausitz' (www.wn-s.de).

select program slots of his/her interest, notices the user of parallel programs with similar orientation and generates schedules for the user. The program guide ruler is similar to the TV ruler.

Developing internet sites. The large variety of websites is reminiscent of the chaotic development of AI tools and expert systems. The AI 'century' provided frameworks for development of reasoning tools and descriptive (logical) languages, and has changed software architecture. User-centered software design is now commonly accepted. Natural language tools such as [2] for database design demonstrated the power of linguistic approaches to software systems development. The behavior of a user dealing with an application can be understood as a dialogue [5,20]. Thus, behavior of user/system interaction can be modeled by dialogues. Websites require a greater user-centeredness. AI tools are used by specialists. Websites have to be used by naive users. Therefore, we need at the same time more sophisticated user interfaces [14,19], which are intuitively understandable, which can be used intuitively, whose 'philosophy' or 'mission' can be captured within seconds by novel users, and which do not have to be learned [1].

For this reason, interface or dialogue design has become more important. A 'simplistic' interface enables novel, naive users to use the site in a fashion that supports the aim of the site.

[1] We call, in our projects, this requirement 'großmuttersicher' (usable by a grandmother).

Fig. 2. Shopping mall of the 'Marktplatz Oberlausitz' (www.wn-s.de).

The power of metaphorical structures in site design. In order to develop such sites, we can learn from natural language [7]. One of the approaches for a simple and fast understanding is the utilization of metaphors. Metaphors should meet some requirements [25] such as

- simple interpretation,
- common sense of the meaning,
- abstraction in the right (user-centered) way and
- integrability into the dialogue.

In our daily language, metaphorical structures have great power, so why should not we use them within our information services? In order to do that, we have to integrate the metaphorical structures into the complete site development. Stand-alone metaphors are already often used in sites. However, integrated metaphorical structures are still an open issue.

The information service '*Cottbus net*'. Due to the large variety and diversity of information services, it is certainly advisable to concentrate either on specific aspects or characteristics. To bridge this gap, we introduced in [13] *information units* and *information containers* and discussed how to integrate information services with database-backed infrastructures. This approach is based on practical experience gained in projects for the development of a regional information and shopping service. Our own experience with information service development is based on large industrial cooperation projects intending to develop sites. The project Cottbus *net* (since 1995)

aims at the development of intelligent information services that are simple to capture and simple to use. These should be available to around 90,000 households in the Lusitian region through the internet and the cable nets using either computers or TV set-top boxes. Up to now the project has developed a number of information services for travel information, shopping, regional information, industry, administration, and booking services. Several architectures and suggestions from the literature have been tested, including multidimensional database architectures [16,41]. Unfortunately, it was shown to be too weak to provide acceptable performance. The proposals recently made in [3,12] are similar trials but different in scope and application area, and devoted to different users. The ideas presented below have been used in the development of different information services for Cottbus *net*. Currently, two other architectures (multi-tier architectures with fat or thin clients [29–31]) are tested in parallel. Within our cooperation project the provided information service consists of thousands of pages most of them generated on demand within a time frame of 3 s and adapted to the user's platform, user's profile, and communication channel capacity.

The sites of Cottbus *net* are currently presented in the 'fourth' generation, i.e., already have been redeveloped three times after reconciling and solving a larger number of problems each of the developments had. Currently, our information sites are developed based on the co-design approach.

Content of the paper. The co-design approach for information sites is discussed in the next section. In Section 3, we introduce the linguistic and cognitive concept of metaphors. These concepts are generalized in order to meet the needs of website development in Section 4. In Section 5, we give a conclusion and consider future work.

2. Development of information services

Information services can be understood as special information systems whose clients are distributed over the web or over cable nets. User works locally with the site. The site is maintained in a global fashion. It can be distributed but the architecture is still a multi-tier architecture. The user uses the site in different manners: scanning the page, exploring the page, remarking the existence of the page and comprehensively using the page. Thus, pages should support very different user behavior. While the first three approaches are the user's primary during entering a site, the four approach (complete use of a page) is the main technique for information gathering and page utilization.

In the past, the development of information systems has concentrated on the specification of structures and static integrity constraints. Meanwhile, it is accepted that structures and processes should be developed together. The classical Seeheim model [26] has been used to separate the application engine from the user interface engine. Whenever the application engine is able to handle any user request, this architecture can be successfully used. When users require dynamic pages and the behavior of users is heavily dependent on the previous dialogue steps, the interaction has to be supported efficiently by the engine as well. Thus, we have to integrate structures, processes, semantics, and interfaces.

Requirements for web information services result in yet higher quality criteria for interfaces and their support by the engine.

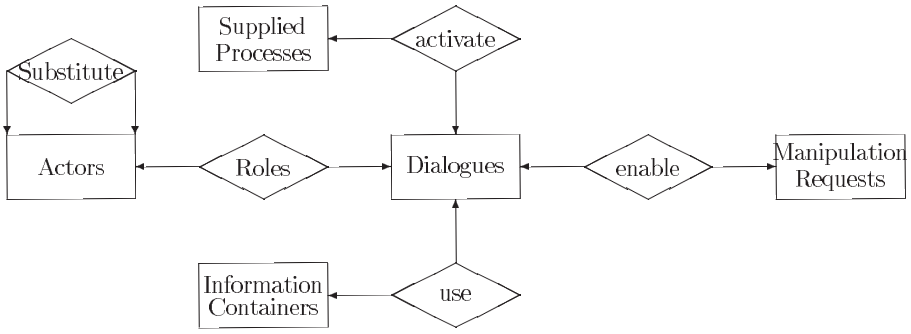

Fig. 3. A segment of the dialogue model used for developing information services.

