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An Investigation of Web-based Personalisation Technologies for Information Provision Focussing on the Multiple Sclerosis Community

by

Fadi Taher Qutaishat

A Doctoral Thesis

submitted in partial fulfilment of the requirements for the award of the degree Doctor of Philosophy at Loughborough University

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Department of Information Science – Research School of Informatics Loughborough University

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Abstract

The exponential growth of online information has made the process of locating appropriate information complex. This complexity increases when individuals are characterised by changeable needs, preferences, goals or knowledge, because this requires the system to personalise or adapt e.g. content in accordance with these needs.

This research developed a prototype system for personalising information and investigated the appropriateness of using personalisation techniques. It focused on people with MS (Multiple Sclerosis) who have changeable needs. During the investigation, a prototype of a personalised system was developed to provide personalised content, links and content presentation (i.e. layout). A number of personalisation approaches, techniques and models that are used in the domain of adaptive hypermedia, were selected in the development of the prototype system. Furthermore, XML, XSL and the Apache Cocoon framework were used as the underlying technologies for this development.

In order to better understand and satisfy user needs, users were involved in testing during the implementation phase of the prototype system. In this phase, users with MS, HCI (Human Computer Interaction) and MS domain experts evaluated the prototype system. Feedback helped to determine users' personalisation needs and to understand the characteristics of effective personalised systems within the MS domain.

Results from this research revealed a variety of user needs which can be met by using a personalisation approach. It showed that provision of personalised content in terms of the complexity and content presentation and giving users the opportunity to control the personalisation process, enhanced the access of people with MS to information resources contained within the prototype system.

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Chapter 1

Introduction

This research work provides an opportunity to explore and determine the role of personalisation in facilitating the access to information that is accessed via the World Wide Web (WWW). The investigation took place with information that was relevant to a community that has different and constantly changing information needs i.e. the Multiple Sclerosis (MS) Community.

The advancement of Internet technology and computers have enabled users to access and to publish documents on the Internet irrespective of the time or geographical binderies. However, such ease and freedom in producing and publishing resources – particularly the information resources – has made the Internet grow exponentially in the amount of information that it holds. This in turn makes locating relevant resources, understanding emerging trends and managing information increasingly difficult (Korth & Silberschatz 1997, pp. 139-140). Moreover, Internet users are increasingly becoming more knowledgeable in their use of the Web due to the wide range of experiences they are exposed to. They are becoming more specific about their needs, and they are becoming more proficient in knowing what constitutes a good service or a good resource of information (Bonett, 2001).

Many of today's Web sites are trying to adopt methods by which content can be provided or delivered dynamically in accordance with perceived users' needs. The increasing demand on using dynamic content is mainly driven by "the requirements of for interactive business transactions, as well as Web sites that are personalized on an individual basis." (Kothari & Claypool 2001, p. 18).

The major challenge confronting accessing Web-based information resource is not the lack of content, it is how such content is optimised and appropriately delivered to users. Furthermore, users have only limited time while they are trying to find their way to relevant/preferred information. This is particularly true in situations where "time-sensitive" data are required (e.g. stock market information) (Ko, Yao & Neches, 2002).

Appropriate technologies and strategies, which attempt to deliver relevant information to users within the exponentially growing Web environment, are increasingly developed. Personalisation and particularly Web personalisation is an approach that can be used to tackle the formerly mentioned challenges.

This research project looks at people with Multiple Sclerosis (MS) as the target community. This study involves building and utilising a prototype system which enables the provision of a personalised service in accordance with highly changeable preferences (conditions) for people with MS.

Web personalisation is defined as the process by which the content or services can be adapted to users' needs. Generally, Web personalisation can be achieved by combining the knowledge gained from the navigational behaviour of users, the perceived interests of users and the structure of the Web site content (Eirinaki et al. 2004, p. 72).

The Internet is considered as an ideal place for personalisation where content can be adapted based on users' preferences. This is particularly true on Web sites that include different types of information. For example, on news Web sites where various types of information are found, users might be interested only in reading a certain type of information (e.g. sports or market news). Therefore, adapting the news to the needs/preferences of users could save time and effort (Liang, Lai & Ku 2006, p. 46). This has led to an increasing demand to include personalisation features in many services such as portals, online catalogues, virtual learning environments and search engines. Despite this wide spread of personalisation features, limited studies have been conducted to reveal the impacts and benefits of personalisation (Hepworth et al. 2006, p. 38-39; Liang, Lai & Ku 2006, p. 46-47). Therefore, this research provides the opportunity to investigate the impact and benefits of using personalisation as an

approach to access Web-based information by a target community i.e. the MS community.

Personalisation technology is implemented in many areas; one area is adaptive hypermedia. The implementation of personalisation in adaptive hypermedia systems aims to guide users through the universe of the hypermedia system through the generation of personalised documents and links to individual users (Dolog & Henze, 2003). Therefore, this research project explores how adaptive hypermedia methods and techniques can inform the design of a personalised prototype that is intended for people with MS.

People with MS have various physical and psychological conditions that result in different needs for information (Hepworth & Harrison 2004, pp. 50-51). MS is the most common disabling neurological condition affecting young adults. Within the UK, there are around 85,000 people who have Multiple sclerosis (MS). "MS is the result of damage to myelin – a protective sheath surrounding nerve fibres of the central nervous system. When myelin is damaged, this interferes with messages between the brain and other parts of the body" (Welcome to the Multiple Sclerosis Society, 2004). Damage in the myelin sheath causes MS sufferers to have various physical and psychological symptoms which can vary from time to time. These can affect their desire and ability to use information sources (Hepworth, Harrison & James 2003, p. 291).

Recently, research studies have been conducted at Loughborough University entitled 'Information needs of people with multiple sclerosis and the implications for information provision based on a national UK survey' (Hepworth, Harrison & James, 2003) and 'A survey of the information needs of people with multiple sclerosis' (Hepworth & Harrison, 2004). These studies have investigated the information needs of people with MS and suggested possible solutions in order to fulfil those needs which could eventually improve the life quality of people with MS.

The studies suggested that there is a need for information to be made available for three communities, which are subsets of the whole MS community, including (Hepworth, Harrison & James 2003, pp. 294-300; Hepworth & Harrison 2004, p. 59-61):

- The general public and the sufferers family: a basic understanding and knowledge of MS should be made available to the general public and family in order to avoid any misconception about a person with MS. For instance, considering MS sufferers as individuals who do not seek to take an active role in life due to their illness is a misconception.
- The service provider, including the health and social care professionals and support groups: this would help them to effectively direct people with MS to relevant information and practical support.
- The person with MS: the studies stressed that the person with MS should be considered as a person who seeks to take an active role in life and, therefore, information provision should help them to achieve that goal. Hence, the following categories for information have been identified:
 - □ Information about MS including: a general explanation about MS, current research, drug treatment, symptoms, prognosis, physiotherapy, complementary therapy, nutritional advice, health and fitness and emotional changes.
 - □ Information that helps the MS people to interact with the world around them including: service providers, support groups, aids and appliances, facilities for the disabled, employment issues, communicating about MS and leisure activities.

Also, the studies provided a number of information characteristics for successful information provision. Some of these characteristics are due to the differences in how people with MS want information. The studies recommended providing the information:

- In a positive manner.
- In a way that helps and motivates people to take action.
- In a way that corresponds to the physical, psychological and social situation of the person with MS.

- In a way that is sensitive to the desire for information and its possible impacts on the individual.
- Using the most effective means of communication.
- Using different presentation techniques to cater for individual conditions that a person with MS may experience.

Satisfying the different information needs for people with MS can improve their well being through increasing their personal control and reducing their reliance on the health services (Hepworth & Harrison 2004, p. 49). On the other hand, fulfilling those needs is considered a complex task due to the changeable nature of those needs over time, the wide range of the topics involved, the differences in the desire for information and variations in how the information is needed (Hepworth, Harrison & James 2003, pp. 290-292).

Bearing this in mind, this research chose to focus solely on the 'person with MS'. In addition, the content generated and used within the prototype system was only concerned with 'information about MS'. This content was adapted only to the physical conditions (including visual problems and fatigue) of people with MS.

1.1. Aim

The overall aim of this research is to determine whether access to Web-based information, by people with MS, is facilitated by the personalisation of the information in terms of the content, links, and presentation.

1.2. Research questions

In order to achieve the aim of this research work, there are some questions which need to be answered including:

- 1. To what extent does modelling users with MS, in a personalised system, based on their conditions and state of knowledge (i.e. seen/unseen pages) help meet their information needs?
- 2. What is the most effective conceptual model for modelling the personalisation environment with respect to the MS domain?

- 3. Are technologies such as XML, XSLT and Apache Cocoon appropriate for constructing a personalised information system within the MS domain?
- 4. What are the most significant characteristics of a personalised information system that should be taken into consideration when designing a personalised system for people with MS?

1.3. Objectives

- Understand the information needs of people with MS.
- Review the literature in order to identify the approaches, conceptual models, and tools that are being used to implement Web personalisation/adaptation.
- Adopt appropriate personalisation approaches, conceptual models, and tools to underpin the design and development a personalised prototype system for the target audience.
- Build a prototype system that provides personalised information access in terms of the content, links, and layout (i.e. presentation) to people with MS.
- Evaluate the prototype system in order to:
 - Acquire feedback from users with MS on the personalisation/adaptation functionalities implemented.
 - Acquire better understanding of the MS users' requirements in terms of using personalised content, links, and presentation.
 - Assess the effectiveness of XML, XSLT and the Apache Cocoon publishing framework to construct a personalised information system for the MS community.
 - Develop or adapt a conceptual model of personalisation in order to make it applicable to the MS community.

1.4. Scope of this research

All research faces limitations that may result in difficulties meeting the research aims and objectives. Therefore, when conducting research, it is vital to scope the research and its boundaries carefully.

This research work did not undertake a full users' requirements study. Instead, it was based on previous users' needs studies that were carried out by Hepworth, Harrison & James (2003) and Hepworth & Harrison (2004). In addition, a better understanding of users' requirements was acquired by evaluating a prototype system and utilising other data collection methods (explained in Chapter 3).

Furthermore, this research work did not intend to provide a full-blown system design, because this would require time and effort that exceed the boundaries of this research work. Instead, a prototype system that applies personalised techniques and functionalities was developed.

1.5. Organisation of the thesis

This thesis is divided into eight chapters. Chapter 1 presents a brief introduction about the thesis including the aim, objectives and research questions. Chapter 2 reviews the literature in terms of two themes – personalisation and adaptive hypermedia (as an application area for personalisation). The literature about personalisation reviews personalisation in terms of its approaches and their enabling technologies. The adaptive hypermedia literature covers many areas including the structure of adaptive hypermedia systems (AHS), elements of adaptation, methods and techniques of adaptive hypermedia, examples and models of AHS. Chapter 3 discusses design research as the adopted research methodology, the development (i.e. design) methodology and the data collection methods that were used in this research. Furthermore, the rational behind these choices are provided.

Chapters 4 and 5 report evaluations of the first and second implementations based on the users' responses. In addition, the analysis, interpretations and reflections of users' responses are presented in these chapters. Chapter 6 presents a discussion (based on the research findings in Chapters 4 and 5) in terms of the technology and the adopted personalisation model. In addition, modifications to the adopted model (based on the

research findings) are explained. A future development for the prototype systems is also outlined. Finally, a design guideline for the development of a future personalised system within the MS domain is provided. In the last chapter (Chapter 7), conclusions, recommendations and suggestions for further research are presented. Limitations and contributions of this research are also outlined.

Chapter 2

Literature Review -

Personalisation and Adaptive Hypermedia

2.1. Introduction

The following chapter is divided into two parts, the first defines personalisation and describes its approaches. The second part, focuses on adaptive hypermedia as an application area for personalisation. The second part also discusses the current practice, methods and techniques and models of adaptive/personalised systems.

2.2. The concept of personalisation

Although personalisation can be defined according to many perspectives and contexts, the majority of these definitions agree on the fact that personalisation involves the process of delivering a tailored service according to certain preferences or interests specified by/allocated by explicit or implicit means from users.

A broad definition of personalisation was given by Searby (2003, p. 13) who stated "whenever something is modified in its configuration or behaviour by information about the user, this is personalisation".

Bonett (2001) described personalisation as a process of gathering information about users during a session of interaction. This information is subsequently used to deliver appropriate content and services that meet the user needs.

The personalisation consortium defined personalisation from a marketing perspective as using technology and customers information to tailor interactions to each individual customer (Personalization Consortium, 2000).

Personalisation is widely implemented in e-commerce (electronic commerce) Web sites to deliver tailored services based on the individuals' profiles (Rossi, Schwabe & Guimarães 2001, p. 275). In the e-commerce context, the ultimate goals of personalisation encompass simple objectives such as enhancing the shopping experience of customers by only showing relevant items/products. Personalisation, in this context, also pursues more complex objectives such as "developing long-term relationships with consumers, improving consumers loyalty, and generating measurable value for the company" (Adomavicius & Tuzhilin 2005, p. 84).

Access to information is not restricted in today's world. Due to technological advancement, people can access information, anytime and anywhere, using wireless devices such cell phones and personal digital assistants (PDAs). However, the problem with this is that most information on the Internet is designed to be displayed on desktops of broadband users. Therefore, the ability to adapt (i.e. personalise) Web content to meet the need of mobile users, in terms of content presentation and connection speed, become very important (Zhang 2007, pp. 75-76). Hence personalisation to the platform is an issue.

In the context of the health domain, patient education about their disease can reduce the cost of health services and enhance the quality of patients' life. This can be achieved by traditional means such as posters and leaflets or by alternative means using computers. Several studies showed that such "educational materials have a higher impact when they are adapted to the individual patient" (Bental et al. 2000). In respect to printed materials, it was found by Skinner, Strecher & Hospers (1994, p. 43) that tailoring printed materials to women with breast cancer were more memorable and read than standard printed materials.

Conversely, personalisation has faced criticism for being very expensive (in terms of the effort needed) to run (compared to the development of normal Web sites) and for being time consuming from the users' perspective – e.g. users do not have time to set up complex personalisation options (McGovern, 2003; Nielsen, 1998). According to Nielsen (1998), it is very difficult for personalised Web sites to guess the needs of individuals, because people's desires/interests change quickly. Both McGovern (2003) and Nielsen (1998) argue that a good design of Web sites in terms of layout, content and navigation can simply replace the need for personalised Web sites.

It is true that many issues can be resolved by presenting a well-designed Web site. However, this situation represents the paradigm of one size fits all. Kurniawan et al. (2005, pp. 474-475) argued that while a good Web site design helps users to navigate and to view content, this does not negate the importance of adapting Web sites to the needs of individuals for example with particular impairments. They also found that giving older people the opportunity to use personalised options allowed them to use the Web more effectively.

It should be noted however that this does not indicate that personalisation suits only people with disabilities, instead it shows the different needs and situations that people may experience which can be accommodated using an appropriate personalisation approach.

2.3. Personalisation approaches and techniques

In order to undertake Web personalisation, the underlying system should be able to recognise the users or users groups (Eirinaki &Vazirgiannis, 2003). Most Web users have different attributes, preferences, needs or interests, which need to be partially or entirely captured and processed (Bonett, 2001). This process of collecting users' information is called user profiling, and its objective is to build an information base relying on users' attributes, preferences, etc. User profiling has played a significant role particularly in the e-commerce environment where collecting information about users is vital, as they might be perceived as potential customers (Eirinaki &Vazirgiannis, 2003). According to Adomavicius & Tuzhilin (2005, P. 84) and Zhang (2007, P. 76), the successful implementation of a personalisation application relies on exploiting the users' information which can be collected from their user profiles.

The following sections describe the different approaches and techniques for personalisation as well as the various ways in which the users profiles can be built in respect to each approach.

2.3.1. Customisation

In this approach, users are able to customise the layout of the user-interface and content, within a given system, based on a match between the attributes of users (which are explicitly collected in the user profile) and the attributes of the content. For

instance, when users make selections, these preferences are stored in a user profile and then used by the system to filter out the required content and to control the presentational aspects of the user-interface (Hyldegaard & Seiden, 2004).

An enabling technique for this type of personalisation is typically achieved using fillin forms. In this technique, data about users are stored in the user profiles which are built through the direct involvement of the user. The fill-in forms technique requires users to explicitly express their preferences/interests in order to control the type of received content and customise the 'look and feel' of the user-interface (Bonett, 2001).

Fill-in forms typically can be created using HTML. Fill-in forms contain normal content, markup, special elements called controls (e.g. checkboxes, radio buttons and menu items) and labels for those controls. The interaction occurs when users complete the from by modifying its controls, for example, entering a text value in a text box element or selecting a particular radio button value. This interaction is carried out before submitting the form to the Web server for processing (W3C Recommendation, 2004).

A user for example fills-in a form ordering some items on a commercial Web site, such information is then posted to the Web server. A process might occur on the server side such as examining if there are enough quantities of the requested items. The process of quantities examination can be accomplished by having a scripting programme written in a scripting language (e.g. CGI, PHP or ASP) on the server side. After carrying out the assigned processes, the server sends the page back to the browser for the user including a confirmation of the requested item (see Figure 2.1) (Nuñez, 2003).



Figure 2.1 Fill-in form technique (Nuñez, 2003)

My Yahoo is one of the personalised services that uses customisation. In this approach, users are exposed to a great deal of options. The user can control the content channels which are relevant to their needs (e.g. news, weather, TV, etc.) by selecting checkboxes and menus. Furthermore, users can change the presentational aspects of the received content on the screen (My Yahoo!, 2004).

Figure 2.2 shows a customisation page where information relating to weather and company news is selected. In response, a Web page including content based on the selections made earlier is shown in Figure 2.3.

| Page Name: My Front Page | | | | |
|-----------------------------|--|--|----------------------------|-----|
| My Yahoo! Essentials | a da ser esta esta esta esta esta esta esta esta | · · · · · | Community | |
| 🔲 <u>Headlines</u> wo | 11 | 1. A. | Teen Stuff from Bolt (N) | |
| 🗇 <u>Message Center</u> (N) | e Ar an | | Evite (N) | |
| Weather (N) | | | 🔲 Favorite Chatrooms (N) | • |
| 🗋 Inside My Yahool (N) | | ta i tarria | 🛄 <u>Message Boards</u> տ | |
| Yahool Mail Preview 👀 | | an e genere por | Entertainment | с., |
| Υahool Search (Ν) | | and a second | Artist of the Day (N) | |
| Business & Finance | | en en statue | Comics 00 | |
| Stock Portfolios (N) | 14 A. | | Gossip (w) | |
| Company News (%) | · | and a second second | My Napster (N) | |
| Market Summary (N) | I | | (N) Music Video of the Day | |
| Currency Converter (W) | | | Horoscopes (w) | |
| Upgrades/Downgrades (N) | | | Video Features (vv) | |
| Earnings Surprises (N) | | · · · | TV Listings (M) | |
| Small Business Features (M | ٥ | | Movie Showtimes (vv) | |
| 🔲 In Play® လာ | | | Album Releases (N) | |
| News | | | Movie Releases (N) | |

Figure 2.2 Customisation options available on My Yahoo (My Yahoo!, 2004)

| My Front Page | wednes | day - mar 1(|
|--|-----------------------|-----------------|
| Change Color: Choose Contant Change Layout / Add/Delate Pages | I make this my homeya | ge] (hidebytt |
| Company News Mar 10 607pm | Weather | Edit |
| <u>YHOO</u> M& 10 85350 | Hong Kong | 6474 F |
| • AOL, Earthlink, Microsoft, Yahoo file anti-spam suit (Reuters) | London UK | 3443 F 💽 |
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| Federal Anti-Spam Law (Business Wire) | Paris Orly Auport | 2639 F 🛃 |
| <u>[external] Tech stocks try to get Dack on Fack (at CBS MarketWatch)</u> Javewire: Internet radio finds its groove (Reutere) | Rome, II | 4353 F 💈 |
| GE, Juniper Made a Smart Tradeoff (RealCommentary from TheSizesi.com) | Sydney | 6272 F |
| | Tokya | 5362 F |
| | Los Angeles, CA* | 6184 F 🚰 |
| | New York, NY* | 3445 F 🖉 |
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Figure 2.3 Content received based on the earlier selections (My Yahoo!, 2004)

This personalisation approach however has some disadvantages from the users' viewpoint. It is considered time consuming for the users to spend time setting up complex personalisation features and therefore the provided service may remain unutilised (Bonett, 2001). The user profile created by this technique is also static i.e. the collected preferences/choices of users are not changed unless the user makes an effort to input amendments (Bonett, 2001; Nielsen, 1998; Manber, Patel & Robison, 2000).

2.3.2. Rule-based personalisation

Similar to customisation, rule-based personalisation carries out a match between the user's attributes and the content attributes based on rules set up by the developers of the system. These rules are similar to if/then conditionals and can be used to expose users to relevant content. For instance, if a user adds a printer to the shopping cart, a typical personalisation response could be a promotion for buying some printer paper (Hyldegaard & Seiden, 2004; Payne, 2000).

However, the drawback of this type of personalisation is that developers should know in advance the rules and the reaction of these rules. Also, there should be a continuous update of these rules in order to reflect the changing needs of users (Hyldegaard & Seiden, 2004; Payne, 2000).

2.3.3. Behavioural-based personalisation

This approach refers to personalisation which occurs based on the user's behaviour in the system such as clicks, purchases or search terms. A model of a user (i.e. user profile) in this case is built dynamically without any user intervention based on the user's behaviour in the system. This user model is subsequently used to filter out and recommend relevant content or service to users (Hyldegaard & Seiden, 2004).

One of the enabling techniques for behavioural personalisation is click-stream analysis. This technique is based on analysing the Web log files that are generated by the Web server each time the user visits a Web page and clicks on a hyperlink. These generated files contain information about users' navigational behaviour on a Web site (Hall, 2001). These log files can be used to record the navigational paths of users including their last location before reaching the Web site, their movements within the Web site and the destination on exit. The information in Web log files can be intensively analysed. Analysing users' clicks is one of the analyses that can be

performed on these files. It is possible in this technique to track the clicked links and the time spent on each page (Bonett, 2001).

Web log files analysis can be advantageous for learning users' behaviour. For example, it can be used to segment and characterise users according to their preferred pages. It can also be used to observe the most frequent navigational paths on the Web site. Accordingly, having such information is vital in redesigning and optimising the Web site so that it suits the user needs (Hall, 2001). All these operations can be carried out anonymously and therefore the user's privacy is protected (Bonett, 2001).

The Web log files are usually generated in a text format by the Web server. These files are not easy to read in their raw format, particularly if they are to be used to identify users' behaviour. Accordingly, special computer programs have been developed called 'Log File Analysers' that are capable of reading these log files and transforming them into an understandable format e.g. statistics. WebTrends, WebSideStory and eXTReMe Tracking are examples of these analytical programs (Reading the log files, 2002).

It can be seen that behavioural-based personalisation can be achieved in two modes – online and offline. The online mode depicts the situation where users get online recommendations as they interact with the system. The system in this case should be able to track and analyse the user's behaviour to make appropriate recommendations. For instance, Amazon's Web site provides users with direct recommendation based on their navigational behaviour or buying history. Behavioural-based personalisation can be carried out in an offline mode. Using analytical software, to determine the least desired page and undertaking necessary changes (e.g. editing its content) to make it more attractive to users, is an example of the offline mode.

Figure 2.4 represents a recommendation page for the user based on a previous buying history of that user.

| 2] Amazon co. uk: Recommer | ided for You - Microso | ft Internet Explorer provided by L | oughborough University | | G G G G G G G G G G G G G G G G G G G |
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Figure 2.4 Recommendation page based on a buying history of the user (Amazon, 2007a)

Figure 2.5 shows a statistical analysis for a Web log file that identifies the number of visits being carried out by users on a Web site for the year 2003. This statistical analysis has been generated using WebTrends software.



Figure 2.5 A statistical analysis of a Web log file using WebTrends (AbilityHub, 2001)

Chapter 2

Using Web log files however result in difficulties concerning the increasing size of these files. Normally, a Web server writes to the log files each time a user visits the Web site. Consequently within a period of time such files may include a huge amount of information about users. It is therefore necessary to take the right decisions about the preservation time of these log files. In addition, the cost of the adopted software that will undertake the analysis should be considered (Fleishman, 2004).

An alternative behavioural technique is when a user model is built based on a community or a group of like-minded people. This is called collaborative filtering (Payne, 2000). Collaborative filtering, which is some times called social filtering, is a technique by which people's recommendations about a product or a service can be automated and then presented to other people who share the same opinions or experience. A user may need, for example, to make a choice within a variety of options in which he does not have any experience, this user may depend on other peoples' opinions who have experienced the same options. In a Web environment however where users can have myriad options, it becomes impossible to seek advice for each option. Therefore, collaborative filtering systems are being used and developed in order to address this problem (Heylighen, 1999).

Heylighen (1999) described the basic mechanism by which collaborative filtering systems work:

- Recording the preferences of a large group of people.
- Selecting a sub group of those people that have similar preferences to the user who needs advice by using a similarity metric.
- Calculating an average of the preferences of that sub group.
- Using the resulting preference function to recommend options for the user who needs the advice.

To provide better chances of relevant recommendations for the advice-seekers, the similarity metric, within the collaborative filtering system, needs to select a group of people who share similar interests to evaluate the available options (Heylighen, 1999). Therefore, the people's interests or preferences need to be collected. One of the

possible ways to collect user's preferences is to infer from their previous actions (e.g. buying or viewing a product) or by asking them directly to rate a product (Bonett, 2001).

Figure 2.6 shows the results when searching for XSLT books using the Amazon Website. Choosing, for instance, the first book (in Figure 2.6) returned a page including recommendations based on the buying history of like-minded people (i.e. people who bought the same XSLT book) (see Figure 2.7).

However, the collaborative filtering technique has some limitations in that the quality of the provided recommendation depends on the size of the sample of similar people. A small sample may decrease the quality of the recommendations whereas a large sample increases the recommendations' quality (Bonett, 2001).



Figure 2.6 A search result for XSLT books (Amazon, 2007b)

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| ISBN-13: 978-0764569098 | | | | |
| Product Dimensions: 9.2 x 7.4 x 2.2 inches | | | | |
| Average Customer Review: **** based on 1 review. (Write a review.) | | | | |
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Figure 2.7 recommendation page for other XSLT books based on the buying history of likeminded people (Amazon, 2007c)

Having reviewed the personalisation approaches, it was decided to adopt rule-based personalisation and behavioural based personalisation. The choice of these approaches was driven by research question 1. Applying personalisation techniques based on the users' conditions and level of knowledge were best met by adopting rule-based and behavioural approaches respectively.

Personalisation is found in many application areas. One is recommender systems where techniques involve analysing users' ratings, analysing users' usage information, clustering users with similar interests/preferences etc. Another important area for personalisation is adaptive hypermedia which aims to guide users (e.g. presenting relevant content) within the universe of a hypertext/hypermedia systems based on a maintained user model (Dolog & Henze, 2003). The sections below provide an overview of adaptive hypermedia and show the techniques that were used to inform the implementation of the adopted personalisation approaches.

2.4. Adaptive hypermedia

Brusilovsky & Maybury (2002, p. 31) mention that Web systems suffer from the inability to accommodate the different needs of users with different knowledge, interests and goals. Such Web systems apply the traditional "one-size-fits-all" approach, for instance, some Web-based courses provide the same static learning content to students characterized by variant knowledge of the subject. Some virtual museums on the Web present the same guided-tour to visitors with different interests. A number of Web health sites offers the same information for patients with different health problems.

Therefore, efforts have been moved towards developing methods and techniques that are capable of generating more intelligent, collaborative and personalised applications to satisfy the different needs of users (Koch 2001, p. 1).

Adaptive Hypermedia is one of the recent research areas that attempts to replace the traditional approach. In adaptive hypermedia it is possible to build systems that have the ability to adapt their interactions to individual or group of users' preferences, interests, goals, tasks, etc. Currently this domain is capturing the attention of many researchers from different communities including hypertext, user modelling, machine learning, natural language generation, information retrieval, intelligent tutoring systems, cognitive science, and Web-based education (Brusilovsky & Maybury 2002, p. 31).

2.5. The evolution of adaptive hypermedia

Adaptive hypermedia has its origin in a previous work related to adaptive hypertext in 1990 (Brusilovsky& Maybury 2002, p. 31). Hypertext structure consists of interlinked pieces of information (i.e. text). The units of information are called nodes and the pointers, which connect the units, are called links. Hypertext provides a non-linear way for presenting the information which means there would be no single way by which the documents could be read/viewed. Therefore, hypertext has become as an alternative for traditional text documents which represent the content in a sequential order. Figure 2.8 shows the structure of the hypertext as a network being formed between the nodes and links. In this network structure, users can not only read the

nodes, but they also can move around in an activity called browsing or navigating (Wu 2002, pp. 5-6).



Figure 2.8 The network structure of hypertext (Wu 2002, p. 6)

Hypermedia has the same network structure of hypertext. However, it extends the hypertext structure by including multimedia elements within the nodes such as: images, videos, audios or animations. Although there are advantages offered by such a network structure, there are some shortcomings and limitations including the following problems:

- Navigation and the orientation problems caused when users navigate in the system's hyperspace without any guidance. This kind of problem is known as "lost in hyperspace" and it increases especially when the hyperspace is very large (Wu 2002, p. 6).
- Providing the same information to users having different needs, goals or knowledge (Wu 2002, p. 6).
- Cognitive overload, which is represented in requiring users to remember the hyperlinks and to understand the entire information space of the system in order to find a suitable links that lead to desired information (Koch 2001, p. 3).

Adaptive hypermedia systems (AHS) seek to resolve these problems by "adopting a user-centred approach" (Koch 2001, p. 3). In this approach the user is observed by the system, depending on these observations a user model is built for the individual user and adaptation aspects are provided based on the built user model. The adaptation of the systems content and presentation can be achieved in AHS by providing users with relevant information in an appropriate layout. Consequently, this prevents users from facing the cognitive overload problem. Furthermore, the adaptation of the navigational paths, by "limiting the browsing space, providing annotations for the links, hiding some irrelevant links or suggesting the best link to follow" resolves the disorientation problem (Koch 2001, p. 3).

2.6. Structure of adaptive hypermedia

Understanding adaptive hypermedia systems/applications can be achieved through reviewing their general structure. In this sense, a framework of adaptive hypermedia systems, developed by De Bra, Brusilovsky & Houben (2000, p. 2), was outlined.

This framework was developed to describe and define adaptation and other structural aspects in AHS. In this framework there are three types of concepts defined including:

- Atomic concept or fragment, which represents the smallest unit of information in the domain model (i.e. the knowledge contained within the hyperdocuments).
- Pages, which are composed of fragments.
- Abstract concept which represents a larger unit of information (i.e. it could be a collection of pages which refer to a broad concept).

These concepts are connected together using concept relationships such as prerequisites relationships (i.e. links that lead to prerequisite concepts for the concept being viewed).

According to this framework, the following functions occur in AHS:

• During the browsing process of users in AHS, all users' activities are observed using observation/tracking techniques such as logging of the requested pages.

Based on these observations, the AHS builds a user model containing, for instance, the user's knowledge about each concept in the domain model. For example, the attribute knowledge value (e.g. beginner, expert, etc.) reflects the user's knowledge about concepts in the domain model. Another knowledge attribute such as 'read' could also be used to reflect if the user has read something about the concept being viewed (e.g. if the user has read prerequisite concepts).

- Depending on the user model, the AHS classifies the nodes (pages) into groups in accordance with the users' knowledge and interests of the user. The AHS manages the existing link anchors and destinations in order to direct users to the required and relevant information. Based on the node classification, link anchors could be annotated, disabled or removed this is called adaptive navigation support.
- The AHS shows, hides, highlights or dims conditional fragment on a page when representing it in order to ensure that an appropriate content with appropriate level of difficulty or detail has been delivered to the user – this is called adaptive presentation.

Koch (2001, p. 16) devised a model specifically concerned with describing the states of adaptation lifecycle and the possible transitions between these states in AHS. She describes that AHS go through different states (steps) during their use or stay in different conditions when interacting with the user, adapting the presentation and updating the user model. These states occurring in AHS are called the adaptation lifecycle. Figure 2.9 shows a lifecycle model for adaptation including the states of the adaptation lifecycle and the possible transition between these states. The model is represented using a UML (Unified Modeling Language) state-diagram (Koch 2001, p. 16).



Figure 2.9 Adaptation lifecycle (Koch 2001, p. 16)

In this model four states for adaptation lifecycle are identified encompassing 'presentation', 'interaction', 'user observation' and 'adjustment'. It can be seen from Figure 2.9 that the 'adjustment' state consists of two potential options the 'user model update' and 'system adaptation', and the order of their occurrence is determined by values stored in the user model. The adaptation lifecycle model also includes four sequential transitions: 'user action', 'adaptive reaction', 'observation completed' and 'adaptation completed'. In addition to the previous transitions, the model includes two further transitions represented by the 'user inactivity' and 'non-adaptive reaction' (Koch 2001, p. 16).

The adaptation lifecycle in this model starts with initial presentation and initial user model. The following describes the semantics for states in the model (Koch 2001, p. 17):

• In the 'presentation' state the AHS presents an appropriate page with suitable presentation elements to the user according to initial values stored in the user model. The AHS does not change to the next state (interaction state) until an interaction occurs or a 'time-out signal' is received. The user inactivity transition in this state represents the system waiting for the user action.
- In the 'interaction' state the AHS chooses between two alternative transitions in order to respond to the user action including 'adaptive reaction' or 'nonadaptive reaction'. The later (i.e. non-adaptive reaction) depicts the ability of the system to carry out the response without updating the user model and the presentation. The former transition (i.e. adaptive reaction) involves updating the user model and presentation. Depending on which transition is applied, the system moves either to the user observation state or to the presentation state (see Figure 2.9).
- If the transition applied was the adaptive reaction then user observation would be the next state in the sequence. The aim of this state is to evaluate the collected information during the user interaction with the adaptive hypermedia system.
- After the completion of the 'user observation', the adaptation lifecycle proceeds to the adjustments state which involves two sub-states the 'user model update' and 'system adaptation'. In the former sub-state, the system uses the information collected during the user observation state to update the user model. In the latter sub-state, the system uses information collected in the user model to apply adaptation on the level of content, links or presentation.
- After the finalisation of the 'adjustment' state, (i.e. as soon as the user model updated and system adaptation occurred), the system is then prepared to proceed to the next presentation state with all the required adaptations.

As described earlier, adaptation in AHS can be applied on different levels including content, links and presentation. The following describes these levels of adaptation:

2.7. Levels of adaptation

A hypermedia system can be perceived as a set of nodes (pages) connected together using links. These pages include some local information, a number of links to related pages and sometimes index or global maps which enable users to access all the available pages (Brusilovsky 1996, p. 10).

The adaptation elements in a hypermedia system are to some extent limited. What can be adapted in these systems involves adaptation of content and links (Brusilovsky 1996, p. 10). Based on these aspects of adaptation, Brusilovsky (1996, p. 10) distinguished two different levels for adaptation in AHS:

- Adaptive presentation, where the adaptation is applied to the content of normal pages (adaptation at the content level).
- Adaptive navigation support, where the adaptation is applied to the links in the normal pages, index pages and maps (adaptation at the link level).

Patterno & Mancini (1999) presented different elements for adaptation in AHS by introducing adaptation at the presentation level (i.e. layout of the user-interface). They distinguished the following levels of adaptation:

- Adaptive content which involves showing different pieces of information including texts and images, video, animations, etc. based on the state of the users model. For instance, provide more information to experts than novices.
- Adaptive navigation which is concerned with applying changes to the links in AHS. This involves applying changes to links appearance, destinations, number and order.
- Adaptive presentation which is related to providing users with different layouts of the system's interface elements using different order of media types, different colours and different font size and type.

It can be seen that the first classification for adaptation depends on the structure of hypermedia systems including content and links. The second classification takes the presentation element of hypermedia systems into account (in addition to the content and links) and applies adaptation on the levels of presentation, content and links. Bearing in mind this context, the following reviews the various methods and techniques used for applying adaptation focusing on the levels of content and links.

Chapter 2

2.8. Methods and techniques for adaptation

Different methods as well as their corresponding techniques can be used to apply adaptation in hypermedia systems. Adaptation techniques consist of methods that provide adaptation in existing hypermedia systems. Each technique is attributed by a specific type of knowledge and performs a specific working method (Brusilovsky, 1996, pp. 2-3).

The adaptive methods can be perceived as a generality of the existing adaptation techniques. Each method depends on a plain adaptation idea that can be presented at the conceptual level of the system, e.g. hiding the links of a concept that is not ready to be learned yet. Furthermore, some of these methods can be applied using different techniques, e.g. additional explanations can be applied using conditional text, stretch-text or frame-based techniques (Brusilovsky 1996, p. 3).

The following sections provide a detailed description of the various methods and techniques of the adaptive presentation (i.e. adaptive content) and adaptive navigation support.

2.8.1. Adaptive presentation (adaptive content)

According to Brusilovsky's classification for adaptation, the aim of the different adaptive presentation methods and techniques is to make the content that is read/viewed by users adaptive to their knowledge, goals, background and preferences (Brusilovsky 1997, p. 13).

Brusilovsky (1996, pp. 14-15) distinguished various methods and techniques to apply adaptive presentation at the content level. The following is Brusilovsky's (1996, pp. 14-15) classification for methods of adaptive presentation at the content level:

• Additional explanations: this is the most frequently used method of content adaptation. The idea of this method is to hide the pieces of information, concerning a particular concept, that do not match with the user's level of knowledge about that concept. For instance, detailed concept information can be hidden from users showing little knowledge about that concept.

- Prerequisite explanations: based on the user level of knowledge (reflected in the user model), the AHS provides prerequisite links between concepts. These links present all the prerequisite information about a concept, which are not well known to the user, before showing the concept itself.
- Comparative explanations: also based on the user level of knowledge about a concept, the system provides similarity links between concepts. The idea of this method is to present comparative explanations (similarities and differences) between a related concept and the concept being presented if both are known to the user.
- Explanation variants: this method considers that hiding or showing pieces of information does not always satisfy users, because different users have different information needs. Therefore, the AHS maintains several variants for some portions of the content and the user then receives the matching content variant depending on the user model.
- Sorting: the idea of this method is to sort the fragments of information in a descending order i.e. form the most relevant to the least relevant. Depending on the user background and level of knowledge, the most relevant fragments are shown first in content order.

