Metadata and information structure design on websites – towards a web for all

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Abstract: When we transmit information through the internet, we would usually like it to reach many people. Our aim is for people to read it, to utilise it as a source, and to make use of it in their studies, e.g., in postgraduate courses, or in other fields of life. This article seeks to identify what elementary criteria our information source has to fulfil in order for search engines to find it, for users to consider it relevant and appropriate, and for it to meet the demands of users with disabilities. Only if these criteria are fulfilled does our website become really accessible. To promote this possibility, the article deals with the theoretical and practical dimensions of screen structure, data structure and metadata.

Keywords: semantic self-organisation; information retrieval; semantic web; disabilities.

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1 Introduction

Information and the knowledge derived from it has become power, and not only in the world of science and technology, but in the development of knowledge-based economy. The immediate finding, processing and utilisation of reliable and complex information is a necessary condition of our participation in the functioning of the economy and the society, and it is imperative for society to provide this possibility to each and every one of its members (Könczei, 1999; Kovács and Pető, 2007).

The primary source of information today is the World Wide Web, and access to the internet is therefore essential for every member of the society. Physical access itself is a social responsibility. However, the availability, retrieval and processing of information on the web must be supported by information technology. This paper aims to contribute to this latter.

1.1 Globalising information

There are countless ways of representing, finding and presenting information. The emergence of the World Wide Web and the expansion of the internet have brought the most significant changes in this regard. A considerable leap in the development of transmission and storage possibilities permitted the appearance of global information centres, – independently of time, space or creator (group).

Information on the web is global in the sense that it can be seen or used by anyone around the world. However, for information to become global, it is not sufficient merely for it to appear on the web; it has to be searchable, and its contents identifiable and interpretable, since immediately available information is crucial in economic and business life, in education, in research, in health care and in virtually every other sphere of life. As the amount of information on the web grows, the circle of users and information producers similarly widens. Target groups of conventional information systems are known, with well-definable and distinct properties; and producers have the needs of these homogeneous groups in mind. Internet users nevertheless make up a heterogeneous group, and at best can be organised in smaller homogeneous groups. Most information systems still target only one group, and these are therefore difficult to interpret and navigate for members of other groups.

This paper discusses the three main steps of information organisation and the design of information objects that meet both the demands of well-definable groups and global requirements.

The second section of the paper focuses on the different criteria that web pages have to meet in order to support web use by disabled people, with special regard to multimedia elements. We briefly touch upon the new developments in the application of the multimedia in healing. Following this, some of the criteria of displaying navigation that reflects information structure and information processing will be discussed. The third focal point of the paper is metadata, which provides formal and content information on information, and support search engines in searching and organising objects. Their significance has undergone a drastic increase in parallel with the growing emphasis on information identification; metadata can conceal or reveal information.

2 Limited access to websites

We have to consider how disabled people can access the information available on websites and how they can utilise it. By providing additional physical accessibility, we can extend the group of end-users.

Multimedia applications that came to the forefront in recent years have fundamentally changed the possibilities of information transmission. People with disabilities, such as blind people or people with severely impaired vision, often cannot interpret the usual multimedia elements, whereas they have several advantages for others. Cases where the multimedia is used in healing deserve special mention.

2.1 The dominance of multimedia

Besides the globalisation of information sources, significant changes have taken place in the representation of information. Digital technology has become an integrated part of the

production of images and sounds, and made it quick and cheap. Their extended production allows the use of visual elements in information storage and presentation that was previously based primarily on elements of verbal language. The simplicity of image and sound production and application, and the easy accessibility through the internet, have opened up the way for a more enjoyable and efficient technology, that merges visual and verbal elements (Tzouvaras et al., 2007).

Furthermore, it supplements verbal presentation, which is often difficult to interpret for many people, in order to attract attention and promote better understanding. Application of such tools is desirable as long as they make our website richer and more colourful, but the use of more and more images, sounds and videos can have a reverse effect, and make our message increasingly congested, confused and difficult to follow. Congestion makes great demands on attention, memory and nerves, and the remaining limited navigation surfaces require precise muscle work. Fully efficient use of websites crowded with various multimedia elements requires good hearing and sight, excellent physical condition and mental abilities, and extensive competence (Haslhofer et al., 2009; Mödritscher et al., 2007).