The dialogue approach. Users should be modeled together with their possible behavior. The users can be grouped according to actors. Actors have to solve some tasks with the site. Actors can be substituted for other actors. The interaction of an actor in a certain role with the system can be modeled by dialogues. Dialogues consist of dialogue objects which can be partially ordered, sequenced, etc. Dialogue objects are supported by the system. During a dialogue step, a dialogue object requires a certain amount of information. This information is provided by the website. The information for a dialogue step can be stored within pages or is generated by information systems. These information systems can provide certain processes. Some of the dialogue steps need to be stored. In some cases, information generated during the dialogue or provided by the actor has to be stored by information systems. Therefore, the information system also enables manipulation requests for the dialogue objects. This architecture is displayed in Fig. 3.

Besides the various approaches to grasp the meaning of 'information' [38] and the large number of books on 'information systems', it is generally accepted that information needs a carrier in the form of data or generally 'media objects' (including audio and video). For our purposes, we may assume that these data are: structured, formatted, filtered and summarized, meet the needs and current interests of its receiver, and is going to be selected, arranged and processed by him/her on the basis of his/her interests, experience, intuition, knowledge, etc. Within this context, we can assume that information services are systems that are based on database machines and that use a certain communication infrastructure. Loosely spoken information can be extracted from filtered and summarized data collections, where filtration is similar to view generation and summarization of selected data can be performed on the basis of the computational functionality of the given machine. Finally, information presentation respects environmental conditions and user needs.

Our current research is concentrated on two main concepts for user-adequate presentation and delivery of information:

- information unit and
- information container.

Information containers. Information containers are transmitted through the network according to the necessary amount of information. They transfer only those data as are necessary for the current dialogue step. Technically, this optimization of data transmission is achieved by careful

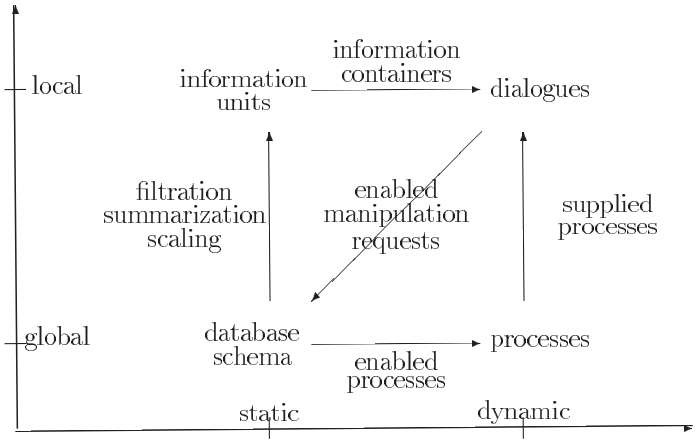

Fig. 4. Information services codesign: data and process flow perspective.

integration of data modeling with supplied functions and dialogues. The approach has been used to develop a platform that is now in use for Cottbus *net*.

Information units. Information units [13,32] can be the input for dialogues using either the formation at run-time according to the actual environment and the user request, or predefined data collections. The first approach is more general but seldom computationally tractable. The second approach is simpler and can be based on results of conceptual design. Information containers are obtained by the application of formation and wrapping rules to collections of information units. In [13], the complete definition of containers is given. Containers are constructed from information units according to the user's needs and their environment. The chosen approach to create information services is illustrated in Fig. 4.

Information units depend on the database schema. They represent data in a standard, intuitive framework that allow high-performance access. Information units' modeling can be compared with the modeling of semi-structured data. Then information units turn out to be generalized views on the database [6,22]. The generalization should support data condensation and supplementary facilities to enable an adequate representation to the user.

At a first glance, this approach seems to be more complex. However, based on this understanding information services can successfully be developed, redeveloped, and extended. The development of an information service cannot be done in one step. We use the abstraction layer model [40] for a stepwise development.

Dialogue objects are developed step by step together with structures, units, and processes. This approach enables us to also develop very large sites in a consistent fashion. The abstraction layer model allows for the derivation of different development strategies. The main strategy currently in use is the unit-centered development. This strategy is based on 31 development steps. Since the aim of the paper is to demonstrate the power of metaphorical structures, we do not discuss this strategy in detail here.

Each of the dialogue objects needs a representation which is easy to comprehend. This representation has to adapt further to the user group (actor), to the platform the actor is currently

using (from simple displays and video text displays to internet machines), and to the communication channel capacity. These representations need a common glue. We discovered that this common glue could be the metaphor. Further, metaphors ease the perception of the page and the site. Whenever metaphors can easily be understood, the actor is able to understand the mental model of a page or a site in a very short time frame and is able to use the page in the manner which meets the intentions of the provider.

3. Linguistic and cognitive principles of metaphorical structures

Metaphorical structures are well understood in the linguistic community (see, for instance, the extensive selection of references in [4,10,17,23]).