There are a number of adaptive presentation techniques that are used to apply the methods of adaptive presentation. As mentioned before, a method can be applied using more than one kind of the following techniques (Brusilovsky 1996, pp. 15-16):

- Conditional text: in this technique all the related pieces of information about a concept are partitioned into several chunks of texts. Depending on the user's level of knowledge stored in the user model each chunk is linked to a particular condition. When information is required about a concept, the AHS only shows the chunks that meet the condition (i.e. the system only shows the chunks which fulfil the associated conditions and the level of user knowledge).
- Stretch-text: hypermedia or hypertext systems normally contain hot-word(s) within the page that leads to another page or object when clicked on. Instead of moving to another page, the stretch-text technique replaces the hot-word

with extendable and suitable text that fits with user level of knowledge. Furthermore, it is possible to shrink the extended text back again to a hotword. Therefore, when information is required about a concept, the AHS determines which hot-words are extended and which are shrunk in an initial presentation according to the user's level of knowledge. Moreover, this technique allows users to control the processes of extending and shrinking the text if the system's suggestions did not match their needs.

- Page variants: the idea in this technique is that the AHS maintains two or more alternative pages having different presentations of the same content. Each page is ready to fulfil one of the existing user models. Therefore, when a page is requested the system presents one of the alternative pages to users that corresponds their user model.
- Fragment variants: is more fine-grained than page variant technique. This technique considers that a page can present more than one concept to users and therefore the system maintains different explanations for each concept. Accordingly, the system provides users with different explanations of concepts that matches their level of knowledge about these concepts reflected in the user model.
- Frame-based technique: in this technique all the information concerning a particular concept is presented in the form of a frame. Each frame has several slots which can be used for several purposes, for example, to present variants of explanations for a concept or to present links to other frames. The appearance and the order of these slots are determined by special presentation rules. These rules can be used, for instance, to calculate the presentation priority for each slot within a frame where slots with highest priority are presented first to users. These rules take into account the values stored in the user model (e.g. level of knowledge) when calculating the presentation priority.

Table 2.1 shows techniques that can be used in order to implement each one of the adaptive presentation methods. For instance, the explanation variants method can be

applied using the conditional text, fragment variants, page variants or frame-based technique.

| Techniques Methods | Conditional text | Stretch-text | Fragment variants | Page variants | Frame-based technique |
|--|---------------------|--------------|----------------------|------------------|--------------------------|
| Additional, prerequisite and comparative explanations | Х | Х | | | Х |
| Explanation variants | X | | х | Х | X |
| Sorting | | · · · · · · | | | Х |

Table 2.1 Methods and techniques of adaptive presentation (Brusilovsky 1996, p. 15)

2.8.2. Adaptive Navigation Support

The goal of adaptive navigation support at the content level is to support the users in their navigational activities by avoiding presentation of irrelevant navigational paths. This is achieved by adapting the way of presenting the links in accordance with the user's knowledge, goals and other characteristics maintained in the user model (Brusilovsky 1997, p. 14).

Brusilovsky (1996, pp. 18-21) has identified possible methods and techniques for adaptive navigation support. The following depicts Brusilovsky's (1996, pp. 18-21) classification for methods of adaptive navigation support including:

• Global guidance: the objective of this method is to support the users in finding the shortest path to the information they want to find or to learn about, which may be scattered in several nodes across the hyperspace. This method can be applied in a way where the system can recommend suitable links to users at each navigational step from the current node. This in turn helps users to achieve their global goal.

- Local guidance: the aim of this method is to aid the users in one browsing step by suggesting the most relevant link (i.e. the best link) from the current node. This method does not consider global goals, instead the suggestions are made in accordance with the users' knowledge preferences or background stored in the user model.
- Global orientation: the aim of the global orientation method is to help users to understand the overall structure of the system's hyperspace and to understand this or her current position in it. This method can be considered as a user's guided tour that supports the users to gradually build a comprehensible idea about the entire hyperspace.
- Local orientation: the objective of this method is to assist the users in understanding 'what is around' within the hyperspace i.e. understanding the various navigational possibilities from the current node. Also, this method aims to help users to follow the appropriate links.
- Personalised view: the personalised views method provides users with a way
 to organise personalised views of the system's hyperspace. Each view consists
 of a set of links that leads to nodes which are appropriate to the user's goals.
 In classic hypermedia systems, it is the users responsibility to create and
 manage these personalised views, but in the AHS the adaptation of the
 personalised views is more developed; for example, some AHS use intelligent
 agents which are responsible for creating and maintaining up-to-date set of
 links (i.e. up-to-date personalised view) relevant to the users' goals. This
 method is appropriate for users who only need to access small portions of the
 system's hyperspace.

The following depicts the techniques of adaptive navigation support which can used to apply the earlier methods of adaptive navigation support. The implementation of these techniques depends on manipulating the anchors and links taking into account the current state of the user model. Brusilovsky (1996, pp. 12-13) identified the following techniques:

- Direct guidance: in this technique the system shows only one best link to users to proceed with their next browsing activity. The system provides these links according to the user's goals and other significant characteristics represented in the user model. However, The direct guidance technique has some limitations it provides users with limited support and does not suit users who do not like to follow the system's recommendations.
- Adaptive link sorting: in this technique all the links available within the nodes are sorted according to the user model values (knowledge, background or goals). Sorting of links is carried out in a descending order from the most to the least relevant links (i.e. the most relevant links are placed towards the top). However, adaptive links sorting has some disadvantages it can not be applied to the contextual links (i.e. links embedded within the context of the presented content that cannot be removed from it e.g. hot-words) and can hardly be applied on the indexes and content pages links. This technique can only be used with the non-contextual links (links which are independent from the context of the presented content). Furthermore, this technique is considered unstable since the order of the links may change each time the user visits a page.
- Link hiding: the objective of the link hiding technique is to limit the navigation possibilities by hiding inappropriate links based on the user goals. This technique helps users to avoid the cognitive overload problem and the complexity of the hyperspace by leaving only the relevant links shown.
- Links annotation: with this technique the link anchors are consolidated with comments according to the values (i.e. knowledge) represented in the user model. Using links annotation technology gives users an idea about the state of the nodes behind the annotated links. Links annotation can be applied in different forms (as in textual or visual hints that use different colours, icons, or font sizes) in order to indicate the degree of appropriateness.
- Map adaptation: the map adaptation technique is concerned with adapting the structure of hypermedia maps (i.e. graphical representations of the links structure). This technique can only be applied to the links available within

global maps (i.e. a graphical representation of the overall system's hyperspace) or local maps (i.e. a graphical representation of a local area of that hyperspace) of hypermedia systems.

Table 2.2 shows techniques that can be used to implement each method from the adaptive navigation support methods. For instance, the method global guidance can be applied using the direct guidance or sorting techniques.

| Techniques Methods | Direct guidance | Sorting | Hiding | Annotation | Map adaptation |
|-----------------------|--------------------|---------|--------|------------|-------------------|
| Global guidance | X | Х | | | |
| Local guidance | х | X | X | х | x |
| Global orientation | | | Х | X | Х |
| Local orientation | | X | х | х | |

Table 2.2 Methods and techniques of adaptive navigation support (Brusilovsky 1996, p. 17)

After reviewing the techniques of adaptive hypermedia, for this research it was decided to choose particular techniques that are applied on content, links and presentational aspects of the content (i.e. the layout). In terms of content adaptation techniques, it was believed that applying the conditional text technique would be more appropriate compared to the others because it was necessary to be able to filter out the content based on the user's condition (research question 1). The stretch-text technique was also deemed appropriate, however it was decided to keep the implementation of this technique simple (i.e. to let the user to control when to expand or shrink the content) because the users' requirements at this stage were not determined. In terms of link adaptation techniques, it was decide to implement the direct guidance technique. This choice was deemed useful as it allowed the implementation of behavioural personalisation based on the user's knowledge

(research question 1). Finally, the implementation of layout personalisation in terms of using different font size and background colour were deemed necessary as this could cater for the different sight problems.

2.9. Examples of adaptive hypermedia systems

A good number of AHS have been constructed to act as information resources that are capable of serving a wide range of groups or individuals. Those groups or individuals may have different backgrounds, goals, experiences, preferences and knowledge. Therefore, such AHS have adopted several adaptive features to accommodate differences between users while providing the information.

Most of the existing AHS serve as single-purpose applications, i.e. they contain specific topic content. Exceptional cases can be found in some developed AHS where they serve as a general-purpose application (authoring system). These authoring systems are capable of generating systems on different topics (De Bra & Calvi, 1998). The following are illustrative examples of these AHS. Most of these systems were developed in the educational domain:

2.9.1. InterBook System

InterBook is a Web-based authoring system that has been designed to serve as an electronic textbook (ET). This ET is capable for presenting different topics, from the educational domain, as online course material. The following presents some structural aspects and adaptation features used for this authoring system (Brusilovsky, Eklund & Schwarz 1998, pp. 291-300):

2.9.1.1. InterBook structure and adaptation

The InterBook approach utilizes two types of knowledge when adapting its content and link structure – knowledge about the introduced domain (i.e. the domain model) and knowledge about students (i.e. the user model). The domain model can be perceived as a collection of the domain concepts that are interlinked via the links which depict the relationship between concepts in the domain model. Each user model contains values, which reflects the user's knowledge about concepts within the domain model. Furthermore, each user model is kept up-to-date through monitoring the students' actions (e.g. their browsing activities and quizzes answers). The values in the user model are then used to alter (i.e. increase or decrease) the students' level of knowledge about the given concepts.

InterBook uses the following structure for content representation:

- The glossary: this constitutes the main part of the ET. The glossary visualises the nodes from the system's hyperspace by representing the concepts from the domain model and showing links between these concepts. In other words, each glossary entry is assigned to one domain concept, and the links between domain model concepts establish navigational paths between glossary entries. The objective of the glossary is to provide a description for concepts from the domain model. In addition, the glossary section provides links to all sections that introduce or require the current concept (see Figure 2.10).
- Indexed textbooks: In InterBook, each ET is structured as hierarchical units of a human-written textbook including: chapters, sections, and subsections. The units in each ET are indexed based on the concept of the domain model. This allows the system for instance to identify the prerequisite concepts needed for the current concept. Each unit in an ET is attached to a group of related concepts, which is called the 'spectrum' of the unit. This spectrum includes the names and roles of the involved concepts. In the current implementation of InterBook, two types of concept roles are supported – outcome concept and prerequisite concept to understand the content of the unit (see Figure 2.10). An outcome concept means that some parts of the unit provide knowledge about this concept (see Figure 2.11).



Figure 2.10 An entry in the glossary page (Brusilovsky, Eklund & Schwarz 1998, p. 296)

The InterBook approach applies several navigational features (see Figure 2.11):

- Regular navigation features include:
 - Moving sequentially (forward and backward) or hierarchically (up and down) within the unit hierarchy.
 - Providing a navigation centre, which allows students to move to all sections at the same or upper level.
 - Generating a table of content.
 - Generating links between the ET units and the glossary pages through links in the concept bar.

- Advanced navigation features include:
 - Providing a concept bar shows outcome and background (prerequisite) concepts for the involved unit. Links in the concept bar are able to transfer the student to the corresponding glossary pages (see Figure 2.11).
 - Providing links in each glossary page that transfer the students to all the units of an ET, which introduce or require students to the current concept (see Figure 2.10).
- Adaptive navigation support: InterBook implemented adaptive navigation support using the adaptive link annotations technique. This technique was achieved by using special icons (traffic light icon), fonts and colours for links based on the users' level of knowledge, to show the state of the educational concept behind links. In InterBook, a red colour means that the concept is 'not ready' to be learned, green colour means 'ready and recommended' to be learned and white colour means 'no new information'. Moreover, using the checkmark in front of a link means this link leads to an already visited page (see Figures 2.10 and 2.11). Using the annotations within some parts of an ET can indicate different meanings (other than the mentioned above), for example, in the concept bar using a small checkmark means 'unknown', a medium checkmark means 'learned' and a big checkmark means 'well-learned'.
- Direct guidance: in InterBook, this technique was achieved by using the 'Teach me' button (see Figure 2.11). Clicking this button makes the system select the most appropriate link in each navigational step until the learning goal is reached.
- Prerequisite-based help: this technique was adopted in InterBook to help students who have problems with understanding some of the explanations presented due to not understanding some of the prerequisite information. This technique was applied through using the 'Help' button in the toolbox (see Figure 2.11). Clicking this button allows the system to generate a list of links for all the sections that provides prerequisite concepts for the current section.

The generated list of links is sorted according the student's level of knowledge where the most 'helpful' links are listed first.



Figure 2.11 InterBook Navigational and Adaptation Features (Brusilovsky, Eklund & Schwarz 1998, p. 297)

2.9.2. KN-AHS System

KN-AHS is an adaptive hypertext system that depends on the current user's level of knowledge when adapting the content. KN-AHS utilises software called BGP-MS for constructing the user model components. The following presents an overview of the functionality of BGP-MS and shows how it communicates assumptions about the user's knowledge to the KN-AHS system (Kobsa, Müller & Nill 1994, pp. 99-105):

2.9.2.1. BGP-MS Specifications

BGP-MS (which stands for Belief, Goal, and Plan Maintenance System) is a user modelling shell system that receives information about users from the application, and in return provides the application with assumptions about the user's knowledge of the current concept. This process, which is carried out independently (i.e. the user model is not integrated in the KN-AHS system), involves a communication process between BGP-MS and KN-AHS (see Figure 2.12).



Figure 2.12 Communication between KN-AHS and BGP-MS (Kobsa, Müller & Nill 1994, p. 100) Figure 2.12 shows the communication process between BGP-MS and the KN-AHS systems. This process involves the following steps:

- The user's actions are tracked by KN-AHS and then reported to BGP-MS.
- KN-AHS asks BGP-MS about particular assumptions concerning the user's knowledge of the current concept.
- In return BGP-MS provides KN-AHS with those assumptions.

The BGP-MS system uses a partition mechanism that allows collecting different types of assumptions about users such their knowledge, goals, stereotypes of users groups. In this mechanism, all partitions are ordered in a hierarchical structure where inferior partitions are capable of inheriting the content from the superior partitions. These partitions include the following (see Figure 2.13):

- The user model is represented in SBUB (System Believes User Believes) and SB¬UB partitions. The SBUB partition contains assumptions about the user's knowledge and SB¬UB partition contains assumptions about what the user does not know.
- Stereotypes of users: the current implementation of the KN-AHS system included the following types of user groups and subgroups: 'any person',

'Hypertext user', 'PC user' and 'CS student'. These stereotypes contain typical characteristics of potential users for the KN-AHS system with different backgrounds. The stereotype 'any person' includes general information that is available to any type of users. The other subgroups of stereotypes contain typical characteristics of users with different backgrounds; users of hypertext systems, PC users and computer science students. These subgroups of users inherit the content from the general stereotype 'any person'.

• The SB partition represents the domain knowledge of the KN-AHS system.





In BGP-MS, each individual user model is assigned to one (or more) stereotype(s). This is accomplished by a mechanism that analyses the received users' observations and then establishes connections between the user-model (which is included in the SBUB and SB-UB partitions) and the matched stereotype(s) so this stereotype becomes active. These connections can be deleted so that the stereotype becomes inactive (see Figure 2.13). This process of activation and deactivation is necessary because, for instance, the computer science students would definitely have knowledge in using PC; consequently, activating the 'PC user' stereotype would be needed.

In KN-AHS, assumptions about the user's familiarity with concepts can be accomplished through the messages that are reported from KN-AHS to BGP-MS. These messages are important when adapting the hypertext documents. For instance, to generate an assumption about the user's familiarity with a concept, KN-AHS reports observations about the user's familiarity with a concept, KN-AHS contain information that is concerned with the user's knowledge about a concept. This

information constitutes primary assumptions reflecting the user's familiarity or unfamiliarity with the concept(s) presented. These primary assumptions are then incorporated in the SBUB and SB¬UB partitions and compared with the all stereotypes. Consequently, matching stereotype(s) then become active.

2.9.2.2. KN-AHS structure and adaptation

The user interface in KN-AHS consists of a number of regular and adaptive areas which aid users in reaching their learning goals. These areas encompass the following (see Figure 2.14):

- Headings area.
- Text objects area that includes textual and graphical objects. Boxed text elements can be found within the text called hot-word, for example, the word 'Konzepten' (means concept).
- Status line area, which informs the user about the possible functionality assigned to the hot-word.
- Action buttons, which provide users with the navigational functionalities within the KN-AHS hyperspace. These action buttons include the following:
 - □ Context-sensitive help button.
 - □ Table of content button (produces graphical table of content).
 - Dialog history button, which generates a clickable list of links that have been already accessed by the user.
 - □ Context-independent glossary button.



Figure 2.14 The user-interface in KN-AHS (Kobsa, Müller & Nill 1994, p. 102)

KN-AHS implements the stretch-text technique for content adaptation using hotwords within the text. Moving the mouse pointer over the hot-word informs the user about the assigned functionality with these hot-words. This functionality involves moving users to another text object that provides additional information for the current hot-word, or showing a pop-up menu that contains the following functions:

- Erklärung (Explanation): provides additional information that explains the hotword. Such additional information can be inserted near to the hot-word or in some situation it replaces the hot-word with a term or expression.
- Grafik (Graphic): shows a graphical representation that demonstrates the hotword.
- Glossar (Glossary): shows a glossary page that contains the current hot-word.
- Detail-Info (Detailed Information): inserts additional information near to the hot-word.

For each expandable hot-word there is a corresponding concept, which represents that hot-word in BGP-MS. Hence, any performed action on a hot-word enables KN-AHS to make assumptions about the user's familiarity with that hot-word and its corresponding concept. These assumptions are then reported to BGP-MS. The following assumptions can be made when users perform the following actions:

- If the user selects an explanation, a graphic or a glossary definition for a hotword, then the user is assumed to be unfamiliar with this hot-word and its corresponding concept.
- If the user unselects an explanation, a graphic or a glossary definition for a hot-word, then the user is assumed to be familiar with this hot-word and its corresponding concept.
- If the user requires further information for a hot-word (i.e. the user already knows this hot-word and asks for additional information), then the user is assumed to be familiar with this hot-word and its corresponding concept.

An automatic adaptation process occurs when the user moves to a new text object. Based on the assumptions that are received from BGP-MS about the user familiarity/unfamiliarity with the corresponding concept for each hot-word, KN-AHS can perform the following actions:

- If the user is reported as unfamiliar with the corresponding concept of a hotword, then a basic explanation is automatically added to this hot-word.
- If the user is reported as familiar with the corresponding concept of a hotword, then further information is automatically inserted near to this hot-word.
- If there is no reporting available then the hot-word is not changed.

Referring back to Figure 2.14, it can be seen that the user requests additional information for the hot-word "Konzept" through clicking on the 'Detail-Info' element in the pop-up menu. Additional information is inserted next to that hot-word as a response to the user's request. Such user action makes KN-AHS presume that the user is familiar with hot-word and its corresponding concept. In return, BGP-MS enters that corresponding concept in the SBUB partition as a known concept and draws

assumptions about the user's knowledge. Based on these assumptions, BGP-MS starts the stereotypes mechanism, which initialises (activates) suitable stereotype(s) for that user and then inheritance links are added or deleted between those stereotype(s) and the individual user model.

In Figure 2.15, the user has moved to a new text object 'Rollen'. Before moving to that hot-word, KN-AHS asked BGP-MS about the user familiarity with the hot-word 'Rollen'. Based on certain rules, BGP-MS reported to KN-AHS that the hot-word 'Rollen' and its corresponding concept 'Rollen' were known by the user, because they were included in the SBUB partition. Consequently, KN-AHS automatically inserted additional information to the hot-word 'Rollen' even though the user did not explicitly ask for this additional information.



Figure 2.15 Automatic insertion of additional information to the hot-word (Kobsa, Müller & Nill 1994, p. 104)

2.9.3. The AHA system

AHA (Adaptive Hypermedia Architecture) is an adaptive hypermedia authoring system that allows authors to generate adaptive hypermedia systems on any desired topic. AHA was originally developed to serve as an educational hypermedia system. Later, AHA was developed into a generic authoring system, which is able to generate systems with adaptive content and link structure according to a maintained user-

model. The following presents an overview of some significant aspects in AHA (De Bra & Calvi, 1998):

2.9.3.1. AHA specifications & adaptation

In AHA, the user-model is represented by using a set of pairs (c,v), where 'c' represents a concept and 'v' reflects the user's knowledge about that concept. Boolean values true/false are used in AHA to denote the concept value 'v'. In AHA, users are able to select link colours; therefore, 'c' could indicate the user preference of link colour and 'v' would include an explicit colour value. The knowledge about a particular concept is generated in two ways – either by reading a page or by taking a test associated with a concept.

AHA maintains a user log file for each individual user. In this log file two log values are stored each time the user accesses a page – the start and the end periods for reading a page. The collected information is also used for seen or unseen pages.

Depending on the user's level of knowledge, which is represented in the user model, AHA presents the information differently. To achieve such a different provision of content, AHA uses the fragment variants technique for content adaptation (see Section 2.8.1). This technique is applied in AHA by using pre-processors, which filter out fragments of texts according to particular conditions structured in the form of HTML comments. Listing 2-1 is an example of this structure.

Listing 2-1 Fragment variant example (De Bra & Calvi, 1998)

<!-- if definition and history --> This part appears if the two "concepts" definition and history are both known according to the user model. <!-- else --> If this is not the case then this alternative is presented instead. <!-- endif -->

AHA depends on the user level of knowledge to present different link structures in order to guide users to relevant information. This is achieved in AHA using the techniques of adaptive link annotation, adaptive link hiding and adaptive link removal (see Section 2.8.2).

Adaptive link annotations is applied in AHA using classes of links, where each link is associated with one of these classes depending on the user model. AHA uses different types of classes to classify links specified by authors. These classes include conditional, unconditional, good, neutral and bad. A colour scheme is then applied to distinguish links in these classes using a CSS file (cascading style sheet). Hence, each colour indicates the appropriateness of the information behind these links. Moreover, AHA allows users to configure their preferred link colours of these classes through a set-up form.

Adaptive link hiding is implemented in AHA through making the anchor of the undesired link unnoticeable. This is achieved by changing the text colour of the link into black so it becomes unnoticeable (because the surrounding text colour is black). The link's functionality remains and it only can be noticed when moving the mouse pointer over the link.

Adaptive link removal is a subtype of adaptive links hiding. Adaptive links removal means that not only is the link text colour made unnoticeable from the surrounding text, but also the link's functionality is removed. Adaptive links removal is achieved in AHA by transforming the link's anchor tag into conditional text as in Listing 2-2.

Listing 2-2 Adaptive links removal example (De Bra & Calvi, 1998)

2.9.4. Personalised information systems for patients

Unlike the AHS developed within the educational domain, few AHS have been developed within the health domain. Bental et al. (2000) mentioned that although there are overwhelming range of health information systems on the Web, few of them offer personalised features to patients.

However, in research carried out by Bental, Casawy & Jones (1999, 172-174) a number of personalised systems that tailor information to the patient's needs are listed, including:

- Piglit system: this system was based on AI (Artificial Intelligence) techniques to provide tailored information for patients with diabetes. The goal of this systems was to allow patients to understand and manage their conditions via providing them with the required information based on their medical records. The content provided in Piglit included information about the disease, treatment, the patient's medical records, hospital and health professionals involved in care and local sources of support.
- Migraine system: similar to Piglit, the Migraine system used AI techniques to produce personalised information for patients with migraine. However, this system depended on a simple interview (i.e. fill-in form) instead of using the patient's medical records for content personalisation.
- Stress control: is a tutorial system that helps patients with anxiety to cope with their condition. The systems is divided into eight sections where each section includes information relevant to a particular type of anxiety. Users can be directed to the appropriate section after filling-in a simple questionnaire which identifies the patient's level of anxiety.

Bental, Casawy & Jones (1999) also outlined other systems. However, these systems were used to generate personalised printed materials such as leaflets. For example, Grassic was a system used for generating personalised leaflets based on the medical record for patients with asthma. Healthdoc and OPAD were also systems used for generating tailored leaflets, however, these were based on simple fill-in forms completed by patients. The Healthdoc system was used to generate health promotion leaflets, and the OPAD system was used for generating more informative prescriptions.

The problem with these systems is that most of them were used in clinician evaluation settings and there was no complete study that revealed the effectiveness (and even the cost) of using personalised systems by patients. However, evaluation results for some of these personalised systems showed that patients either benefited from, read more or felt positive about the information when it was personalised to their current situations/conditions (Bental, Casawy & Jones 1999, p. 178).

No subsequent literature was found that shows the current state or the underlying technologies used for development of these systems. In addition, there was no indication if these systems have taken into consideration the accessibility issues concerned with information personalisation.

2.10. Models of adaptive hypermedia

The structure and functionality of hypermedia or hypertext systems can be described at an abstract level. Reference models are a way to accomplish this. These reference models are used to describe the conceptual elements (i.e. network structure of nodes and links) and the functionality of these systems. In addition, using these reference models is useful in providing a basis for comparisons as well as developing standards for interoperability among these systems (Koch 2001, pp. 62-63; Wu 2002, pp. 13-14).

The specifications of the reference models use the following types of techniques (Koch 2002, p. 63):

- Formal techniques: involves using specification languages based on mathematics, logic or algebra.
- Semi-formal techniques: where the specifications are presented and structured using diagram or tabular techniques.
- Informal techniques: involves using natural languages to represent the specifications.

In 1988 and 1990, two workshops on hypertext were held at the Dexter Inn in New Hampshire. These workshops were concerned mostly with existing hypertext systems and the common abstraction found among them. To capture and formalise the discussions of these workshops, the Dexter hypertext reference model was introduced (Halasz & Schwartz 1994, p. 30).

Although several models have been introduced for describing hypermedia or hypertext, the Dexter model has proved to be the most widely used reference model for describing the architecture and modelling most kinds of hypermedia or hypertext

applications. Therefore, it can be used as the basis for developing reference models for adaptive hypermedia applications (De Bra, Houben & Wu 1999, p. 147).

2.10.1. The Dexter hypertext reference model

The Dexter model is an attempt to capture, both formally and informally, the important abstractions found in a wide range of existing and future hypertext systems. The goal of the model is to provide a principled basis for comparing systems as well as for developing interchange and interoperability standards. (Halasz & Schwartz 1994, p. 30)

The following is an overview of the Dexter model including its different layers and mechanisms that form the model (Halasz & Schwartz 1994, pp. 30-37):

The Dexter model, which has been formally specified using a specification language, divides a hypertext system into three layers, the 'Run-time' layer, the 'Storage' layer and the 'Within-component' layer. These three layers are connected by interfaces called 'Presentation Specification' and 'Anchoring' (see Figure 2.16). It is worth noting that in the Dexter model the word hypertext refers to both hypertext and hypermedia systems.



Figure 2.16 The three layers of the Dexter model (Halasz & Schwartz 1994, p. 33)

The layers of the Dexter model are described in order of priority during the course of the following sections.

2.10.1.1. The Storage layer

In the Dexter model the main focus is on the storage layer, which models the network structure of nodes and links which constitute the core of any hypertext system. The storage layer describes the structure of a hypertext system as a finite set of components. These components are treated as generic data containers. The structure of these containers is not modelled in the storage layer (because this is the concern of the Within-component layer) and therefore, this layer handles textual and graphical components in the same manner.

A component in the storage layer is one of the following entities:

- An atomic component which represents nodes in hypertext systems.
- A link component which represents the relationships between components.
- A composite component which has a recursive structure and made out of other components. This structure must be constructed in a way that ensures that no component can be a subcomponent of itself either directly or indirectly.

In Figure 2.16, 'Anchoring' is a critical interface between the storage layer and the within-component layer. Anchoring is a mechanism by which the hypertext system addresses locations or items within the content of a component. Another critical interface is also found between the storage layer and the run-time layer that is the 'Presentation Specifications'. Presentation specifications is a mechanism that involves information about how the Run-time layer should present a component to the user.

For each component there is global unique identity (UID), which uniquely identifies the component in the hypertext system. In the storage layer two important functions are the 'resolver' and 'accessor' functions. These two functions are responsible for retrieving and accessing the components. The resolver function is responsible for resolving a 'component specification' into a UID(s), which is then used by the accessor function to access the correct component(s), i.e. map the UID into the component itself. Hence, in the Dexter model, hypertext systems are modelled as atomic, links and composite components with associated resolver and accessor functions.

More precisely, a component in the storage layer consists of a component UID with associated 'component information' (see Figure 2.17), which describes the properties of the component (other than its content) including:

- A sequence of anchors which can be used as an index to the component.
- A presentation specification: includes information for the run-time layer about how the component should be presented to the user.
- A set of attribute/value pairs, which can be used to attach any property to a component.

An anchor is an indirect addressing entity that consists of two parts – an 'anchor id' and an 'anchor value'. The anchor id is responsible for uniquely identifying the anchor within the scope of its component. Therefore, the anchor can be uniquely identified within the entire hypertext by the 'component UID-anchor id' pair. The anchor value contains an arbitrary value that specifies some location, region, item or substructure within a component.

The anchor id and values serve as fixed point of reference for a link, which is used by the storage layer. When a component is edited during the run-time layer, the withincomponent layer changes the anchor value to reflect the change in the component's substructure or to reflect the new point, region or item to which the anchor is attached. However, the anchor id remains constant.

In the storage layer, the anchoring mechanism is combined with another mechanism – component specification mechanism (see Figure 2.17) – to provide end points for a link. This is called a 'specifier' which consists of:

- A component specification.
- An anchor id, which serves as an end point of a link.
- A direction which specifies if the end point of a link is considered as a source of a link, a destination, source and destination or neither. In the model, these

directions are represented using the values: from, to, bi-direction and none respectively (see Figure 2.17).

• A presentation specification: this is part of the interface between the storage layer and the run-time layer.

In the storage layer there is a set of defined operations which enable access to or modification of the hypertext structure. These defined operations encompass adding a component e.g. adding an atom, a link or a composite, deleting a component or modifying the content of a component. Furthermore, there are operations for retrieving a component according to its corresponding UID or specifier.



Figure 2.17 The overall structure of the storage layer (Halasz & Schwartz 1994, p. 35)

2.10.1.2. The Run-time layer

The run-time layer describes how the components should be presented to the user. This presentation is based on the 'instantiation' of a component, which is the essence of the run-time layer. During the instantiation of a component, a copy of that component is cached. When a user views or edits this instantiation, it is then written back into the storage layer reflecting the changes that occurred to the instantiation. More than one instantiation can occur simultaneously. In order to distinguish between them, each instantiation is attached to an instantiation identifier (IID), which uniquely identifies the instantiation within the run-time layer.

In the run-time layer, instantiation of a component leads to instantiation of its anchors – this is known as 'link marker'. The anchor in the run-time layer refers to an attachment point or region and the link marker refers to the appearance of that anchor within the displayed page/document.

In the run-time layer each instantiation consists of a 'base instantiation' that serves as the presentation of a component to users, a sequence of link markers and a function that maps the link markers to the anchors which they instantiate.

To keep track of all changes occurring to components' instantiations (e.g. when a user views or alters a component instantiation), the run-time layer uses an entity called 'session'. In particular, when users access a hypertext system, a session is opened. When components are displayed, their instantiations are created; this is achieved through an operation called 'presentComponent'. As mentioned before, the user is able to alter the instantiation; this is achieved in the Dexter model through an operation called 'realizeEdits'. It is also possible for the user to destroy the instantiation through an operation called 'unPresent'. If the user deletes a component through one of its instantiations, then all of other related instantiations are automatically removed. Finally, when the user finishes interacting with the hypertext system, the session is closed.

This session entity consists of the following:

- The hypertext system involved.
- A mapping from the IID of the current instantiations to their associated components in the hypertext.
- A history, which represents a sequence of all the operations that have occurred since the last 'openSession' operation at any given time.

- A run-time version of a resolver function that is responsible for mapping a given specifier into a component UID that matches the specifications (similar to the storage layer's resolver function).
- An instantiator function which is composed of a component UID and a presentation specification. The presentation specification of this function contains information about how the instantiated component should be presented during the instantiation.
- A realiser function which includes the run-time layer's operation 'realizeEdit'.

2.10.1.3. The Within-component layer

This layer is specifically concerned with the content and the structure of components that form the network of the hypertext system. This layer deliberately was not elaborated in the Dexter model. This is because there are different content types which can be used within the components such as graphics, text, animation, simulations, images, etc. Therefore, it would be impractical for the within-component layer to cover all of these types of data.

2.10.2. AHAM: the adaptive hypermedia application model

The AHAM model is a reference model for adaptive hypermedia applications, based on the abstract description of hypertext/hypermedia. The AHAM model is considered as an extension to the Dexter model and informal definitions have been chosen to describe the AHAM model. Although this model was primarily developed within the educational domain, it intended to act as a generic model which is capable of modelling any type of adaptive hypermedia systems (De Bra, Houben & Wu 1999, p. 147).

The following is an overview of the AHAM model (De Bra, Houben & Wu 1999, pp. 149-155):

As in the Dexter model, AHAM divides AHS into three layers: the Run-time layer, the Storage layer and the Within-component layer. These layers are connected by the same interfaces – 'Presentation Specifications' and 'Anchoring'.

In AHAM, the focus is also on the storage layer, which is described as a network of nodes and links. This network structure consists of three parts:

- The domain model, which represents the author's view of the application domain.
- The user model, which contains tracking information about the user that reflects how much the user knows about the each concept in the domain model.
- The teaching model, which consists of rules that help to carry out the adaptation. These rules contain information, which identify how the domain model and the user model influence each other when presenting information from the domain model. Such rules are fed into the Adaptive Engine of the AHS that is responsible for generating the right presentation specifications of components to users.

Hence, the AHAM model defines any AHS as a tuple <DM, UM, TM, AE> where the 'DM' is the domain model, 'UM' is the user model, 'TM' is the teaching model and 'AE' is the adaptive engine of the AHS (see Figure 2.18).



Figure 2.18 The structure of the AHAM model (De Bra, Houben and Wu 1999, p. 149)

In the Dexter model, the storage layer uses the term 'component' to denote nodes and links, whereas the storage layer of the AHAM model uses the terms 'concept' and 'concept relationships'.

A concept is an abstract representation of an information item from the domain model. It is represented as <uid, cinfo> pair where uid is a unique identifier of the concept and cinfo is the component information. The component information consists of a set of attribute-value pairs, a sequence of anchors and a presentation specification.

As in the Dexter model, AHAM distinguishes between atomic and composite components:

- An atomic concept represents a fragment of information.
- A composite concept has a child attribute which is a sequence of concepts. A composite concept is classified further into two types:
 - □ An abstract composite which is composed of other composites, i.e. composed of children that are themselves composites.
 - A page concept which is composed of children that are themselves atomic concepts.

To ensure the conformance with the Dexter model, the hierarchy structure of the composite concepts must be a 'directed acyclic diagraph' which means that no component can be a subcomponent of itself directly or indirectly. Also, each atomic concept should be at least a subcomponent of one concept.

In AHAM a sequence of anchors of a concept enables links to be attached to a specific part of a component. Each anchor is defined in AHAM by <aid, avalue> pair where:

- aid is a unique identifier of the anchor in the scope of its concept component.
- avalue which can be any value that represents some location, region or item within a concept component.

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The AHAM model uses the term concept relationships as an alternative to the term links reflecting that it can be used for several purposes not only for navigation. These concept relationships consist of a sequence of components, which are represented as specifiers. Similar to the Dexter model, each specifier needs to be resolved to UID(s) of a composite concept(s) that corresponds to a page or pages. A specifier is defined in AHAM as a tuple
uid, aid, dir, pres> where:

- uid is a unique identifier for a concept component.
- aid is a unique identifier for an anchor.
- dir is a direction including: FROM, TO, BIDIRECT or NONE.
- pres is the presentation specification.

The concept relationship is defined in AHAM by <uid, ss, cinfo> where:

- uid is a unique identifier of a concept relationship.
- ss is a sequence of one or more specifiers.
- cinfo is a component information which includes:
 - □ A set of attribute-value pairs.
 - \Box A sequence of anchors.
 - □ A presentation specification.

The concept relationships (links) are used in AHAM for navigation and also for adaptation in most of the existing AHS. The following types of relationships are captured in AHAM:

- Prerequisite concept relationship: means that the specifiers with the direction 'FROM' represent a prerequisite knowledge for those specifiers with the direction 'TO'.
- Inhibitor concept relationship: means that in order to have access to the specifiers with the direction 'TO', the user must not have too much knowledge

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about the corresponding concepts of those specifiers with the direction 'FROM'.

A distinctive feature in AHAM is the use of a user model (this is not found in the Dexter model). Most AHS are characterised by maintaining a user model, which reflects the user's knowledge about the domain concepts and other information (e.g., browsing history). AHAM uses a table representation for each user to conceptually represent the user model (see Table 2.3).

| uid (name) | knowledge value | read | ready-to-read |
|------------------|-----------------|-------|---------------|
| intro | well learned | true | true |
| Xanadu | learned | true | true |
| KMS | not known | false | true |
| WWW ₁ | well known | true | true |
| WWW ₂ | not known | false | true |
| WWW | learned | false | false |

Table 2.3 A tabular representation of a user model (De Bra, Houben and Wu 1999, p. 151)

For each user, there are particular attributes associated with each concept in the domain model including:

- Concept uid which is a unique identifier of a concept.
- Knowledge value which represents the user's knowledge about a domainmodel concepts. Some AHS use a boolean representation for this value indicating that the concept is either known or unknown to the user. Other AHS use a small set for representing the knowledge value such as: not known, learned, well learned and well known.
- Read attribute which indicates if the user has read something (fragment, a page or pages) about the concept. This attribute is useful particularly in Webbased AHS where the anchors or links to seen pages can be marked differently from those unseen pages. A boolean representation or a list of accessing times are possible values for this attribute.

• Ready-to-read, this attribute is used less frequently than the above attributes. It indicates if the user is ready to read the concept. This attribute would be true if enough prerequisite knowledge has been satisfied.

Another distinctive feature in AHAM (which is not found in the Dexter model) is the use of a teaching model which is considered as the core of the adaptation in AHAM. This teaching model collects information from the domain model and the user model, which are then fed into pedagogical rules. Such rules are responsible for determining how the information should be presented to the user. Two types of pedagogical rules are distinguished in AHAM including:

- A Generic pedagogical rule, which is defined by <R, PH, PR> where:
 - **R** which is a triggered rule.
 - PH is a phase for a rule execution where it values 'pre' and 'post' values.
 The pre value indicates that the phase of a rule is executed before and during the page(s) generation. The post value indicates that the phase of a rule is executed after the generation of the page(s). Having two-phase values are useful when it is required, for example, to carry out some adaptations depending on the current state of the user model (i.e. pre phase) and then to update the new state of the user model after the generation of page(s) (i.e. post phase).
 - PR is a propagate field, which shows if the current rule is going to trigger other rules.
- A specific pedagogical rules, which is defined by <R, SC, PH, PR> where:
 - \Box R is a triggered rule.
 - **u** SC is a set of concept components.
 - **D** PH is a phase of execution.
 - □ PR is a propagate field.