2.2 Visual and hearing disabilities and the webpage

Some of the most important aspects of the accessibility of information on the web are the abilities to perceive, comprehend, interpret and conveniently navigate within the information of a given webpage. Most websites consider their end-users to be in full possession of all these abilities. However, many users are in a disadvantaged situation, in the sense that they have some kind of disability, disease or impairment, or they are simply aging or lack knowledge on the given specialty. In this case, the questions that arise are how the targeted end-user's presumed physical, mental and cognitive abilities differ from the actual abilities of the user, and consequently the extent to which the information on the webpage is available for the user.

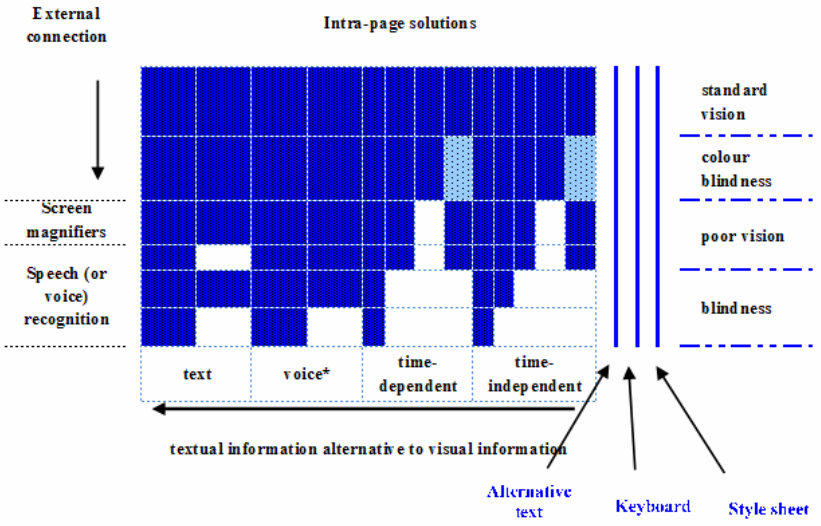
Let us focus on the case of visual and hearing disabilities, since other disabilities require essentially the same web design and organisational methods, and application of the same external technologies (Kim et al., 2009).

The 'the World Wide Web Consortium' has developed the 'Web Content Accessibility Guidelines 2.0' in order to provide introduction to the use of the web by people with physical, visual, hearing, cognitive or neurological disabilities. Numerous detailed documents and sources help with the interpretation and understanding of the guidelines.

2.2.1 Visual disabilities

Usage of a webpage is primarily built on vision. There are three main types of visual disabilities: colour blindness, poor vision and blindness, among which the first is the most common. In extreme cases, colour cannot be perceived at all. Poor vision has many types, and usually refers to poor acuity or viewing angle problems. Unlike in medicine, from the aspect of informatics, persons may be regarded as blind if they are functionally blind at a given moment, i.e., they cannot receive information visually about their environment (WCAG 2.0, 2008). Whether a person has ever been able to see, is familiar with the personal environment, or has memories about shapes or colours, make an important difference (see Figure 1).

Figure 1 Visual disabilities and the webpage (see online version for colours)



It is helpful for everyone if there is always a possibility to navigate and to enter text via a keyboard. The use of style sheets is elegant and is a necessary basic requirement. For people with poor vision, enlargement of the font size, or the use of a screen magnifier or a screen projector can likewise be useful.