In this paper, we consider the following metaphorical structures: metaphors, allegory, metonymies and synecdoches. All of these are traditional embellish structures.

3.1. Definitions and examples of metaphorical structures

In general, a metaphorical structure is the unusual usage of a language expression, i.e., using a language expression in a meaning which is not expected in the application context. The language expression is used as a language pictorial which works on the basis of a similarity of two objects/words. These objects/words are described by some dominant properties (cf. [8])

Metaphor. Two kinds of metaphor definitions exist. First (traditionally), a metaphor is characterized by a substitution of names.

Example: 'Virus' stands for a 'damaging computer program'.

Secondly (the modern definition), the metaphor generates a new coherence of meanings. Two semantic fields are put into a similarity relation.

Example: 'URLSnoop' is a 'Trojan Horse' that gathers email addresses secretly. The old characteristics of the myth are projected on to the computer. But also the characteristics of the computer give an update of myth – a modern serial of the Troy story.

Allegory. An allegory is an extended metaphor that stands for a complex idea.

Example: 'Orchestra' for a 'group of people whose working together (e.g. a company)' related metaphors:

'the conductor' as 'the executive manager of the company'

'the first violin' as 'the star designer', 'the chief programmer', or ...

'playing together' as 'working together'

...

The allegory 'orchestra' generates a complex metaphor field which includes several metaphors.

Metonymy. A metonymy is a replacement of a term that is related to this term. The relation can be real, mental, factual, or causal.

Examples: 'This Kafka' is interesting. The author Kafka stands for one of his books. 'The Rostocker' will win the German League. The citizens of Rostock are standing for the Rostock soccer team.

Synecdoche. Synecdoches are closely related to metonymies. In contrast to a metonymy a synecdoche stands for a part-whole-relation.

Example: 'to start a computer' – 'Computer' stands for the 'operating system'.

Furthermore, some other metaphorical and rhetorical structures are known; for instance, synonyms, paraphrases, analogies, oxymorons, emphases, or irony. All of them can be used for site design in a different manner but will not be considered in detail and used in this paper.

3.2. The use of metaphorical structures

The illustrated metaphorical structures (metaphor, allegory, metonymy, synecdoches) will now be analysed in order to find common characteristics that can be exploited for site design. We will group and sort the characteristics to get an abstract view at the structural metaphors. The starting point for that will be the general definition of metaphorical structures [8].

Main concepts of metaphorical structures. The definitions of the metaphorical structures show two main concepts of their usage:

1. the (language) representation of a metaphorical structure and
2. the cognitive understanding – the characterization of the actions and actors underlying the metaphorical usage.

The aim of metaphorical usage. The usage of metaphorical structures can have the following intentions:

- an unusual effect,
- an insufficient expression power for describing a thing/an action, or
- make an abstraction of one or more things/actions.

Based on the intentions, the usage and the functionality of metaphors can be very different. For this reason, we distinguish between

- internal functions (extending the expressive power),
- predicative functions (modeling and describing by analogy),
- heuristic functions (adding information which can be interpreted differently),
- emotional functions (using the intuitive experience for complex associations),
- social functions (developing specific static presentations),
- rhetoric or persuading functions (changing users behavior), and
- esthetic functions (pleasing the user).

Understanding metaphorical structures. Metaphorical structures do not have their own importance to the user. They are realized through the context they are put into. Users have certain expectations. Metaphorical structures are counteracting. This action is based on the dominant property of the content of the metaphorical structures. Therefore, they can only be used within the context of the application. The interpretability of metaphorical structures depends on the common experience of the sender and the receiver. Metaphors such as *folder*, *files*, *trash can*, and *recycle bin* are used in desktop computers in a figurative sense. They are common to computer users but not so common to naive users. Metaphors can mislead users like in the case of the trash box for ejecting the disk in Apple computers or the clipboard for one singleton message in the Windows environment. Naive users are not acquainted with these metaphors. Thus, metaphorical structures, if they are to succeed, must be familiar to users. The understanding of metaphorical structures of a certain user group can be realized if we change the linguistic representations of them but use the same cognitive content.

Within the context of site design, the linguistic and the cognitive aspects have to be analyzed in detail. First, we consider the cognitive aspects and then we can use the cognitive characteristics in order to illustrate the representations.

3.3. Cognitive aspects of metaphorical structures

In linguistics, different **forms of metaphorical structures** are used:

- *Personalized* structures can be used to express similarity. (The expression 'the sun is laughing' is using human properties for pointing to a property.)
- *Allegoric* structures ('friend Hein' for death) are based on a common culture of the receiver and the sender.
- *Symbolic* structures have a rather concentrated message.
- *Synoptic* structures assemble words from different areas ('dark tones').

Metaphorical structures change the meaning of an expression by adding new, extended, shortened, or different meanings.

The **substitution direction** of metaphorical structures is classified by Aristoteles [1] into:

- *from family to kind* ('ride at anchor' instead of 'not moving');
- *from kind to family* ('100 times I told you' instead of 'many times ...');
- *from kind to kind* ('door' instead of 'leaving the site'); and
- *by analogy* ('evening of life' by (seniority: life) and (evening: day) pairs).

Further metaphorical structures can be classified by their **directions**:

- *from unanimated to animated* (using inanimate properties);
- *from animated to unanimated* (using animate properties for characterization);
- *from animated to animated* (comparing different animations); and
- *from unanimated to unanimated* (transferring inanimate properties).