These rules are used to set the attributes of the user model. Also, they have priority in execution over the generic rules.

As in the Dexter model, AHAM calls a resolver function (due to the user's action on the system e.g. following a link) to resolve a given specifier to a uid of a composite concept that corresponds to a page or pages. The selection of page(s) depends on the information collected from the domain model and the user model. For each selected page, an accessor function is called to return the concept component that matches the resolved uid.

An arbitrary syntax was chosen to describe these rules in AHAM. The following are some illustrative examples of these pedagogical rules:

- <access(C) ⇒ C.read := true, post, true>. This rule indicates that when a page is accessed then the 'read' attribute for the corresponding concept in the user model becomes "true" in a post phase. This rule triggers another rule, because its propagate field value is true.
- <access(C) and C.ready-to-read = true ⇒ C.knowledge-value := well learned, pre, true>. This rule represents that if the page attribute (ready-to-read) for the corresponding concept in the user model is 'true' and it is accessed, then the knowledge value of that concept becomes 'well learned' in a 'pre' phase.

These pedagogical rules only set the attributes in the domain-model concepts and the user model values. The interpretation (i.e. the actual execution) of these rules is part of the AHS. Specifically, these rules are implemented by the 'adaptive engine' of the AHS. The working methodology of the adaptive engine can be summarised as in the following:

Initially, the adaptive engine restores all the saved attributes from the user model. Depending on the user model, the adaptive engine resolves the specifier to a page concept by applying the pedagogical rules that are responsible for determining the relevant page for that specifier. The engine then executes the rules with the 'pre' phase, which result in determining the presentation specification of the page (i.e. determine which fragments are going to be shown, hidden and possibly sorted). The
engine then applies the actual techniques, which are responsible for generating the required HTML pages on the Web browser. All the rules with the 'post' phase are then executed. Finally, all the altered attributes are saved into the user model.

2.10.3. The Munich Reference Model

The Munich model is a reference model for adaptive hypermedia applications. The objectives of this model are similar to the objectives of the previously mentioned models which are to describe the functionality of adaptive hypermedia applications at an abstract level, and also to provide the basis for the development of these applications.

The following is an overview of the Munich reference model (Koch & Wirsing 2002, pp. 213-221):

The Munich reference model is similar to the AHAM model in that it is based on the Dexter reference model with some enhancements depicted in the inclusion of the user modelling and adaptation aspects. However, the Munich Model takes an objectoriented approach where UML is used to formally and visually represent the model. Whereas AHAM takes a more database oriented approach where tuples are used to represent the model.

The Munich reference model has been used in the development of SmexWeb. This is an adaptive learning system that is capable of observing the behaviour of students and reacting adaptively according to these behaviours. Each time a student enters into the system, a component called 'Tutor' is setup. The main functionality of this component is to record the student's actions and preferences and then adapt content, links or presentation in accordance with these actions and preferences. The system maintains a user model for each student to store the actions and preferences. This user model is updated continuously to ensure that relevant adaptation features are presented to students (Albrecht, Koch & Tiller, 2000)

The Munich reference models uses the same three layers (the Run-Time layer, the Storage-Layer and the Within-Component layer) of the Dexter model. However, the functionality of these layers are extended in Munich model to include user modelling and adaptation aspects (see Figure 2.19)



Figure 2.19 UML representation for the architecture of adaptive hypermedia applications (Koch & Wirsing 2002, p. 215)

Figure 2.19 provides an overview for how the Munich reference model describes the architecture of adaptive hypermedia applications. This architecture includes:

• The Run-Time Layer: the objective of this layer is to describe how the components (nodes and links of the system) are presented to users. Also, this layer is responsible for collecting information about users' interactions and behaviours. The functionality of this layer is still the same as in the Dexter model. However, the functionality of gathering users' behaviours and interactions is considered as an extended feature. As in the Dexter model, the presentation of components are based on the instantiation mechanism where the 'IID' and 'LinkMarker' and the session entities have the same functionality. The only difference is that these entities are depicted in Munich reference model using UML. Furthermore, all users' interactions, e.g. editing an instantiation or following a link, are recorded in a history that constitutes the basis for applying the adaptation mechanism.

- The Storage Layer: as in the Dexter model, this layer describes the network structure of nodes and links of the hypermedia system. However, the objective of this layer is to support the adaptation in hypermedia systems and therefore, the storage layer is divided into three sub-models (see Figure 2.19) including:
 - The 'Domain-Meta' model: this is responsible for managing the network structure that is formed by nodes and links of the adaptive hypermedia system. As in the storage layer of the Dexter model, the 'Domain-Meta' model describes the structure of the adaptive hypermedia system as a finite set of components, but with three functions (instead of two) including resolver, accessor and constructor. The first two functions operate exactly the same as in the storage layer of the Dexter model. The constructor function allows for the construction of adaptive components.
 - The 'User-Meta' model: the objective of this model is to describe both the Q structure and the management of each user model within the system. This model is divided into subsystems including 'UserManager' class, a set of users and a set of functions including 'initialiser', 'updater' and 'evaluator'. The 'User-Meta' model depicts the users of an adaptive hypermedia system by 'User' class connected to an aggregation of a class 'UserID' and a set of 'UserAttributes' (see Figure 2.20). the 'UserID' uniquely identifies the user within the universe of the system and the 'UserAttributes' are a representation of users' relevant characteristics for the application. Different information can be stored in the 'User-Meta' Model such as knowledge, preferences, background experience, etc. Therefore, this information is classified into two classes including 'DependentAttr' and 'IndependentAtrr' classes. The first class contains users' characteristics that are related to the domain model components. The second class contains users' characteristics that are not related to the domain model components - e.g. user's preferences or background knowledge.
 - The 'Adaptation-Meta' model: this model is responsible for achieving the required adaptation using two classes 'Adaptation' and 'Rule' classes (see Figure 2.21). The 'Adaptation' class includes three operations: an

'adaptation resolver', a 'finder' and a 'trigger'. The first operation resolves a component specification into a component UID that builds an adapted page. The second operation uses a mechanism that returns all the triggered rules at a given time. The last operation triggers the rule itself. The execution of these rule is accomplished by the 'executor' operation which is part of the class 'Rule'. This operation allows the system to select the appropriate component and to apply content, presentation and link adaptations in addition to updating the user model. An object of the class 'Rule' consists of two classes - 'Condition' and 'Action' classes and attributes including 'phase' and 'propagate'. The functionality of these attributes is similar to the functionality of the 'phase' and 'propagate' fields of the AHAM model. The 'Condition' and the 'Action' classes contain the class 'ModelElements'. This class is defined by two attributes 'elementID' which is an element identifier, and 'Modified' which takes a boolean value to indicate if the element was modified when implementing the adaptation. Only the user model attributes and the presentation specifications can be modified.



Figure 2.20 The User-Meta Model and its connectivity with the Domain-Meta Model (Koch & Wirsing 2002, p. 218)





• The Within-Component Layer: as in the Dexter model, this layer is concerned with the content and the structure within hypermedia nodes. As in the Dexter model, this model is not elaborated further.

2.10.4. The LAOS model

Another model for AHS is called LAOS (stands for Layered WWW AHS Authoring Model and their corresponding Algebraic Operators). This model is built upon the AHAM model however it extends it by including a goal and constraint model (GM) that is inserted directly after the domain model. Therefore, LAOS model consists of five layers including domain model (DM), goal and constraint model (GM), user model (UM), adaptation model (AM) and presentation model (PM) (Cristea & Mooij, 2003) (see Figure 2.22).

The aim of introducing these layers is to guide users by limiting the system's hyperspace and focusing the presentation of the domain model concepts based on the GM layer. The authors of the LAOS model argue that not having a GM may lead to possibility of reading the whole domain model (DM) (Cristea & Mooij, 2003). Therefore, the GM layer can be considered as a filter to the DM layer.



Figure 2.22 The five layers of LAOS model (Cristea & Mooij, 2003)

In general the LAOS model can be seen as an extended version of the AHAM model. A great deal of the LAOS model functionalities are still the same as in AHAM but the new introduced layer (GM), the refinements of UM and AM, and the way of defining the five layers using more formal definitions are different. Finally, the PM in LAOS is responsible for the physical presentation of generated documents which would be, for example, as HTML files. PM is not detailed in LAOS since the focus is on the idea of keeping the PM separate from the other layers (Cristea & Mooij, 2003).

For this research, adopting an adaptation/personalisation model was necessary as one of the research questions (research question 3) and one of the objectives were concerned with identifying and devising a model to describe the designed personalisation system at an abstract level. Therefore, this was facilitated by the adoption of AHAM as the underlying model for developing the personalised system. The rationale behind the selection of the AHAM model was driven by its simplicity and ability to model the personalised system in respect to the MS domain compared to other model. Chapter 4 (Section 4.3.4) provides greater details about the rationale for selecting the AHAM model as well as its implementation.

2.11. Summary

In this chapter the approaches and the enabling technologies for personalisation were reviewed. Adaptive hypermedia as an application area of personalisation was explained in terms of the methods and techniques for adaptation, examples and models of adaptive hypermedia systems.

The next chapter (Chapter 3) provides details of the research methodology, design methodology and data collection methods used in this research.

Chapter 3

Research Methodology

3.1. Introduction

In the IS (Information Systems) research domain there is a confusion about whether undertaking research through the design of artefacts (e.g. development of systems) could be considered as research. This confusion is manifested when posing questions such as "Does the development of a software system constitute a research project (in the academic sense)?" (Nunamaker & Chen 1990, p. 631).

Nunamaker and Chen (1990, p. 632), reported the work of Blake (1978), who stated that the focus of undertaking academic research is to extend human knowledge and demonstrate technical excellence. Design or development has been used for a long time to study nature and create new things. Nunamaker and Chen (1990, pp. 632-634) outlined a number of interesting examples where design or development of things contributed to knowledge and enhanced understanding in many research domains. One of these, for instance, was the invention of the first aeroplane by the Wright brothers. This invention occurred before the introduction of the aerodynamic science. The creation of the discipline of aerodynamics was entirely based on studying a model of an aeroplane (in a laboratory) and learning from experiences accumulated through building real aeroplanes. Nowadays, the creation of aeroplanes is facilitated by using design tools such as the CAD/CAM (Computer-Aided Design/Computer Aided Manufacturing). These tools include theories and knowledge of aerodynamics (gained through the creation of real aeroplanes) and have been used to improve the performance of the new generation of aeroplanes.

Owen (1997, pp. 37-38) also stated that "knowledge is generated and accumulated through action". Owen created a model that demonstrated how knowledge is created, see Figure 3.1





Figure 3.1 suggests that generating knowledge is achieved through a cyclical process where initially knowledge is used to create works and works are then evaluated to build-on and refine the knowledge. According to Owen (1997), the processes of 'knowledge building' and 'knowledge using' are controlled by channels. These channels includes the conventions and rules (e.g. theory or criteria) that operate the discipline. These channels exemplify the "measures and values" that have been empirically developed during the course of a discipline (Owen 1997, p. 37).

In this sense, undertaking an academic research project can be achieved through designing artefacts. However, this process should be formulated and take the shape of academic research rather than a pure design process. As mentioned earlier, the aim of undertaking academic research is the generation of new knowledge within research disciplines. In the IS domain, undertaking research through making (i.e. designing) of artefacts is called a 'design research'.

Design research "involves the analysis of the use and performance of designed artefacts to understand, explain and very frequently to improve the behaviour of aspects of information systems" (Vaishnavi & Kuechler, 2004).

Vaishnavi & Kuechler (2004), described the work of Takeda, et al. (1990), who presented a model that described the reasoning in the design cycle (see Figure 3.2).



Figure 3.2 Reasoning in the design cycle (Vaishnavi & Kuechler, 2004)

Figure 3.2 shows the cyclical process of the design research. This cycle starts with 'Awareness of Problem'. This is followed with a 'Suggestion' step where a solution is (abductively) chosen based on the existing knowledge base for the problem area. A step of artefact 'Development' then follows based on the suggested solution. The developed artefacts are then evaluated according to the criteria of the suggested solutions (i.e. the 'Development' and 'Evaluation' steps deductively occur based on the criteria of the suggested solution). The steps 'Development', 'Evaluation' and (further) 'Suggestion' (referring back to the base 'Awareness of the Problem') are carried out in an iterative process during design research. This iterative process is indicated in the Figure 3.2 by 'Circumscription'. The 'Conclusion' step represents the termination of the design research. The 'Circumscription' and 'Operation and Goal Knowledge' processes indicate the generation of new knowledge. In particular, the 'Circumscription' process is a significant process in design research as it repeatedly reveals or identifies the reality and knowledge from a design research (Vaishnavi & Kuechler, 2004).

It is significant, particularly within the IS domain, to understand the philosophical grounding of design research, because it is essential to IS researchers to consider the "assumptions about reality, knowledge and value that underlie any intellectual endeavour" (Vaishnavi & Kuechler, 2004). Hence, the following section explains the philosophical underpinnings of design research.

3.2. The philosophical considerations of design research

Positivism and interpretivisim are among the most common philosophical perspectives that are found within the IS research domain (Blaxter, Hughes & Tight 2001, p. 60; Myers, 2005). Positivism proposes that an objective reality exists external to the individual, and it can be measured using objective methods to generate new knowledge. It believes that the social world exists as an impartial constant, and that there is no relationship between reality and what people believe about this reality. In this philosophy, the observer's (researcher's) feelings, perceptions and interpretations and his instruments should not interfere with the phenomena being studied (Blaxter, Hughes & Tight 2001, p. 61; Easterby-Smith, Thorpe & Lowe 1991, p.22; Myers, 2005). However, there has been much debate about positivism in terms of its suitability for the social sciences. Positivism has been criticised because it places no emphasis on the role of human sensations when studying phenomena. Hence interpretivism (anti-positivism) has emerged as a philosophy. A number of philosophers have suggested that human's perceptions and feelings are important to the phenomena being studied (Hirschheim 1985, pp. 21-22).

Unliké positivism, the interpretivism philosophy assumes that reality and the social world are interlinked and that reality can be understood using subjective methods. Interpretivist philosophy believes that the researcher should study phenomena through the meanings that people assign to them. Hence, the study should focus on understanding different people's meanings and experiences rather than trying to find "external causes and fundamental laws" that explain the phenomena (Easterby-Smith, Thorpe & Lowe 1991, p. 24; Myers, 2005).

In design research, the ontological (the study that describes the nature of reality) and epistemology (the study that explores the nature of knowledge) stances are not necessarily constant throughout a design/research process which is often iterative and arbitrary as new insights are acquired as the research proceeds. During design research, the researcher may introduce novel (design of) artefacts in order to test the central hypothesis or theory that is being tested. In this process the 'world-states' of the research are changed as each new artefact which has been newly introduced, modified or removed can change the basic research design or assumptions from that originally envisaged, in order through iteration to reach a satisfactory design. Such differing and shifting multiple 'world-states' may be seen as a contradiction to the ontological viewpoint, however most of design researchers "believe in a single, stable underlying physical reality that constrains the multiplicity of world-states." (Vaishnavi & Kuechler, 2004).

The epistemological viewpoint of design research suggests that the researcher knows the meaning of information through the process of construction or circumscription. When an artefact is constructed, the behaviour of this artefact is described through the interaction between its constituent components. This description represents information which is ascertained based on the degree to which the artefact behaves predictably. This element of predictability gives "design research an epistemology that resembles that of natural-science research more closely than that of either positivist or interpretive research." (Vaishnavi & Kuechler, 2004).

It can be noted that design research is not assigned to one particular philosophical aspect (positivism or interpretivism); it can be considered as a mixture of and shifts between these perspectives as the research proceeds. Vaishnavi & Kuechler (2004) indicated that the design researcher starts creating reality through the construction of an artefact (based on solution which is abdutively chosen form the existing knowledge base of the problem area, see Figure 3.2). Subsequently, the researcher observes the behaviour of the artefact and compares it to the suggested solution set out during the abductive phase. These observations are then interpreted (i.e. evaluated) and proceed as a cyclical process (i.e. circumscription, see Figure 3.2) (Vaishnavi & Kuechler, 2004).

Table 3.1 shows and summarises the characteristics of research approaches from the perspective of the design research philosophy. It can be seen from Table 3.1 that the characteristics of design research are interdependent and complement the positivist and interpretive perspectives.

| Basic Belief | Research Perspective | | |
|--------------|---|--|--|
| | Positivist | Interpretive | Design |
| Ontology | A single reality. Knowable, probabilistic. | Multiple realties, socially constructed. | Multiple, contextually situated alternative world- states. Socio-technologically enabled. |
| Epistemology | Objective; dispassionate. Detached observer of truth. | Subjective, i.e. values and knowledge emerge from the researcher-participant interaction. | Knowing through making: objectively constrained construction within a context. Iterative circumscription reveals meaning. |

Table 3.1 Philosophical assumptions of three perspectives (adapted from (Vaishnavi & Kuechler,2004))

3.3. Design research as a research methodology

Vaishnavi & Kuechler (2004) developed a research methodology of design research. This research methodology is a variant of Takeda, et al. (1990) model (refer to Figure 3.2). In this revised methodology, the 'Logical Formalism' of the reasoning in the design cycle was replaced with 'Output' to emphasise the process (of the design research) as a research method (see Figure 3.3). This research methodology includes the following steps (Vaishnavi & Kuechler, 2004):

- Awareness of the problem: the awareness of the problem may come from different resources, new advancement in industry or from a related discipline. The outcome of this phase is a 'Proposal' for a new research.
- Suggestion: this phase comes directly after the awareness of the problem. A 'Tentative Design' is the output of the suggestion phase wherein new functionality is visualised based on a novel configuration of existing or new elements.
- Development: in this phase the tentative design is implemented. The implementation techniques in this phase are based on the artefacts (e.g. the software package) used for the development.

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Figure 3.3 The methodology of design research (Vaishnavi & Kuechler, 2004)

- Evaluation: in this phase the constructed design is evaluated according to the criteria set out in the awareness phase. The evaluation includes an analytical phase wherein a hypothesis is made about the behaviour of the constructed artefacts. The fluid nature of design research (manifested in the analytical phase which involves interpretation of the design behaviour) contrasts the positivist stance. In a typical positivist research, the researcher should have one strict interpretation of reality which leads to the confirmation of contradiction of the hypothesis. However, in design research the hypothesis, which may be broad, is not completely rejected. Instead, it is modified according to the observations. The evaluation phase leads to additional information which is obtained from constructing and evaluating the artefacts and fed into another iteration of suggestions (i.e. Circumscription in Figure 3.3).
- Conclusions: this represents the last phase in the general design methodology. Results from this phase are not optimal due to the deviation in the behaviour of the artefacts from the prediction of the (revised) hypothesis. However, results from this phase are considered good enough and there are two types of knowledge gained; one is the (firm) facts which have been learned and can be repeatedly applied. The other type of knowledge concerns the (loose) aspects which are likely to form the subject of further research.

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In this sense, adopting the design research as a research methodology was appropriate. This was due to nature of this research which involved the design of a prototype system which needed to be evaluated by people from the MS community. Furthermore, the choice of design research was based on the research questions (see Chapter 1, Section 1.3) which were effectively answered by designing a personalised system.

The main sources, which revealed the problem and provided input into the 'problem awareness' stage of design research, were achieved through previous research that was carried out by Hepworth, Harrison & James (2003) and Hepworth & Harrison (2004). This research stressed the fact that a person with MS should be considered as a person who seeks to take an active role in life. This active role could be supported by providing MS sufferers with relevant information that may increase their self-reliance and enable them to interact with the world around them. This could eventually enhance the well-being of MS sufferers.

Furthermore, the literature survey (Chapter 2) accomplished in this research gave an awareness of the problems of Web-based information (i.e. information overload problem) and also identified the approaches and techniques that are being used to overcome this problem.

Looking at Web-based information as resources where MS sufferers could locate relevant information that may increase their independence and eventually enhance their well-being, formed the basis of the 'Awareness of problem' phase.

The research (mentioned earlier) was concerned with identifying the general information needs of people with MS and suggested that the information provision would be more effective if information could be adapted to the changeable conditions and hence the needs of MS suffers. MS causes a range of symptoms to MS sufferers such as visual impairment, fatigue, mobility problems and many more. This therefore requires that the information to be adapted to these changeable conditions. Designing a prototype of a personalised system in terms of the content, links and presentation based on the user condition may help meet the requirements of an information system for people with MS. This constituted the 'Suggestion' phase of the general methodology of the design research. However more explanations are presented in

Chapter 4 (Section 4.2) which describes the prototype system based on the initial users' requirements derived from the previous research (mentioned earlier) concerning the information needs for people with MS.

The 'Development' phase of the general methodology was undertaken through the application of the prototype system using the technologies (i.e. artefacts) XML, XSLT and Apache Cocoon. The justification behind the selection of these technologies as well as the design process are presented in Chapter 4 (Sections 4.3.1, 4.3.2, 4.3.3 and 4.3.4 respectively). For this development phase, prototyping was deemed as an appropriate methodology for conducting the design process of the personalised system. Section 3.4 justifies the choice of prototyping and explains the steps of this design methodology.

The 'Evaluation' phase was required to evaluate the behavior and the interaction that occurred between the users and the prototype system. This consequently helped to achieve the aim and meet the research questions of this research work. In order to observe and analyse the interaction between users and the prototype systems, a number of data collection methods were used including observational methods, interviews and focus group (a full explanation about these collection methods is provided in Section 3.5). To be in an accord with the 'Circumscription' process, two evaluations were conducted where users feedback was collected, analysed and then used to modify the design of the prototype. The users' feedback and the analysis of the two evaluations are presented in Chapters 4 and 5.

The 'Conclusion' phase of the general methodology was reached when the final results acquired were discussed in terms of the research questions. This phase constituted the end of this research where firm facts, about using personalisation as an approach to facilitate access to Web-based information by people with MS, were generated and documented. However, other (loose) results from this research were pointed out as avenues of further research. Chapter 7 represents the 'Conclusion' phase in the research methodology of the design research.

The design research (described earlier) represents the research methodology of this work. Although, this research methodology included a design phase of artefacts (see Figure 3.3) it did not explicitly mention or suggest a methodology in which the design can be achieved. Furthermore, in the IS domain there are different approaches that can be used as the underlying design methodology. Therefore, it was necessary to choose a particular design methodology that was used during the 'Design' phase of the research methodology. Section 3.4 outlines different design methodologies and justifies the selection of an appropriate methodology for undertaking the design in this research.

3.4. The design methodology selected

In an attempt to help IS developers to effectively select the appropriate design methodologies, Avison and Taylor (1997, p. 74) suggested classifying these methodologies based on problem situations. They argued that this classification would give the developers/practitioners more practical ways when selecting the required design methodology. Therefore, they suggested the following classes of problem situations and the appropriate design methodology to be used:

- "Well-structured problem situations with a well-defined problem and clear requirements", in these cases traditional methodologies based on the systems developments life cycle (SDLC) – e.g. Waterfall model – are appropriate design methodologies.
- "Well-structured problem situations with clear objectives but uncertain user requirements", in these cases data modelling, process modelling, or prototyping based methodologies are the most appropriate to be used.
- "Unstructured problem situations with unclear objectives", in this situation soft systems approaches are the most appropriate.
- "Situations where there is a high user interaction with the system". In such situations socio-technical approaches are the most appropriate.

The problem in this research project is well-structured. The situation problem is identified but the users requirements in are not certain. Moreover, it is not only the users needs that are not certain, it is also the development tools of the prototype and

the personalisation model that are uncertain. Consequently, this problem situation led to selection of the second class where design methodologies based on data modelling, process modelling, or prototyping were most appropriate for the underlying design methodology.

Conallen (2002) stated that using a working prototype which enables stakeholders to visualise the application's features, requirements and behaviour, produces good-valid results, better understanding of the application complexity and scope, and insurance of successful fulfilment of user needs. Furthermore, one of the research questions in this research is whether technologies such as XML, XSLT and Apache Cocoon are appropriate in designing a personalised system for the MS domain. Another research question seeks to identify the most effective conceptual model for modelling the personalisation environment with respect to the MS domain. These research questions were felt to be better answered through a working prototype (often called a high-fidelity prototype (Rudd, Stren & Iseness 1996, p. 78)) that can be interacted with. Therefore, the best candidate was to use a prototype methodology where a real working example depicting a personalised IS could be presented to users. This approach, as indicated above, conforms to design research.

The prototyping methodology includes techniques by which a small-scale or partially working system is constructed to elicit the users' requirements or to test a proposed design of an IS (Whitten, Bentley & Dittman 2004, p. 112). In the literature, there is much debate about using prototyping as a methodology on its own or as a part of the traditional SDLC (Software Development Life Cycle) methodology for IS development (Avison & Taylor 1997, p. 75; Kendall & Kendall 1998, pp. 203-204; Martin et al. 2004, pp. 396-400). For this research, it was believed that adopting prototyping as a methodology on its own would better serve the aim of this research work. The aim of this research was not to develop a full working system that would require one to go through all the stages of the SDLC methodology; rather, the aim was to investigate the appropriates of personalised information for people with MS and this would be facilitated by presenting a working prototype of a personalised IS.

According to Martine et al. (2005, pp. 396-397), adopting prototyping as a methodology on its own for IS development involves seven steps (see Figure 3.4) including:

- 1. Identify the basic system's requirement: in this step, analysts/programmers and users conduct meetings in order to identify the basic requirements of the initial version of the required system.
- 2. Develop initial prototype: the system builders (i.e. programmers) produce the initial design of the prototype based on the requirements collected in step 1. The development step involves selecting the software tools, locating the data and integrating it into the prototype, and constructing the physical components of the prototype.
- 3. Use prototype and note desired changes: in this stage, the initial design of the prototype is handed to the users in order for them to use it and give feedback on the necessary modifications that are needed. Subsequently, meetings with the analysts and programmers are needed to discuss the changes.
- 4. Revise and enhance the prototype: it is the programmer's responsibility in this step to undertake the required modifications and then refer back to users to get their feedback on the changes. It should be noted that steps 3 and 4 are iterative i.e. these steps are repeated until users show a satisfaction of the current design.
- 5. Evaluate as operational system: if the prototype is decided to function as an operational system then it should be evaluated as the final prototype in this case, the prototype system is called evolutionary prototyping. The other possibility is to discard the prototype, because it was used only for identifying the requirements in this case, the prototype is called throw-away prototyping.
- 6. Make necessary changes or abandon: in this phase, if the prototype is considered as an operational system. The system builders should undertake all the necessary modifications and finish incorporating all the required controls/functions, backups, and documentation.
- 7. Install, operate and maintain: this step is concerned with installing the system and move it into an operational status. Moreover, this step involves maintenance of the IS.

In this research Steps 1 to 4 were followed, because the goal in this research was not to design a complete working system (which would require applying the seven steps shown in Figure 3.4). Chapter 4 explains exactly how the prototyping methodology was applied.



Figure 3.4 Steps of the prototyping methodology

3.5. Data collection methods

The adopted research methodology (design research) involves an 'Evaluation' phase wherein the behavior of the constructed artefact is observed and compared to the assumptions envisaged about that behavior. The 'Evaluation' Phase was met in this research by demonstrating and observing the usage of the prototype system. This section describes the methods used to observe and collect the usage of the prototype.

This research project was conducted in social settings because it involved collecting feedback of users while interacting with an intended personalised system. Therefore, the following describes only qualitative methods for data collection.

In qualitative research there are two classical forms used for data collection – interviews and observations (Hoepfl, 1997). The interview method is a data collection technique that involves "questioning or discussing issues with people". In some situations, interviews can be very useful to collect data that it would not be possible to collect using other techniques such as questionnaires or observations (Blaxter, Hughes & Tight, et al. 2001, p.172).

There are three types of interview including (Denscombe 1998, pp. 112-115):

- Structured interview: in this type, a set of pre-formulated questions is given to respondents (interviewees) to answer, with the purpose of addressing some particular issues. The structured nature of this type of interview gives control over the wording of the questions, the sequence of asking the questions and the answers offered by respondents. This allows asking respondents the same set of questions and ensures easier analysis of the collected data. However, this type of interviews is most likely to be used in quantitative research since it resembles, to a large extent, the nature of the questionnaire techniques.
- Semi-structured interviews: this type is similar to structured interviews in terms of having a set of questions to be answered and issues to be addressed. Nonetheless, questions are more open-ended in nature. This allows the interviewees to elaborate their ideas about the given issues and provide more rich information.
- Unstructured interviews: this type of interviews places a great emphasis on the thoughts of the interviewee. The role of the researcher should not exceed the limits of introducing a theme or topic and then letting the interviewee's thoughts evolve.

Semi-structured interviews and unstructured interviews share the advantage of allowing interviewees to use their own words and thoughts; this allows for discovery of complex issues. Semi-structured interviews are considered a very efficient way of eliciting people's own experiences and feelings, and lend themselves to in-depth investigations.

According to Denscombe (1998, pp. 112-115), there are two forms in which interviews can be conducted: one-to-one interviews and group interviews. The one-to-one interview is the most commonly used form. It occurs between the researcher and one interviewee at a time. The advantages of this form are that it is relatively easy to arrange and to control since there is only one person to be interviewed at a time. There is also only one source for opinions and views i.e. the interviewee. This makes it relatively easy to relate specific ideas to specific people.

Group interviews are used when there is a need to conduct an interview with a group of people at the same time. Focus groups are a typical form of group interview. In this form, a small group of people, usually from six to nine people, are involved in a meeting facilitated by the researcher to investigate people's perceptions, attitudes or ideas towards an issue. The advantage of a focus group over the other forms is that they can bring out some ideas from interviewees that would not come out in the other forms. However, in the case of focus groups it becomes difficult to record the discussion. Also, it might become difficult for interviewees to discuss sensitive or personal information in front of others (Denscombe 1998, pp. 112-115).

To serve the purpose of this research work, a semi-structured interview approach was selected. This research involves a set of predetermined issues that need to be addressed (i.e. the research questions). Furthermore, open-ended responses are needed for these issues to help in collecting in-depth data. Therefore, face-to-face interviews were the dominant form used. However, conducting focus groups was deemed appropriate as new ideas/feedback might be raised by interviewees.

The second classical form of data collection methods is observations. Observation can capture valuable information that would not be captured using interviews alone (Hoepfl, 1997). The observation method helps researchers to capture "what people actually do rather than what they say they do" (Wisker 2001, p. 178).

According to Wisker (2001, p. 178), there are two types of observations including:

- Participant observations: in this type the researcher becomes a member of the group being studied and participate in their activities as well.
- Non-participant observations: the researcher role in this type becomes more passive. The researcher does not participate in the group's activities, rather, the researcher becomes a "passive observer" who watches and records activities as they occur and accordingly draws conclusions.

However, Wisker stated several drawbacks to the observation method which are:

• A change in individuals' or groups' behaviour when they know that they are being observed.

- Different researchers may have different interpretations for observations.
- Possibility of researcher's bias when doing the interpretations
- Possibility of incomplete observation due to a failure in the recoding method.

In the human computer interaction (HCI) discipline, observational methods can be used to collect data during the interaction between users and an interactive system. This is typically carried out by giving users a set of tasks to accomplish while using the system. The researcher watches and records the user's actions with the system using various techniques (e.g. note taking, tape recording, video recording, etc). While users are interacting with a system, the observational process can be taken a step further by asking users to vocalise what they are thinking while they are being observed; this is called the 'Thinking-Aloud' protocol. This should enhance the quality of the captured information (Dix et al. 2004, p. 343).

3.5.1. The design and sequence of data collection methods

Observational method, interviews and focus group were the main methods used for data collection. After the initial development of the prototype system, an observational method followed by interviews were used. The observational method was facilitated by providing users with a task-sheet to accomplish using the prototype systems. After each particular step, within the task-sheet, users were prompted by a set of questions to vocalise their thoughts and feelings about particular issues in the design. This is an observational method from the HCI domain called 'Question-Asking' protocol which is a particular form of the 'Thinking-Aloud' protocol mentioned earlier (see Section 3.5) (Hom, 2003).

The task-sheet handed to the users, during each observational session, included two representative tasks where each task consisted of a set of steps. The following shows the typical scenarios on which these tasks were based.

Scenario – task (1)

The scenario for task (1) was: a Web-based prototype system is available on a local machine for providing a personalised orientation on general topics about Multiple Sclerosis (MS). A non-registered person who has MS comes into the system for the

first time looking for general information about MS. This person needs first to create a user profile to be able to browse the content in the prototype system.

Task (1) consisted of nine steps (see Appendix 1, Table 1) that were designed to guide users within the context of above scenario. Furthermore, questions (used during the 'Question-Asking' session) were pre-formulated alongside particular steps to acquire an insight on additional personalisation requirements. The questions were important as they gave an insight into further elements that may be used to enhance the process of modelling users with MS within a personalised system (research question 1). These further elements were considered as important characteristics that were needed to be included within any personalised system within the MS domain and therefore helped address research question 4.

Scenario – task (2)

The scenario for task (2) was a continuation of the above scenario: The person with MS logs-in into the prototype system to start the orientation. After accomplishing particular interactions such as: exploring different content formats and accessing relevant links, the user wishes to change the preferences outlined in their user profile to better suit his/her current needs. When users wish to finish the session, they simply log-out from the prototype system.

Task (2) consisted of eleven steps (see Appendix 1, Table 2) that were designed to guide users within the context of latter scenario. Moreover, questions (used during the 'Question-Asking' session) were pre-formulated alongside particular steps in order to:

- Obtain feedback on the appropriateness of personalisation techniques based on the user condition including the content and the presentational aspects of content (back ground colour and font size).
- Obtain feedback on the appropriateness of the personalisation technique applied to links (i.e. providing appropriate links based on the user's level of knowledge).

- Obtain a feedback on the way content was presented (i.e. at different levels of complexity) including basic, intermediate and detailed.
- Acquire a feedback on the usefulness of enabling users to override the personalisation rules in the prototype system.

The questions used during the observational method were formulated taking into account the research questions. This method of acquiring users' feedback, as they interacted with the prototype, on the appropriateness of providing personalised content, presentation and links based on the user's condition and level of knowledge, helped ascertain the usefulness and gave a better understanding of modelling users based on these elements (research questions 1 and 2). Furthermore, obtaining users' feedback on the levels of complexity and the ability to override the personalisation rules was significant as these issues partially gave an indication of the appropriateness of the technology used (research question 3) and revealed the characteristics of the personalisation conceptual model adopted (research questions 2 and 4).

Subsequent to each 'Question-Asking' individual session, face-to-face interviews were conducted. Users were asked a set of open-ended questions (see Appendix 2, Table 3) in order to:

- Obtain feedback on the appropriateness of the level of personalisation applied to content, links and presentation of content.
- Acquire an insight into additional user requirements that may help to implement personalisation efficiently.
- Gain an insight into additional personalised features based on gender, age and role of the user.
- Gain feedback on personalisation in general.

The above areas were the focus of interview questions. These questions helped acquire more in-depth answers to the research questions as the interviewees had, by now, experienced the personalised prototype system and therefore their responses would have a better grounding.

Due to the interrelationship between the research questions, some of the interview questions addressed more than one research question at a time. For instance, obtaining users' feedback on the level of personalisation applied within the prototype system not only gave feedback on the appropriateness of modeling users based on their conditions and level of knowledge (research question 1), but also gave an insight into the appropriateness of the technology used for applying personalisation within the prototype.

The use of the observational method (i.e. 'Question-Asking' protocol) and interviews during the 'Evaluation' phase took place in the first iteration (i.e. circumscription) of adopted design research methodology. The issues raised in this first iteration were incorporated (i.e. used to modify the prototype) and fed into a second iteration in the design research methodology (refer to Figure 3.3). During the second iteration, (one) 'Question-Asking' protocol session and a focus group interview was the dominant methods used for data collection.

In respect of the focus group interview, the researcher demonstrated the prototype system to evaluators in the focus group. The purpose of this was to show the evaluators how the prototype system can provide a person with MS, who is experiencing sight and fatigue problems, personalised content and presentation based on the person's sight and fatigue problems. The researcher practically demonstrated the earlier scenarios using the prototype system. After the demonstration, evaluators were asked a set of open-ended question that were pre-formulated to facilitate the discussion in the focus group.

Generally, the group questions focused on the following areas (see Appendix 2, Table 4):

- The usefulness of personalising content and presentation of content based on the user's condition.
- The ability to override the personalisation rules within the prototype system.
- A new theme emerged during the group interview which warranted further investigation regarding the willingness for, and the degree of, personal

information disclosure that would enable more refined personalisation to happen.

Again, some of the group questions provided feedback for more than one research question at a time. For instance, asking evaluators from the focus group about the usefulness of the personalisation form (which enabled users to override the personalisation rules) not only gave feedback on important characteristics of the personalised system (research question 4), but also provided an insight into important elements (i.e. control of the personalisation process) that were necessary to consider when refining the adopted personalisation model (research question 4).

In respect of the instruments used for data collection (during the 'Question-Asking' protocol, individual interviews and the group interview) tape recording and note taking were the main instruments. In addition, a brief description of the research project and its aim was given to the interviewees prior to commencing the session. Most importantly, before conducting the interviews, the consent of users was obtained.

Users' responses that were collected from the observations, interviews and the focus group were analysed manually using a 'meaning condensation' approach. The basis of this approach is to allow the reduction of large volume of interview text into "briefer, more succinct formulations" (Kvale 1996, p. 192). According to Kvale (1996, p. 192), meaning condensation involves five steps. First, the whole interview should be read to gain an understanding of the whole subject. Second, 'meaning units' of the interview are determined by the researcher. Third, the key and dominating theme for each meaning unit is concisely stated. In the fourth step, the researcher reflects on the meaning units in terms of the purpose of the study. Finally, the dominant and non-repeated themes are tied together into a descriptive statement.

In this research the dominant themes, within a group of meaning units, were condensed and then tied into a single descriptive statement taking into account the research questions. Table 5 in Appendix 4 shows some examples of using the meaning condensation approach to analyse the users' responses. These dominant themes enabled the issues raised to be considered in a logical fashion and are used in Chapters 4 and 5 as the headings used to structure in these chapters.

3.6. The population and sampling techniques

Population refers to the target group of individuals that the study aims to research. The process of selecting a portion of that population is referred to as sampling.

The target population for this study is the MS community in the United Kingdom. Individuals from the MS community constitute the required sample. Hence, it is important to investigate the various sampling techniques available.