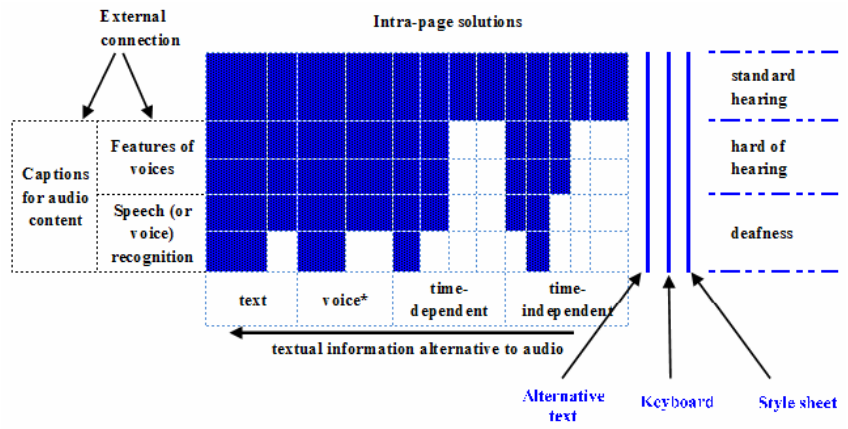
The greatest constraint for blind people is that the web is defined as a multimedia surface. Omission of the decorative graphic design elements does not cause any problem. However, the animations, images, diagrams, formulae and animated texts that have an important content or serve as navigating tools cannot be omitted. Assistive technologies developed for blind people do not reveal the substantive content in image information. The tendency to display important textual or navigation content in animated form is therefore problematic, since no assistive technology will be able to recognise the content on the ever-changing screen surface. Image information is often connected with sound. This can be a solution only if the text is comprehensible without images, or if the image does not contain information that is unknown for a person blind from birth (WCAG 2.0, 2008).

The addition of textual descriptions as supplementary or substitutive information to multimedia applications is a possible solution. Blind people often use a screen reader, a voice browser, or other external devices, which are usually connectable with the keyboard, and hence provide rapid navigation; the textual information therefore has to be well-structured. The text read by the software is transmitted to a voice speech synthesiser and/or a refreshable Braille display.

2.2.2 Hearing impairments

Hearing impairments are usually divided into two main types: hard of hearing and functional deafness. From the aspect of informatics, persons are considered deaf if they are functionally deaf at a given moment, i.e., they cannot receive information by hearing about their environment. Here again, it is an important difference whether a person has been deaf from birth or not (Figure 2).

Figure 2 Hearing impairments (see online version for colours)



People with hearing impairments rely to a greater extent on textual and visual information, captions and visual supplements for audio content, and the possibility to change the physical properties of sound. They often have reading difficulties, and clear information structure and multimedia applications are therefore crucial. Hearing impairments frequently result in speech disabilities. Users with speech disabilities have to apply alternative input methods instead of their voice, e.g., the keyboard. The features of a website that meet the demands of blind users can also be of value for users with a hearing impairment.

There are countless other forms of disabilities, such as physical, motor or neurological disabilities, which can occur in combination. Aging too can be accompanied by a decline in the cognitive and physical parameters.

With regard to all the above-mentioned disabilities, we can generally conclude that the most important principle of accessibility to a webpage is to provide alternatives for the different media applications and their navigating functions. Further essential requirements are:

- a syntactically and semantically correct webpage in order to provide assistive software for the recognition of forms, and figures, e.g., a table
- the use of style sheets
- clarification of the meaning of acronyms applied
- the provision of alternative texts to non-textual information
- the provision of synchronised alternatives to time-dependent media, such as audio applications or videos
- the provision of full navigation via the keyboard.

Besides alternative options, easy navigation on the screen demands certain webpage-editing principles, such as a clear and comprehensive structure, the constant location of function and navigation buttons (Garrett, 2003), and the consequent use of colours and typographic styles, avoiding too many links (Even 100 links per page is common on news portals).

2.3 Software for users with special needs

We can find outstanding examples of the use of multimedia applications and the web to assist the therapy of people with various disabilities. In these projects, researchers are developing software in order to facilitate rehabilitation. I will briefly mention three such projects in Hungary.

Multimedia can be an important tool for the teaching of children. The teaching of handicapped children with multimedia tools is an essential area of application. A research group at the University of Pannonia selected the area of producing multimedia games for partially sighted children, because multimedia games can be used here very effectively. They have produced three programs for partially sighted children with the aim of improving their vision. These games can be used in individual and small-group teaching, and parents too can use them with their children (Sik Lányi et al., 2005).