Thus, we have three orthogonal classifications:

- *abstraction* (specialization/generalization);
- *direction* (inanimate/animate);
- *interkind/-type* (transferring or reasoning by analogy).

The cognitive characteristics illustrate that it is possible to get an abstract view of metaphorical structures [9]. Nevertheless metaphorical structures must be expressed in natural language or as graphical items or in another form. Therefore, an appropriate representation is needed for a particular metaphorical direction.

3.4. Representation of metaphorical structures

The granularity of metaphorical structures is different. Linguistics differentiates among word-based, sentence-based structures, and idioms [8]. Besides that, other representation forms are known. Colors, graphics, gestures, stories, etc., are also possible and used. Additionally, metaphorical structures can be used in a compositional fashion.

Construction of a representation. The aim of the use of metaphorical structures is that the receiver (user) understands the content of a metaphor and even more that the receiver associates the dominant properties. In order to use an appropriate linguistic representation for a metaphorical structure the following questions have to be considered:

- Who will the user be? (experiences, age, knowledge, etc.)
- What kind of communication is used? (verbal communications vs written communication vs internet communication, etc.)
- What are the possible communication objects? (e.g., verbal communications have the gestures; e.g., the internet communication has the colors and icons)
- Which connotations (i.e., social and emotional side conditions) should not be used?
- Which cultural background does the user have?

These questions show that a profile of the user and an analysis of the domain is needed for metaphor understanding.

Representation forms. In general, metaphorical structures are used with different intentions. They can be predicative or persuading. Attributive, genitive, and apposition metaphorical structures add some information. Icons or colors illustrate properties. Thus, the choice of a representation form is restricted. It is not possible that all cognitive characteristics can have all representation forms.

Metaphorical structures can be classified as follows [18]:

- *conventional* metaphorical structures on the basis of stereotypes such as a phone icon;
- *ex-metaphorical structures* in technical terminology;
- *creative* metaphorical structures which require greater reasoning abilities from the user;
- *re-metaphorical structures* through activation of images with modification.

A dictionary for handling the representations. Starting from the analysis of characteristics and representation forms of metaphorical structures we have to construct a dictionary. A dictionary for users is needed to find the right metaphorical structures for site design in a certain context.

The intuitive usage of metaphorical structures in everyday life is the reason that users cannot easily give examples of metaphorical structures when needed. On the other hand, systems like MIDAS [11,21], have shown that an automatic interpretation of metaphors is actually not really possible. The problem is the context-based interpretation.

Thus, we use a feature semantic approach to access the metaphorical structures. In the dictionary, different representation forms are stored with their relation to the known characteristics. Idioms, phrases and dialogues and those as can be metaphorical structures are selected from common dictionaries. The potential metaphorical structures are classified using the illustrated properties like abstraction, direction, etc. Additionally, we consider common characteristics like color which are directly related to the metaphor specification frame.

Searching a concrete metaphor we define one or some dominant properties and take an applicable representation form.

3.5. Aspects of metaphorical structures within the context of site design

Metaphorical structures are used for the *exchange of semantical units*. The exchange is dependent on the receiver, the sender, the 'tertium comparationis' (dominant properties), and the context (language context, intentions of the sender and expectations of the receiver). The idiom 'folder' has the dominant property of being able to store items. This property is known to both computer users and the system supporting the stored action.

Metaphorical structures for selecting information. Metaphorical structures can introduce unwanted baggage or unwanted restrictions. For example, users might expect a virtual shopping

mall to be staffed by a shop-assistant, who will answer questions and who will help in selection. Users visiting a virtual bookshop might expect that somebody will help in selection instead of advising to buy the best advertised products. From the other side, metaphorical structures might introduce additional restrictions. For example, the telephone symbol is often used in web sites for links to addresses, phone, fax, etc.

We often meet internet pages whose graphical items and metaphors are overwhelming. Users cannot concentrate on the content or are not able to capture the mental model of the site. Metaphors can be used in a completely misleading fashion. For instance, one of the design companies is using a pencil as a metaphor. This metaphor is important for the company itself, but not for the visitors of their page or their customers. The message of working thoroughly with appropriate instruments can be of importance. However, it is a side message. Thus, metaphorical structures are wrongly developed if they are carried forward into the site itself. Even worse, they can hamper usability. Typical examples of such metaphors can be found in everyday life. For this reason, they should be applied with care.

Since metaphorical structures are supporting dialogue objects, they do not play a major role in a site. They do not have a dominant role. They support the intention of the site. They are an element of the form and can partially present the content of a page. Metaphorical structures should be integrated into the site development process. The development of sites includes, as mentioned above, different perspectives. Metaphorical structures can introduce inconsistency into the site. Metaphorical structures should be a part of the interface.

Metaphorical structures for complex information. Metaphors currently in use are stand-alone metaphors. They mainly denote atomic information units such as phone, address, next step, special action. They are displayed by buttons. Metaphorical structures can be more sophisticated. They can represent a complete mission of a page. They can be displayed in very different fashion such as background color, background picture, texture, and special alphabets, etc.

Some of the principles can be applied to metaphor development of sites [44]. The principles are fairly unknown to computer science where metaphor development has been understood mainly as development of representation of widgets in the GUI community or where metaphors are used to describe areas of research in a simple way (information highway, artificial intelligence, agent technology).