There are two techniques used for sampling: probability sampling and nonprobability sampling. In the former technique, people are selected randomly based on the assumption that this selection would provide a "representative cross-sectional" sample if the researcher selects a large number of examples randomly. In the case of the latter technique, people are selected without the assumption that the selected sample is representative (Denscombe 1998, pp. 11-12).

In general, probability sampling techniques tend to be used in quantitative research rather than qualitative research. They allow for statistical analysis and they better suit large-scale research. On the other hand, the non-probability sampling techniques are more likely to be used in qualitative research, because in qualitative research a small numbers of instances are involved (Denscombe 1998, p. 25) and the research tends to be exploratory.

Since this research project is qualitative and exploratory in nature, a non-probability sampling technique was deemed appropriate. Therefore, the following discussion is related to the non-probability sampling techniques only.

There are different types of non-probability sampling techniques including (Denscombe 1998, pp. 15-17):

• Purposive sampling: in this type, the researcher selects people where there is some knowledge about them. The researcher chooses particular people with a belief that they would provide information relevant to the research. The advantages of purposive sampling is that it allows the researcher to select cases that the researcher believes would be significant for the research, hence, the researcher can focus on the obtaining rich data from the case rather than trying to obtain typical instances as in the probability sampling.

- Snowball sampling: at the beginning the researcher starts with a few people where each one is asked to nominate, for example, two other people willing to be involved in the research. Snowball sampling is useful when it is necessary to increase the number of the people in the sample. Furthermore, snowball sampling can be incorporated with purposive sampling where people, in this case, are asked to nominate other people according to particular criteria.
- Theoretical sampling: selects instances (i.e. the sample) depending on "the development of a theory which is 'grounded' in evidence. At each stage, new evidence is used to modify or confirm a 'theory', which then points to an appropriate choice of instances for research in the next phase." (Denscombe 1998, p. 16).
- Convenience sampling: is based on the selection of people that are convenient to and are readily to hand to the researcher.

In this research work, it was believed that purposive sampling was appropriate. The sample of people with MS were needed with some particular characteristics:

- It was preferred that they have at least basic knowledge of Internet browsing.
- It was preferable if the sample were experiencing or had experienced visual and fatigue problems. Hence, more accurate and valid data could be obtained with regards to these conditions.

However, at the very out set of the implementation phase, convenience sampling was the predominant form of sampling. The study depended on people volunteering and who were available in the time frame of the study. Subsequently, a snowball technique was used, as the researcher asked respondents to recommend other participants including friends or relatives. However, certain criteria were applied in selecting the sample and a degree of purposive sampling was maintained.

In respect to the number of people with MS involved in the implementation, nine individuals were observed (i.e. participated in the 'Question-Asking' protocol session) and subsequently interviewed. Seven participants were individuals at various stages of the disease; two participants were individuals with HCI and MS domain expertise.

Individual sessions were conducted in difference places including: Loughborough, Hathern, Rothley, Leicestershire and Letchworth. With regards to the group interview, one focus group was conducted where ten people were able to participate. This group interview took place in Gorse Covert Community Centre – Loughborough.

3.7. Summary

In this chapter, the design research methodology (design research), the design methodology, the data collection methods and the sampling technique used were explained. The rationale behind these choices were justified in the light of the research questions.

The next chapter (Chapter 5) provides detailed information about the prototype system used to acquire the users' responses in this study and the results of the first implementation (i.e. evaluation).

First Implementation

Chapter 4

First Implementation – Findings and Analysis

4.1. Introduction

Having passed through the 'Awareness' phase of the adopted research methodology (i.e. the design research methodology) wherein the problems of the research became apparent by conducting a literature survey and taking decisions concerning the adopted techniques and models of personalisation, the 'Suggestion' phase was the next step in sequence. In the suggestion phase the solution to the problem was envisaged by undertaking the design of artefacts producing a 'Tentative Design' as an output of this phase. This initial design was based on the decisions made during the 'Awareness' phase (Chapter 2), and also by identifying the initial users' requirements based on previous research concerning the information needs for people with MS. Section 4.2 visualises the initial design and personalised functionalities of the prototype in the light of the information needs of people with MS outlined in the research previously mentioned. Section 4.3 (and subsequent sections) shows the development of the prototype system based on the solution (envisaged in the suggestion phase) and the decisions made concerning the adopted techniques and model of personalisation; this represents the 'Development' phase in the design research methodology.

Subsequent to the 'Development', the 'Evaluation' phase was implemented. Due to the iterative nature of the design research methodology (i.e. circumscription), the 'Evaluation' phase was undertaken at two stages. This chapter only presents findings and analysis from the first implementation (i.e. evaluation) where seven interviews and simple observations were carried out with individual users as they interacted with the prototype system. Six users were individuals with MS at varying stages of their condition. One of these also had extensive MS domain expertise. The other user had

extensive HCI (Human Computer Interaction) expertise. A subsequent iteration through the process is described in Chapter 5.

4.2. Identifying the initial users' requirements

The initial users' requirements were mainly based on the research carried out by Hepworth, Harrison & James (2003) and Hepworth & Harrison (2004), which were concerned with identifying the information needs of people with MS. Moreover, these researchers suggested taking a holistic approach and making the information available to three communities including the general public & family, service providers, and the person with MS. These sub communities constitute the whole MS community (see Chapter 1).

It is apparent that the whole MS community (including the sub communities) is large. Therefore, it would be impractical in a small-scale research project to produce personalised information access for the three communities. As a result, and with respect to the design of the prototype, it was decided to focus on the person with MS and only to generate personalised content about MS.

Hepworth, Harrison & James (2003, pp. 294-300) also described the characteristics of the information provision for people with MS (see Chapter 1). Therefore, the design of the prototype tried to conform to these characteristics by undertaking the following points:

- To provide the information in a positive manner: information was gathered from materials published within the MS domain. Therefore, it was presumed that this material was already authenticated. It was also tried to use nonthreatening content about the disease.
- To encourage people with MS to take an action: the information acquired contained suggestions/tips in addition to available treatments to allow people with MS to better manage their conditions.
- In order to respond to the physical needs for users with MS: information was personalised within the prototype in accordance with the user's physical needs in this case with regards to fatigue and vision e.g. information is presented in

different font sizes and background colours and in different levels of complexity.

- To provide information in a way that reflected the needs of the person with MS and its possible impact on the individual: information was collected about significant topics ranging from the basic information (e.g. what is MS) to more advanced topics (e.g. causes of Acute Pain in MS).
- To use the most effective means for information provision, it was decided to design the prototype in an electronic format (i.e. as a Web site) which could be accessed and interacted with through the Internet. Martine et al. (2005, pp. 96-97) mentioned that the WWW nowadays is becoming the ultimate means for information access and sharing. It has become very popular, and it has a rapidly growing number of users where each user can have easy access to an extensive amount of information on any subject.
- To use different formats and presentation techniques that could correspond to an individual's condition: the prototype used different presentations of the user-interface that were related to individuals with visual impairment and/or fatigue. In terms of the content presentation, topics were provided in the prototype system at three levels of complexity including basic, intermediate and detailed. This was an important part of the prototype as it enabled personalisation of the detail of the topics presented to users.

It was suggested in the research by Hepworth, Harrison & James (2003, pp. 300-301) that responding to the individuals' needs can be achieved using different formats/presentations of information based on the condition being experienced. For instance, people with fatigue and/or concentration problem would need information that is provided in brief. Therefore, this informed the design of content within the prototype system to be in a simple (i.e. basic) format. However, due to the nature of MS, people may go through periods of time where they do not experience symptoms (e.g. fatigue). Consequently, people may want at this stage to acquire more detailed information about the disease or the different symptoms that they may experience in the future. Hence, it could be beneficial to users with MS if the content could also be

provided at different levels of complexity where users could view the appropriate level based on their conditions.

4.3. Developing the initial prototype

In this 'Development' phase, a decision regarding the adopted tools was made. The decisions relating to the adopted personalisation techniques and models, as mentioned earlier, was made during the 'Awareness' Phase. The following describes and justifies the tools and the model adopted for the development of the personalised prototype. In addition, the main technical aspects concerning the development of the prototype system is provided.

4.3.1. XML technology

XML is an Extensible Markup Language recommended by the World Wide Web Consortium (W3C). XML is an emerging technology with powerful real-world applications for the management, display and organisation of data. XML is a subset of SGML (Standard Generalized Markup Language). SGML is a meta language for developing tag sets to maintain and code structure and semantics about information. However, XML, unlike SGML, is well-suited for integration into Web applications. Because XML is a meta language, the semantics and the tag sets that can be defined are not fixed, unlike HTML. HTML (Hypertext Markup Language), which has been widely used for creating documents on the Web, is limited in its scope. For instance, when creating a document about a person's name, HTML can only display the person's first name or last name, since HTML does not have markup symbols (tags) to describe such types of specialised information (Hunter 2000, pp. 9-13).

Although XML is still relatively a new technology, many companies have given attention to it. For example, Microsoft have taken an interest in XML; its Internet Explorer (version 5 and above) can render XML documents. Also, it has been well utilised in the digital library domain (Seadle 2001, p. 207).

One of the most important features of XML is that it can "separate data from its manipulation and display", which can be handled by variety of tools such as XSL (Extensible Stylesheet Language) (Seadle 2001, p. 208).

Chapter 4

The ability to separate data from presentation is a very significant feature of XML. This allows authors to focus on the creation of content (and the semantics of the content) rather than worrying about how it would be rendered in a Web browser. Furthermore, the growing range of XML applications indicates the reliability and robustness of this technology. Therefore, XML was seen as a good candidate to be used as the underlying tool for the development of the personalised prototype.

4.3.2. XSL (XSLT & XPath)

As CSS (Cascading Style Sheet) is a style sheet used to format HTML documents, XSL is also a style sheet for XML documents. XSL exceeds the limits of simple formatting by manipulating the structure of the XML document and allowing the complete transformation of XML content into another format (including HTML). XSLT (XSL transformation) is the XSL component supported by Web browsers, which allows transformation of XML documents using style sheet code. XSLT does not directly assist the formatting of XML content for display purposes. XSL-FO (XSL Formatting Objects) is the formatting component of XSL, which consists of special style objects that can be applied to XML documents to format it for display. Nonetheless, XSL-FO is not supported yet in the most used Web browsers. Therefore, it might be necessary when transforming XML documents into HTML to use CSS to have a well-formatted display of the resulting documents (Morrison 2002, pp. 200-203).

When using the XSLT language for transforming XML documents, it is often necessary to locate elements or sections within an XML document to carry out some particular process. XPath, is another component that is designed by W3C to be used with XSLT. XPath is used to specify locations and navigate within the XML documents' structure from a current position to any other position. It is worth noting that both XSLT and XPath are W3C formal recommendations (Holman, 2000).

Because XML was chosen as the underlying tool for the development of the prototype system, XSLT and XPath were naturally selected, because they are able to manipulate and render XML documents in a Web browser. CSS was also chosen, because it is supported by most Web browsers and necessary for styling the appearance of rendered documents.

Other tools, such as a database, was needed for the development of the prototype system. Using a database was necessary for storing data about users – e.g. preferences/conditions. There are many options in terms of the database software available such Oracle, MS Access, PostgreSQL, MySQL, etc. However, MySQL was thought a good candidate, because of its reliability and popularity. MySQL also has very good documentation and a user community that could offer help in case of difficulty. Furthermore, MySQL database can be plugged into the Apache Cocoon publishing framework easily.

4.3.3. Apache Cocoon

Apache Cocoon is a web development framework that allows for the development of flexible, maintainable, scalable, and robust XML applications (Melhem, 2003).

Apache Cocoon offers a flexible environment where a separation between content, logic and style is possible. Apache Cocoon can effectively interact with most data sources such as file systems, RDMS (Relational Database Management System), LDAP (Lightweight Directory Access Protocol), XML databases and network-based data sources. Apache Cocoon can produce adaptive content delivery by allowing different presentation of the same data depending on the device capabilities of the requesting client, such as HTML, WML (Wireless Markup Language), PDF (Portable Document Format), SVG (Scalable Vector Graphics) and RTF (Rich Text Format) (Apache Cocoon, 2005).

Apache Cocoon allows (and is well-suited for) building three-tier architecture applications. In this architecture Cocoon lies in the middle between client and the data storage (i.e. a database) or legacy system. This architecture is often called middleware (Langham & Ziegeler 2002, p. 14).

The three-tier architecture (middleware) emerged to overcome the disadvantages of the traditional two-tier client/server architecture including poor performance when serving large number of users, limited use of data sources and restricted output format (it only produces HTML documents) (Sadoski, 1997; Francis, 2003).

Using Apache Cocoon as a middleware allows publishing XML documents to be made available in many formats such as HTML, PDF, WML based on the client type
such as PC, workstation, or mobile phones. Apache Cocoon also allows "data aggregation" from different data sources. For instance, in an online banking application, details of a user account can be first fetched from a database. Then a function might be called from a legacy system (typically a mainframe) which stores, for example, the user's account balance. Based on the user's balance, a customer relationship management systems (CRM) might be called to indicate that offers should be made to this user (Langham & Ziegeler 2002, p. 15) (see Figure 4.1). Although many data sources and formats could be used (such as in the above example), users see only a single view of data presentation i.e. the data sources and original formats are kept hidden from the end-users (Francis, 2003).



Figure 4.1 Apache Cocoon used in a three-tier architecture application (Langham & Ziegeler 2002, p. 17)

Apache Cocoon depends on a pipeline approach for processing content. Developers using Cocoon can define a number of these pipelines and the components inside each pipeline which are responsible for content processing. These components, including generators, transformers, matchers, and serializers, are defined in the Cocoon's sitemap (Punte, 2002). Figure 4.2 presents a simple example of how an XML document is processed using the pipeline approach. The pipeline starts with a single generator which is a component that reads the input data (i.e. File.xml) and turns it

into a SAX (Simple API for XML) stream (Punte, 2002). SAX is an event-based API (Application Programming Interface) that can be written in any programming language such as Java. SAX allows XML documents to be parsed as a stream of events where they can be processed by an application program (XML.ORG, 2006). The middle component in above example represents an XSL transformer which accepts the XML stream and processes it by – for example – adding HTML tags in order to enable the document to be rendered by a Web browser. Finally, the serializer component is used to terminate the pipeline processing and turn the content into HTTP format (Punte, 2002).



Figure 4.2 Simple pipeline example (Punte, 2002)

The figure above shows only basic XML content processing within a pipeline. However, in real-life applications the use of Cocoon's pipelines would be more advanced. In such advanced situations data might be fetched from other resources such as a database. In this case it is the responsibility of Cocoon to communicate with the database, fetch the required data, and place it in its designated place within the XML stream. Figure 4.3 shows an advanced example using the pipeline approach in Cocoon. As mentioned before, the pipeline should start with a generator that reads an XML document. Then the stream passes through to the second component – the SQL transformer – where it processes the SQL statement(s) included within the original XML document and replaces results within the XML designated tags with data from a database lookup. The stream continues inside the pipeline to another component, XSL transformer, which (as mentioned before) acts on the stream by adding the necessary HTML tags for example to allow the document rendering on the Web browser. The

final step in the pipeline is using the serializer where the pipeline processing ends and the stream is converted to HTTP response so it can be accessed by the Web browser.



Figure 4.3 Advanced pipeline example (Langham & Ziegeler 2002, p. 73)

As mentioned before, developers using Cocoon need to define the pipelines in the sitemap (see Listing 4-1). This sitemap is considered the heart of Cocoon where all necessary configurations are defined.

Listing 4-1 presents an extract from sitemap which defines the components shown in Figure 4.3. It starts with the tag *spipelines* which tells Cocoon to carry out processing based on the embedded tags. The first component used in the above listing is the matcher component which allows the document request to be matched against a pipeline (Langham & Ziegeler 2002, p. 74).

Listing 4-1 Sitemap example

```
<pipeline>
<map:match="example1.html">
<map:generate src="file.xml"/>
<map:transformer type="sql">
<map:parameter name="use-connection" value="mydatabase"/>
</map:transformer>
<map:transformer>
<map:transformer type="xsl" src="toHTML.xsl"/>
<map:serializer type="html"/>
</map:match>
</pipeline>
```

In other words, when a user types into the Web browser the following URL (Uniform Resource Locater) http://www.imaginary-server.com/example1.html, this URL tells Cocoon to process the pipeline holding the name example1.html (which should be specified in a matcher). Having determined the pipeline required, Cocoon starts processing the embedded tags. The process starts exactly as described in Figure 4.3 - i.e. reading the XML document, fetching the data from a database and placing them in their designated place(s), adding the HTML tags and finishing the process by using the serializer.

Cocoon allows developers to define as much as is needed of pipelines for their application. In Cocoon, data which are processed by one pipeline can be passed into another one for further processing until the termination point (i.e. a serializer) is reached in the sitemap. Moreover, Apache Cocoon includes other components which allow developers to accomplish other functionalities – for instance, Cocoon can read HTML pages, using the html generator, and turn them into well-formatted XML documents for processing (Cocoon can only process XML format) (Langham & Ziegeler 2002, p. 71).

Apache Cocoon is entirely written in Java; therefore, it is platform-independent. In other words, Apache Cocoon can run on any machine regardless of its operating system (Langham & Ziegeler 2002, p. 40). Cocoon also has been tested and used in the domain of adaptive hypermedia; It was used in the WHURLE system to underpin the processing and publishing of biology lessons (authored as XML documents) for students (Brailsford et al., 2002).

Apache Cocoon therefore offers a flexible environment for content processing, integration, and publishing making it a very good candidate for the development of the prototype system.

4.3.4. The model adopted for personalisation

A number of models for adaptation were reviewed in Chapter 2 (Section 2.10) including the Dexter Model, the AHAM model, the Munich model, and the LAOS model. The focus of these models was to describe the functionality of hypertext/adaptive hypermedia in order to come up with standards that can be used to underpin the development of hypertext and adaptive hypermedia systems.

Consequently, this would encourage the interoperability and resources sharing between different systems.

However, each model has its own approach which requires one to think carefully before deciding on which model to adopt. For instance, the LAOS model takes a mathematical approach for describing the adaptations in IS. The Munich model adopts an object-oriented approach using UML (Unified Modelling Language) for describing adaptive hypermedia systems. However, these two models were primarily based on AHAM, but with some extensions specifically being added to achieve more adaptation within the educational domain.

AHAM adopted an informal approach for the model description which makes it easier to adopt when compared to the other models. It is based on the Dexter model which is the most widely used model for describing the architecture of hypertext/hypermedia systems. The AHAM has been used as the underlying model for the development of an authoring system – AHA (described in Chapter 2, Section 2.9.3). Therefore, it was believed that the AHAM model was the most appropriate model to underpin the development of the prototype system in this research. The following explains the elements adopted from the AHAM model.

4.3.4.1. The domain model (DM)

As in AHAM, the DM of the prototype system is concerned with describing concepts and concept relationships. In the prototype developed, the DM was authored using XML chunks that represent the concept (i.e. topics) and their relationships to other concepts. Seven XML resources were authored at different levels of information complexity including basic, intermediate, and detailed. These XML resources covered several topics including general explanations about MS where themes such as: what is MS, what causes MS, types of MS, how MS is diagnosed were covered. Also, topics concerned with symptoms of MS were explained including themes describing emotional and fatigue symptoms. Finally, topics concerned with MS treatment including fatigue and pain treatment were authored.

The general structure of these XML resources is depicted in Listing 4-2. This listing shows the XML resource named 'General explanations' which covers general information about MS. This XML resource was authored into three levels of

information complexity as shown above in the listing. The structure started with the <generalexp> tag which is the root element of the resource.

The tag <chunk name="general explanations" type="text" simplicity="basic" priority="1"> defined the information contained in this chunk using the several attributes. The name attribute gave a unique name to the chunks authored. The type attribute was used to indicate the format of information that was presented inside the chunk. Other possible values for the type attribute could be "pics" to indicate the pictorial information or "mix" to indicate both - textual and pictorial information (however, the value "text" is used to indicate all possible types of information in the current development of the prototype). Simplicity was a significant attribute. It represented the level of complexity using three values including "basic", "intermediate", and "detailed". The simplicity attribute was also used to distinguish between chunks that have similar name attribute – for instance, <chunk name="general explanations" simplicity="basic"> would be different (in terms of the depth of information) from <chunk name="general explanations" simplicity="intermediate">. This tag was useful to extract the information chunks by comparing users' attributes (stored in their profiles) with the simplicity attribute (see Listing 4-6). This represented the conditional text technique where information chunks are presented based on a particular condition within the user model (see Chapter 2, Section 2.8.1). The attribute priority was used to determine the sequence of the presented topics - e.g. priority="2" reflects the second topic in sequence. Values from "1" to "7" were used as seven topics were authored.

Tags were also created to help the prototype system to recommend links to related topics based on users' knowledge. The tags <symbolizedname> and <symbolizedknowledge> indicated how the concept e.g. 'general explanations' was symbolised (i.e. represented) in users profiles. This facilitated the manipulation of knowledge about DM concepts for each user with MS (more explanation is provided under the user model and personalisation engine headings).

```
<generalexp>
<chunk name="general explanations" type="text" simplicity="basic"</pre>
priority="1">
         <symbolizedname>chunk_name1</symbolizedname>
         <symbolizedknowledge>chunk_name1_knowledge</symbolizedknowledge>
         <acquiredknowledge>1</acquiredknowledge>
      <sections>
         <section>
            <h1>General explanations</h1>
            MS is a chronic, i.e. long-term, condition that affects the
functioning of the central nervous system (the brain and spinal cord).
            . . . .
          </section>
    </sections>
<relatedpipeline>
         <knowledgebased-url>
            <pipeline id="symptoms in general">continue(2)</pipeline>
            <pipeline id="treatment in general">continue(5)</pipeline>
         </knowledgebased-url>
         <static-url>
            <pipeline info_simplicity="intermediate">other(1) </pipeline>
            <pipeline info_simplicity="detailed">other(1)</pipeline>
         </static-url>
 </relatedpipeline>
</chunk>
<chunk name="general explanations" type="text" simplicity="intermediate"</pre>
priority="1">
<chunk name="general explanations" type="text" simplicity="detailed"
priority="1">
 . .
```

```
Listing 4-2 The general architecture of XML resources
```

</generalexp>

The tag <acquiredknowledge> indicated the knowledge that users would acquire after seeing/browsing the topic in the chunk presented. Values such as "1" was used to indicate the amount of knowledge which should have been acquired by users about the topic presented after reading the chunk. Based on this knowledge, the prototype system could present links to related topics (more details are in Section 4.3.5). More complex representations for knowledge could have been used (e.g. known, well-known, learned, or well-learned). However, it was decided to keep this representation

as simple as possible, because the complexity of personalisation (required by MS users) was, at this stage of development, not fully understood.

The actual content was stored in the <sections> tag where it was broken into subsections using the <section> tag. Each <section> tag contained a particular part of the overall topic presented.

The <relatedpipeline> tag was used to identify the relationships to related concepts in other XML resources i.e. to define external relationships. The tag <knowledgebased-url> defined the links that would be generated based on the knowledge acquired in users' profiles. The location of these links were determined inside Cocoon's sitemap; therefore, when the prototype systems reads the tag <pipeline id="symptoms in general">continue(2)</pipeline> it would be able to determine which resource to call. For example, the above <pipeline> tag tells the prototype system that from the topic presented ("general explanations") users can navigate to other related topics such as "symptoms in general". The value continue(2) reflected the location of "symptoms in general" page inside the sitemap which would be generated using the pipeline approach explained in Listing 4-1. Hence, links to this related page would be presented to users. However, links leading to related pages are not presented unless the user has seen their prerequisite topics. For instance, users would not be able to see the topic "symptoms in general" and "treatment in general" unless users have seen the prerequisite topic "general explanations".

The <relatedpipeline> tag was also used to define relationships (i.e. links) between chunks of different levels of complexity within the same XML resource i.e. to define internal relationships. These internal links enabled users to link to topics at other levels of complexity from the level being viewed. For instance, if users are presented with topics at basic level of information complexity, they could view the other levels of complexity for the same topic including intermediate and detailed. The tag <static-url> included sub-tags that define the internal resources with different of instance. the sub-tag levels complexity. For <pipeline info_simplicity="intermediate">other(1)</pipeline> informed the prototype system about the location of the page that described the same topic, but with the 'intermediate' level of complexity.

The </chunk> tag indicated the end of the chunk (general explanations) with the basic level of complexity. Following the same structure, another two chunks describing the same topic (i.e. general explanations) were authored but at different levels of complexity including intermediate and detailed (see Listing 4-2). Finally, the </generalexp> tag was required to close the root element.

The rest of the XML resources of the prototype system were authored using the same structure.

4.3.4.2. The user model (UM)

The UM in the prototype system was constructed using the MySQL database. Three important tables were built, these were 'ms_users', 'ms_concepts', and 'ms_concepts_knowledge'. The 'ms_users' table included information about MS users encompassing a unique identification for each user, problem(s) being experienced by users including sight and/or fatigue, the assigned/preferred type of information complexity and any layout preferences (see Table 4.1).

| Field name | Type |
|-------------------|--|
| ID | Integer |
| Name | Character |
| Password | Character |
| Diagnosis | Character: values (none, sight, fatigue, or |
| Info_simplicity | Character: values (basic, intermediate, or detailed) |
| Background_colour | Character: values (white or yellow) |
| Font size | Integer: values (12-20 point) |

| Table 4.1 | Structure | of ms | users | table |
|-----------|-----------|-------|-------|-------|
| | | | | |

Table 4.1 shows the information stored about each MS user (i.e. users profiles). The information in this table was used by the prototype system to determine the relevant chunks of information from the DM. The information presented in Table 4.1 is the initial information collected from users. This was achieved by asking users to fill-in a simple form.

The values of the 'Info_simplicity' and 'Font_size' fields in Table 4.1 were conditioned by the 'Diagnosis' field. For example, if a user selected from the fill-in form 'Sight' as the problem being experienced, the value '19' point (to show large font size on the screen) would be assigned to the 'Font_size' in the user profile (see the personalisation model part for complete personalisation rules).

The 'ms_concepts' table stored information about the concepts (i.e. topics) of the DM. Similar to the AHAM model, there is a UID (Unique Identifier) for each topic represented by the concept's name. Topics' names were presented in the form of 'chunk_name(n)' where 'n' takes the value from 1 to 7, as there were seven topics authored (see Table 4.2).

Table 4.2 shows the topics' names and their denoted values. For instance, the field 'chunk_name1' represented the first topic in the DM with the value 'general explanations'.

| Field name | Туре |
|-------------|--|
| Subject | Character: default value (orientation to MS) |
| Chunk_name1 | Character: default values (general explanations) |
| Chunk_name2 | Character: default values (symptoms in general) |
| Chunk_name3 | Character: default values (emotional symptoms) |
| Chunk_name4 | Character: default values (fatigue symptom) |
| Chunk_name5 | Character: default values (treatment in general) |
| Chunk_name6 | Character: default values (fatigue treatment) |
| Chunk_name7 | Character: default values (pain treatment) |

Table 4.2 Structure of ms_concepts table

The field 'Subject' in Table 4.2 represented the overall topic (i.e. orientation to MS). The 'Subject' field was used to map between topics and the user's knowledge about these topics. As mentioned before, the knowledge value in this context indicated the topic(s) that were seen by each user (see Table 4.3).

The knowledge value in AHAM represented the user's knowledge about the DM concepts. Similarly, in the prototype system the user's knowledge about DM topics was represented using the values '0' or '1'. '0' (which was the default value) indicated that the topic was not seen, whereas '1' indicated that the topic was seen by the user. The knowledge values shown in Table 4.3 were represented using the fields 'chunk_name(n)_knowledge' where 'n' indicates the chunk number (from '1' to '7') which was mapped eventually to the 'chunk_name(n)' (i.e. topic). For Instance, 'chunk_name(2)_knowledge' represented the user's knowledge about the 'chunk_name(2)' which was eventually mapped to the value 'symptoms in general' (see Table 4.2).

The fields 'ID' and 'Subject' in Table 4.3 were used to map between the tables 'ms_users', 'ms_concepts', and 'ms_concepts_knowledge' to retrieve records for each user. This was achieved using the SQL select statement that joins the previous tables using the 'ID' and 'Subject' fields (see Listing 4-5 under the personalisation engine heading).

| Filed | Tima |
|-----------------------|---------------------------------------|
| ID | Integer |
| Subject | Character: values (orientation to MS) |
| Chunk namel knowledge | Integer: default value (0) |
| Chunk_name2_knowledge | Integer: default value (0) |
| Chunk name3 knowledge | Integer: default value (0) |
| Chunk_name4_knowledge | Integer: default value (0) |
| Chunk_name5_knowledge | Integer: default value (0) |
| Chunk name6 knowledge | Integer: default value (0) |
| Chunk_name7_knowledge | Integer: default value (0) |

Table 4.3 Structure of 'ms_concepts_knowledge' table

4.3.4.3. The personalisation model (PM)

Two approaches to personalisation were mainly used in the prototype system – rule-based personalisation and behavioural personalisation. Table 4.4 shows the personalisation rules that were used within the prototype system.

| Condition | Action |
|--|--|
| Problem (i.e. diagnosis) is sight | Font_size value is set to '19' points |
| Problem is fatigue | Info_simplicity value is set to basic |
| Problems are sight and fatigue | Font_size and Info_simplicity values are set to '19' points and basic |
| Otherwise (i.e. no problem being selected) | Font_size and Info_simplicity are set to the default values – '16' points and intermediate |

| Table 4.4 Rule-based | personal | isation a | dopted |
|----------------------|----------|-----------|--------|
|----------------------|----------|-----------|--------|

As can be seen from the table above, the scope of the rules were only concerned with sight or/and fatigue problems. Table 4.4 shows four rules (i.e. conditions) and actions that were authored. For example, if users indicated they suffer from sight problems (during the creation of the user profile), they would be assigned to font size of '19' points (this was felt to be large enough for most users). The table also shows the default values assigned by the prototype system concerning font size (16 points) and the level of information complexity (intermediate). These values were chosen for users who did not select the fatigue and/or sight problems during the creation of their profiles. The 'white' background was always used as the default colour in the prototype (this was felt to give a good contrast for the black text). However, there is no one particular combination of background and text colours that can suit all situations – different sight problems may result in different needs of colours (Accessibility 101, 2007).

Behavioural-based personalisation was achieved in the prototype system by identifying topics that were seen by users. To identify seen topics, the prototype system (specifically the personalisation engine) updated the knowledge of concepts from '0' to '1' in the 'ms_concepts_knowledge' table. Therefore, when the prototype system retrieved records from this table, '1' indicated the seen topics and '0' indicated

the unseen topics by users. Table 4.5 shows the behaviours as well as their consequences.

| Behaviour | Consequence |
|---|---|
| Accessing the page (i.e. topic): general explanations | Updating the chunk_name(1)_knowledge to '1' |
| Accessing the topic: symptoms in general | Updating the chunk_name(2)_knowledge to '1' |
| Accessing the topic: emotional symptoms | Updating the chunk_name(3)_knowledge to '1' |
| Accessing the topic: fatigue symptom | Updating the chunk_name(4)_knowledge to '1' |
| Accessing the topic: treatment in general | Updating the chunk_name(5)_knowledge to '1' |
| Accessing the topic: fatigue treatment | Updating the chunk_name(6)_knowledge to '1' |
| Accessing the topic: pain treatment | Updating the chunk_name(7)_knowledge to '1' |

Table 4.5 The behavioural-based personalisation adopted

Having determined the knowledge value of concepts, the prototype system (particularly the personalisation engine) was able to generate links to related concepts. For example, if the UM of a user reflected knowledge about the 'general explanations' concepts (i.e. the value of the chunk_name(1)_knowledge was '1') then links to the related concepts would be presented. As described before, the prototype system identified the related concepts using the tag <knowledgebased-url> (see Listing 4-2). This is an example of the 'direct guidance' technique (see Chapter 2, Section 2.8.2). In this technique, one link is shown in accordance with e.g. the user's level of knowledge. However, the current implementation of 'direct guidance' (within the prototype system) presented more than one suitable link to users due to the structure of chunks within the domain model – i.e. a topic might be connected/related to more than one topic (see Figures 4.10 and 4.11).

The actual execution of the personalisation approaches adopted, including the rulebased and behavioural-based personalisation, was achieved by the personalisation engine.

4.3.4.4. The personalisation engine (PE)

The main goal of the personalisation engine was to execute the rules authored in the PM. Rule-based personalisation was executed during the first stage of creating the user profile -i.e. These rules were carried out during the registration process.

Listing 4-3 shows the actual XSLT used to implement these rules. The XSLT was divided into three parts; each part carried out a particular rule from the rule-based approach (presented in Table 4.4). The XSLT used the <xs1:choose> tag to test against each rule. The first case was to test if the problem being experienced (by a user with MS) was a 'sight' problem. This was represented using the test <xs1:when test="\$problem='sight'">. In this line, the problem being experienced was represented as a parameter that took its value from the fill-in registration form (see Figure 4.5, Section 4.3.5). If this test was true (i.e. the user selected the 'sight' problem in the registration form) then the font_size field would be set to '19' in the 'ms-users' table. The other fields, including the name and password, took their values from users input in the registration form. This was achieved using XSLT elements <xs1:value-of select="\$password"/>.

In Listing 4-3, the <xsl:when test="\$problem='fatigue'"> test executed the second case (i.e. rule) if users selected 'Fatigue' as the problem being experienced in the registration form. In this case, the info_simplicity field should be set to 'basic'. The test <xsl:when test="\$problem='sight, fatigue'"> executed the third rule if users selected 'Fatigue and Sight' as the problems being experienced. As a result, the fields 'font_size' and 'info_simplicity' should be set to '19' and 'basic' respectively in the 'ms_users' table. Finally, the fourth situation was carried out in the <xsl:otherwise> section. This section was executed if users selected the 'none' option in the registration form, or if they simply did not select any of the options given. In this case, the default values of 'Font_size' (i.e. '16' point) and 'Info_simplicity' (i.e. 'intermediate') should be initialised in the 'ms_users' table (see Tables 4.1 and 4.4). As can be seen from Listing 4-3, data manipulation (i.e. fields values) in tables is achieved using the SQL insert statements.

Chapter 4

First Implementation

In addition to the information collected from users when they register for the first time, other information regarding their knowledge about the topics of the DM was initialised by the PE. This was achieved using the XSLT presented in Listing 4-4. The purpose of this XSLT was to insert the last created users ID automatically in the 'ms_concepts_table'. The last created user was acquired using the SQL function last_insert_id(). Hence, if a new user registered in the prototype system, a new ID value number would be created in the 'ms_users' table. This ID value was used, at the same time, to create a record for that user in the 'ms_concepts_knowledge' table. Therefore, this simplified retrieving records for users and their knowledge about the DM concepts from the 'ms_users' and 'ms_concepts_knowledge' tables using this ID field.

The other personalisation approach used (i.e. the behavioural-based approach) was also carried out by the PE. This approach was accomplished using the following steps:

- Retrieving the current user profile and placing it at the top of the DM concepts document.
- Examining the user's knowledge of the current DM topic being presented. If it was equal to '1' then the PE should use the <knowledgebased-url> to generate links to the related concepts that were described inside the <pipeline id="...">tags (see Listing 4-2).
- Updating the knowledge of users in the 'ms_concepts_knowledge' after seeing each DM topic.



Listing 4-3 XSLT for executing the rule-based personalisation

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Listing 4-4 XSLT for initialising the user's knowledge of DM concepts based on the user's ID

Retrieving the current user profile was carried out using the SQL statements presented in Listing 4-5. The SQL syntax shown in Listing 4-5 retrieved records from the tables 'ms-users', 'ms_concepts', and 'ms_concepts_knowledge'. These records should belong to the current username that was equal to the value obtained by the XSLT element <xsl:value-of select="\$name"/>. For instance, if the username (during the registration process) was 'Fred' then this value would be stored in the 'ms_users' table and also in a parameter called `\$name'. Therefore, if the current user (interacting with the prototype system) was 'Fred' then the XSL-value element would be evaluated to the value 'Fred'. This ensured that the system would extract records which only belong to this particular username.

Listing 4-5 SQL statements for retrieving the current user record

```
<user>
<user>
<execute-query xmlns="http://apache.org/cocoon/SQL/2.0">
<query>
select * from ms_users,ms_concepts,ms_concepts_knowledge
where ms_users.name='<xsl:value-of select="$name"/>'
and ms_concepts.subject=ms_concepts_knowledge.subject
and ms_users.id=ms_concepts_knowledge.id
</query>
</user>
...
```

The 'Subject' and 'ID' fields were used as foreign keys to retrieve records from three tables simultaneously.

Extracting DM topics at an appropriate level of complexity was based on the user's diagnosis (i.e. problem being experienced) (see Table 4.4). Therefore, when users selected (during the registration), for example, fatigue as a symptom being experienced, this would be used as the basis for extracting chunks of information at the 'basic' level of complexity (see Listing 4-6).

Listing 4-6 shows the XSLT which extracted chunks from the DM based on the problem(s) selected during registration. This XSLT had two functions; first, it copied (using the XSLT copy-element) the current user information which had been already queried from the database using the SQL presented in Listing 4-5. Second, it extracted the chunks from different XML files and combined them in one place – this technique is called 'Transclusion'.

Listing 4-6 XSLT for copying the user's profiles and extracting chunks based on the user's diagnosis

```
</user>
</user>
</user>
</user>
</user>
</user>
</user>
</userset
```

Transclusion is a hypertext technique that is similar to the XInclude recommendation from the W3C. The XInclude recommendation allows aggregation of different XML documents in one place (i.e. new XML document) (W3C Recommendation, 2006). However, the transclusion technique used in the prototype system had more advanced functionality. It allowed the inclusion of specific parts from each XML document rather than including the entire XML document. This techniques was achieved using XSLT 2.0 which allowed using the XSLT 1.0 Document() function with XPath expressions to retrieve specific parts from the designated document (see Listing 4-6) (DuCharme, 2003).

In order to use the transclusion technique in the prototype, it was important to use xsl:version="2.0" to allow the XSLT processor to differentiate between the XSLT 1.0 and XSLT 2.0 elements (see Listing 4-6). Subsequently, the XSLT-copy element was used to copy chunks of the XML document specified inside the copy element. As mentioned before, the transclusion technique used the document function and XPath expression to extract specific locations from each XML document. For instance, the first XSLT-copy element in Listing 4-6 informed the XSLT processor to copy information chunks from the XML document 'general explanations' starting from the root node 'generalexp' reaching to each child-node named 'chunk' with a specific 'simplicity' attribute equal to the value of the variable $sinfo_simplicity$. Allowing the 'simplicity' attribute to take its value from a parameter makes the transclusion technique more dynamic. It should be mentioned that seven transclusion retrieved specific parts from an XML document and then aggregated these parts into another new XML document.