Sik Lányi et al. developed a multimedia rehabilitation software package and an interactive virtual world, a Virtual Home, to improve speech readiness and the ability to orient with a view to helping the therapy of aphasic patients. Both programs aim at strengthening the patients' grasp of everyday vocabulary and improving their spelling skills with demonstrative environments and graded tasks (Sik Lányi et al., 2006).

The experiments of Mátrai et al. (2008) included normal users and users with intellectual disabilities. They tested whether the characteristic searching routes and navigation methods differed between normal users and those with intellectual disabilities. The results showed that, on an ordered page which contains little information, the navigation strategies of normal users and those with intellectual disabilities correspond to the global strategy and proceed from left to right, while on a more crowded and disordered screen, less organised sequences were observed only in normal users, with no discernible patterns observed in users with intellectual disabilities.

3 Information content

Depending on the target population an ideal website provides users with a wide range of information. If they use the website for studying, they must have the possibility to find all information, starting from the exact definitions of terms, and continuing through the elaboration of the subject field to the external links. If they search for practical examples, the website has to provide case studies, either by demonstrating cases from the literature, or by processing the users' own cases (e. g. decision support systems).

Thus, the thematic orientation and the level of specification of information processing provided by the website determine the circle of users. The two types of examples (academic information processing and processing through case studies) require dissection of the information into elemental data, such as fundamental terms, conceptions and relations (Turban and Aronson, 2001). The usual method of data processing is the organisation of data in relational databases, but for the search engines such databases remain hidden; accordingly, it is not recommended for information management on the web (see Section 4.1). The organisation of information into ontology is an ideal solution. This involves a hierarchic information structure and logical relations between the elements of the structure. In this case, information is built up from the structural elements through the application of logical rules. The result is a well-constructed, retrievable and

properly maintainable system. The construction of complex systems by using these elemental units is obviously the most efficient and precise way, though, it is enormously demanding. The theory and practice of information system development on the web is not yet such a well-elaborated area as, for example, relational database management. A search of the literature mostly yields practical recommendations for execution. Let us consider three aspects of the development, the careful application of which may be regarded as inevitable in the development of information systems on the web.

For the enterprise to be feasible, instead of the above-mentioned elemental data we should consider elemental units such as knowledge items, which are still manageable as concerns their size and information content (Auillans et al., 2002). These knowledge items can be used to develop our knowledgebase within the frames of an open (surface web) system. Whichever solution we choose, we have to define a hierarchy, i.e., how the knowledge items relate to each other, and how strong these relations are (Cañas et al., 2003).

Following the information structure a navigation structure needs to be created (Novak and Cañas, 2006). The navigation points, which are usually hyperlinks or sometimes interactive decision points, should be built into the information structure. Navigation points determine the course of processing, and they should therefore match the hierarchy of the information structure (main subject field, subfields, supplementary information and external links). In order to keep the subject field centred, all paths within the navigation structure should return to the main subject field and, where possible, the branches of a hierarchy level should be on the same webpage (Oren et al., 2008). If the navigation is well-organised, visitors can assess the information content and structure, and also their navigational position within the site at any moment of time.