Metaphorical structures for teaching the user. Since metaphorical structures are intended to be used several times, they have a learning effect [15]. They are used to give a better description. They are intended to be recognized by the user. They have a specification functionality. They are both common and unfamiliar. They extend the understanding. They force an event of immediate learning through playing. They can contain requests to act.

Composition of metaphors. Metaphors can be combined in order to weaken or to strengthen properties. For instance, the event database engine in Cottbus *net* is based on several metaphors at the same time: TV program journal, cultural journal, supermarket basket, phone book, landscape, and internet browser. The combination of these metaphors implies the functionality of query interfaces for daily, weekly and category-based display of information. The presentation of search results can be chronological, alphabetical, categorical or can be based on landscapes. Program journals have a specific survey approach and use escort information. Cultural journals discuss events with background information. Baskets allow

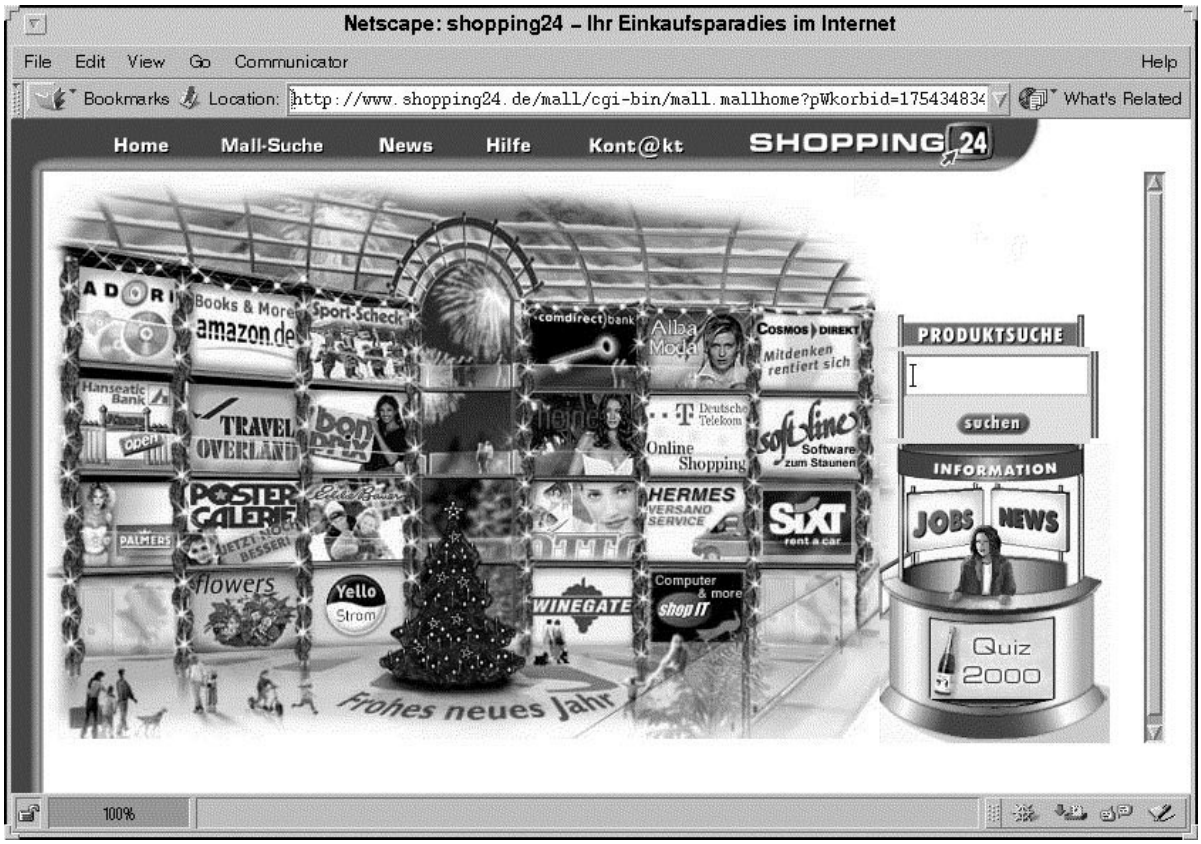

Fig. 5. Shopping mall 'Shopping24.de' (www.shopping24.de).

interactive combination of objects. Internet browsers have additional support functions such as bookmarks. The combination of these metaphors also suppress properties such as piles in baskets.

4. Metaphor development

Metaphors are known in the GUI community as an instrument to transfer the content of an icon or a button to the user. Except for [28], none of the texts on internet design such as [33,34,43] (or one of the other hundreds) treat them explicitly. The main usage of metaphors is still the simplified presentation of icons [27,42].

Metaphorical structures are an element of the implementation of the site. They can be used to represent

- a story or scenario of the dialogue [2],
- a workflow or the process in a certain dialogue step,

[2] An example of a metaphorical dialogue realisation is shown in Fig. 5. There, the search dialogue is realised as a personal information desk that implies a natural language and intelligent search interface.

- escort information about the scenario or workflow step and the information unit,
- specific functionality of web pages such as navigation, searching, or labeling,
- a class of objects, specific objects, or
- application restrictions (user profile, communication channel, users platform).