Listing 4-7 shows the new aggregated XML document with the user's information (stored in the database) placed at the top of this document. The document in Listing 4-7 was divided into two parts; an upper part where the current user's records were retrieved from three tables including 'ms_users', 'ms_concepts' and 'ms_concepts_knowledge'. The lower part shows chunks of information, at a particular level of complexity, that were extracted based on the user's diagnosis.

Having retrieved the user's information (including the knowledge about DM topics) and placed it at the top of the aggregated chunks, the PE performed a test based on the user's knowledge about DM topics. This test was accomplished using the XSLT code presented in Listing 4-8.

```
Chapter_4
```

```
Listing 4-7 The new aggregated XML document with a user profile placed above
                                             <page>
 <user xmlns:sql="http://apache.org/cocoon/SQL/2.0">
  <name>fred</name>
  <password>cvx</password>
  <diagnosis>fatigue</diagnosis>
  <info_simplicity>basic</info_simplicity>
  <background_color>white</background_color>
  <font_size>16</font_size>
  <chunk_namel>general explanations</chunk_namel>
  <chunk_name1_knowledge>1</chunk_name1_knowledge>
  <chunk_name2>symptoms general</chunk_name2>
  <chunk_name2_knowledge>1</chunk_name2_knowledge>
  <chunk_name3>symptoms emotional</chunk_name3>
  <chunk_name3_knowledge>0</chunk_name3_knowledge>
  <chunk_name4>symptoms fatigue</chunk_name4>
  <chunk_name4_knowledge>0</chunk_name4_knowledge>
  <chunk_name5>treatment general</chunk_name5>
  <chunk_name5_knowledge>0</chunk_name5_knowledge>
<chunk_name6>treatment fatigue</chunk_name6>
  <chunk_name6_knowledge>0</chunk_name6_knowledge>
  <chunk_name7>treatment pain</chunk_name7>
  <chunk_name7_knowledge>0</chunk_name7_knowledge>
  </user>
<chunk name="general explanations" type="text" simplicity="basic"</pre>
priority="1">
         <symbolizedname>chunk_name1</symbolizedname>
    <symbolizedknowledge>chunk_name1_knowledge</symbolizedknowledge>
         <acquiredknowledge>1</acquiredknowledge>
      <sections>
      </sections>
  </chunk>
<chunk name="symptoms in general" type="text" simplicity="basic"
priority="2">
         <symbolizedname>chunk_name2</symbolizedname>
    <symbolizedknowledge>chunk_name2_knowledge</symbolizedknowledge>
        <acquiredknowledge>1</acquiredknowledge>
      <sections>
       </sections>
 </chunk>
<chunk name="emotional symptoms" type="text" simplicity="basic"</pre>
priority="3">
         <symbolizedname>chunk_name3</symbolizedname>
    <symbolizedknowledge>chunk_name3_knowledge</symbolizedknowledge>
         <acquiredknowledge>1</acquiredknowledge>
      <sections>
      </sections>
 </chunk>
```

```
33. 128
<xsl:if test="number(preceding::*[name()=$symbolizedknowledge])=1">
<xsl:for-each
select="//chunk[position()=$now]/relatedpipeline/knowledgebased-
url/pipeline[1]">
<knowledgebased-url>
   <xs1:element name="a">
     <xsl;attribute name="href">
         <xsl:value-of
select="concat(text(),'?id=',$id,'&','name=',$name,'&'
info_simplicity=',$info_simplicity,'&','background_color=';
$background_color,'&','font_size='
,$font_size)" />
        </xsl:attribute>
       <xsl:attribute name="target">
   <xsl:text>_blank</xsl:text>
 </xsl:attribute>
<xsl:value-of select="@id" />
</xsl:element>
</knowledgebased-url>
</xsl:for-each>
```

Listing 4-8 XSLT responsible for testing users' knowledge and generating links to related topics

The XSLT-test shown in Listing 4-8 examined the current user's knowledge of each information chunk (shown in Listing 4-7). In this test, the value of each <chunk_name(n)_knowledge> in the upper part (i.e. user information) was examined against the value '1'. Fortunately, the XSLT processor can traverse the XML document from any current position. At this point of processing (shown in Listing 4-7), the XSLT current node was the <chunk name="general explanations"...> tag. This location was important as each chunk contains necessary information for generating links to related topics (see <knowledgebased-url> in Listing 4-2). However, the position of the user's knowledge, which needs to be tested, preceded the chunks shown in Listing 4-7. Therefore, the XSLT test was structured to be able to examine the user's knowledge in the upper part of the document without losing its initial place. Because each information chunk contained how the knowledge about DM chunks should be represented in the UM using the <symbolizedknowledge> tag, this tag was used as a parameter (i.e. \$symbolizedknowledge) inside the XSLT test

statement (see Listing 4-8). Combining the parameter \$symbolizedknowledge with function preceding::*[name()...] allowed the XSLT processor to look exactly at the name of the preceding node based on the value \$symbolizedknowledge parameter, and examined it against the value '1'.

If the XSLT test value evaluated true (e.g. if the value of the node <chunk_name2_knowledge> equals to '1'), then the XSLT processor would execute the XSLT syntax that generates links to related topics (see Listing 4-8). This syntax used the XSLT-for loop element to ensure applying the knowledge test on all chunks. The XSLT shown in Listing 4-8 assembled links from elements, attributes and values. First, the XSLT built the links anchor <a> element of a link, then it added the 'href' attribute to the this anchor. As with any HTML link, the 'href' attribute should include the URL of the destination document. In the prototype system this was achieved by adding the name of the pipelines (in Cocoon's sitemap) responsible for creating the destination documents. As described before, each chunk and particularly the child-nodes of the <knowledgebased-url> node include the URL of the pipeline that was responsible for generating the related pages. Hence, these nodes values (e.g. continue (2) and continue (5)) were copied using the XSLT-copy element. This XSLT-copy element used the concatenation function concat() to attach information about users (such as ID, username, information simplicity (i.e. complexity), background colour and font size) to links. This information was important, as it fed into the XSLT files which were responsible for extracting chunks at an appropriate level of complexity. This information fed also into the XSLT files which were concerned with rendering XML documents to HTML with appropriate layout (i.e. font size and background colour). The XSLT code in Listing 4-8 built the attribute 'target' with the value '_blank' to enable links to be opened in a new window. Finally, links names took their values from the '@id' attribute specified in the childenodes pipeline id="symptoms in general"... and pipeline id="treatment in general"... of the <knowledgebased-url> tag (see Listing 4-2).

Using this approach to generate links in the prototype system made links authoring simple. Once this approach is applied, developers only need to author and specify the pipelines that are responsible for creating the destination documents.

Moreover, the same approach described earlier was used to generate another set of links i.e. <static-url> (see Listing 4-2) which provides users with the other levels of complexity available in the prototype system.

It can be seen from Listing 4-7, all DM chunks were extracted with the current user profile information waiting to render them into HTML on the Web browser. However, these chunks were divided into several pages where users saw only one chunk (i.e. topic) per page. This was accomplished using the pagination transformer from Apache Cocoon. This transformer provided 'previous' and 'next' links which enabled users to move sequentially – forward and backward – throughout the orientation presented.

4.3.5. The user-interface of the prototype system

The user-interface is that part of the system that users interact with e.g. a computer screen, a computer mouse and keyboard, touch screen, voice recognition software, etc. (Martine et al. 2006, p. 755).

The prototype system, in this research work, provided a user-interface that adapted to sight and fatigue symptoms of MS sufferers. This interface was generated as HTML pages that could be rendered by the Web browser.

Potential users of the prototype system are MS sufferers with fatigue or/and sight conditions looking for information about MS with an appropriate layout and at particular level of detail. A possible scenario for using the prototype system by a user with MS could be as follows:

A user with MS comes to the Website (i.e. the prototype system) for the first time looking for general information about MS. This user needs first to create a user profile in order to be able to browse the content of the Website. The user is experiencing sight and fatigue problems and therefore he/she selects the 'Sight and Fatigue' option in the registration form. Data are then collected and used by the prototype system to create the user profile. Subsequently, the prototype system personalises the layout and the details of content (i.e. the level of information complexity) based on data stored in the user profile. Moreover, users of the prototype system are able to override the assigned values of the layout and the level of information complexity in their profiles. The prototype system was constructed as a Website which presents HTML pages to end-users. The Website was hosted on a local machine (the author's laptop) where the development environment¹ of the prototype system was installed including:

- Java development kit J2SDK version 1.4.2_13
- Apache Tomcat version 4.0.6
- Apache Cocoon version 2.1.6
- MySQL database version 4.0.13

To access the Website of the prototype system, users needed to type in the following URL in the Web browser:

http://localhost:8080/cocoon/msportal

Typing this URL in the address bar informed Apache Cocoon to call the resource called 'msportal' from the sitemap. Consequently, an HTML page was generated and presented on the Web browser (see Figure 4.4).

Figure 4.4 shows the log-in page where users were required to register if they were new users or simply to type-in their username and password if they were already registered users.

The log-in and the registration were important processes in the prototype system. The log-in was important as it allowed user identification so that users profiles could be initialised and used to deliver an appropriate presentation and a suitable level of information complexity to users. The registration process was required for new users and it was an important step, as it allowed building the initial users profiles.

Referring to the scenario mentioned earlier, it was assumed that the user was not registered within the Website and therefore he/she was required to undertake this step.

¹ A user installation guide for the development environment can be found on: <u>http://cocoon.apache.org/2.1/installing/index.html</u>

|--|

Users could access the registration page by clicking on the link 'Register' (see Figure 4.4).

| Multiple Sclerosis Community New use? If yes, please Ecgular Otherwise use your usemane & password Password: Password: Igin | |
|---|---------------------------|
| New user? if yes please: Register Otherwise Use your username & password follogini login lo | |
| Figure 4.4 The log-in page | an internet in subject to |
| Figure 4.4 The log-in page | tai Intranat George |
| Back - O R Registration Form | (.) 6 |
| Registration Form | (🛃 Go 👘 Livi |
| | |
| ller a username fred | |
| | · . · . |
| sight fatigne | |
| sight and fatigue | |
| none Register Back | |
| | |



Figure 4.5 shows the registration page where the initial user profile was created. The design of this page was deliberately kept as simple as possible – users were required only to select a username and password (no special characters or length were required for these fields). In addition, users were required to select the problem(s) being experienced from the options presented so that the prototype could carry out the rules associated with each option (see the PE description). Having finished entering the fields in the registration form, users should click the button 'Register' in order to proceed with building the initial user profile.

When clicking the 'Register' button, data entered in this registration form were collected and used to build the initial user profile. As mentioned before, building the user's profile was carried out by an XSLT file that executed SQL statements (see Listings 4-3 and 4-4). Subsequently, a page appeared to users confirming if their user profile had been built successfully (see Figure 4.6). This type of feedback ensured that users were always kept informed about what was happening in the system. This is called "visibility of system status" which is a usability guideline provided by Nielsen (2005)

At this stage, users needed to log-in into the Website using the username and password which had been created. Thereafter, a homepage was presented to users where they were able to review their assigned values in their profiles including font size, background colour, and the level of information complexity. As described before, these assigned values resulted from executing the rule-based personalisation adopted (see Table 4.4). Figure 4.7 shows the system's homepage where users have the option either to change layout or/and the level of information complexity assigned or to proceed with the orientation using their current preferences. Changing users preferences could be accomplished using the link 'Personalise'. Proceeding with the orientation (i.e. the overview) could be done using the link 'Start overview'.

| | http://locahost:8080/cococ | on/createprofile?name=fred8pas | sword=test&age=&gender=& | problem—sight%2Cfatique | | | <u> </u> | Gola |
|------|--|--------------------------------|--------------------------|-------------------------|-----------------------|-----------|----------|----------|
| | | | Profile | created | | | | |
| | | | | | | | | |
| ւս հ | ove successfu | lly built your pi | ofile, please k | oin using the | link helow | and use v | our user | name |
| nd p | assword to er | nter | onie, prease ic | gin using the | | und use j | | 11001110 |
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Figure 4.6 Confirmation of profile creation page



Figure 4.7 Users homepage

When users clicked the link 'Start overview', the prototype system called that pipeline inside the sitemap of Cocoon. This pipeline was responsible for generating HTML pages that constituted the orientation. As explained earlier, these HTML pages were produced using an XSLT file which extracted the information chunks based on the users' diagnosis (i.e. symptom(s)) selected during the registration (see Listings 4-6 and 4-7). Furthermore, the layout values (i.e. font size and background colour) were taken from the user profile and fed into an the XSLT file which was responsible for transforming the extracted information chunks into HTML pages. These layout values were already embedded in the URL as parameters. Therefore, when any URL was accessed the values of, these parameters were transferred by Cocoon to an inline CSS embedded within this XSLT file. Figure 4.8 shows the information chunk 'general explanations' rendered in HTML format on the Web browser.



Figure 4.8 'General explanations' chunk rendered as an HTML page

Figure 4.8 presents the first concept 'general explanations' in the orientation rendered on the Web browser. With respect to the content, the level of information complexity presented was basic. In this level, the content was presented as short paragraphs and the images were presented in their full size. The font size² and the background colour values were '19' point and 'white' respectively. These assigned values were based on the option selected during the registration process – 'sight and fatigue' (see Figure 4.5). In order to make users recognise the level of complexity assigned to their profiles, the heading e.g. 'Information level: basic' was placed at the top of the content area (see Figure 4.8).

At the end of each page, sequential links (i.e. next and previous) were presented. These links enabled users to move sequentially (forward and backward) within the course of the orientation (see Figure 4.9)

| ktp://ocalhost:8060/cocoon/contin Traterranie/Liste | ue(2)?d=688name=fred8topic=fatigue8info_type=text8info_sinplity=basic8background_color_white8font_size=178font_type=sa 📯 🔛 🕼 |
|--|--|
| mermedate | Sensory (touch) problems such as numbness or tingling of the hands |
| detailed | and feet |
| 动动动动动动 | • Visual problems such as blurred or double vision, or a temporary los |
| | of sight in one eye caused by optic neuritis (inflammation of the opti |
| | nerve) |
| | • Fatigue - an overwhelming sense of tiredness making physical and |
| | mental |
| | • Dizziness |
| | • Pain |
| | Loss of muscles strength and dexterity |
| | • Problems with walking, balance and co-ordination |
| | • Muscles stiffness and spasms - tightening or rigidity in particular |
| | muscle groups (known as spasticity) |
| | • Bladder and bowel problems |
| | • Cognitive problems (i.e. problems with memory and thinking) - sucl |
| | as forgetting names |
| | Claumation and Lana |

Figure 4.9 Sequential links - previous and next

Referring back to Figure 4.8, it can be seen that there were two sets of links presented – 'Appropriate links' and 'Available levels of information'. The earlier set of links were generated based on the user's knowledge acquired about the topic presented. As described before, if users accessed the page e.g. 'general explanations' it was assumed that they had read this topic and therefore link(s) to related topic(s) could be

 $^{^{2}}$ It should be noted that the font size in the figures is much smaller than reality, since these figures were taken as screenshots.

presented. Figure 4.10 shows one of the 'Appropriate links', i.e. 'treatment in general', which was opened in a new window.



Figure 4.10 Appropriate link opened in a new window

In the prototype system, 'Appropriate links' were designed to be opened in a new window (see Figure 4.10). However, if users accessed one of the appropriate links from the 'Treatment' page (in the figure above), another new window would be opened. This could be difficult to users with MS especially if they are experiencing fatigue. At this stage more investigation was required to determine how these links should be presented to users.

Two means for navigation were presented to users within the prototype system – sequential links and appropriate links. Figure 4.11 shows the sequential navigation between pages (i.e. topics) using the links 'next' and 'previous'. The figure also shows knowledge-based navigation using appropriate links. For example, reading the topic 'Fatigue symptom' allowed users to access the topic 'Fatigue treatment'.



Figure 4.11 Sequential and knowledge-based navigation

Users were able to see the other levels of information complexity irrespective of their assigned level. This was accomplished by presenting the links under the heading 'Available levels of information'. For instance, if the basic level of information complexity was assigned to users then links to the other levels of complexity including intermediate and detailed would be presented (see Figures 4.9 or 4.10). This provided users with the ability to override the level of complexity assigned by the prototype system.

Figures 4.12 and 4.13 show intermediate and detailed levels of information complexity that were available to users.



Figure 4.12 The intermediate level of information complexity



Figure 4.13 The detailed level of information complexity



Figure 4.14 Expanded content on the detailed level of complexity

Figure 4.12 shows the intermediate level of information complexity. In this level the content was more detailed in comparison with the basic level of complexity. In addition, in this level pictures were presented in a thumbnail format where users should click on the picture to view its full size.

In Figure 4.13, the detailed level of complexity is presented. The content in this level was designed in a way that allowed users to expand/hide the content on the page. This was achieved using the CSS display property – 'none' and 'inline' – which was concerned with hiding/showing specific parts of the text. These properties were directly added to the required text inside the XML chunks and invoked using links that apply those properties to designated text upon access. Therefore, the link 'show more' applied the 'inline' property which showed the content on the page. The link 'hide more' applied the property 'none' which prevented the content from being shown (i.e. hidden) on the page (see Figures 4.13 and 4.14). This represented the stretch-text technique which was used for content adaptation (see Chapter 2, Section 2.8.1). However, the current implementation of this technique (within the prototype system) did not take the user's knowledge into account – i.e. the content was not

stretched or shrunk based on the user's profile, it was rather left to users' to control this process.

Images were presented as a link leading to a picture in this level of complexity (see Figure 4.14). It should be mentioned that although users could view other levels of complexity, the links to subsequent pages were disabled until users returned to their assigned level of complexity. The aim of this restriction was to prevent users from delving into the new level being viewed and losing the trail of the original level. For this reason, users were only presented with a 'Back' link (see Figures 4.12 and 4.13) so that they could return back to the original level being assigned to their profiles.

The prototype system allowed users to override the assigned values to their profiles in terms of the layout (font size and background colour) and the level of information complexity. This was accomplished using a personalisation form where users were able to change these values in the user profiles. This personalisation form could be accessed using the 'Personalise' link from the horizontal menu (see Figure 4.8).

Figure 4.15 shows the personalisation form where the values of the current user profile values were loaded in this form. For instance, the form presented in the Figure 4.15 shows that the current user profile values were 'white', '19' and 'basic' for the background, font size and the level of complexity respectively. In this personalisation form two buttons were also presented – 'Change' and 'Back'. The 'Back' button should be used if users decided to get back to the original page without changing the values in their profiles. The 'Change' button should be used if users decided to change any option in the personalisation form. Figure 4.16 shows that the level of information complexity was changed to intermediate.

Clicking the 'Change' button brought a confirmation page on the user's screen. In this page, users were given the opportunity to return back to the personalisation form to amend their selections or simply to proceed with the changes that had already been made. This was achieved using the 'Back' or 'Apply Changes' links respectively (see Figure 4.17). Assuming that the user was happy with changing the information level to 'intermediate', clicking the 'Apply changes' link regenerated the orientation based on this selection – i.e. the intermediate level of information complexity would be the main level of the orientation presented. Consequently, links to the other levels of

information complexity were presented including 'basic' and 'detailed'. Moreover, the same appropriate links were presented, but they led to related topics at an intermediate level of information complexity (see Figure 4.18).

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| Change background colour: White | • |
| Change font size: 19 | |
| Change level of information: basic | |
| | |
| Change Back | |
| <u>1.</u> | |

Figure 4.15 Personalisation form to enable users to change values in the user profile

| Personalisation form | | | |
|--|----|-----|--|
| Change background colour: White | ** | | |
| Change font size: 19 | | | |
| Chauge level of information: intermediate × | | | |
| Change Back | | | |
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Figure 4.16 Changing the level of complexity to intermediate in the personlisation form

| ou have successfully made the changes, click "Apply changes" link to confirm otherwise click Back" link to return to the personalisation form. pply changes Back | Confirmation page hanges, click "Apply changes" link to confirm otherwise click mails ation form. | oss i aggi http://localnostieueu/cocoon | /editaction?id=888na | me=fred&topic=fa | stigue&info_type= | text&page=18be | ckground_color | -white&font_si | ze≂178info_sk | mplicity=interme | diate 💓 🛃 Go | in a la Chairtean Chairtean |
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| ack" link to return to the personalisation form. <u>ply changes</u> <u>Back</u> | onalisation form. | u have successful | w made th | e change | s. click ". | Apply ch | anges'' | link to | confirm | , otherw | ise click | • . |
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Figure 4.17 A confirmation page for changing the values in the personalisation form



Figure 4.18 Changing the level of information complexity to intermediate
Technically, when users changed value(s) from the personalisation form, these changes were stored in a temporary user session. This session was created by Cocoon immediately after the user logged-in into the prototype. Also this session should be destroyed when the user logged-out. This means that these changes were not stored permanently. However, these values could permanently be saved into the user profile in the database if users clicked on the 'Logout' link. Figure 4.19 shows a log-out page to users when they clicked the 'Logout' link.

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Figure 4.19 The termination of the user interaction with the prototype system

4.4. Users' responses to the initial prototype

As mentioned before, The 'Evaluation' was followed subsequent to the 'Development' phase in the design research methodology. Section 4.4.1 to 4.4.8 presents the dominant themes derived from the users' responses (using the 'meaning condensation' method outlined in Chapter 3) as they interacted with the prototype system during the evaluation session. Sections 4.5.1 to 4.5.8 fully discuss the implications of these findings.

4.4.1. User profiling

Users were required to register within the prototype system by filling out a registration form, which fed into the creation of their profiles. In the evaluation, users were asked questions in order to determine the ease of filling in the registration form, and to identify whether further fields were needed within the design of the registration form.

Users commented that it was fairly easy to fill in the registration form. They felt that a small number of fields/options within this page made the registration process simple.

"It is easy. I have been to other websites where you must have letters and numbers to fill in; this one is quite straightforward."

However, it was found that additional options/fields in the registration page were needed. One user (the MS domain expert) suggested having another personalisation feature, a list of symptoms, so that users would be able to chose only symptoms that they wanted to know about. In addition, she suggested that the language used and the content displayed was very important especially during the early stages of diagnosis.

"You could personalise symptoms that people with MS experience, but you need a very clear statement indicating that very few people experience all of these symptoms – most people do not get all the symptoms. Most people are information seeking around the time of diagnosis, so you have to be very sensitive how to tell people about MS when they are newly diagnosed, because they will feel worse if you give them a bad image about MS. The language and the content should be non threatening."

This indicated that more personalisation options would be welcomed within the prototype system. However, these options should enable users to easily select the desired information, and should take into account the time of diagnosis in order to present information at an appropriate level. These personalisation options could be a 'list of symptoms' and a 'time since diagnosis' field.

4.4.2. Suitability of the information on the homepage

The prototype system included a homepage that appeared to users after completing the registration process. During the evaluation, users were prompted by questions to

identify the suitability of the information on the homepage, and whether it guided them while interacting with the prototype system (see Figure 4.7).

Some users considered that the information on the homepage was easy to understand, but they gave little attention to the usefulness of the information.

"Yes, I think information there is easy to read and to understand."

However, other users, who considered the quality of information, expressed the need for extra information (i.e. explanations) about the various elements on the homepage.

"Yes I think it tells you everything that you need to know. Just make clearer the description of the 'start overview' link."

"I do not know anything more at the moment; it is said that this website is intending to provide a general overview about MS, so I presume that it will just say that. If you [could] have just a little bit of explanations about various links [functionalities] rather than having the information about your profile."

Moreover, one user (the MS domain expert) expressed a strong desire to have more explanations on the homepage about how the prototype works, and how it presents information to users. She believed that providing users with these explanations would be considerably significant, and without such explanations the information could be threatening to users.

"You could say, it is general information presented in a format which is personalised [in terms of e.g. colours]. The bit I am bothered about is suggesting that it is going to give the information I want. I could be quite frightened by that, because how did they know that I have got spasms in my left leg or whatever, and also it is frightening because it is going to be generic information about MS which is going to probably cite lots of different symptoms. So if I get [this information from this system that is personalised to me], does that mean that I am going to get all those symptoms! This could be quite threatening. I think you have to be careful about the use of the word 'personalised'."

This indicates that people with MS are willing to learn about how a personalised system works. This desire to be engaged with a personalised system by being motivated to know how it presents information was deemed significant. However, this

also indicates that users (particularly novice users) may misunderstand the way that a personalised system works and what its role is.

4.4.3. Additional users' requirements in terms of navigation

When users explored the content, they were asked whether there was a need for adding personalisation options that would enhance their interaction with the prototype system. The purpose of this was to elicit any additional users' requirements.

Some users (including the HCI expert) suggested having links to all of the available pages, so that users could pick up their preferred routes in the prototype system. It was also suggested that having links that changed colour when a page was visited would be useful, so that users would know which pages that they have already accessed.

"I always like to see at the top, groups of links that I can look at. I might know what types of MS there are, so I would like to be able to choose from a set of links. I do not want to read through the whole. I prefer to pick out the topic that I want."

"I think it is better to have a content page with all of the different links, and the ones that you have already visited should be in a different colour to know which ones you have already seen and to know which ones you have not seen."

Although changing the colour of the visited link is done automatically by many web browsers, these users liked and emphasised this feature. Users felt that changing the colour of the visited links would help them in determining their location and prevent them from getting lost while browsing the information.

In the design of the prototype system, placing all the Web pages links at the top of the page being viewed enabled users to actively choose their preferred links. This is particularly true for web systems that include a small number of pages; however, it would be impractical to include all of the links when the web system includes too many pages, because doing this would result in a 'links overload' problem. Also, doing this in the prototype system would produce lengthy pages that require considerable scrolling effort by users. Therefore, more appropriate personalisation/adaptation should be used in order to enable users to effectively

browse the structure of a personalised system particularly when it has a considerable hyperspace structure. One solution to this is to use a 'site map visualisation' techniques (see Section 4.5.3).

4.4.4. The suitability of the inferences

4.4.4.1. The assigned level of information complexity based on symptoms

The prototype system assigned users to a particular level of information complexity (basic, intermediate or detailed) based on the symptom they selected within the registration page. In the evaluation, users were asked a set of questions to determine their thoughts/opinions about the level of information complexity they were assigned. This provided an indication about the suitability of the inferential rules of personalisation, which mapped users to a particular level of information complexity based on their symptoms.

Three users felt that their assigned level of information complexity was suitable. This was particularly true of users who were assigned the basic level of information complexity.

"I think it is good. There is just a little bit of explanation and I think that is ideal. If you got a lot of writing, you would get fed up with reading it, but this is just little paragraphs which I think is very good."

"The content is quite well presented with drawings of the nerve cell getting affected by MS. Lots of text is not good."

"I think short bursts of information are better to take in than long ones."

It was clear that people with MS were more inclined to read short and concise information. This means that a personalised system should default to the basic level of information complexity – rather than intermediate or detailed – as this level probably is the most appropriate one to start with.

Moreover, one user, who was assigned to the intermediate level, commented that providing users with general information about MS was not beneficial, stressing again the fact that people with MS wanted to know specific information - i.e., information related to their symptoms/conditions (as found in Section 4.4).

"This kind of information is unnecessary, what they want to know is about their problem. If they have fatigue so they want to know what is fatigue, how you get rid of it, which magic pill do you take!"

However, there might be some occasions where people with MS would genuinely need information on a general level as in the case of a person newly diagnosed with MS. This signifies that personalisation may be able to meet the users' needs.

Furthermore, one user (the HCI expert) felt unconvinced about the that fact that the prototype system selected the level of information complexity for users based on the selected symptoms, and also suggested this as an option that should be left to the users' choice.

"I am less convinced about the system choosing it for you based on criteria that you set. I think it is good if you set it for yourself. I think it is best if you know what the choices are and what the consequences of those choices are, so if you say: you can choose the font size and that will make the screen easier to read; you can choose the information complexity and that will mean how much text is presented to you, and then the user makes the choice and personalise it to the preferences. There is very much variation even between people with sight and fatigue problems in terms of what makes things easy for them to read; so, in a way it is better let users find their comfortable set of parameters and then to be able to tailor that."

Although users were given the option to change the level of information complexity at a later stage, it was apparent that users must be given a quick and easy way to personalise the content; for example, allowing users to choose the level of information complexity on registration rather than being assigned to a particular level.

4.4.4.2. Overriding the assigned level of information complexity

While using the prototype system, users were given the ability to override the value of the assigned level of information complexity based on the selected symptom(s). In the evaluation, users were prompted by questions to acquire their thoughts/opinions about this personalisation feature.

All of the users felt positive about being able to change the level of the information complexity, because this gave them a sense of controlling the level of information complexity they wanted to see.

"People like a certain degree of self control if you like, and the ability to change things to fit their way of reading things."

"It is a good idea, because if somebody has got MS and they know the basics maybe they do not want to read that twice."

"It gives you choice; It is good to have a choice, and the choice of two or three is sufficient as well, and it does not get you into confusion."

There is a strong desire for users with MS to be in control over the information they can get about the disease. This desire can be fulfilled by including simple personalisation options that particularly enable users to control/override the personalisation rules that govern how the content that is presented. For instance, as the last user suggested, the number of options within a personalisation field can be relatively small (two or three) for users to choose from. This enables them to easily control the content without being confused.

Moreover, one user (the MS domain expert) felt positive about this feature, but suggested providing more explanations about its consequences so that users could make appropriate selections.

"Yes I think it is a useful feature, but I want it clearly sign posted. I want a clear explanation upfront of how it is working so that I can actively choose what level of detail I want. I think it is a good feature."

Similar to the result in Section 4.4.2, a consensus of having more explanations about how the prototype system works, again shows the willingness of users with MS to learn about a personalised system in order to make accurate/appropriate selections.

4.4.4.3. The assigned layout based on symptoms

The prototype system assigned a particular layout to each user according to the symptoms they selected within the registration form. During the evaluation, users were asked to express their thoughts about the suitability of the layout. This reflected

the suitability of the personalisation inferential rules which matched users with particular symptom(s) to a particular layout in terms of the font size and background colour.

Most users felt positive about their assigned layout in terms of the font size and the background colour.

"The font size is easy to read. It is fine for the white background colour."

However, two users preferred a yellow background colour, as this made the text easier to read.

"I have a visual problem, and I do not find the white background colour is a good idea; I prefer a yellow background colour."

"I prefer the yellow background colour with black font on it – that is a lot easier for me."

This variation in terms of which background colour is more appropriate for reading signifies that users should be able to personalise this aspect during the registration (with the ability to override it later); this would fulfil users' different needs in terms of this particular presentational aspect.

Moreover, most users felt that the font 'Times New Roman' was hard to read, and they expressed the need to have the 'Arial' as an alternative.

"Well, it is great that I have got black on white text. The italics are difficult to read, and I think that the Arial font is easier to read than this one with the serifs on Times New Roman."

"I do not like Times New Roman I would like it to be set to a Sans Serif [font], because Times New Roman is hard to read when you have visual problems."

Nevertheless, there was a unique case where a user stated a preference for 'Times New Roman' rather than 'Arial', as the latter caused him a visual disturbance.

"I prefer Times New Roman. There are some fonts which cause me a problem like Arial."

The variation of which font type is easier for users to see, indicates that users with MS should to be able to personalise the font type in order to fulfil their needs.

4.4.4.4. Overriding the assigned layout values

In the prototype system, users were given the option to override the personalisation rules that attached users to a particular layout based on their symptoms. During the evaluation, users were asked questions in order to know the usefulness of changing their assigned layout values.

Users gave varied opinions on this feature; two users felt that the ability to change the font size would be useful (though they were happy with the current values of font size and background colour). However, they considered changing the background colour pointless, but they mentioned that this feature could be useful for other MS users.

"Changing the font size I think is useful. I did not like changing the background colour, but somebody else might need to change it; I personally prefer white."

"There must be some people who are colour blind who cannot tell red from green for instance, but I find that perfectly easy to read. As far as I know, people with MS have a trouble with seeing so it is nice to make font bigger that is certainly very good, but I do not think there is a great deal of [importance in] changing the background colour."

Other users felt that it was a very useful feature to able to personalise the font size and the background colour, stressing the fact that people with MS have different needs specifically in terms of background colours.

"Yes it is good; it is really useful to change the font size and background colour."

"My son comes and plays around with the computer, and he always changes it back to the original look of the machine; he has a blue background colour, because he cannot cope with my preferences – everybody is different."

"but you see other people might think very differently; just because I like the yellow background colour with bold black font other people might say: no, no I do not want that at all."

While most users expressed comfort over the assigned layout values, other users felt it necessary to personalise these values to better suit their conditions; this clearly indicates that it is necessary for MS users to be able to override/personalise layout values suggested to them.

4.4.5. Using different levels of information complexity

Users were provided with different levels of information complexity according to the symptom(s) they selected within the registration page. However, users were able to view the other levels of information complexity if they desired even if they were assigned to a particular level. This was accomplished either by using links located under the 'Information level' heading or by changing the 'level of information' option in their profiles (see Figures 4.8 and 4.15 respectively). The aim of this was to find out the appropriateness of presenting the information to users using three levels of information complexity – basic, intermediate, and detailed. During the evaluation users were asked a set of questions to capture their opinions/thoughts about introducing information in this way.

Users felt very positive about having information available at different levels of complexity, and also they valued the opportunity of viewing these different levels simultaneously.

"Say you want to find something about MS, you can go and look into the intermediate, and if you want a bit more details then you can go to the detailed one, and that is a good thing."

"One leads you automatically to another and that is a good thing. When I was first diagnosed, it was intensive; we wanted to know very much about MS. So, I think you can start with basic information on any subject then if you want to go a bit further you can browse the intermediate and detailed information."

"I think the idea of choice is a good one, and you can control the amount of information on a given topic."

Users liked the idea of having progressive levels of information rather than being assigned to a particular level of information complexity. This indicates the importance of authoring content with progressive levels where users should be given the option to

choose the preferred/appropriate level to start with, or they could be defaulted to the basic level of information complexity (as suggested in Section 4.4.4.1).

However, two users (including the MS domain expert) pointed out some usability issues concerning some of the link's names and their headings; they considered the labels describing the level of information ('basic', 'intermediate', and 'detailed') as not being clear enough in reflecting their meaning or their functionality to users.

"What I imagine is that there are some people who would not understand what information level means; that is why you have got to explain it. It is not clear to me what intermediate means; you have to tell the person what to do."

"Well, I think that the words basic, intermediate and detailed are not easy to understand for all people, because these words require people to have a good knowledge of computers."

Although users liked having the content in three levels of complexity, and appreciated the ability to view the other levels of information, users' feedback indicated that appropriate use of language was deemed very significant when designing a personalised system in order to remove any confusion that may occur to them.

4.4.5.1. The presentation of text/images on each level of information complexity

The text/images were presented in three styles with regard to each level of information complexity. For instance, short paragraphs and full size images were used on pages containing the basic level of information complexity. While evaluating the prototype system, users were asked questions to ascertain the appropriateness of presenting the text in short, medium, and detailed paragraphs and to identify the suitability of presenting the images in different styles – full size, thumbnail or link leading to an image – with regards to each level of information complexity.

In terms of the amount of content available at each level, users thought this was reasonable with most expressing a strong preference for having the content presented as it was provided in the basic pages -i.e. short paragraphs.

"You can read and read about the causes of MS, you can write a whole book about it but I just want to see some basic stuff in there, and I think what you have got is a good basic stuff; I think the content looks very reasonable." "I think it was quite good. I like the basic one because it just tells you in plain ordinary language what MS is; there are lots and lots of readings that you cannot get done with it."

As far as the text presentation was concerned, users were more at ease with the basic level of text presentation - i.e. short paragraphs. This indicates that the text of the other information levels (intermediate and detailed) could be presented in the same way as the basic level but with more details to make the information more attractive/encouraging to continue reading for users.

However, one user (the MS domain expert) commented on the complexity of the language at the basic level, and felt that the this level of information could be hard to understand by a newly diagnosed person although the content was presented in a simple way – i.e. in the style of simple tips or hints.

"The language is quite complex; It looks as if the content is simple, because there is not a lot of it, but actually someone who did not know anything about MS might struggle with it."

Apart from the significance of having a computer analyst/programmer involved in the design, the MS expert's comments signify the importance of involving individuals with other expertise such as an expert in the MS domain, or even a medical journalist. Including such expertise in the design of a personalised system would ensure the production of more relevant/appropriate content, and thus a more reliable personalised information system.

Furthermore, some users commented that it was difficult to cope with the large amount of text on the detailed pages.

"I do not like the way the text is presented in the detailed one, because it is just too much."

Although viewing the detailed pages was appreciated by users to get more in-depth information about a particular subject, it was clear that the text on these pages needed to be properly formatted - e.g. including white space between paragraphs and clear headings that could be easily read by users.

Chapter 4

In terms of the image presentation, most users preferred the presence of images (as full size or thumbnail images) rather than having a link that led to an image. Furthermore, users criticised the lack of explanations about the expandability of thumbnail images.

"Pictures tell a thousand words; I am a great believer in pictures. Anybody can know what is happening in MS with those two pictures there, which is good whether you want to see that all the time or as a thumbnail that you can just click on. In the detailed version if you have got a link that says 'myelin sheath' for instance you will not know if you are going to more text or going to a picture. I prefer having a picture or a thumbnail of a picture."

"I prefer the presence of the full size [image] and I did not appreciate that the small picture would increase if I clicked on it, because there was nothing telling me anywhere that this would happen. You know some times you need to be led a bit by directions on the website; you need more clarifications."

Another user felt positive over the presence of the images in the text with a preference to have them as a thumbnail presentation; She said:

"I prefer clicking on the thumbnail picture to enlarge it, because if you want to see it you can click on it and expand it, otherwise you can carry on reading. I prefer the presence of pictures, because sometimes there is too much writing, and I cannot take it all in."

However, one user liked the idea of a textual link leading to an image; he felt that having a thumbnail image within the running text would make it not noticeable, or that full size images would distract users from reading the text; he said:

"When you go into detail, I think it is good to have to click on a link to get a picture; if the picture was just there with all those words it would get lost in it, and I think it almost needs that reaction from the user to bring up the picture; otherwise things can be often too easy, and you don't take it in. I quite like the discipline of reading it first without being distracted by a picture; that is a personal thing, but I quite like it that way."

It was clear that there were variations with regards to the preferred type of image presentations among users. Some of them liked the presence of full images, some users liked the thumbnail images and others preferred to have textual links leading to images. Therefore, personalisation of image presentation could be useful in these situations where users would be given the option to choose their preferred style for the presentation of images.