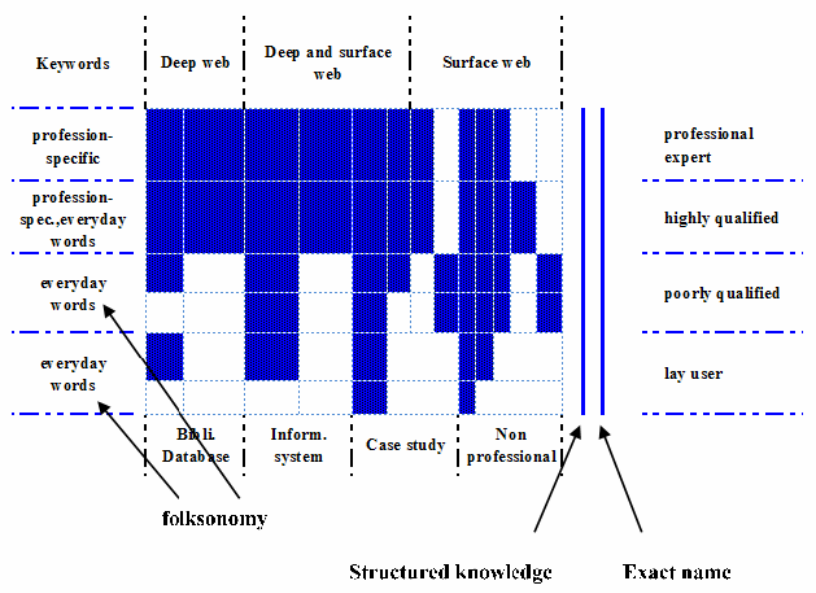
On the web, information is displayed through the windows of browsers. Due to the high degree of freedom, browsers often display interrelated information in a disorganised way, in several, separate windows. Not managing the hierarchy of the windows (even by programming), and not decreasing the freedom of browsers in using windows can quickly lead to navigation chaos, and we also have to face an unmanageable amount of loosely related information, within which it is impossible to find our way back to the starting source, and we can therefore forget about systematic information retrieval (Coffey et al., 2002).

The informational, navigational and display structures of websites are largely subjective. The efficiency of display depends primarily on the knowledge, judgement and professional experience of the experts (knowledge engineers) who create the knowledge base.

4 Information search by metadata

As a significant part of the development of our website, we have to consider what segments of the web our end-users use and what type of keywords they employ to access them (see Figure 3). In order to make our website accessible, we need to add metadata (also known as metainformation) to our information, which we define according to the web-use practices of our end-users (Madhavan et al., 2008; Manouselisa et al., 2009, 2010).

Figure 3 Information search (see online version for colours)



Metadata is data on data (NISO Press, 2004). It is either technical, when it serves to identify objects and define their parameters, or descriptive and supports the identification of content. Descriptive data can be free texts, structured texts or texts with inner logical relations, i.e., ontology. Metadata can ensure the consistency of the content, and also an easy relation between different well-organised objects. This is essential in the efficient processing of multimedia and textual documents (Taylor, 2003; Yorick, 2008).

4.1 Storage and representation for searchable data

We usually store our data, even our multimedia documents, in databases. Their advantage is that we can make information 'data-like' through a consistent, usually relational data model, and we can define properties and relations accurately. Manipulation of the 'subtly' coded data is simple, and it is easily searchable inside the database. However, it is difficult at the beginning of a project to know all the details, the possible data types and the possible relations. Thus, the substantive extension of databases is problematic (Forczek, 2007). The most significant disadvantage of database model is its concealed nature: it does not appear on the 'surface web', and search engines cannot find it, so that its content remains hidden for the users (deep web) (Madhavan et al., 2008).

With the expansion of the web, the number of textual documents has increased enormously. Most of the information appears as free text without any content structure or relations. Images or other multimedia elements on websites can be identified only by texts in their environments, links and other parameters, if identification is possible at all. A conventional search can therefore be successful only with a 'trial and error' method. However, since these websites are open, search engines can find them.

Accordingly, the great advantage of the surface web is that the search engines have free access to the information. Nevertheless, they identify information primarily by formal properties, and not by content characteristics. If we leave open the possibility for

unstructured free text or 'quasi-free text' data processing, but at the same time describe the data in a way that software can manage it by content as well, we will be able to search information not only by formal appearance, but also by content (Lucas and Topi, 2005).

In consequence of their extended functions, some search engines can search locally as well, among local documents and images on a personal computer. This is a significant advance, considering that the rapid increase in the capacity of storage devices made the amount of data stored nearly unmanageable. In the lack of any other efficient assistance, the desktop search option of search engines is invaluable.