Metaphors can be used as singleton elements, parts of the page representation, or as a substantial element of the whole page.

Using different kinds of metaphorical structures: structural and behavioral metaphors. Metaphorical structures can be used for structural or behavioral information, or both.

Structural metaphors are used to represent the structure of objects, the underlying types (or their properties) of objects, or the content of objects. Typical examples are dealership sites. People have a mental model of how dealerships are organized.

Behavioral metaphors can be used to describe actions, the current state of an object, tools or agents, or actors. They make a connection between the tasks which can be performed in a traditional environment and those the user can perform in the new environment. Shopping baskets, browsing through shelves in a library, or browsing in a book are examples of commonly used behavioral metaphors.

Using visual representations of metaphorical structures. Visual metaphors are based on familiar images. For instance, yellow and white phone buttons direct to print-based yellow and print-based white pages. They are mainly used to support navigation. There are other visual metaphors beyond labels of icons. In Cottbus *net* (cf. Fig. 6), we used colors to denote the subsite, with the colors 'blue', 'red' [3], and 'green' denoting business information, inhabitant information and tourist information, respectively. The presentation of historic information, can be based on the metaphor of the 'old parchment'.

Hierarchical structures can be visualized through different metaphors such as plain two-dimensional representations, cone trees, hyperbolical figures, perspectives in rooms or as abstract information landscapes. The Fürst Pückler pyramid used in *cottbus.de* combines a Cottbus identity picture with a functionality of selecting an appropriate page for the next step. While selecting a page, the actor is classified into being an inhabitant of the town, being a visitor, or being interested in business.

Metaphor specification frame. Summarizing the characterization of metaphorical structures presented above and applying this to metaphorical structure in internet sites, we obtain the following specification frame for metaphorical structures:

Name of the metaphorical structure.
Property specification relates properties of metaphorical structures to application areas. The relationship is weighted by an intensity value. Based on the intensity, the dominance of properties for a given application area can be deduced.
Class of the metaphorical structure (personalized, allegoric, symbolic, synoptic).
Meaning to different groups of actors in different cultural contexts.

[3] The heraldic animal of Brandenburg is the red eagle. All official governmental and community documents use the red color.

Fig. 6. Cottbus *net* (www.cottbus.de).

Representation specification relates metaphorical structures to representation patterns such as images, color, words, sentences, etc.

Selection specification. During design of the architecture we obtain specification of actors (especially their profile), of their platform, of their information units, of their information containers and of their manipulation requests for each of the dialogue steps. These specifications can now be used to select appropriate metaphors for each of the dialogue objects. The selection specification is described by the following frame:

Dialogue object name with information units, information containers, supplied processes, enabled manipulation requests, and actor characteristics.

Metaphor embedding specification with parameters for

function of the metaphor within the dialogue object,

applicability of the metaphorical structure (full page integration, partial integration with specification to which structural or behavior elements the metaphorical structure is attached),

donor area of the metaphorical structure,

abstraction (generalization/specialization),

direction (inanimate, animate),

intended effect of the metaphorical structure (predicative or persuading, attributive, genitive,

compositional, apposition) to the actors and
presentation form selected from possible representations of the metaphorical structure.

Metaphor intention specification with parameters for
context specification (intention for given actor, expectations of actors, connotation (social and emotional side conditions)),
metaphor function (internal, predicative, heuristic, emotional, social, rhetoric, esthetic) and
type of metaphor (conventional, creative, ex-metaphorical structures, re-metaphorical structures).

The embedding of a metaphorical structure into a dialogue object has a higher quality if an appropriate metaphor with the right dominant property has been selected. The specification of available metaphorical structures can be made outside an application. The selection specification depends on the application and the dialogues.

Let us consider the metaphor of a cultural journal in our specification framework. Cultural journals are of higher value than other journals such as TV program guides. They have properties such as serosity. The content is seldom updated.

```
*** Metaphor specification and representation ***
 name: cultural journal
  property:      well-founded, solid side information
    description:        .....
    application area:       information-intensive services
         intensity:          middle
  property:      reliable information
      description:        .....
      application area:       quality services
         intensity:          middle to intensive
  .....
  class:   allegoric (in combinations)
       structure specification:  specialization of journal
          sequential page order
          page consists of hypertext and pictures
          ....
          color:         irrelevant
       functionality
            navigation:    content-based
            search:        table of content, index
            index:         content-based, chronological
  .....
  meaning for user group <elderly people>:  solidity, well-based
        alternative meaning:    information which should be read
  substitution direction: from cultural journal to application
       cultural context:   advanced culture
  .....
  representation:         journal with table of content
       usual appearance:  journal ready for browsing
       pattern:           journal
       alternative:       open journal with bookmarks
  .....
```

Serious and reliable information is used for escorting other quick informative messages. Therefore, the escort information provided by journals can be combined with other information.

```
*** metaphor object integration ***
 metaphor <cultural journal>
  integration into dialogue object <retrieve events in Cottbus>
     information unit:       event snowflake schema
     information container:  large size container with categorization
     supplied processes:     select; temporal storage
     manipulation request:   none
  composed with metaphors:
      TV program journal:  survey
      supermarket basket:  selection of events
      phone book:          order
      landscape:           highlights
    strengthened property: findability, highlights
    weakened property: strong content-based order
  embedding context
     function:          reliable side information
     applicability:     additional information
     donor area:        quality and personalized information
     abstraction:       same level
     direction:         inanimate/inanimate
     intended effect:   quality persuading
     presentation form: open journal with bookmarks
  intention of integration
     context for actor  <elderly people>
           intention:   read this side information if there is time
           expectation: get review of the event
           connotation: personalized experience report
     metaphor function
           internal:    weakening TV program journal metaphor
           predicative: reliable information
     type of metaphor
           ex-metaphor
```