4.4.5.2. The ability to show/hide content

Users were given the ability to control the amount of the information presented on the detailed pages. This was accomplished by including the 'show more'/'hide more' links that enabled users to show/hide some parts of the content (see Figures 4.13 and 4.14). In the evaluation, users were asked about the usefulness of this feature. Most users felt very positive about the ability to control the amount of content displayed on the screen, because this empowered them to easily find the required information.

"I think these links are very useful. I like the idea of being able to expand or hide information; it saves a lot of time and I can find what I want easily."

"I think it is useful; it gives people a wide control."

"Yes, I think they are useful."

The users' responses therefore clearly indicated a strong desire to control the amount of information being displayed.

4.4.5.3. Using other media types including videos and audios

At this point in the evaluation, users had become familiar with the kind of personalised functionalities that were provided by the prototype system. Therefore, they were asked if they could think of any other features that would enhance their access to the information within the prototype system.

One user, who was experiencing mobility problems, suggested the use of other media types such as video/audio files so that he could watch/listen rather than reading a lot of text particularly during periods of fatigue.

"You can always do sounds as well of course which you do not have here. That is something I quite enjoy on other sites every now and then instead of reading through loads of explanation – just click on it and see a film. On the BBC you can watch a snippet of news instead of reading about what is happening in Palestine at the moment; you just click on it and there is a little film and you can listen to what is the reporter saying – it is a lot easier. Going back to my fatigue I find it a lot easier to listen rather than to read through all of this writing; so to my mind you can incorporate those; I like to see something like that; it would make it good."

Other users, who were also experiencing mobility problems, suggested using computer software that enabled the text to be read out to users.

"Some people have problems with sight, so what about a bit of talk? I use a programme on the computer that reads the text for me."

Using these other media types were suggested by some users, but other users did not suggest anything regarding this, and felt happy with the current implementation - i.e. pages with text and images. Therefore, including these other media types could be part of the personalised choices that the system could provide to users.

4.4.6. Suggesting links based on knowledge (appropriate links)

The prototype system implemented a simple tracking mechanism of pages accessed by users. Users were provided with appropriate links related to the topic being viewed (see Figure 4.10). One purpose of the evaluation was to identify the usefulness of using this mechanism which exemplifies the 'behavioural-based' personalisation approach. During the evaluation, users were asked to identify if they could ascertain the usefulness of appropriate links that resulted from this type of personalisation.

Most users seemed uncertain about the functionality of these links and, consequently, identifying their usefulness. Users perceived these links in different ways; some users perceived these links as normal links connecting to another webpage – i.e., they could not identify the relation between the current topic and those links.

"Another page, which either I have to enlarge or just scroll through."

"It is just a general overview of what you might get; It just tells you what the symptoms are and what the treatments are."

One user perceived these links as external links connecting to an external website, and felt confused about these links' destinations; he said:

"I expect these links [are] to MS society or other things; I am probably wrong but that is what I am excepting to see. I find the words of these links long – I find things now a bit complicated with these links; they did not clearly represent their functionality to me. Appropriate links to me is often another website somewhere."

Furthermore, three users felt that there was inappropriate explanation of these links:

"I do not know whether the word 'Appropriate' is quite suitable!"

"If I am in a general explanation page you can just have 'symptoms' or 'treatment' why have 'treatment in general' while I am in the general section. Keep it as easy as possible – the more words you have the more complicated it becomes."

It was clear that users did not fully appreciate that the 'Appropriate links' were the ones deemed most appropriate by the system. It was true that there was an element of ambiguity about the functionality of the links; this was partly because of inappropriate links headings and destinations. Therefore, during the evaluation more details were given to users about how these links were suggested by the prototype system. However, users still seemed reluctant to use these links; one user specifically commented on this by saying:

" If all links are there down the side of the screen, and then I have got to click the ones that I want. I think I prefer that rather than being told which way to go. We are also very different; we are individual people, and what might work very well for some people might not work at all for others."

MS users seem not to favour situations where the element of control is taken away from them. This implies that adopting a pure personalised system would likely to be rejected by this community, because it is not only taking control away from users, but also it does not give them the opportunity to comprehend or learn about the system's actions (as found in Sections 4.4.2 and 4.4.4.2).

4.4.7. Users' thoughts about providing additional personalisation features

It was felt that when users had finished their interaction with the prototype system (i.e. had completed the tasks that were provided in the task sheet) that they had gained

a better understanding of personalisation and how personalisation could help them to find information in the required format, and what aspects could or could not help them to access the information within the prototype system. Therefore, users were then asked a set of questions to determine their thoughts/opinions about the usefulness of the following additional concepts. Therese are included in Sections 5.8.1 to 5.8.3.

4.4.7.1. Providing personalised information based on age

MS usually affects young and old adults. Therefore, it was thought that it might be useful to provide users with personalised information based on their age. For instance, a video information about new treatments of MS may be better presented by an older authority figure (i.e. a doctor). Other information, however, could be more appropriately communicated by peers – for example, videos presented by a middle-age male/female probably would make the video more engaging for middle-age MS sufferers.

Users were asked questions to capture their thoughts about providing this level of personalisation. Most users felt that providing personalised information based on age was not a necessary feature.

"I do not think age group makes any difference."

"I do not think you would need something else."

"I do not think it is necessarily at the moment."

Similarly, one user felt that having this feature was not necessary, and expressed a worry of making the design of the prototype complicated by adding this feature. He said:

"People in most cases got MS commonly at 30 by which the time you are entering a very general age group, and I am not sure if it would warrant the effort to provide this feature in your website; also it could overcomplicate it."

However, one user (the MS domain expert) felt that taking the age group into account to provide easier format of information would be helpful particularly for older people, because they would probably be less knowledgeable in using the Internet in comparison with younger people.

"Yes, it is good idea. I think there are different types of information searchers, and I think they probably correlate to age. So, I think it is likely that some in my age is less familiar with internet use than someone in 25. Therefore, I think if we are talking about an easier format based on age then I think it is probably a good idea."

It was clear that people could not appreciate the difference of information needs based on age. This may be because there was only one age group (40-60 years old) willing to participate in the evaluation. However, it was understood from the comments made by the MS expert that people could be different in their information needs based on age; therefore, providing personalised content and presentation based on age could be useful. One way of accomplishing this is by adding an 'age group' option in the registration page. This would enable the prototype system to select the appropriate content to users based on their age. Nonetheless, users access' should not be restricted and they should be able to view information from the other age groups if they required to.

4.4.7.2. Providing personalised information based on gender

Certainly some of the symptoms in MS affect men differently than women; e.g., sexual dysfunction. Therefore, it was thought that giving users personalised information based on gender would make the information more tailored to their specific needs. Hence, users were asked questions in order to acquire their thoughts/opinions about this personalisation feature. Most users felt that providing personalised information based on gender would make no difference, or might make the prototype system more complicated to users.

"I do not think gender makes any difference."

"I do not think so personally. You can get too detailed and lose what you are aiming to do in the first instance if you are not careful. If you want to develop a good website you should not over rig it by trying to put in too many [criteria], because it starts getting very confusing then."

"Personally I do not think there is a need to go to that level. What you have got is OK with me."

Similarly, One user believed that most MS symptoms were not gender related, nonetheless, he thought taking the gender aspect into account when providing information could be successful on particular occasions – e.g. during pregnancy – he said:

"Almost as a sub thing yes; I mean because most MS symptoms seem to be not gender related, but obviously some specific things like: does MS affect pregnancy? This would be gender related. So I am not with applying this idea as a whole split male and female, but just for some minor things which are very specific."

However, one user (MS domain expert) considered providing this feature as a useful idea, because there are very different information needs among men and women in relation to many symptoms, and particularly those related to sexual/bladder dysfunction.

"Certainly within MS there are very different information needs among men and women; for instance, symptoms in sexual dysfunction and bladder dysfunction (and those are the obvious ones) affect men differently than women and therefore there would be different needs for information. Lots of symptoms in MS would result in different needs for information."

It was noticed that the MS expert had a more overarching view than users. Users with MS did not appreciate the difference in the information needs, because they had not experienced being a different gender and therefore another gender's requirements. Moreover, introducing other personalisation features would not necessarily complicate the prototype system (this worry also was found in Section 4.4.7.1) because of the fact that personalisation occurs behind the scenes. Hence, personalisation based on gender could be a very useful feature.

4.4.7.3. Providing personalised information according to the role of the user

Although this theme was beyond the scope of this research project, which only looked at providing information to individuals with MS (see Chapter 1), it was felt that acquiring users' thoughts/opinions about this issue could feed into the requirements of future personalised systems for the MS community. Therefore, users were asked questions about providing personalised information according to the role of the user; i.e., person with MS, a family member, health worker, etc. Most users thought that this level of personalisation was unnecessary; they thought that using three levels of information complexity could serve the information needs for different roles of users.

"I think you have almost done it by having those three different levels anyway. I think you could just get it too complicated. I think the three levels are quite good. A child in a school who wants to know about MS can look at the basic level, or perhaps you and I can look about MS in the intermediate and the detailed ones. Intermediate and detailed levels also might be suitable for doctors, nurses and specialists to look at."

"You have already covered a certain amount of it, because you got basic information, intermediate information. I am not sure if there is any point going any further really. I do not think it is worthwhile going to that level of personalisation – In the library you do not find books that are labelled Aunty's copy or Dad's copy or something like that!"

In contrast to these comments, leaflets do exist called 'My Dad's got MS' and 'My Mom's got MS' that have been very popular in teaching children about their parents' illness. Moreover, there is a book called 'The young person's guide to MS' that helps young people to learn about MS and how it affects their feelings. This implies that perhaps users interviewed are, again, not seeing the bigger picture or the benefits of this type of personalisation.

However, two users (including the HCI expert) felt that providing information based the user's role could be a useful feature. In addition, the HCI expert suggested that users should not be restricted to one view, and should have a full access to information for the other viewpoints if they wanted to. She said:

"I think that is useful. I think that you ought to be able to look at other aspects/kinds of information even if it is personalised, so if I was registering as a carer then it would be good to know information for carers specifically, but I think you might also want to look at information as if you were a patient, because you want to understand from the patient point of view or the sufferers point of view. So I think you ought to be able to switch between the different views of the information without restrictions."

The second user with MS said:

"I guess MS as a personal experience is different from a carer experience; so, yes there is case for a carer section – I would say – because it must be obviously a different experience to experience MS on a daily basis rather than the person who has got it; I think there is some argument for something to be included in."

This probably reflects the overarching view of the HCI expert compared to MS users. The majority of users with MS who were interviewed could not identify the benefit of using personalisation based on the user's role (though the last user appreciated the usefulness of this feature), because they had not experienced the other viewpoint – i.e. being a service provide or health worker; this was a limitation of the evaluation, because there were no interviews conducted with individuals with these roles. Nonetheless, providing this type of personalisation could be very useful; people could learn about MS from different perspectives; consequently, this could lead to the integration of people's efforts to better handle/manage the MS disease.

4.4.8. Users overall thoughts/opinions about personalisation

At the end of each individual session of evaluation, users were asked about their overall thoughts/opinions about the usefulness of using a personalised system to access the information.

All users agreed that it was very useful to them to be able to particularly personalise the font size and background colour and also to personalise the level of information complexity.

"I think you have done it quite well with the fact that you can change the background colour to a certain extent – that is about accessibility, and the fact that you can change the level of content – you can look at basic or detailed information if you want. In general, I think it is a good thing to have these personalised features particularly the background colour, because you cannot alter that on most of the websites."

"I think personalisation is good; it is lovely having the font size I want, and the colour I want although I think colours should not need changing often, but there will be time to change them. It is a shame in some way that you cannot choose font size and colour with every website you go to."

"I think it is very good; It helps people with MS to increase the font size so they can see it bigger, or if they cannot read black font on white background colour they can change the background colour to something more suitable. Generally, I think it is handy."

Furthermore, one user (the MS domain expert) valued the ability to control the font size and background colour; however, she felt that the feature of personalising the detail of information - i.e. levels of complexity - was a difficult task, and it would need not only someone with good writing skills, but would also need someone with deep knowledge in MS to be able to produce appropriate information at different levels of complexity.

"I think the ability to choose background colour and text size is good. In terms of detail of information and actual content, I think it is a hugely difficult task; I think it has got potential. I think it actually needs someone not only with a great deal of understanding of writing, but also someone with a great deal of knowledge about MS in order to produce something useful. So I am uncomfortable about some of the information which I think is not right, and I think it could be done. I think you could get different levels of complexity, but it is a huge job."

The MS expert comments have implications for the development of a personalised system in the MS domain. Producing personalised content about MS needs the involvement of individuals with different skills (as found in Section 4.4.5.1) and this approach could be quite expensive.

Moreover, she suggested a way by which information could be presented more appropriately to users rather than presenting the information at different levels of complexity. This was to use information at a general level, and then to highlight the important words that users could click in order to acquire more specific/detailed information.

"What I would perhaps prefer, and what might be more useful generally is to have a load of stuff at the general level or the basic level perhaps with highlighted bits that you can press on to get more information. You can say something like: 'for more information on spasticity click here', so then you can click on that link and expand it in a conventional way into what is spasticity looks like."

While this way of presenting the information to users is not a complex personalisation techniques (i.e. it is simply a hypertext technique similar to the one explained in Section 4.4.5.2), the MS expert's feedback shows the importance of allowing users to control the details of information that they can see rather than being assigned to a particular level of information complexity based on any criteria – i.e. the information should be provided in a less predetermined way and allowing more user control.

4.5. Discussion and implication of users' responses

The following sections reflect on the results of the first implementation and discusses their significance in terms of the personalisation prototype.

4.5.1. Users profiling

Acquiring information about users was deemed important for two reasons; the first is to determine how to present information, and the second is to determine what information to present. For example, a visually impaired user may not need information about visual problems. Yet this type of information about the user's condition is vital for presentation purposes – i.e. to provide font size and background colours that are appropriate for a visually impaired person.

It was found that users with MS welcomed having more personalisation options being added to the prototype system. Users' comments/suggestions indicated that introducing more personalisation options such as 'list of symptoms' and 'time since diagnosis' could be beneficial to them.

The 'list of symptoms' option would help users to actively choose their specific information need about a particular symptom. Most users preferred having direct access to specific topics about MS symptoms rather than starting with introductory materials. However, this did not negate the importance of having information on a general level; for instance, a newly diagnosed person with MS would still need some information on a general level – e.g. 'what is MS?' – and might find it difficult to start with a very specific topic such as 'Spasticity'. Implementing the 'list of symptoms' option does not require any additional attributes to be included within the structure of

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the XML resources, because chunks that describe symptoms could be extracted based on the chunk's name, and this is an already existing attribute (see Listing 4.2). However, for the future design of a personalisation system, more materials specifically describing symptoms of MS would need to be produced.

The 'time since diagnosis' (TSD) option was found to be a significant factor that would facilitate the generation of more appropriate information based on the stage of diagnosis for people with MS. During the early stages of diagnosis, people usually tend to be very sensitive to the information that they get about MS. Therefore, the information must not provide users with a threatening image of MS, as doing this may make them feel worse. This option can be integrated within the design of the prototype system in a way that enhances the accuracy of the user model, and consequently enhances the relevancy of the extracted information chunks. The user model values for TSD could be: newly diagnosed (ND), medium-term sufferers (MTS) and long-term sufferers (LTS). Adding the TSD factor in the user model would require adding further attributes to the structure of the XML resources - e.g. some of the basic chunks would include the attribute TSD = "ND". This may also require alternate versions of existing chunks being rewritten. Hence, a person with a fatigue problem whose TSD is ND will get information that is authored appropriately in terms of the presentation (e.g. in a tips style) and with appropriate language (e.g. very positive). Most users (except the MS domain expert) did not comment on the language and whether it was threatening or positive, because they were LTS. This most likely reflected an extensive experience with their condition.

As users' symptoms and 'time since diagnosis' would definitely change over time, this means that their information needs would change accordingly. Therefore, users should be able to override these personalisation options – for example – in their profiles.

4.5.2. The suitability of the information on the homepage

It was felt that identifying major usability problems in the prototype system would benefit the evaluation purpose although the primary aim of the evaluation was to evaluate the personalisation features used within the prototype system. Therefore, making a clear separation between what users had accepted/rejected as personalisation features as opposed to usability issues was vital to the evaluation.

It was clear that the material on the homepage lacked enough information about link destinations and accurate details of what the prototype was intending to provide to its users. Nielsen (2003) has discussed "the ten most violated homepage design guidelines". Nielsen stated the importance of including explicit summaries of what the website does and what type of service it offers. As being of vital importance, while his argument was mainly focused on Websites in the corporate sector, the idea was also seen to be vital to the design of the prototype system. However, there is a conflict between providing an overview of what people may want know and what they need to know. For example although the prototype system helped users to find and learn about the various symptoms of MS, there was a worry that newly diagnosed users might assume that they may develop all the cited symptoms within the prototype system. Therefore, users must be made aware that they may not get all of the symptoms they may learn about, and that the information was personalised to them only in terms of the presentation and the level of information so that it becomes more appropriate/accessible to them.

The users' requirements for having additional information that explains how the prototype system works, shows that they are willing to learn and engage with a personalised system that they could potentially use and that users of adaptive systems should be provided with information about how these systems work. However, this type of information should be presented in a simple format. Tsandilas & Schraefel (2004, p. 8) suggested using descriptive information that considers the behaviour of the system so that the system's behaviour would be "transparent" and "predictable" to users.

4.5.3. Additional users' requirements in terms of navigation

Although there was a set of personalised links (i.e. appropriate links), and sequential links (i.e. previous and next links) provided for navigation, users preferred having a list of all the available links with clear destinations – at the top of each page – where the link colour changed if a page had been accessed previously. Such a preference was not a personalisation feature and changing the colour of the accessed link is already a default behaviour of most web browsers. However, users preferred having such links. They felt that these links would not restrict their access and would enable them to actively choose their preferred pages about a desired topic. Nonetheless, as

mentioned in Section 4.4.3, placing all links at the top of the page could cause 'links overload' if the system's hyperspace is enormous. This problem is generally referred to as 'lost in the hyperspace' problem where users could easily get lost while browsing any hypertext/hypermedia system, because of the unrestricted access to links. In addition, users could experience a cognitive overload when trying to comprehend and visualise the context/scope of the system's hyperspace (Diebold & Kaufmann 2001, p. 159; Andrews 1998, p. 40).

However, adaptive solutions such as providing users with relevant links based on their knowledge and showing specific parts from the entire hyperspace (based on users' knowledge) would be less successful and inappropriate for the MS community (see the finding and discussion in Sections 4.4.6 and 4.5.6 respectively). In situations like this where an overview of the entire hyperspace (i.e. the site map) of a system is required, other approaches can be used.

Visualisation of site maps and overview diagrams are thought to be useful approaches to present the entire hyperspace to users. These approaches allow users to identify their locations and to see other related information from other locations within the hyperspace of a system. However, it is very difficult to visualise a large hyperspace of a system all at once on the screen to users. This problem can be managed to some extent by using the 'Focus+Context' approach. In this approach information from the same context. There are several techniques that can be used for data simplification – "Filtering" and "Abstraction" for example (Mukherjea 2000, p. 2). The filtering technique benefits from the use of a search engine where users could retrieve information of their interest, and these results are then integrated with visualisation techniques in order to enable users to effectively browse the results. The abstraction describing the same subject are classified and then combined with a visualisation technique for browsing (Mukherjea 2000, p. 2).

The 'Harmony browser' is an example of an information system that uses the 'Focus+Context' approach. In this system there are collections browser, local map, and text viewer (see Figure 4.20). The collections browser includes a hierarchical structure of the system's hyperspace and users can choose the required location or can

perform a search where results would be also displayed in the collections browser. The text viewer shows the content behind link(s) that have been accessed in the collection browser. Furthermore, when a link is accessed from a document within the text viewer a feedback of the location is shown in the collections browser. This gives continuous feedback to users about the location and the context of the document being viewed. The local map in the 'Harmony browser' visualises the document being viewed and its incoming and outgoing links using a graphical algorithm (Andrews 1998, pp. 40-41).



Figure 4.20 Components of the Harmony browser (Andrews 1998, p. 40)

Figure 4.20 shows the three components of the 'Harmony browser' with a link being selected within the collections browser and shows the path and the context of this link. The content behind the link being selected is viewed in the text viewer. Also a graphical representation of the document being viewed and its incoming and outgoing links is shown in the local map component.

Techniques of site maps visualisation have been implemented in several hypermedia systems, and seemed to be promising techniques. However, there have been no extensive studies that reveal the usefulness of using these techniques (Mukherjea 2000, p. 3).

Using the techniques of site map simplification and visualisation could be useful to the design of a future personalised system. Nonetheless, further investigation would be needed in order to ascertain the appropriateness of adopting such techniques for the MS domain. Since the hyperspace of the prototype system is relatively small it was felt that placing all links at the top of each page could be useful to users. Adding these links to the current design of the prototype system would not need any change to the structure of the XML document. Accomplishing this would need some modifications to the XSLT file that is responsible for extracting the information to include references to all of the chunks locations.

4.5.4. Suitability of the inferences

4.5.4.1. The assigned level of information complexity based on symptoms

It was clear that there were variations in users' responses regarding this personalisation feature. Positive feedback from users who were happy with the basic level assigned to them, signifies that the prototype system should employ the basic level as its default level of information complexity. This is because it was clear from the users' responses that they were more comfortable with concise/short information. Responses of users who were unhappy with the subject type of information presented on the other levels of information, indicates once more the importance of including the 'list of symptoms' option in the prototype system (discussed in Section 4.5.1). Finally, the comments of the HCI expert suggested that users should be able to choose their preferred level of information complexity; this should be accompanied with clear explanations about what those options and their consequences were.

Generally, users seemed to prefer the system to default to the basic level of information complexity and then be able to choose the other levels as they wanted to. However, this would require users to put in extra effort when setting up these options. However, indications are that they seem happy to do this on the condition that this does not complicate the registration process.

Therefore, users were highly likely to reject the idea of a personalised system that assign them to a particular information complexity. In most cases, users would like to set this themselves. This shows the importance of including more controlled

personalised choices and lends weight to the concept of personalisation in general in fulfilling the different users' needs.

4.5.4.2. Overriding the assigned level of information complexity

It was suggested (by the MS domain expert) that in MS there was an a element of loss of control over the body - e.g. difficulties in moving hands/legs and sometimes complete loss of mobility. This loss of control resulted in people having a strong desire for being in full control over as many situations as possible, including the information being presented to them. The desire for being in control seems to be fundamental in the MS domain, and it possibly affects all of the themes presented within the course of this chapter. This desire strongly manifested itself with regards to overriding the assigned level of information complexity. This is supported by a study that showed a correlation between psychological factors and fatigue. It was found that people with MS who were able to "choose or create environments suitable to their psychic or physical conditions reported less global fatigue and less fatigue-related distress" (Schwartz, Coulthard-Morris & Zeng 1996, p. 168). Mitchell et al. (2005, p. 558) have reviewed a number of heath-related quality of life (HRQoL) measures which they say clinicians should use when they are choosing appropriate therapies for MS sufferers. They also suggested that people with MS have a strong desire to maintain a degree of control and decision making over their conditions. For instance, people with MS have been known to refuse the help of a carer that they could have even when they know they need it, because they consider these situations as being intrusive and a threat to their dignity. Therefore, they wish to retain control and some degree of autonomy by making some of the choices themselves.

The ability to control the level of information complexity was certainly a popular personalisation feature. Users felt that they were not restricted to one type of information complexity, and they were able to choose their preferred levels of complexity if they were not happy with the level assigned to them. However, the provision of this personalisation feature would need to be accompanied with descriptions of its consequence so that users could accurately make choices. The need for including these additional descriptions again indicates the importance of including the elements of transparency and predictability of a personalised system to users (discussed in Section 4.5.2).

While it was suggested that users should be able to select the level of information complexity during the registration process, this does not reduce the significance of having this option within the design of the prototype system. This has two advantages; on the one hand, it gave MS users the sense of being in control, and on the other hand users would still need an easy way to override even their own choices at any time. For instance, if users select a basic level of information complexity they would be likely to change their own selection as they get used to the basic information. Therefore, they may prefer to default their profiles to another level of information complexity, e.g. intermediate or detailed, for subsequent access.

4.5.4.3. The assigned layout based on symptoms

It was found that users felt positive over the presentational aspects of the personalisation of HTML pages. The white background colour, and large font size were liked by most users. This gave an indication that it was relatively successful (in some cases) to provide users with presentational aspects based on their symptoms. Although it was true that the background colour and large font size provided a good contrast for the written text, this layout did not cater for all of the users needs. There were some occasions where users needed to change to yellow instead of the white background colour. Therefore, users should be able to select their preferred presentational aspects of font size and background colour during the creation of their profiles (i.e. during the registration) and be allowed to override these values subsequently upon need.

Users' biggest discomfort was with the font type; the serifs in 'Times New Roman' disturbed the vision of most of the users and they felt this was hard to read. Kyrnin (2004) and Liebel (2006) compared sans-serif versus serif fonts. They suggested that serif fonts are better suited for printing, and therefore they are easier to read in a printed format, as they allow users to see the text more clearly. However, Kyrnin (2004) and Liebel (2006) suggested that serif fonts are less suited for reading on the screen, because of the low resolution of the computer's monitors. This results in unclear rendering of text on the screen which is consequently much harder to read. Therefore, they recommend the use of sans-serif fonts such as 'Arial', 'Geneva' and 'Helvetica', as letters using these font types are more clearly rendered in low resolution conditions.

It is likely that using sans-serif font type such as 'Arial' could solve this problem – this is partially true as was revealed from the users' feedback. Surprisingly one user specifically preferred 'Times New Roman' to 'Arial'. This clearly indicated that people with MS need the ability to control further presentational aspects of a personalised system such as the font type. Therefore, it was decided to change the default font into 'Arial' and to enable users to easily change this option.

Introducing new personalisation options leads to the question of how to provide users with these options without causing them confusion or information overload.

While there was a need for the inclusion of more options/choices in order to make the pages more readable/accessible, users responses gave an insight into the possible layout values that a future personalised system could default to (of course with users being able to override them) – i.e. '16pt' for the font size, 'White' for the background colour and 'Arial' for the font type.

4.5.4.4. Overriding the assigned layout values

During the evaluation some users with MS needed to change the layout values – particularly the background colour – based on their condition. Even users who felt satisfied with the suggested layout were very likely at some point to change the layout due to the fact that the conditions/symptoms of MS are not stable. Therefore, users will probably need to change the layout in order to better suit their new situations. Of even greater importance, users would still need to override the layout values even if they had the opportunity to select their preferred layout values during the creation of their profiles (as discussed in above Section 4.5.4.3) due to the nature of MS (i.e., symptoms/conditions keep changing over time).

Although most users were able to setup/modify the options from the personalisation page, it was noticed that users were more comfortable with setting up/modifying options that included fewer values; for example, they were more comfortable with modifying the level of information complexity (as it included basic, intermediate and detailed) than modifying the font size (from 12 to 28). Furthermore, users felt more at ease with modifying the level of information complexity perhaps because of the more user-friendly representation of this option - i.e. users found it easier to recognise values such as 'basic', 'intermediate' and 'detailed' in comparison with the values

'12', '13', '14', etc. Therefore, personalisation options should be accomplished in a way that ensures choices and an appropriate representation of values per option. Keeping options at minimum is a guideline generally used to ensure the usability of websites' forms and particularly drop-down lists. The more options that are included within the form, the less usable it becomes. It is advisable that users are able to see all the of the options in one glance, otherwise they need to put extra effort and scrolling up/down to make a selection (Nielsen, 2000; Miller & Jarrett 2001). It is also recommended to use option names that can be easily read and distinguished by users (Miller & Jarrett 2001).

However, this raises the question of what are the most appropriate representations of the personalisation options to give to users?

4.5.5. Using different levels of information complexity

The idea of providing information at progressive levels of complexity was much liked rather than being assigned to a particular level based on symptoms (Section 4.4.4.1). There were possibly two reasons for this preference. One reason was that such provision of information empowered users to find the level of information that they could cope with. For example, some users may prefer to start with the intermediate level of information complexity, because they already know all the basics. The second reason was that users felt that their access to the levels was not restricted even if they were assigned to a particular level, because they could explore them at any time – i.e. by using the 'Information level' links or by overriding their assigned level of complexity in their profiles (as discussed in Section 4.4.4.2).

However, there was an argument about the appropriateness of the headings and link names that were used for this feature. Some users suggested that the current heading and link names could affect the clarity of the conveyed functionality particularly for less frequent users. Unfortunately, evaluators were not able to come with more appropriate wording for the current heading and link names.

In practice, it would not be an easy task to author content – about MS – and classify it into three levels of complexity. Authoring content in different levels would need an extensive knowledge of MS in order to ensure the consistency, and the appropriateness of the produced materials. This also needs a good command of

English. Although the employed content in the prototype system was produced by consulting published materials in the MS domain, it clearly lacked consistency (but still provided valid information about MS). In order to produce more appropriate and consistent levels of content (and probably appropriate heading and links names), collaboration with individuals with extensive MS expertise and good writing skills is needed. However, the cost of this approach would need careful consideration.

4.5.5.1. Presentation of text/images at each level of information complexity

It was found that presentation of text/images was appropriate with regard to each level of information complexity. Users specifically expressed a preference for having short text (as presented in the basic level), because this did not cause them any cognitive overload, and enabled them to easily read and comprehend information from the screen. Similar results were found in a research done by Hudson, Weakley & Firminger (2005). They tested the design of a Website that provided users, who experienced cognitive and learning disabilities, with long and short content. Users were more attracted to the short rather than the long versions of the content.

Although the other text presentations (as presented in the intermediate and detailed levels) were necessary for users, as they provided in-depth information about MS, it was noticed that users did not like reading long text on screen. This was very apparent when users viewed the detailed pages. Therefore, providing detailed information with an appropriate presentation – e.g. using shorter paragraphs and other media types such as images – could make it more attractive for users with MS. However, in situations where users might be more text-oriented, this way of presenting information would be less successful. Therefore, personalising text inclusion would be useful in this case. This could be accomplished by asking users during the registration about their preferred reading orientation. In the case of users who are more text-oriented, the system could provide them with, for examples, more textual and less pictorial information. Implementing this require authoring additional content and tagging it with appropriate attributes to enable extraction in accordance with the user preferences.

As far as image presentation was concerned, users liked the presence of images, particularly at full size. It was apparent that the pictures conveyed the meaning to users without requiring much effort. This was a key element behind the strong

preference for images. This complements the W3C suggestion to include images in order to make pages more comprehensible (W3C, 1999). However, it was found that some users preferred the idea of textual links leading to images. This could be a situation where personalisation may help. The different style of images presentation could be handled by enabling users to select their preferred style during the registration process. This could be achieved using a CSS file (Cascading Style Sheet) that controls the presentation style of images in accordance with the user preference.

4.5.5.2. Ability to show/hide content

Users experienced positive feeling towards the ability to show/hide content. This could be due to several reasons. The first being that instant control over the information gave users a different experience of being in control in comparison with the other personalisation options. In other words, users did not have to configure/setup values in order to show/hide content. Another reason could be that it reduced the page's complexity when hiding the undesired/irrelevant content. Of even greater importance, was that the consequence of this personalisation technique was very apparent to users – i.e. they did not need to spend much effort and time in order to figure out what the effects/results were. A similar approach of presenting content was recommended by Hudson et al. (2005). They suggested that users should be given the opportunity to control the content, and that one way to achieve this was by presenting the content as expandable bullet points allowing users to expand/collapse the information when they needed to.

This implies that simplicity is a key element that affects MS users acceptance of personalisation. Therefore, simplicity should be considered when designing a personalisation system so that users could use such a system more easily and effectively. Simplicity in this context means the use of clear and understandable personalisation features/functionalities.

4.5.5.3. Using other media types including videos and audios

It was evident from the discussion in Section 4.5.5.1 that using pictorial representation of information (i.e. images) would convey 'meaning' more easily than using purely text-based information. In this context, some suggestions were made proposing that the use of video files would help people with MS to access the required

information more easily. This was particularly true for people with fatigue problems, as they would be less likely to be able to read a lot of text when feeling severely fatigued.

Using videos may help people with MS to access information. In most cases watching a video file on an HTML page requires users only to click the video link in order to activate/play the video file. This certainly would be effortless compared to the effort needed when scrolling up/down while reading long text. Using videos could not only help people with fatigue problems, but also it would help people with mobility problems – e.g. individuals experiencing difficulties in moving their hands.

Of even greater importance, videos can be more accessible in comparison with textual information for people with cognitive disabilities (people with MS may experience cognitive problems such as defects in memory, attention, word finding or concentration (Multiple Sclerosis International Federation, 2006)). Videos can communicate a richer content including emotion and atmosphere as well as, of course, visual information. It is can therefore be easier for users with cognitive disabilities to watch video rather than trying to comprehend the written text. Furthermore, people with visual impairments who use assistive technology such as screen readers, they could benefit from listening to the audio included with the video content instead of listening to synthesised speech output of text. It should be noted however that using such media types would probably work more effectively if it is used as an enhancement to the textual information and not as a replacement to it (Skills For Access, [n.d.]).

While analysing the benefits of videos was beyond the scope of this research work, it indicated that personalised systems that locate appropriate video clips and give users the chance to view them alongside textual material maybe beneficial.

Other users' suggestions were concerned with using audio, and particularly speech assistive technology. It was noticed that most users with MS, who were experiencing complete loss of mobility, did benefit from using speech assistive technology on their computers. The use of audio/speech assistive technology is not necessarily a personalisation feature. However, incorporating such technology within the design would help particularly those with complete loss of mobility.

Generally, the inclusion of the these media types should be made easily configurable by users. It is likely some users would not need to see videos, because the webpage would appear complicated – i.e. filled with text, images and videos. Therefore, users should be able to control this by allowing them to switch on/off the inclusion of video files during registration. On the other hand, users should also be given the ability to override this inclusion if required. Furthermore, not only could the inclusion of video files be personalised by users, but also these videos could be personalised according to their content – basic, intermediate and detailed, and therefore users would be able to choose which type they want to see. However, since videos, for example, are not textual in nature, classifying them into three levels of information complexity would require descriptive information – i.e. metadata such as 'Dublin Core Metadata Element Set' (see Chapter 6, Section 6.4) – and this would need to be developed specifically for this purpose.

4.5.6. Suggesting links based on knowledge (appropriate links)

Using the appropriate links in the prototype system was deemed less successful for two reasons. First, the 'Appropriate links' heading and the anchor text of these links (e.g. 'symptoms in general') were unclear (see Figure 4.8). This caused confusion about their functionality. Second, users perceived these links in many different ways. For example, some users always perceived links within a website as links to external websites and feared being lost by following them.

Surprisingly, users continued in their reluctance to follow appropriate links even after they were provided – by the author – with explanations about how this feature works. The reason for this was probably because users in such a situation feel that control is being taken away from them, and they have to follow the system's suggestions rather than their own choices. Disabling users from being in control over the system's actions is one of the main criticisms that faces adaptive/personalised systems (Tsandilas and Schraefel 2004, p.7).

It is apparent that the sense of being in control is a fundamental and significant element to people with MS (as discussed e.g. in Section 4.5.4.2). Therefore, the idea of adopting a purely personalised/adaptive system for the MS community would be likely to be rejected, since it would take the control away from users and disable them from taking an active role - i.e. the opportunity to engage with and learn about the
system's behaviour. Therefore, developers need to take this issue (i.e. control) into consideration when developing personalised systems for the MS community.

4.5.7. Users' thoughts about additional personalisation features

In order to identify further useful personalisation features, it was decided to ascertain users' thoughts/opinions towards particular themes including providing personalised information based on age, gender and the role of the user. These themes are discussed in Sections 4.5.7.1, 4.5.7.2, and 4.5.7.3

4.5.7.1. Providing personalised information based on age

Users felt negative about this feature, because they believed that providing personalised information related to age was not needed. There were several possible reasons for their negative feelings. First, all users were in the age of 40 to 60 years old; therefore, they could not comprehend the different needs for people aged, for example, 20 to 25 years old. Second, there was an implicit worry that adding new personalisation features would complicate the prototype system leading to users confusion when configuring/setting many personalisation features. Finally, users could not identify the benefit of using 'information based on age', probably because it was hard for them to visualise this feature due to the absence of this feature in the prototype system.

In contrast to the MS users, the MS expert's comments suggested that providing alternative formats for information based on age would be a good idea. This reinforces the importance of the cooperation with experts from the MS domain when designing such a personalised system (see Sections 4.5.5 and 4.5.5.1).

It can be inferred that taking age into account to provide personalised information could be beneficial. Content and presentation could be personalised in different ways. The provision of personalised information based on age would need the creation of additional content that is tagged with age-related attributes. This would enable the personalised system to extract related information based on the age group specified by users during the registration.

This led to a question of who should take control of personalisation/adaptation within a personalised system – users or the system? It was found that users with MS

expressed a strong desire for being in control. However, it would be impractical to let users to control/modify every single aspect of a personalised system, because this negates the rationale of using a personalised system. The goal of a personlised system is to help users to find information tailored to their needs rather than spending their time in modifying/setting up personalisation options. However, a future personalised system may benefit from the idea of personalising the degree of 'control' of personalisation. For example, users who wish to control all the aspects of personalisation could set this options to e.g. 'Low'. Therefore, they would be responsible for setting up most of the personalisation options. Users who wish to acquire help/recommendations from the system, or those who would not mind system interventions, could set the control to e.g. 'Medium'. In this case, both users and the system would be controlling personalisation. For example, users who already have accessed the system could be assisted, by the system, to skip introductory pages on subsequent access. When the control is set to e.g. 'High' this means that users would be more reliant on the system's recommendations. For instance, the system could provide users with a personalised learning orientation to MS. In this case, users' actions could also be monitored (e.g. time spent on reading a page and users' clicks) and accordingly a set of links would be suggested. This would resemble the three types of personalisation approaches including customisation, rule-based and behavioural-based personalisation.

Once again, explanations about the consequences of setting up a 'control' would need to be provided to users, so that they could make accurate decisions about the degree of desired control. A similar approach was adopted by Tsandilas and Schraefel (2004, pp. 14-15), they used adaptation technique whereby users were able to control the adaptation process, and they were able to show/include content that was left out by the adaptation process.

4.5.7.2. Providing personalised information based on gender

MS affects men in different ways to women which results in different information needs. This is particularly true for gender-related symptoms such as sexual dysfunction.