When applying multimedia tools, we have to be aware that their successful identification depends on which dimension we can utilise to add information to images. If we can add valid metainformation to an image either in an algorithmic way during creation or during processing, the image becomes identifiable and accessible by content, while failure to provide this (primarily) verbal information above the content results in the failure of content-based access. (Forczek and Szanyi, 2008). Since the recognition of images or their particles is currently possible only with special software in specific areas, the extensive expansion of searches based on image recognition is not probable in the near future (Papadopoulos et al., 2006).

4.2 Content representation by metadata

An immense number of documents are now available on the web, in our own computers, and in archives. The practical use of the various databases, the web portals and the information collected by users depends on how easily and quickly we can find the information we need. The main problem with search engines is that they do not interpret the meaning of documents or search queries, but merely examine the occurrence of keywords. Without standard solutions, the compatibility of contents cannot be ensured. One standard procedure is to add information (the above-mentioned metainformation) to the information on the web, in such a way that it enables reasoning regarding the relations of the information (Forczek and Szanyi 2007).

The use of metadata is a common tool with which to identify objects or files, or to describe their technological parameters and (for a more semantic searchability) their content as well.

Metadata serves to describe the parameters of files (e.g., size, dates, etc.), but also the characteristics, such as the name of the creator, or the date and location of the creation regarding an image or a document. Metainformation can also be part of the web environment (e.g., HTML called META), and we can add free text annotations to files. The former requires descriptive metadata, and the latter semantic metadata.

Annotations provide information about the content of a document or file. This is especially important in the case of multimedia elements, where the content identification is otherwise often impossible. The use of formalised data, code systems, a thesaurus, topic maps or ontologies means that the possibilities offered by the Semantic Web yield much better results than an evaluation based on free text description. This is of particular significance in describing and finding multimedia elements.

Annotations can describe the relations of the various elements to each other and to the environment.

It can occur that only the annotations are accessible for the users, while the availability of the full content is restricted (e.g., in the case of full text databases).

4.3 Managing annotations, using coding systems

In order to make an object widely accessible on the web, it is more suitable to publish it on the surface web. However, for a more efficient search, metainformation should incorporate a consequent system of names and relationships. The creation of exact terms, using established terminologies, is therefore crucial. This is supported by thesauruses, topic maps and coding systems. Coding systems usually do not include definitions of terms, or a repository of logical relations, although the position of a term within the hierarchy refers to the content. If the information is not strictly of a professional character, then application of the common keywords and tags used on blogs, forums and community websites can help to build up the system of metainformation (Caplan, 2003; Popov et al., 2008).

4.4 Techniques of representing metadata

Due to the many different kinds of file formats, and to the fact that metadata is usually to be found within the object (.jpeg, DICOM, .TIFF, .pdf, .doc, etc.), present-day search engines can see at best only a part of the information stored on the web, and probably the full content of only some of these objects will be accessible in the future.

For a content search, the Semantic Web provides a standardised solution. Among the different options, the use of ontology is the most thorough, although its great time and energy-consuming nature means that it is rarely applied. Several simple standards have been developed recently, but the Dublin core (DC) metadata scheme, which consists of only 15 items, has become the most popular (the Dublin core). In DC, we can work with universally interpretable elements (e.g., the author of an academic article and the writer of a script are equally a ‘creator’), and in item 13 we can add annotations as well. Formalisation of the free text in the annotation (in a manner discussed above) leads to better search results (Manouselisa et al., 2009, 2010).

5 Conclusions

In this paper I have discussed three aspects of information organisation that help make information systems with limited target groups meet global demands. This means the extension of end-user groups by making web information accessible to people with disabilities. Other important criteria of information organisation are the display of the structured information and the relation of elements, and the application of a navigation system and different window techniques which correspond to them. Perspicuity and the multidirectional availability of information, an organised display process and the determination of several levels of knowledge can result in the growth of end-user groups. Finally, the paper discusses metadata, which supports primarily storage, search and interpretation. The type of metadata determines whether we produce an open or a closed system, and whether the information will become a part of the deep or the surface web. Consideration of these issues is inevitable, since they all contribute to reach a wider circle of end-users.

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