The `cultural journal` metaphor example demonstrates how deep is the influence of metaphor integration. The metaphor is integrated into the dialogue object `retrieve events in Cottbus`. This dialogue object is based on a specific view on the event database which is extended by the dimensions time, event category and organizations and linked to the map objects. The information container which is transferring the content and the functionality of the information unit to the user is rather simple with categorization functionality. The metaphor is composed with other metaphors in order to weaken or to strengthen properties of those. For instance, the TV program journal is usually not considered to be serious. This property is completely overwritten by the cultural journal metaphor. From the other side, the strong content-driven order of the cultural journal is contra-productive. This order is weakened by the other metaphors. The metaphor is used as a secondary metaphor for the case that a user wants to get

more information on the events. In this case, the user needs to be convinced that he/she can rely on the information. Due to the integration of different metaphors and to the intention of the event dialogue objects, the main representation form of the metaphor is changed to the alternative form which fits better into the entire site.

The typical application for composed metaphors is the entry page of a site. The composition used in the entry page of www.cottbus.de has the intention to relate the site to Cottbus, to attract users who are interested in the three entry scenarios of the site and to weaken expectations of users who are not interested in information of higher serosity. This kind of metaphor application is similar to the set-up or the exposition of stories and movies. The example above shows however that metaphors can be applied in far more wider range.

5. Conclusion

This paper discusses the experiences we have gained during developing sites for the internet and cable nets. Since most users are scanning or browsing a page, they need support for a quick and correct understanding of the contents of the pages. One classical possibility is to structure pages. Another possibility is the introduction of metaphors. Metaphors are used to point on information presented by the sender that can be easily encoded by the receiver within the sites context. Metaphors have properties. Some of the properties are dominant for certain applications. Now we have the task to map our application to one of the dominant properties in an area which could be a donor for the given application area. Properly applied, metaphors can simplify the task of communicating complex ideas, create interesting relationships, and result in enthusiastic users.

Acknowledgements

We would like to thank the members of the Cottbus *net* project teams for their stimulating discussions and their effort to implement our ideas. Further we are grateful to Bernhard Debatin for some very helpful comments in order to extend our philosophical and linguistical metaphor knowledge.

References

[1] Aristoteles, Poetik. Stuttgart, Reclam, 1961.
[2] A. Albrecht, M. Altus, E. Buchholz, A. Düsterhöft, B. Thalheim, The rapid application and database development (RADD) workbench – a comfortable database design tool, in: J. Iivari, K. Lyytinen, M. Rossi (Eds.), Proceedings of CAiSE 95, LNCS 932, Springer, Berlin, 1995, pp. 327–340.
[3] P. Atzeni, G. Mecca, P. Merialdo, Design and maintenance of data-intensive web sites, in: H.-J. Schek, F. Saltor, I. Ramos, G. Alonso (Eds.), EDBT 98, Valencia, 1998, LNCS 1377, pp. 436–450.
[4] M.A. Arbib, M.B. Hesse, The Construction of Reality, Cambridge University Press, Cambridge, 1986.
[5] E. Buchholz, H. Cyriaks, A. Düsterhöft, H. Mehlan, B. Thalheim, Applying a natural language dialogue tool for designing databases, in: M. Bouzeghoub (Ed.), Proceedings of the First Workshop on Applications of Natural Language to Database Design, Paris, Afcet, 1995, pp. 119–133.