When users were asked about the provision of information based on gender, they felt that this feature would be pointless. Possible reasons for this rejection were mentioned

in Section 4.5.7.1. Firstly, users were not able to able to appreciate the different needs based on gender, because they did not experience the other gender's needs of information. Secondly, this rejection was due to the worry of complicating the interface. Finally, users were not able to visualise this feature due to the absence of a working example that showed its benefits. Moreover, it was noticed that users were not fully aware of all possible gender-related symptoms in MS. They were aware only about the obvious symptoms such as sexual dysfunction. Therefore, users with MS assumed that providing personalised information based on gender did not make a difference.

In contrast, the MS domain expert felt this idea could be useful, because she believed that there were many symptoms in MS that could affect men differently than women. Once more, this indicates significance of incorporating MS experts during the design of a future personalised system (Sections 4.5.5, 4.5.5.1, and 4.5.7.1). Furthermore, if younger people had been included in the study, users responses could have been different.

Broadly, the provision of information based on gender could be a useful feature. The success of this feature depends to a large extent on ease of its configuration. This feature requires authoring of additional content (XML chunks) about gender-related symptoms and adding further attributes to this content – e.g. Gender = "Female". Including this attribute would enable the prototype system to extract specific chunks based on the user's gender, as specified in the users profile. This could be extended to the way information was presented – e.g. using male/female language (i.e. he/she and male/female characters in images/videos). Furthermore, male users may want to view how a particular gender-related symptom is affecting females. Therefore, users should be able to browse this symptom from the other gender perspective if they wanted to.

4.5.7.3. Providing personalised information based on the role of the user

The future version of this personalised system should adopt a holistic approach for the provision of personalised information. Hepworth et al. (2003) suggested that the information should be available to all parties that were involved in the MS community including the general public and family, service provider and the person with MS (see Chapter 1). In this context, it was felt that it would be useful to identify users'

thoughts about this concept, because this could be vital to the design of a future personalised system.

Ironically, the MS users feedback on this type of personalisation was negative. There were possibly several reasons for users' negative feeling towards the provision of personalised information based on the user's role. Firstly, interviewees only represented one category – i.e. a person with MS. Therefore, they could not experience the viewpoints or differing needs for information. Secondly, the same misconception about adding to the complexity of the system and how this may affect users' acceptability of this feature was mentioned (see discussion in Sections 4.5.7.1, and 4.5.7.2). Thirdly, it was hard for users to visualise this feature and its benefit due to the absence of a working example that shows its potential benefit.

In contrast, the HCI expert perspective was different. She believed that this type of information provision would be very useful, but on the condition that users should be able to access all the different views if they needed to explore the information from the other perspectives.

Generally, the provision of personalised information based on the user's role could be beneficial. Users' categories that constitute the MS community may need to learn about MS from different viewpoints. Accomplishing this has the potential of establishing good communication between all users and therefore better understanding of different users' needs. For instance, if a family member of an MS individual learns about MS from a health worker or an MS patient viewpoints, he/she may be more able to understand the condition. Therefore, a better understanding of the individual's physical or psychological needs is acquired as well as the viewpoint of others who may be involved.

4.5.8. Users' overall thoughts/opinions about personalisation.

In general, users felt positive about using personalised features within the prototype system to acquire information about MS. However, the appreciation of these features were varied. Most users liked the ability to change presentational aspects - i.e. the font size and the background colour. Less attention were given to the ability to control the content in comparison with changing the presentational aspects. However, users did appreciate a degree of control in being able to override this feature.

4.6. Summary of key findings

Having discussed and reflects on the implications of the first implementation, a summary of key findings is shown below.

- First, the strong desire for being in control over the information was fundamental in such a situation, where people may lose their physical abilities. Hence, it is necessary for a personalised system to fulfil the desire of being in control by giving users with MS the ability to override/control the personalisation process. This was clear from the discussion in Sections 4.5.4.2 and 4.5.4.4 where users liked to override the personalisation rules.
- Second, the provision of content at three different levels of complexity was deemed significant. It was discussed in Section 4.5.5 that users liked the content to be presented at three levels as this could help them to avoid cognitive overload or loss of concentration (during fatigue) caused by the overwhelming amount information. However, as discussed in Sections 4.5.5 and 4.5.5.1, designing a complete personalised system and particularly the design of content would definitely need collaboration with individuals with extensive MS expertise and excellent writing skills. As the expense of such approach are expected to be high, it would be sensible to conduct a costbenefit analysis (CBA) in order to compare the costs and benefits of designing such a personalised system. A brief discussion of a CBA is outlined in Appendix 3.
- Third, the inclusion of more explanations about the purpose of personalisation was very important. MS sufferers and particularly those who are newly diagnosed need to have clear explanations about the role of personalisation within a personalised system. It is very important, for example, to indicate to newly diagnosed sufferers it is unlikely to develop all the symptoms cited in the system because it is personalised to them.
- Finally, it was found that users' misconceptions about personalisation affected their acceptance of new personalised features for different reasons (discussed earlier in Sections 4.5.7.1, 4.5.7.2 and 4.5.7.3). The inclusion of personalisation options that are easy-to-use could help users with MS to

overcome the worries of complicating the user-interface when adding more personalised options.

It could be argued that the worry of adding new personalisation features contradicts the discussion in Section 4.5.1 where users welcomed the inclusion of more personalisation options. This could be explained by the fact that when users were asked to include the 'list of symptoms' feature (so that they could acquire information about the desired symptoms), they could visualise it, and consequently ascertain its benefit. However, this was not the case when users were asked about adding new personalisation options (that most probably they could not visualise). This reinforces again the importance of including working demonstrations of personalised features, so that users are better able to assess their benefits.

The next chapter (Chapter 5) presents the findings and analysis of the second implementation.

Chapter 5

Second Implementation – Findings and Analysis

5.1. Introduction

The completion of the first implementation (Chapter 4) was followed by undertaking modifications to the prototype system based on those results. Subsequently, and in keeping with the iterative nature of the design research methodology (i.e. circumscription), a second implementation (i.e. evaluation) was needed. The second implementation was undertaken using a focus group and three individual interviews. The focus group included ten people with MS at varying stages of their conditions. Similarly, the three individual interviews included three people with MS at varying stages of the disease.

Participants from the focus group (from now on referred to simply as evaluator(s)) were provided with a demonstration of the prototype system. The purpose of this demonstration was to show the group how the prototype system could adapt the content, and the presentation of information to MS users experiencing sight/fatigue problems. In order to give the audience a clear and easy demonstration, it was composed of the following main steps:

- Creating a user profile by filling-in the registration form.
- Logging into the prototype.
- Browsing some of the content.
- Switching between the levels of information complexity (basic, intermediate and detailed).
- Changing some of the preferences in the user profile using the personalisation/profiling page.

• Saving changes and logging out.

The individual interviews involved interviewing two individuals with MS who had previously used the prototype system (from now on referred to as the former users). Those interviewees were asked to freely interact with the prototype system as if they were new users – i.e. they were asked to create new profiles using the registration page of the prototype system (because changes were made to the registration page). Subsequently, they were asked to explore and comment on the prototype system including things they liked/disliked about the design. They were asked also to comment particularly on the personalised functionalities provided bearing in mind the new modifications that were carried out. The last user was completely new to the prototype system (from now on referred to as the new user). The same method employed during the first evaluation, 'Question-Asking' protocol followed by an interview, was used with the new user. Involving the former users in the second implementation was useful, because they were able to effectively evaluate the improvements in the prototype system. Most of the results in the second implementation reinforced results from the first implementation.

5.2. The second prototype

The second version of the prototype generally remained similar to the first prototype. Nonetheless, there were some modifications introduced to the second prototype based on the results of the first implementation. Although some of these changes were usability related, there were a number of personalisation/adaptation features added.

During the first implementation, users disliked links being suggested based on their level of knowledge and preferred to choose links on their own. Therefore, this led to replacement of the 'Appropriate links' with 'Content links' where users would be able to choose the links they desire. Figure 5.1 shows content links being placed at the top of the page. On the left menu of Figure 5.1 link disabling was introduced to indicate the level of information complexity being assigned to the user. Previously, the assigned level of complexity was indicated by placing a sentence, for example, 'Information level: basic'. Link disabling in the second implementation was applied based on the assigned level of complexity. For instance, the user in Figure 5.1 was assigned to the basic level of complexity and hence the 'basic' link (under the information level heading) was disabled to indicate the current level being viewed.



Figure 5.1 Content links being added to the prototype system

Another modification involved adding more explanations to the log-in page and the homepage. Users' responses in the first implementation indicated that more explanations were required on these pages. Figures 5.2 and 5.3 shows these explanations incorporated into the design of the second prototype. Although there were other explanations required (e.g. the consequences of selecting/modifying personalisation features), these explanations required good writing skills and expertise of the MS domain to be effectively integrated into the prototype. It should be mentioned that the explanations in Figure 5.3 replaced the information about the user profile (see Chapter 4, Figure 4.7).

Adding videos to the prototype was a modification based on the users' responses from the first implementation where they indicted that they liked using videos. Figure 5.4 shows a video file opened by clicking on the link 'Play video'. This video presentation was short and gave basic information about what MS is, and how it occurs.

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Figure 5.2 Explanation added on the log-in page



Figure 5.3 Explanations added on the homepage



Figure 5.4 Video presentation being added to the orientation



(A)

(B)



(C)

(D)

Figure 5.5 A video presentation explaining how MS occurs

Figure 5.5 shows screenshots that were taken from the video presentation shown to users with MS. Part (A) in the figure, shows the central nervous system which consists of the brain and the spinal cord. Part (B), shows an axon (i.e. a nerve fibre) that is covered with myelin (coloured in red). The myelin helps to ensure the nerves transmit messages to and from the brain quickly and efficiently. Part (C) demonstrates a white-blood cell that has attacked the myelin coating the axon. Part (D) shows sclerotic tissues trying to replace the destroyed areas on the axon. This results in an inefficient transmission of messages causing various symptoms to the MS sufferer such as tremor, visual and fatigue problems.

It was found during the first implementation that some users some could not cope with serifed fonts and preferred to have text displayed in a sans-serif font. Therefore, in the second prototype, the font was defaulted to sans-serif (see to Figure 5.1). However, on the rare occasions where users need to change the font type they should be given an opportunity to do so. In the second prototype, this was achieved by adding this option to the personalisation form (see Figure 5.6).

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Figure 5.6 Adding 'change font type' option in the personalisation form

5.3. Users' response to the second prototype

Undertaking these modifications in the second prototype was followed by another 'Evaluation' phase of the design research methodology. Sections 5.3.1 to 5.3.8 present the dominant themes derived from the users responses as they interacted with the prototype system. Sections 5.4.1 to 5.4.8 fully discuss the implications of these findings.

5.3.1. User profiling

Immediately after finishing the demonstration to the evaluators from the focus group, one evaluator expected the prototype system to provide content about the symptoms that were selected in the registration page.

"When you clicked on sight in the registration page, I wonder why that information is not all about sight? I thought it is going to be adapted, or take you to something about sight problems."

The new user was also asked also about the usefulness of providing users with a list of symptoms, so that they only get information on those symptoms. The new user felt that such a personalisation feature could be useful. He suggested that it would be more appropriate for users to start reading information at a general level then they could delve into more specific information as they progress:

"Because MS does affect people primarily in different ways, I think that could be useful. But I still think that there is a place for the general and the basic stuff, but when you start getting into detail it would be nice to be able to home in on the specific areas such as: fatigue, vision or whatever sort of thing – Yes that would be useful at this point."

The feedback of evaluators and the new user reinforced the finding from the first implementation (Section 4.4.1) where users welcomed the inclusion of more personalisation options such as the 'list of symptoms' feature.

Furthermore, one evaluator thought that it would require users to register again if users' conditions (i.e. symptoms) changed over time in order to access the relevant information within the prototype system. "Say you want to register because you got sight problems, few weeks later you got problem with fatigue then do you have to register again to get into this website? Really you should be able to register once to get into the whole site rather being registering for a different symptom."

One of the former users felt confused over selection of the symptoms being experienced – the purpose and the consequences of that choice were not apparent. Therefore, she suggested adding more explanations to this option that described its purpose:

"Now I am confused with what I have to do, because I have entered my username, I have put my password, and now it says: 'do you experience any of these problems' – is this part of the registration process?"

"When you register, normally you just register, but obviously here you are asking particular questions. It is probably better to say something simple like: 'to tailor this for your particular needs can you answer these questions?' because otherwise people would say what does this mean!"

It was clear that there was misunderstanding of the purpose of the profiling process. Users did not know why this information was collected and how the prototype was going to respond accordingly. Therefore, it was deemed important to include additional explanations to show the purpose of users' profiling (i.e. why information is being collected about users during the registration) and how the system would respond accordingly.

5.3.2. The assigned level of information complexity based on symptoms

During the demonstration evaluators asked (the researcher) to select the 'sight' symptom during the registration. Evaluators wanted to see how the prototype system would respond to this symptom. After evaluators saw how the prototype system made the adaptations, they were asked about the suitability of the assigned level of the information complexity to a person with sight problems. The evaluators responses were varied. Some evaluators expressed a desire to be able to choose another level of information complexity that was different from the assigned one. One evaluator said:

"There might be a time when I got a problem with my sight and I want the font as large as possible, but I also want the detailed information as well. When you first register it is either fatigue or sight, and you are assuming if my sight is bad I only want the basic information; my sight might be bad but I still want to look at the detailed information".

It was not clear to this particular evaluator that the choice to override the level of information complexity was available. However other evaluators appreciated the ability to override this either by showing the other levels of complexity directly using the 'Information levels' links, or by changing the 'Level of information' option within the preferences page. One evaluator said:

"But you have got the choice [to change it to detailed],"

The new user from the individual interview felt positive over the assigned level of information complexity which was the basic level. In addition, he appreciated the opportunity to override the prototype system rules/suggestions for the information level in the personalisation page. The new user said:

"I think that [the content] is quite good, it is very clear. As an initial sort of thing, it seems to categorise everything well, it seems to cover everything that I am familiar with. I would say that is generally good. I like the graphic – the illustration, I think pictures always help."

He also said, with regards to overriding the assigned level of complexity:

"I think it is nice [to be able to change the information level]. [You can change the basic level] if that is not what you want every time, and yet you still have the option of changing it whenever you want."

This indicates that the ability to override the assigned level of complexity is important to fulfil the users' needs.

Furthermore, evaluators were asked about the most appropriate level of information that they could cope with especially during times of fatigue. Evaluators preferred the basic level. They felt that they would not be able to cope with reading long text particularly during times of fatigue.

"We just want the basic to start with and then when you get better you can expand on that."

"Because if we are tired, we do not want to read too much information."

"Your concentration just goes after so long if there is too much of the same thing [i.e. text]."

"You feel very tired when you have a lot of reading."

This reinforces the finding from the first implementation (Section 4.4.4.1) that the prototype system would look simpler to users if it defaulted to the basic level of information.

5.3.3. The assigned layout based on symptoms

Based on the selected symptom (i.e. sight) during the demonstration, the prototype system chose particular presentational aspects – i.e. a point of 19 point font size and a white background colour. In addition, evaluators were shown how the assigned layout could be overridden in the preferences page. Afterwards, evaluators were asked about the appropriateness of the assigned layout for a person with MS experiencing a sight problem. Evaluators, felt positive over the prototype system's recommendations in terms of the font size and background colour. However, there was one evaluator who found a yellow background colour much easier when reading.

"I found the yellow background colour is a lot easier for me; is that just for me or is there anybody else? I could read it with the yellow, but I could not read that at all [with white background colour]."

"I find that better! [the white background colour]."

Evaluators' feedback on which background colour was easier to read indicates that it is very important to MS users to be able to personalise the layout particularly the background colour during the registration. This reinforces the finding (in Section 4.4.4.3) from the first implementation.

The new user felt positive over the assigned layout, he said:

"I always choose fonts without serifs, and that size is about ideal for me; I find a good balance between getting enough of it on the screen and getting it a big enough to read. Also, I think the contrast of a good dark typeface and light background is a good contrast. I am personally quite happy with that." This indicates that changing to sans-serif (i.e. 'Arial') as the default font style was successful.

Other evaluators felt positive over the current assigned layout, and appreciated the ability to override the prototype system's rules/suggestions.

"But at least you can adapt it, can't you."

"That is alright for me, and there again if you have the chance to personalise it and change it to something like the yellow, you can have the yellow."

"Yes, that is right."

The new user appreciated the ability to override these rules. The new user also liked the limited number of values for the given options in the preferences page, because he thought that giving such limited number of choices made the design of the prototype system more user-friendly.

"It was nice that there was a choice without there being endless choice, and I suppose it is probably always satisfying to be able to personalise something in gratifying way – if you know what I mean – because it makes [the website] more user-friendly in some respects, and that is a good practical thing to be able to choose a different type face and certainly type size when people have problems with vision."

It seemed that users' acceptance of some aspects of the system's recommendation depends on whether users appreciate the chance to override/control those recommendations. This reinforces findings from the first implementation where the sense of being in control is fundamental to people with MS.

5.3.4. Using different levels of information complexity

While demonstrating the prototype system to evaluators, they were presented with three levels of information complexity – i.e. basic, intermediate and detailed. They were then asked how useful it was for them to view information in the three levels of complexity. Evaluators felt very positive about this presentation of information. Furthermore, they expressed a desire to start with the basic level of information and then to explore more details as they progressed.

"Oh yes [it is useful to have the information in three levels]."

"If you are going too deep to start with it goes over your head and you don't take anything in, and here it is useful that you feed it in at different levels."

"That is a progressive thing; start with basic [and then view intermediate and detailed]. [For instance, if you have a sight problem] you will say 'why have I got a sight problem with MS? Why does MS cause my sight problem?' It is like a progressive thing isn't it. You follow like a sort of basic mode then why I got it, and why is it causing this then you want to delve into more of it don't you? So, progressively you want to get more and more details as you progress."

In the same way, the new user thought that having different levels of information complexity was a good idea. He preferred to start with the basic information, particularly for the newly diagnosed users with MS, and then gradually delving into the other levels as the user progressed to seeking more information.

"I think the idea of different levels is a good idea, and I certainly think with MS. I am thinking back when I was told I had MS and I didn't know what it was! This basic level with pictures is something I would be able to look at once, store, and then when I wanted to know more it would be something to build on. Whereas to get perhaps the intermediate level or certainly the detailed level from scratch, would be too much."

This reinforces the finding from the first implementation (Section 4.4.5) where users liked to be presented with progressive levels of information rather than being assigned by the system to a particular level based on their symptoms.

5.3.5. Using other media types such as videos and audios

A video presentation, giving a brief introduction about MS, was played during the demonstration of the prototype system. Evaluators were asked about the suitability of using such media types within the prototype system. Evaluators very much liked the video presentation, and mentioned that having such media types would be much easier for comprehension than reading long text.

"I like the video, I am lazy! I do not want to read pages and pages of stuff. If somebody can show me a video, it is a lot easier." "It is showing you what it is telling you, so it is easy."

"It is nice to see what the words are saying. You understand the meaning of the words if the pictures are there showing you."

The new users felt very positive over the video presentation too; he believed that seeing such a video during the early stage of his diagnosis would have explained what MS was in a very simple way without requiring him to dig into the information using different resources – e.g., books. He said:

"Yes, I like that. If I had just been told I had MS, that video would have helped me in many ways. Perhaps it is slightly shocking when it is personal thing thinking 'Oh! That is happening to me', but then you get over it shall we say. But if I could have been shown something like that within a day or two of diagnosis that would have said it all – I like the idea of that. My MS has been diagnosed for 18 years now, but at that time I didn't know what it was so I had to go away and find books. I was going to libraries reading all kind of things and having to piece it together myself. My neurologist hadn't really ever told me what it was. I think access to something like that in a way in your own time and your own surroundings even is of great benefit really."

Similarly, the former users felt very positive over the video presentation. One of them commented that providing such media types would enable users to get the information without spending much effort particularly if users were fatigued or experiencing visual problems. Comparing that to reading the text, he said:

"I much prefer to see videos like that rather than reading loads of stuff. I think a picture worth thousands of words and videos are even better, and when they are talking to me it saves [the effort for reading long text]. You know I am thinking about fatigue in there and sight. It is much easier for me relax and have somebody talking to me rather than having to scroll down through and read loads of stuff."

The other former users said:

"it is good to have there; it is a good idea to have something like that."

Users' responses were positive for having videos included within the design of the prototype system. This indicates that this modification in the prototype (i.e. the inclusion of videos) was successful.

Moreover, some evaluators expressed a preference for using speech assistive technology, whereby the text can be read out to users. They felt that using such technology would assist users, particularly those experiencing sight problems, to easily comprehend the written text.

"In the modern technology, can you have it so that the script can be read it out to me? Because if I got a sight problem that would be ideal for me, it is much easier."

"Once it is reading it to you then you can read it can't you."

This reinforces the users' suggestion from the first implementation (Section 4.4.5.3) for integrating speech assistive technology within the design.

5.3.6. Users thoughts/opinions about personalisation

After discussing various aspects with evaluators about the prototype system, they were asked for their thoughts/opinions about personalisation. Particularly, they were asked how comfortable they were with providing personal information such as names addresses and MS-related information including mobility, state of condition and year of diagnosis. Some evaluators refused to provide their personal information, and even felt worried when they were required to register within a Website:

"I always get wary when I go online where it says 'register here' – why should I register? If I am registering it means that somebody back there wants some information from me."

"I don't want that. I don't want to give them my real name or address."

Furthermore, one evaluator felt unhappy about providing personal information on the Web, because she believed that doing this would disclose her information for everybody. This evaluator felt more happy to talk within a small group of people that she already knew:

"Because I do not want everybody knowing every detail about me. I mean, I am happy to talk to people here about everything I have got, but I don't want it spread all over the place."

It was clear that evaluators did not appreciate the purpose of the registration process. This may be because there were no such explanations integrated into the prototype system that explained this. Therefore, this reinforces the finding in Section 0 that showed the importance of including these explanations, particularly about the purpose of collecting information during the registration.

However, the author explained to evaluators that providing such information, particularly MS-related information, was necessary for the personalised system to carry out the personalisation/adaptation as seen during the demonstration. After this, evaluators seemed willing to provide the information required within the registration page such as username, password and problems/symptoms being experienced. In other words, evaluators felt happy to provide the information as long as they could not be identified/located in person.

"Yes, that is OK [to provide username, password, and symptoms being experienced]."

"Yes, because nobody knows who you are if they have not got your name, your address or your telephone. I think anybody is prepared to give any details as long as you do not have to tell them who you are – you cannot be located!"

"On sites that where you did give that level of information [e.g. real name or address] you should get the choice to keep anonymous. That information is kept within the site and nobody else can view it."

In contrast, the new user did not mind disclosing personal information such as real names, address, time since diagnosis, etc. He said:

"I think I am OK for all those things. I don't have any problem at all."

This indicates that users should be able to choose if they wish to provide information about themselves and also the degree of this information disclosure (e.g. willing to provide personal information or prefer being anonymous). Therefore, personalising the degree of information disclosure could fulfil the different users' needs.

In addition, evaluators were asked whether some of the personalisation features, as they were presented during the demonstration, would be perceived as patronising to users (i.e. the fact that a person with sight/fatigue problems was assigned to an intermediate/basic level of information complexity). There was a general feeling among evaluators that this could be perceived as patronising.

"In a way, yes [I would perceive that as patronising]."

"I might have a sight problem and I might be quite intelligent, so I want all the information I can get."

However, one evaluator did not feel patronised, because she appreciated the ability to override the prototype system rules using the personalisation page; she said:

"But we have said that if we got the choice to adapt it as we want."

The new user described assigning users to a particular content/layout as acceptable. He thought that the aim of it was to help/guide users within the prototype system.

"Patronising could be a word that you used, but then it is [like] that the creator of it is wanting to lead the users through. So, it would be a reasonable patronising – I think it was acceptable."

Generally, it seemed that if evaluators had the chance to know why they have been assigned to particular level of information and appreciate the opportunity to override this, they may accept the prototype suggestions. Once more, this reinforces the importance of including explanations so that users would know what to expect and why they were being assigned to a particular level of information.

5.3.7. Other ways of presenting personalisation features

During the focus group interview, some evaluators suggested other ways for providing personalised features within the prototype system. One evaluator suggested having the information on a general level with highlighted words whereby users could click them on in order to delve into more detailed information.

This technique depends on replacing the content of the destination page within the current page when accessing a link rather than transferring the user into another page.

This technique has been a part of many hypertext systems such as Guide for a number of years (History of the Web, 2002).

One evaluator stated:

"If I see this piece of paper and there is something there that I particularly want to go to, I like to be able to click on it and get more information from there. I don't think there is many times on with what you have got at the moment where is that opportunity. But then as you say, if there is something about the eye sight – yes that is something that I want to find out about – click on the eye sight and then it will automatically bring a lot more detail. I like being able to do that as well. Say you read initially general stuff, but there are lots of words that I can highlight, and I want to go into more details about those."

Presenting information in this way reinforces the suggestion made by the MS expert from the first implementation (Section 4.4.8). This supports the finding from the first implementation (Section 4.4.5.2) where users strongly desired to be in a direct control over the detail of information. It worth noting that this way is similar to the technique used within the prototype system of showing/hiding content (see Chapter 4, Figures 4.13 and 4.14).

Another evaluator suggested taking the control away from the prototype system, and letting users be able to setup/control all of the personalisation/adaptation aspects. Furthermore, this evaluator suggested that the personalisation options provided within the prototype system should be made easy to setup/configure:

"Instead of saying yes I have got a sight problem, and let the computer sort out what it is going to give me, why does it just show different sizes of font and the computer just says 'which one do you want?' As simple as that. [It can represent the font size values like a symbol of little letter or medium letter] – who knows what 19 font is anyway! Whereas If I see the lower letter and that the size I want then I click on that one instead of getting too technical. [By doing this] you can overcome the problem of being patronising and saying that is what I want to have – just let me choose!"

Similarly, another evaluator suggested that configuring the personalisation features should be made uncomplicated particularly to users within their age group, who were

less familiar with using computers/Internet, because this might affect their understanding of how to use these personalisation features:

"I will say our age group were not brought up with computers. We don't know computer language. So, lots of people would not know what font [size] means and when it talks about personalisation, it does not make it very clear what they want you to do with personalisation."

The new user felt that allowing users to setup their profiles by themselves could be useful. However, he stressed that these options should have limited values so that users would not be disrupted by their configuration which might negatively influence the main goal:

"I think it would be a good thing if it is limited. I think if you had a complete spectrum of colours [which require configuration], that could be in a way obstructive. It takes you away from the focus of the main thing. Again, going back to me as an illustrator and graphics designer, I could almost imagine myself playing around with background colours and not progressing with the main purpose. So, there is a need for some limits maybe."

In addition to the strong desire to be in control and the significance of having further explanations, these responses indicated that more simplified representations of personalisation options were needed.

5.3.8. Other usability-related problems

The purpose of the implementation was primarily to look at identifying the usefulness of the given personalisation features within the prototype system for people with MS. However, there were some usability problems, identified mostly by the former users and on some occasions by the new user. Identifying such usability problems was deemed necessary, because it was important to ascertain what was accepted/rejected as a personalisation feature, and what was simply a usability problem which could affect the users' perceptions towards personalisation. The following depicts these usability problems as they were found during the individual interviews.

5.3.8.1 Difficulties with link access

Some explanations were added to the prototype system as a result of the first implementation about the functionality of the links. The former users expected that links would be included within these explanations. Therefore, they felt that reading the explanations – where some of them needed scrolling down the page and then scrolling up to click the required link – would need extra effort from users especially if they were fatigued or visually impaired.

"I am surprised that I could not click [the word 'register' in the explanations] instead of having to go over there to [click] register!"

"It is interesting when I am down here and it says 'click personalise', where is personalise? It is gone!"

"It would have been nice if the 'Start overview' [words] could have come down because I have got a larger typeface. I have had to scroll down the page to read it, and now I have to scroll back up the page to find the 'Start overview' [link]. Again it is an extra effort if I am fatigued and vision problem at my worse time."

While explanations were very important to users, it was necessary to keep links as close as possible to their explanations so that users do not have to scroll up/down the page to access a link. This should be taken into consideration when developing future personalised system.

5.3.8.2 Difficulties with scrolling up the page

While the former users were scrolling down the page reading explanations, or looking at particular information about MS, they faced difficulties in scrolling up the page when they needed to. They expected the presence of a 'back to top' link whereby they could easily navigate to the top of the page.

"That is nice and easy to read. I know that I need to go up there [to click the 'back' link] to go back [to the previous page], but there is nothing at the bottom of the page to say go back."

"Now I am not told how I can get back to the top again. You ought to have something there like 'back to top' [link]."

This indicates that it very important for users with MS to be able to move with ease in the prototype system. This can be accomplished by, for instance, minimising the scrolling efforts (e.g. using 'back to top' link).

5.3.8.3 Confusion with log-in procedure

After the former users had created their profile using the registration page, they were directed into the log-in page and then required by the prototype system enter their log-in information. This caused the former users some confusion and was considered an extra effort on them.

One of the former users said after completing the registration and subsequently arriving at the log-in page:

"Why I have gone back to [the log-in page] now!"

Another former user said:

"So we have now to use our username and password! But haven't we created our profile just for this anyway? why do we need to enter the username and password again!"

Technically, this step was required in order to access users' profiles that were stored in the database. However, assuming this problem could be overcome, users should not be required to log-in if they have just created a username/password to avoid any similar confusion.

5.4. Discussion and implication of users' responses

The following sections comprehensively discusses the implications and reflects on the second implementation results in terms of their significance.

5.4.1. User profiling

Evaluators' feedback on 'user profiling' showed that users misunderstood the purpose of collecting information about their conditions. Evaluators did not really appreciate that the information being collected was used to build their profiles, and to help the prototype system to assign users to a particular content presentation. Evaluators thought that the registration purpose was to enable them to acquire information about

the symptoms being selected during the registration. Furthermore, evaluators not only misunderstood the purpose of questions about their conditions during the registration, but also they thought that users would need to re-register if their conditions had changed.

This misconception about the registration process was clarified – by the researcher – to evaluators where they seemed to understand the purpose of it. This further reinforces the need to add even more explanations (particularly this time about the purpose of users' profiling) to solve any potential misunderstanding.

5.4.2. The assigned level of information complexity based on symptoms

Responses of evaluators were still varied regarding the appropriateness of the level of information complexity assigned to users. Some evaluators felt unhappy about being assigned to a particular level based on symptoms, because they desired to see detailed information rather than intermediate or basic information. Other evaluators, accepted the level of information assigned and appreciated the opportunity to override the level of information complexity. This reinforces the finding from the first implementation (Section 4.4.4.1). However, this poses the question of 'when' to give users this opportunity - during the registration process where users would select the desired level of information complexity, or after the registration where users could change it in their preferences page? Further investigation is therefore needed to ascertain when to give users this opportunity. However, if the prototype system was able to personalise the control (discussed in Chapter 4, section 4.5.7.1), this may solve this problem. For instance, users who set the control level to 'Low' should be able to choose the level of information complexity during the registration, because they would be responsible for setting all personalisation features of the system including complexity level.

Evaluators' preference, for being presented with the basic level of information complexity particularly during times of fatigue, indicated that it would be more appropriate to default the prototype system to the basic level. This supports the discussion from the first implementation in Section 4.5.4.1.

5.4.3. The assigned layout based on symptoms

While evaluators expressed comfort with the assigned layout, there were variations amongst evaluators with regard to which background colour was easier to see. Some evaluators felt that a white background was more appropriate whereas others felt that yellow was the best. This situation lends weight to personalisation and shows that the ability to personalise the background colour helps fulfil the users' needs.

Again, this leads to the question of when users should be given the opportunity to change the presentational/layout aspects of the prototype? Before, during or after the registration (i.e. collecting information about users to build their profiles)? It was suggested in the first implementation (Section 4.4.4.3) that users may benefit from changing the background colour during the registration. However, it seemed that it may be more convenient to users to be able to control the basic presentational aspects (i.e. font size and background colour) as soon as they access the homepage of the prototype (i.e. before the registration process). It was apparent from the first and second implementations that users were very much concerned about these presentational aspects. Therefore, allowing users to personalise font size and background colour) on the top of each page. Values such as small, medium or large could specify the font size. Similarly, small-coloured icons representing white and yellow could be used to specify background colour.

Evaluators seemed to like the prototype system suggesting font size and background colour particularly when they realised that they were able to control these elements. This reinforces the discussion from the first implementation (Sections 4.12.4.2, 4.12.6 and 4.12.8) where the sense of being in control was important and fundamental to users with MS. Again, the main point to learn is that users need more explanations about how the prototype system works in order to interact with it more efficiently. This supports the finding from the first implementation (Section 4.4.2).

5.4.4. Using different levels of information complexity

This theme reinforces the finding from the first implementation where users preferred being presented with progressive levels rather being assigned to a level of information complexity. Evaluators felt that a newly diagnosed person with MS would benefit from reading information at progressive levels. This reinforces the discussion from the first implementation (Section 4.5.1) where incorporating a 'time since diagnosis' element within the design could be beneficial (for newly diagnosed suffers who might be very sensitive to the information about MS).

5.4.5. Using media types including videos and audios

It was apparent that inclusion of videos was a successful modification. Evaluators and the new user felt that watching videos was easier than reading long text. Of even greater importance, they felt that watching videos alongside text would help them to understand the context of information more effectively. This reinforces the discussion from the first implementation (Section 4.5.5.3) where the inclusion of videos could support information comprehension for people with cognitive disabilities.

Evaluators' suggestions about using the speech assistive technology reinforces the discussion from the first implementation (Section 4.5.5.3) where users with visual and mobility problems could benefit from the text being read out to them. The integration of this assistive technology simply involves adding a screen reader to the user's Web browser.

However, as discussed in the first implementation (Section 4.5.5.3) the inclusion of videos or speech assistive technology should be easily configurable by users, as they might not want to watch videos or to use speech. Therefore, these should be part of personalised choices that users are able to select.

It is believed that presenting videos at three levels of complexity would be beneficial to users with MS. However, this requires authoring costs if one tries to embed and classify a large number of videos into basic, intermediate and detailed. Therefore, a future version of this system may benefit from being able to locate videos with differing levels of complexity. In this case, however, there would be a problem of locating videos with the three levels of complexity, as they may not necessarily be marked up into three levels of complexity. In this situation, it may be necessary to consider 'metadata harvesting' where resource descriptions can be shared and searched by content authors (this approach is discussed in Chapter 6, Section 6.4).

5.4.6. Users' thoughts/opinions about personalisation

It was clear that users with MS needed to take an active role within the prototype system. It was noticed that evaluators might be willing to accept the system's behaviour when the situation was clarified to them. Thus, including explanations which allow users with MS to know what is happening, including explanations about why their personal information is being collected, how it is going to be processed and in what ways the information is personalised to users, is very significant.

While it was very useful to explain to users with MS e.g. why their personal information was being collected, it seemed that there might be occasions where users do not wish to provide this personal information. It was clear from Section 5.3.6 that some evaluators were not willing to disclose their personal information, others preferred to reveal information as long as they cannot be identified, and others were unconcerned about providing their personal information. In this case, personalising the extent of 'information disclosure' could be beneficial. This could be accomplished by asking users questions regarding their desire to provide information before starting the registration process. Of course, this should be supported with clarifications about the type of information disclosure that can be selected. Accordingly, the type of information collected would differ based on the questions answered. For instance, users who wish to be anonymous, but were willing to provide information without being located, would provide information such as username, password, time since diagnosis, gender, etc. Whereas users who wish to provide their personal information, they would provide (including the earlier information) information such as real name, address, telephone number, email address, and so forth. Collecting this information may be beneficial, for instance, MS sufferers could be provided with addresses of local support groups in their area.

5.4.7. Suggesting other ways to present personalisation features

It was clear that the desire to be in control was fundamental to people with MS. Users' preference for information presented in clickable 'hot-words' are related to their need for control, as this technique (i.e. hot-word) would allow users to have direct control over the detail of information. This technique would not require users to modify/change personalisation options and therefore would probably be easier for

users to comprehend the results. For this reason, it is believed that implementing such a technique within a future personalised system would be beneficial.

Integrating the stretch text (i.e. hot-words) technique can be taken a step further by being more adaptive/personalised depending on the extent of the user's knowledge. For instance, based on knowledge of the user, the system can determine the initial presentation of these hot-words – i.e. the ones that should be expanded already and the ones that should not be expanded. Therefore users should find appropriate information is already stretched for them. This technique is part of the KN-AHS system (described in Chapter 2, Section 2.9.2). However, referring back to the issue of controlling personalisation (Chapter 4, Section 4.5.7.1), using adaptive hot words might not be liked by users who expressed a desire to have a full control over the system (i.e. the personalisation control is set to 'Low'). In this case, using hot-words that are controlled by users would be more appropriate. The technique of adaptive hot-words would only be appropriate for users with profiles that reflecting 'Medium' or 'high' degree of personalisation control.

Evaluators' responses indicated that employing more user friendly representation and limited entries per personalisation option were important. This reinforced the discussion in Section 4.5.4.4 from the first implementation where users felt more at ease with handling/changing the layout values of the prototype. Therefore, the suggestion of using values such as small, medium or large as a good way for presenting font size options rather than using 15, 16 or 19 points, was supported.

5.4.8. Other usability-related problems

It was clear that the prototype system suffered from a number of usability problems. It was necessary to identify these, so that a future revision of the system would avoid the same (or similar) problems.

Most difficulties that faced the former users were concerned with scrolling when reading explanations about link functionality or when reaching the bottom of a page. While these explanations are deemed very important to users with MS, these explanations should be integrated in a way that would not add a further burden on users. For instance, it would be a lot easier for users to keep links and explanations about their functionality close together. This would minimise the scrolling efforts of

users. Another way to reduce the scrolling is by placing 'back to top' link at the bottom of each page, so that users would move to the top easily. Starling (2001) mentioned that repeating the main links at the bottom of each page saves the users' effort if they scroll up the page to access those links. It may also be beneficial to personalise the degree of explanations in the future system. For example, novice users could get these explanations while experienced users do not.

5.5. Successful modifications incorporated into the second prototype

As mentioned before, some of the modifications to the prototype system were usability related, and some involved adding some personalisation/adaptation features. A number of these changes to personalisation features were identified by the former users and the new user. Generally, they felt positive over these changes and provided suggestions when it was felt necessary. The following discussion shows these successful modifications/changes.

5.5.1. Changing 'Appropriate links' with 'Content links' for navigation

During the first implementation users suggested having content links placed at the top of each page instead of having appropriate links provided by the prototype system (refer to Figure 5.1). The former users felt positive about content links compared to the previous 'Appropriate links' idea. They said:

"That is better up there, and I much prefer that rather than using the appropriate links idea."

"It is better to have it like that [i.e. as content links], because you can go straight to the ones that you want to look at."