[6] P. Bretherton, P. Singley, Metadata: A user's view, IEEE Bull. (1994).
[7] K. Bühler, Sprachtheorie: Die Darstellungsfunktion der Sprache, Fischer, Stuttgart, 1965.
[8] H. Bussmann, Lexikon der Sprachwissenschaft, Kröner, Stuttgart, 1990.
[9] M. Danesi, The neurological coordinates of metaphor, Commun. Cognition 22 (1) (1989) 73–86.
[10] B. Debatin, Literature on the theory of metaphor, http://www.uni-leipzig.de/ ~debatin/english/Research/Metaphor.htm.
[11] B. Debatin, Metaphors and computers, Semiotic Rev. Books 3 (1) (1997).
[12] P. Fraternali, P. Paolini, A conceptual model and a tool environment for developing more scalable, dynamic, and custumizable web applications, in: H.-J. Schek, F. Saltor, I. Ramos, G. Alonso (Eds.), EDBT 98, Valencia, 1998, LNCS 1377, pp. 422–435.
[13] T. Feyer, K.-D. Schewe, B. Thalheim, Conceptual design and development of information services, in: T.W. Ling, S. Ram (Eds.), Proceedings of ER'98, LNCS 1507, 1998, pp. 7–20.
[14] S. Johnson, Interface Culture, Harper San Francisco, 1997.
[15] E. Jüngel, Metaphorische Wahrheit. Erwägungen zur theologischen Relevanz der Methapher als Beitrag zur Hermeneutik einer narrativen Theologie, in: R. Ricoeur, E. Jüngel (Eds.), Metapher, München, 1964.
[16] R. Kimball, A dimensional modeling manifesto, DBMS, July 1996, 51–56.
[17] E.F. Kittay, Metaphor: Its Cognitive Force and its Linguistic Structure, Clarendon Press, Oxford, 1987.
[18] G. Kurz, Die Rhetorik der Metapher, in: G. Kurz, T. Pelster (Eds.), Metapher, Theorie und Unterricht, Düsseldorf, Schwan, 1976.
[19] M.W. Lansdale, T.C. Ormerod, Understandig Interfaces, Academic Press, London, 1995.
[20] J. Lewerenz, Dialogs as a mechanism for specifying adaptive interaction in database application design, Cottbus, 1998, submitted.
[21] J.H. Martin, A Computational Model of Metaphor Interpretation, Academic Press, New York, 1990.
[22] A. Motro, Superviews: Virtual integration of multiple databases, IEEE ToSE 13 (7) (1987).
[23] A. Ortony, Metaphor and Thought, Cambridge Press, Cambridge, 1979.
[24] K. Parsaye, M. Chignell, Intelligent Database Tools and Applications, Wiley, New York, 1995.
[25] G. Persson, Meanings, models and metaphors; A study in lexical semantics in English; Umea Studies in the Humanities, 92, lmquist & Wiksell, 1990.
[26] G.P. Pfaff, P.J.W. Hagen (Eds.), User Interface Management Systems, Springer, Berlin, 1985.
[27] K. Pipke, Verwendbarkeit von User-Interface-Metaphern in 3D-Welten unter spezieller Berücksichtigung von World-Wide-Web-Anwendungen, Diplomarbeit, FH Darmstadt, IuD, 1996.
[28] L. Rosenfeld, P. Morville, Information Architecture for the World Wide Web, O'Reilly, Cambridge, 1998.
[29] M. Roll, B. Thalheim, The surplus value service system FOKUS, in: INFO'95, Information Technologies for Trade, Industry and Administration, Potsdam, 1995, pp. 355–366 (in German).
[30] T. Schmidt, Requirements, concepts, and solutions for the development of a basic technology of information services – The client, Master thesis, Brandenburg Technical University at Cottbus, 1998 (in German).
[31] R. Schwietzke, Requirements, concepts, and solutions for the development of a basic technology of information services – The server, Master thesis, Brandenburg Technical University at Cottbus, 1998 (in German).
[32] K.-D. Schewe, B. Schewe, View-centered conceptual modelling – an object-oriented approach, ER'96, LNCS 1157, Cottbus, 1996, pp. 357–371.
[33] D. Siegel, Web Site Design: Killer Web Sites, Markt und Technik, München, 1997.
[34] D. Siegel, The Secrets of Successful Web Sites, Markt und Technik, München, 1998.
[35] B. Schewe, K.-D. Schewe, B. Thalheim, Co-design of structures, processes and interfaces for large-scale information systems, Tuturial given at ER'98, Singapore, November 1998, 78 pp.
[36] M. Stefik, Internet dreams; Archtypes, Myths, and Metaphors, The MIT Press, Cambridge, MA, 1997.
[37] B. Thalheim, Entity-Relationship Modeling – Foundations of Database Technology. Springer, Berlin, 2000.
[38] B. Thalheim, Development of database-backed information services for Cottbus *net*, Preprint CS-20-97, Computer Science Institute, Brandenburg Technical University at Cottbus, 1997.
[39] B. Thalheim, Database-backed information services for internet and cable nets, Tuturial given at SCCC'98, Antofagasta, November 1998, 56 pp.
[40] B. Thalheim, The strength of ER modeling, in: P.P. Ch en, J. Akoka, H. Kangassalo, B. Thalheim (Eds.), Conceptual Modeling: Current Issues and Future Directions, LNCS 1565 Springer, 1998, p. 227–242.
[41] E. Thomson, OLAP Solutions: Building Multidimensional Information Systems, Wiley, New York, 1997.
[42] K. Väänänen, Metaphor-based user interfaces for information authoring, visualization and navigation in multimedia environments, Ph.D. thesis, TH Darmstadt, Shaker, 1995.
[43] L. Weinman, J.W. Lentz, Deconstructing Web Graphics, Macmillan, New York, 1998.
[44] S. Wolf, Mensch – Maschine – Metapher. Zur Exemplifikation des menschlichen Geistes durch den Computer, Universität Bamberg, Dissertation, 1994.

Bernhard Thalheim (born in 1952) studied mathematics and computer science at the universities of Dresden and Moscow. He held professorship positions in Dresden, Kuwait, Rostock and now Cottbus. He works on the theory of the relational data model, theory & pragmatics of Entity-Relationship modeling, object oriented databases and their design. He led several projects on database design tools (DB^2, RADD) and application projects in collaboration with industrial partners, has been a member of more than three-score program committees, and is a consultant for several large enterprises.

Antje Düsterhöft studied computer science and linguistics in Rostock and received her Ph.D. in computer science from the Technical University of Cottbus, Germany. She is currently working as senior researcher at the database group of the University of Rostock. Her research interests include data modeling, linguistics and internet search engines.