In the same way, the new user felt positive over the presence of the content links. He thought that using the content links enabled him to identify his location within the prototype system; he said:

"I like that idea of picking up these links, because I will feel like I know where I am then."

5.5.2. Introducing 'link-disabling' to the 'Information level' links

It was noticed during the first implementation that it was not clear to users if they were reading basic, intermediate or detailed content. It was also noticed that indicating the assigned level of information at the top of the page with the heading 'Information level: basic' was not sufficient. Therefore, it was thought that including a disabled link outlining the assigned information level could help users to determine their level of information complexity chosen for them (refer to the left-hand menu in Figure 5.1).

The former users liked the idea of link-disabling and felt this had helped them to identify their assigned level of information complexity. However, one of the former users indicated that using a grey colour for the disabled link may be problematical for a person with sight problems. She suggested using another appropriate colour which could be easily seen. She said:

"We are now looking in the basic because it is not underlined, and the other ones are underlined for us to go on if we want to - intermediate and detailed."

"That [disabled link] looks very pale grey comparing with that which is a dark blue with the underline. Somebody has real sight problems would not notice the difference, they might not even notice the line was not underneath it. I suggest that link be in a different colour but I don't know if that is feasible."

One other former user said:

"I think that is fairly obvious where I am, because it is highlighted and not underlined; I can see that. I think most people who use the internet would be able to see that."

The new users was also asked about the usefulness of the disabled link feature in 'Information level' links. He felt that this feature was useful and sufficient for people who were familiar with computers. This also enabled them to confirm the assigned level of information complexity. He said:

"I suppose that does help. It kind of helps confirm where you are."

"I don't think it needs anymore. As a reasonably familiar-computer user, you know, there is almost like a non-written language or understanding."

5.5.3. Adding explanations to the log-in page and the homepage

As a result of the first implementation, more explanations were added to the log-in page to make it easier for users to interact with the prototype. More explanations were also added to the homepage to explain to users the controls on the screen instead of providing them with information about their profiles (see Figures 5.2 and 5.3).

However, the former users' responses showed that they preferred having links within these explanations, so that they do not need to scroll down the page to read the explanations and then to scroll up again to select the required control/option. One of the former users said:

"It would have been nice if the "Start overview" [text becomes as link] because I have got a larger type I have had to scroll down the page to read [these explanations] and now I have to scroll back up the page to click the "Start overview" [link]. Again it is an extra effort especially if am fatigued and have a vision problem."

5.6. Summary of key findings

Generally, it can be seen that the findings from the second implementation reinforced the finding of the first one. The following outlines the key findings of the second implementation.

• The strong desire to control the personalisation process was found important to people with MS. During the second implementation some evaluators were not happy with the system assigning them to a particular level of information complexity or layout based on their conditions. Other users felt positive about the assigned values (i.e. the level of complexity and the layout) because they appreciated the opportunity to override these values. Hence, this should be opportunity (to control the personalisation process) should be incorporated into any personalised system designed for the MS domain. In this sense, controlling the personalisation by users could meet the users' needs (see Chapter 4, section 4.5.7.1).

- Using different levels information complexity was deemed important. Evaluators in the second implementation liked the content being presented in progressive levels of complexity including the basic, intermediate and detailed levels. This was clear from the discussion in Section 5.4.4.
- The inclusion of more explanations, particularly about the aim of collecting users' information during the registration, were deemed significant. While evaluating the second prototype, evaluators expressed a worry about the process of collecting especially the personal information during the registration process. Therefore, users' privacy should be insured and the level of information disclosure could be personalised to ensure this process (see Section 5.4.6).

The next Chapter (Chapter 6) presents an overall discussion of the findings from the first and second implementations.

Chapter 6

Discussion

6.1. Introduction

This chapter provides an overall discussion of the first and second implementations in terms of particular points which are significant to the design of a future personalised system.

6.2. Relation to the adopted model (AHAM model)

Tsandilas & Schraefel (2004, p. 7) stated that adaptive hypermedia systems are often criticised for not allowing users to have control over the systems' adaptations. This becomes even more critical if users' needs are frequently changing. Therefore, it would be hard for an adaptive system to respond accurately to the users' needs unless there is a direct feedback from users.

Both implementations (Chapters 4 and 5) indicated that acquiring information about the users was very significant, and influenced the personalisation process within the prototype system. One of the main findings from this research work was the strong desire for users with MS to be in control over the personalisation aspects within the prototype system. In the educational domain, it has been suggested that users of educational hypermedia are usually "novices who can not make choices" and rely entirely on the systems' suggestion/recommendations to guide them through the hyperspace of a system (Brusilovisky 1996, p. 18). Although this is in the educational domain, for people with MS, the desire for being in control contradicts this suggestion. The reason for these differences could, in part, be due to the nature of MS which removes some physical abilities from individuals. This seems to result in a strong desire to control the adaptation/personalisation aspects within a system. It could be also that Brusilovisky has underestimated the desire for control in general and given this option, other people would perhaps welcome more control.
As mentioned in Chapter 4, Section 4.3.4, the design of the prototype system followed the general architecture of the AHAM model. A domain model, user model, personalisation (i.e. adaptation) model and personalisation engine were created in the prototype system.

However, because the AHAM model was primarily developed for the educational domain (though it is still applicable for implementation in other domains), it was found that certain aspects of acquiring users' personal information and users' ability to override/control the personalisation rules were not clearly reflected in AHAM. The AHA authoring system – which is an implementation of AHAM model (described in Chapter 2, Section 2.9.3) – was used by De Bra et al. (2002) to create an online course on hypermedia. In this instance, students' personal information including their email and programme were captured during the log-in process and then stored in a user model under a special concept called 'personal'. It was claimed that information stored in a personal concept could be used, for example, to provide students from different universities with different assignments. However, the main focus of any system created using AHA is on capturing users' evolving knowledge about concepts based on the browsing history within the hyperspace of an adaptive system (Wu 2002, p. 47). Therefore, any system created using AHA assigns a low priority to users' personal information and maybe less applicable to systems for other learning contexts.

Furthermore, in the online course¹ (created using AHA) about 'Hypermedia Structures and Systems', users were able to override their knowledge about the concepts provided and the link colours used within the system (there were different colours used to distinguish different sets of links including bad, neutral, good and unconditional links). Although this helps users to distinguish appropriate from inappropriate links, this would be insufficient for users with MS to satisfy their desire to be in control.

The AHAM model could therefore be adapted to reflect approaches to acquiring users' personal information and providing users with the ability to override the personalisation rules. Applying this would introduce a change to the way that users are modelled in AHAM. In the prototype system, users with MS were modelled in two stages. In the first stage, users were modelled based on their collected personal

¹ Found on http://wwwis.win.tue.nl:8080/2L690/

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information such as username, password, and symptoms (though results of the first and second implementations suggested the inclusion of more information such as list of topics about the symptoms of MS and time since diagnosis). In the second stage, users were modelled based on their ability to control/override the personalisation rules. Adapting the AHAM model to account for the requirements of users in this study would result in Figure 6.1. This figure shows how the two-stages of the users model, Stage 1 UM and Stage 2 UM, would be integrated into the AHAM model.



Figure 6.1 Two-stages user model integrated in AHAM

Although it is suggested, in AHAM, that users should receive information based on their evolving knowledge, there is no clear indication for how the domain model should be structured. It is left to the author to define this structure. While this is still valid (i.e. leaving the domain model structure to authors/developers) for this research work, it was revealed (during the implementation of the prototype) that presenting information chunks into different levels of complexity was beneficial to the MS sufferers. Consequently, the AHAM model needs to reflect this structure by including the basic, intermediate and detailed levels of information complexity into the domain model (this structure is included and explained in Figure 6.4)

It should be noted that this particular model is appropriate to the MS domain. The applicability of using this model in other domains (e.g. patients with Cancer) would need further investigation. However, it seems that this particular model could be applied in other domains.

6.3. Implications of the technology

The technologies including XML, XSLT and the Apache Cocoon Framework were used to design and implement the personalised prototype. These were found useful in many ways. Because XML is a meta language, it can be used to describe the semantic nature and structure of individual XML chunks in a way that represents the domain. In the prototype system, XML was used to construct the information resources (i.e. the domain model) into different levels of information complexity - basic, intermediate, and detailed. For each XML resource, one topic was authored at three levels of complexity (see Chapter 4, Listing 4-2). This was accomplished easily using XML. However, there was an authoring effort required to produce content at the three levels of complexity. Nonetheless, presuming that content production could be facilitated and better managed, probably by using an XML integrated development environment (IDE) - e.g. Stylusstudio or XMLSpy, using XML to describe content blocks would be appropriate in this type of application. It should be mentioned that the ability to describe content at different levels of complexity was not the only benefit of using XML, there were other (technical) advantages such as using XML attributes to facilitate the mapping between the user model attributes and the attributes of the information chunks. This enabled the extraction and transformation of relevant information to MS users (see Chapter 4, Listing 4-6).

XSLT is a powerful language that facilitated adaptations (i.e. personalisation) within the prototype system. XSLT was mainly used to carry out the extraction (i.e. copying) of information chunks based on the stored variables within the users model and prepare them for rendering by a Web browser (i.e. arranging how content and links should appear in the final construction of a page). Moreover, XSLT helped in executing personalisation rules upon the users' registration (i.e. assigning users to a specific level of information complexity and layout based on symptoms). It also facilitated the overriding of the personalisation rules by users. Another responsibility of XSLT was to achieve the behavioural personalisation technique within the prototype system. XSLT was used to maintain the data about the visited pages within the user model. This data was then used to suggest links (i.e. appropriate links) to relevant topics for users. (This functionality is described in Chapter 4, Listing 4-8). Finally, a very significant role for XSLT was to aggregate information chunks from different XML resources enabling the desired orientation of the resources to be easily authored (see Chapter 4, Listing 4-6).

In the architecture developed in this work, XSLT served a dual purpose. It included the personalisation rules and was responsible for executing them. Carrying out the design in this way offered the advantage of separating content and logic – i.e. the XML resources only include chunks of information and do not include any logic (i.e. personalisation rules), whereas the XSLT files include and execute the logic. This has the advantage of making the system easier to maintain.

All of the previous interactions were supported by the Apache Cocoon publishing framework. The interactions between the XML, XSLT, management of the user model (e.g. changing users' preference), HTML page rendering, etc. were fully supported by Apache Cocoon (a full description about Cocoon framework is found in Chapter 4, Section 4.3.3). Furthermore, Apache Cocoon provides a mechanism whereby integrating any type of RDBMS (Relational Database Management System) can be easily accomplished (it includes a set of predefined protocols that allows any RDBMS to be plugged into the framework). However, the disadvantage of this framework is that problems may appear when migrating to a newer version where compatibility problems may occur which need to be done manually.

Finally, based on the results of the first and second implementations, it is believed that using XML, XSLT and Apache Cocoon were efficient technologies to create a personalised system for people with MS.

6.4. Extensibility for a future revision of the system

It is important that a future revision of a personalised system would be able to extend its capabilities in terms of updating/acquiring new content or applying additional personalisation functionalities. In the context of acquiring new content, this can be envisaged by integrating content harvesting techniques in the future system which allow for acquiring, for example, textual and video content from external resources.

Results from the first and second implementations showed that the inclusion of video files was very beneficial to users. Giving users with MS the opportunity to view/acquire videos from external resources would enable users to view information

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about MS in a desired format. The same approach could be applied to textual information where users with MS could access textual information gathered from other resources.

However, these authored files (videos are used as an example throughout this section) need to be integrated easily within the current design of the prototype, and therefore they are needed at three levels of complexity. While this approach of having information at different levels of complexity was desired by users with MS, it might be difficult to find such content from external resources (i.e. authors do not usually produce information materials that are labelled at three levels of complexity). Nevertheless, approaches that aid harvesting information and describing it at three levels of complexity could be part of a solution to overcome such a difficulty. Possible criteria for classifying video files into three levels could include the topic presented and the length of that file. For example, during the second implementation a video file that included a short animated introduction about the cause of MS was presented. Users' responses showed that this video file was a typical simple introduction to MS. In other words, this means that this type of video could fit the 'basic' level of information complexity.

Metadata could be used to describe video files at different levels of complexity. Metadata is defined as a set of attributes or elements, necessary to describe the resources of information (Hillmann, 2005). There are several standards and approaches for using metadata – one of these standards is 'Dublin Core Metadata Element Set' (DCMES). In this standard there are no restrictions on the resource type that can be described. The DCMES standard uses fifteen elements (some of which are explained in Table 6.1) that can enrich the description of the information resource (Dublin Core Metadata Initiative, 2006).

Table 6.1 shows three elements² from the DCMES with a description of their possible use. These elements can be used to describe videos and therefore ease the extraction of the relevant ones. For example, the title element is important as it gives a name for a video file. The subject could be used to identify the topic of the video. Also, there is a description element (not mentioned in Table 6.1) that could be used to classify the

² A complete list of DCMES can be found at: <u>http://dublincore.org/documents/dces/</u>

r

content of a video into basic, intermediate and detailed. The identifier element would be used to reference the physical location of the video file.

| an a | | | | |
|--|---|--|--|--|
| Element N | ame: Title | | | |
| Label: | Title. | | | |
| Definition: | A name given to the resource. | | | |
| Comments: | Typically, Title will be a name by which the resource is formally known. | | | |
| Flamont | L Jame: Sublect | | | |
| Label: | Subject and Keywords. | | | |
| Definition: | A topic of the content of the resource. | | | |
| <u>Commont</u> | The initial contract will be an | | | |
| Comment: | Typically, Subject will be expressed as keywords, key phrases or classification codes | | | |
| | that describe a topic of the resource. Recommended best practice is to select a value | | | |
| | from a controlled vocabulary or formal classification scheme. | | | |
| Element N | Vame: Identifier | | | |
| Label: | Resource Identifier. | | | |
| Definition: | An unambiguous reference to the resource within a given context. | | | |
| Comments: | Recommended best practice is to identify the resource by means of a string or number | | | |
| | conforming to a formal identification system. Formal identification systems include | | | |
| | but are not limited to the Uniform Resource Identifier (URI) (including the Uniform | | | |
| | Resource Locator (URL)), the Digital Object Identifier (DOI) and the International | | | |
| | Standard Book Number (ISBN). | | | |
| | | | | |

| Table 6.1 | Extract from | n the DCME | S (Dublin | Core M | letadata ' | Initiative. | 2006 |
|-----------|--------------|------------|-----------|--------|------------|-------------|-------|
| | DAH act H VI | | | COLCIN | | ******** | #000j |

Following a standard for describing the information resources would facilitate information sharing between the future personalised system and external resources. This sharing of information could be achieved by using sharing/harvesting approaches. One approach to accomplish this could be by implementing OAI/PMH (Open Archives Initiative Protocol for Metadata Harvesting).

OAI/PMH³ is simply a mechanism whereby metadata records can be harvested from external repositories. In OAI/PMH there are two participants including data providers

³ Full discussion and tutorials about OAI/PMH can be found at: <u>http://www.oaforum.org/tutorial/english/page1.htm</u>

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and service providers. Data providers expose their metadata repositories for harvesting. These repositories should be able to support the OAI/PMH protocol. Service providers use OAI/PMH for metadata harvesting (see Figure 6.2). In OAI/PMH metadata is harvested using six verbs that are communicated through the HTTP (Hypertext Transfer Protocol) using the 'Request' and 'Response' methods. These verbs include 'Identify', 'ListMetadataFormats', 'ListSets', 'ListIdentifiers', 'ListRecords' and 'GetRecord'. Each one of these verbs has its own functionality and a set of arguments (i.e. gET method) using the following structure:

http://archive.org/oaiscript?verb=ListRecords&metadataPrefix=oai_dc&s et=biology

The above line means, list records from the specified archive where these records are specified in DC and the content type is about biology.

The harvested metadata is returned in XML format where it could be stored in a database to on the service provider Web server to facilitate user searching (Carpenter, 2003).



Figure 6.2 Data and service providers in OAJ/PMH (Capenter, 2003)

In Figure 6.2, the upper part shows data providers who make their metadata files available for harvesting. The lower part in the figure shows service provides who are responsible for metadata harvesting. Although OAI/PMH protocol uses the Dublin Core (DC) metadata as the basis for resources description (to allow more interoperability by encouraging involved parties to use DC), other metadata format

are allowed to be used as long as they can be represented in XML specifications (Carpenter, 2003).

However, the major problem with this approach is that data providers are likely to use DC elements to describe their resources in a way which is not compatible with the personalised system. In other words, it is unlikely that the data providers would use the description element of DCMES to describe video files as basic, intermediate and detailed. Thus, it would be meaningless for a future system just to harvest videos metadata without 'knowing' the level of complexity. Therefore, further investigation is required to find the most appropriate approach to overcome this problem. One possible solutions could be achieved by asking data providers to add a further element to their metadata files indicating the level of complexity of existing videos (see Listing 6-1).

Listing 6-1 A proposed solution to identify the assigned level of complexity

<metadata

<?xml version="1.0"?>

xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

xsi:schemaLocation="http://example.org/myapp/ http://example.org/myapp/schema.xsd"

xmlns:dc="http://purl.org/dc/elements/1.1/">

xmlns:vf="URL that uniquely identifies this namespace">
 <dc:title> fatigue treatment </dc:title>

<dc:id>...</dc:id>

<dc:description> </dc:description>

<vf:complexity> basic video explains fatigue treatment </vf:complexity>

</metadata>

Listing 7-1 provides an example of a metadata file that describes a video resource that explains fatigue treatment in MS. In this metadata file an additional element <vf:complexity> which indicates the level of complexity of the video file can be added. To use this element correctly, a namespace URL (Uniform Resource Locator) is required which uniquely identifies this element. This is achieved in Listing 6-1 using the following line:

<metadata

xmlns:vf="URL that uniquely identifies this namespace">
...
</metadata>

A request to data providers would be sent by the service provider to harvest their metadata. According to the suggestion in Listing 6-1, retrieved metadata files would include more than one namespace, each one would be validated against a different XML schema. Combining different XML schemas can be achieved using NRL (Namespace Routing Language). NRL is a recommendation that allows combining different namespaces with different XML schemas to allow validation of a complete document (Clark, 2003). However, more investigation would be required to consider exactly how this can be undertaken.

Another alternative would be for the service provider to acquire DC metadata files (as they were created), but to enhance it as necessary with metadata elements that describe the complexity of resources. This would require the service provider system to suggest potential candidates, by selecting metadata files that describing MS-related content, to authors who could rewrite the resource or manually add metadata elements to the records retrieved.

Therefore, the enhancement of metadata files could occur on the service providers side or data providers side. However, because it is possible to have more than one data provider involved, it might be difficult for them to undertake this change to their metadata files. Therefore, it might be easier for the service provider to undertake this change. If either of the these approaches were developed, subsequently several metadata files could be gathered and should be made available for searching through a searchable database (see Figure 6.3).

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Figure 6.3 A proposed architecture for resource sharing

Figure 6.3 shows the overall architecture for acquiring content from external repositories. It starts with the service provider sending a request using the OAI/PMH protocol to harvest content (about MS) from data providers. Metadata files are then harvested, enhanced (either on the data providers or service provider side as described earlier) and stored on a searchable database. Based on the nature of the service provided by the service provider, it is either that authors of the personalised system may be provided with a user-interface to search the service provider's database and then integrate possible results with the internal XML files. The other possibility could be that the service provider may provide a machine interface where it would be the Coccoon's responsibility to communicate with the service provider's system and to integrate possible results with the internal XML files. If either of these approaches were used, the metadata element dc:identifier, which points to the physical location of a video file on the data providers side, would be handled and rendered by Coccoon on the user-interface of the system.

6.5. Guidelines for the design of a future revision of the system

A future revision of the prototype system may benefit from a design that is specifically developed for the MS domain. The following discussion, represents key guidelines (derived from the first and second implementations) that could be applied to construct a personalised system that is very close to the needs of MS users. These guidelines outline significant elements that should be taken into consideration during the design phase of a future system (research question 4) (see Table 6.2). It should be mentioned that some of these guidelines can be found in other domains, such as usability, however it is important that such guidelines are considered as they may affect people's perceptions towards personalisation. Tsandilas and Schraefel (2004, pp. 5-6) mention that adaptive systems often violate usability principles, and one strong reason for this is the lack of thorough evaluation studies concerning the usability of the adaptations provided by these systems.

Table 6.2 Key guidelines for the design of the future version of a personalised system for people with MS

| Themes |
|-------------------|
| User profiling |

| Homepage | • Explanations describing the type and the nature | <u> </u> |
|-------------|--|---|
| design | of the service should be presented. | It is very important to inform users that the system is personalising only the content and the layout according to their needs (it does not mean that users will develop all the cited symptoms in the system because it is personalised to them). |
| Navigation, | • Appropriate use of headings and anchor text of | Further investigation in |
| and | links (i.e. link names) should be ensured. | Further investigation is |
| scrolling | • Placing all links at the top of each page would be | needed to identify the most |
| | useful if the system's hyperspace is relatively | appropriate technique of |
| | small. | maps visualisation. |
| | Map visualisation techniques would be | |
| | beneficial if the system's hyperspace is large. | |
| | • Lengthy pages that need considerable scrolling | |
| , , | should be avoided. However, if provided, | |
| | presenting 'back to top' links would help. | |
| | | |
| | | |
| Content | • Presenting content in progressive levels of | As mantioned in the first |
| design | complexity is desired. | implementation creating |
| | • Basic level of complexity is preferable as the | appropriate levels of |
| | default level in the system. | appropriate levels of |
| | | collaboration with MS |
| | - | experts and individuals with |
| | | and writing skille |
| | | good writing skills. |
| | | |

Chapter 6

Discussion

| Text, | Short paragraphs are always preferable for text | It is clear that further investigation is needed to determine when to give users the opportunity to | | | |
|--------------|--|--|--|--|--|
| pictures, | presentation. | | | | |
| videos and | • Pictures should be used whenever it is possible. | | | | |
| audio files. | • Videos/audio should be used to help users to | | | | |
| | comprehend the scope of the written text (not as | | | | |
| | an alternative to it). | control/personalise these aspects – before, during, or | | | |
| | • Users should be able to control/personalise: | | | | |
| | The inclusion of more/less text. | after registration? | | | |
| | \Box The presentation style of pictures (full | · · · | | | |
| | size thumbrail or a link leading to an | | | | |
| | image) | | | | |
| | mage). | | | | |
| | | | | | |
| Layout | • Large font size – e.g. 16 pt – should be used | | | | |
| design | as the default font size. | Again, when to give users the | | | |
| | • White background colour is acceptable for | opportunity control/ | | | |
| | most cases (therefore it can be used as the | personalise these aspects | | | |
| | default background colour). However, in | needs further investigation. | | | |
| | some cases a yellow background is | • | | | |
| Í | preferred. | | | | |
| 1 | • Sans-serif fonts are more acceptable as a | | | | |
| | font style, therefore can be used as the | | | | |
| | default font type. However, in some cases a | | | | |
| | serif font is preferred | | | | |
| | There should be able to nerconalize all the | | | | |
| | Osers should be able to personalise all the | · · · · | | | |
| | above aspects – i.e. ioni size, background | | | | |
| 1 | colour and font type. | l | | | |

6.6. The development of a new model

Results from the first and second implementations revealed important findings about the appropriateness of using personalised information for people with MS. Perhaps the most significant finding was the desire for users with MS to control the information that they could acquire about MS. Furthermore, it was subsequently suggested that it would be more appropriate if the AHAM model divided the user model into two stages. Doing this would enable the user model to be more accurate and reflect the actual needs for users with MS. However, users' responses from the two implementations revealed a diversity in the degree of personalisation required. Some users expressed a strong desire to control the personalisation aspects provided while others felt happy about the recommendations presented (i.e. the suggested layout and level of information complexity). Consequently, it was suggested to allow users to personalise the control in the future personalised system (discussed in Chapter 4, Section 4.5.7.1).

Incorporating these elements together and defining their relationships introduces a new model that could be used as the basis for the development of a future personalised system for the MS community. As it can be seen, the elements of the new model have been empirically proven in two 'Evaluation' phases of the design research methodology and therefore this can be considered as the most effective conceptual model for modelling the personalisation environment within the MS domain (research question 3).

This new model still would be inspired by the AHAM model, and also focuses on the storage layer to maintain conformance with the Dexter model. Therefore, it is kept at an abstract level -i.e. it does not show the entire process and interactions. Instead, it suggests an overall architecture and shows significant elements that are fundamental for the development of a future personalised system within the MS domain. Moreover, it explains broadly the interactions and the relationships between its constituent parts.

Figure 6.4 shows this new model. The domain model, personalisation model, user model and personalisation controller are all presented. The user model (UM) includes two-stage modelling – UM stage 1 and UM stage 2. The UM stage 1 is aimed at building the initial users profile which typically could be a accomplished by requiring users to fill out a form. In addition to acquiring information about users themselves (depending on the degree of personal information disclosure chosen by users – discussed in Chapter 5, Section 5.4.6), they can also personalise the control. This could be achieved by including a 'personalisation controller' that allows users to specify the preferred level of control within a personalised system. Applying this, would enable the system to ascertain the degree of personalisation required and hence to determine the level of interaction with users. For instance, if the personalisation controller was set to e.g. 'Low', then the system would determine that setting up all personalisation aspects should be done by the user, and therefore interaction (e.g. system's recommendations/suggestions) should be kept at a minimum.

Information from the UM stage 1 is then fed into the personalisation model where the designated personalisation rules would be executed by the personalisation engine (which is part of the personalisation model). Having determined the relevant personalisation rules, the personalisation engine would then extract the required content that matches information in the user's profile in terms of level of information complexity (i.e. basic, intermediate and detailed) and layout.



Figure 6.4 The new devised model

The UM stage 2 would be needed if users wish to modify the information in their profiles – either their personal information or the level of the personalisation controller. When users change the level of personalisation controller, this information would be communicated to the personalisation model where the personalisation engine selects the appropriate personalisation rules. For instance, if a user sets the personalisation controller to 'High', this indicates that the personalisation engine would be responsible for running the personalisation rules. In this sense, automatic updating of the user's profile (e.g. updating the user's knowledge about a topic or mentoring the browsing history) would be carried out within the personalised system. Consequently, the information maintained in the user's profile can be used e.g. to recommend links to relevant topics or showing the next appropriate level of information complexity.

Figure 6.5 shows the development stages of the new personalisation model for the MS community. Part (a) represents the old AHAM model, part (b) shows the first change of AHAM which required introducing two-stages user model and part (c) represents the new devised model including two-stages user model, a personalisation controller and a domain model developed at three level of complexity.



Figure 6.5 Development stages of the new personalisation model

6.7. Summary

In this chapter, an overall discussion was presented in terms of significant themes including the adopted personalisation model, the used technology for development and suggestions for further development to a future personalised system in the MS domain. Furthermore, a guideline for developing a personalised system and a new personalisation model were presented.

The next chapter (Chapter 7) presents the conclusions, recommendations and suggestions for further research. It also outlines the limitations and contributions of this research.

Chapter 7

Conclusions and Recommendations

7.1. Introduction

This chapter first provides a brief reflection on the methodology and then shows how the objectives of the research were fulfilled by answering the research questions. In addition, the contribution of this work is outlined, limitations considered and a number of recommendation presented. Finally, some suggestions are given for future work within the area of personalisation.

7.2. Reflection on the design research methodology

The design research methodology adopted was deemed successful for this research. The nature of this research was exploratory and based on a design of artefacts (i.e. personalisation systems) that needed evaluation by individuals from the MS community to identify the benefits of using the personalisation as an approach to access Web-based information. The phases of design research including 'awareness of the problem', 'suggestions', 'development', 'evaluation' and 'conclusion', meant that this research could be approached in a systematic way within the time frame allocated. For instance during the awareness phase, the research problem was formulated by surveying the literature and looking at previous research within the same context. This in return, fed into the next phase and helped envisage the solution for the problem. In the same way, this fed into the subsequent phases which involved creating the design and then evaluating it with individuals from the target community. Therefore, it can be seen that these phases helped approach this research in more systematic and planned manner.

The iterative nature (i.e. circumscription process) of the design research methodology was beneficial. The knowledge acquired during the first iteration was transferred into the next iteration where a better awareness of the problem was gained. This enhanced

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the solution envisaged during the first iteration which then led into a modification in the functionalities of the prototype system. Subsequently, this was followed by another evaluation phase which revealed additional information that could have been used to undertake another iteration.

Generally, using design research as a research methodology was beneficial and helped fulfil the aim of this research and answer the research questions. This is outlined in the following sections.

7.3. Conclusions

The focus of this exploratory and empirical research was on determining if the access to Web-based information, by people with MS, is facilitated by providing them with personalised information in terms content, links and presentations.

The fulfilment of this research focus (i.e. the aim) resulted from achieving the research objectives. The achievement of this research aim and objectives were accomplished through answering the research questions which were set out in Chapter 1, Section 1.3. The following shows the main conclusions which answer the research questions.

Q1: To what extent does modelling users with MS, in a personalised system, based on their conditions and state of knowledge (i.e. seen/unseen pages) help meet their information needs?

Acquiring users information was deemed necessary to provide users with appropriate level of information details (i.e. complexity), links and presentation. The process of modelling the users information within the prototype is called user profiling. In the prototype system, users were modelled based on their conditions and their knowledge about concepts (i.e. pages they have seen/read). Results from this research indicated diversity among users with MS in terms of the appropriate level of information complexity and presentation required. Although assigning the level of information complexity and the layout based on the users' conditions was successful in some cases, it still could not cater for all MS users. This implies that modelling users based solely on their condition would not be successful in a future personalised system.

Modelling users based on their level of knowledge for seen/unseen topics was also deemed as less successful. In this approach, users were provided with a set of appropriate links that lead to pages related to the topic being viewed. The results from the implementations indicated that users wanted to make selections of their own choices even in terms of the navigational path (i.e. links) rather than being advised or directed to take a particular route.

However, all users were happy with the ability to change preferences in their profiles. This process was part of the users model in the prototype system. This type of functionality resembles a type of personalisation called customisation (see Chapter 2, Section 2.3.1). In customisation, users are responsible for setting up all the personalisation options which in return lead them (based on the design) to the content or layout they desire. This type of personalisation enables users to take an active role and to engage more with the system as they interact with it. Furthermore, this gave a sense of being in control over the personalisation aspects of the prototype system. Feeling in control was one of the main outcomes of this research work. It affected most of the users' needs in terms of the personalisation options/functionalities required and the way to present these options.

The problem with this approach, however, lies in the fact that some people with MS may not be able to make choices during time of fatigue, or they may simply desire direction. This diversity in terms of the desired degree of control over the personalisation process within a system could be resolved by enabling users to control the level of personalisation within the given system. For instance, levels of control might be 'High', 'Medium', and 'Low'. The level of 'High' means that users wish the personalised system to control all aspects of personalisation. Therefore, the behavioural-based personalisation would be an appropriate approach to apply. The level of 'Medium' means that users wish to be in control, but they do not mind receiving recommendations/suggestions from the system. In this case, a rule-based personalisation approach, with the ability to override it by users, would be a good candidate. When users desire to be in full control over the personalisation process, this means they want to specify a level of 'Low'. In this case, it would be the users' responsibility to setup/select all the personalisation options needed. A customisation approach, in this situation, would be suitable.

Q2: What is the most effective conceptual model for modelling the personalisation environment with respect to the MS domain?

The conceptual model adopted for personalisation, i.e. the AHAM model, was appropriate to the study. However, modifications needed to be introduced to this model based on the implementation of the prototype. The user model of the prototype system went through two stages of development. Initially, users were modelled based on their conditions. Subsequently, users were modelled based on their ability to override the personalisation rules. This formed the first development for the user model, and therefore two-stages for modelling users was added to the AHAM model (see Chapter 6, Section 6.6).

However, even this did not meet all the situations and needs of users with MS. Results from the two implementations showed a great deal of diversity in terms of the needs, preference and the level of control required by users with MS. Therefore, another modification was introduced to the AHAM model – controlling the level of personalisation. As mentioned before, this would enable users to have the required level of control and interaction desired within a given system.

Nevertheless, a disadvantage of this new model might be an increase in system complexity. Adopting this new model for the development of a personalised system would require the designers to apply three personalisation approaches including customisation, rule-based and behavioural personalisation. The amount of coding and effort required is expected to be high. Nonetheless, once the content and the logic are created, it would be relatively easy task to maintain or update the personalised system (this is due to the ability to separate the content, logic and presentation that is facilitated by the XML technology) assuming appropriate content was available.

Q3: Are the technologies including XML, XSLT and Apache Cocoon appropriate for constructing a personalised information system within the MS domain?

It is believed that using XML, XSLT and Apache Cocoon as the underlying development technologies for the prototype system was appropriate. XML was used to describe the semantic of the content and to create information chunks at three levels of details (i.e. complexity) including basic, intermediate and detailed. Another advantage was the use of the XML attributes which helped in extracting the relevant

XML chunks based on users profiles. However, an authoring overhead was required to generate content at appropriate levels of complexity.

XSLT was a powerful language for transforming the XML chunks into HTML format for the final presentation. XSLT also implemented the logic (i.e. the personalisation rules) and facilitated the interaction between the user model and the domain model in the prototype system (i.e. served as the adaptive engine in AHAM).

The interactions between the domain model, user model and the personalisation model were supported by the Apache Cocoon framework. As described in Chapter 4, the pipeline approach adopted in Cocoon enabled the prototype system to accomplish the required interactions between the XML, XSLT and the user profiles stored in a MySQL database. Furthermore, Apache Cocoon is shipped with ready components that enables systems to publish content in other formats such as WML, PDF, SVG and RTF (though only HTML format was used in the current development). This framework is scalable, because it allows the development of components (using JAVA) to achieve a particular functionality required for the system. However, there are some disadvantages of this framework. The main one being that incompatibility problems may occur when migrating to a newer version of Cocoon and the unfriendly errors messages encountered during the development process.

Generally speaking, apart from the minor disadvantages mentioned earlier, XML, XSLT and Apache Cocoon were found to be efficient technologies in constructing the personalised prototype system.

Q4: What are the most significant characteristics of a personalised information system that should be taken into consideration when designing a personalised system for people with MS?

It is true that the successful implementation of a personalised system within the MS domain is facilitated by the use of appropriate technology. However, such a system could still be unsuccessful if the developers do not take on board some key characteristics informed by this research work including:

• Design content at progressive levels: it was found from the implementation that users felt positive about having the content provided at three levels of

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complexity (i.e. basic, intermediate and detailed) particularly with respect to fatigue. However, this approach needs individuals with MS expertise and good writing skills to author appropriate materials. Without this collaboration, it is possible to author content that looks simple (i.e. in basic format), but is still hard to understand.

- Allow users to take an active role by providing them with sufficient level of explanations. It is important that a personalised system be able to engage users so that they can comprehend the results of personalisation. For example, it was found in the implementation that users needed to understand why their personal information was collected. Some users expressed a worry when they were asked to provide their personal information. Other users, during the second implementation, thought that selecting the symptoms being experienced in the registration form would result in generating pages describing these symptoms. Although, this was a valid user requirement (i.e. providing users with a list of symptoms during the registration), it reflected an insufficient level of explanations provided within the prototype system. Furthermore, users need to know on what basis the personalisation occurs. For instance, it was indicated by the MS expert that users (especially those in the early stages of diagnosis) might believe that they might develop all the symptoms cited by the personalised system, because it is personalised to them - this could clearly be quite distressing. A clear statement, indicating that the system personalises the level of details and the layout of content based on their profiles so that they could read and understand the information more easily, would be a suitable explanation. Therefore, incorporating appropriate levels of explanation, in a personalised system, was found to be necessary for users to understand the system's behaviour and resolve any possible misunderstanding.
- Enable users to control, choose and override the personalisation rules. The sense of being in control was one significant finding in the study. For any personalised system designed for the MS domain, it is very important to provide people with MS a certain level of control. For instance, all interviewees felt positive about the ability to override the personalisation rules in terms of the assigned level of complexity and the presentational aspects.

Even users who felt happy about their assigned values (i.e. level of complexity, font size and background colour), appreciated the ability to override these values. Providing users with a level of control within a personalised system can take many forms. For instance, users can select the font size and type, the background colour and the level of information complexity. Users can choose the content type as textual, pictorial, video or a combination of these types. Also, personalisation can take the form of selecting the topic that users wish to see. However, one challenge of this approach is that it is not clear when users should be given the opportunity to control the elements mentioned earlier. One solution to this could be to give the user control of the level of personalisation.

7.4. Recommendations

There are a number of recommendations that can be made that would increase the applicability of such a system to the target audience including:

- Consult MS domain experts during the phase of creating the content of the system. It was found during the implementation that the cooperation with MS experts was deemed necessary to produce more reliable and consistent information within the prototype.
- Integrate assistive technology and make it a part of the personalisation options available to users. This would be beneficial particularly for individuals with mobility or sight problems.
- Publish the prototype system on the Internet (by deploying it on a Web server) to consolidate the implementation process. The methodology used during this implementation was efficient in terms of acquiring in-depth information from interviewees, but it was time consuming. Making the prototype system available on Internet and allowing users to access it during their spare time would speed up the evaluation process, increase the number of participants and allow data to be collected using an alternative research method. For example, a simple questionnaire could be integrated into the design of the prototype that users could be asked to fill-in after completing the interaction. This would enlarge the population sample and help make the results

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generalisable to larger MS community. In addition, activities of users could be logged, analysed and subsequently used to provide additional personalisation.

7.5. Contribution of the study

A number of contributions have been achieved through this research and have been outlined already, however there are two main contributions:

- Exploring how people with MS may benefit from having access to information resources using the prototype revealed two important findings first, people with MS showed a strong desire to control the personalisation process. Second, they liked the information being presented in different level of complexity. This consequently developed a better understanding of the requirements of people with MS in terms of using a personalised system to access Web information resources. The main findings outlined in this research could be applied to other information about MS. For instance, the prototype system included certain topics about, for instance, support groups and service providers could be personalised and provided in progressive levels of details that are controlled by MS sufferers.
- Understanding the personalisation needs for people with MS led to the development of a new model that specifically models the personalisation environment with respect to the MS domain. This new model could be generalised to other domains who share the same conditions with people with MS. For instance, people with cancer, who may also experience periods of fatigue during their illness, may desire to control the detail of information that they desire to read about. Therefore, adopting the model resulting from this research as the underlying model for developing a personalised information system for patients with health conditions that produce similar symptoms (e.g. cancer) could meet their needs by enhancing their access to Web-based resources.

7.6. Limitation of the study

There are of course several limitations to this work. These limitations are represented below:

- The lack of user needs analysis: because of the time allowed, there was no indepth user needs analysis (that relates specifically to their need or desire for personalisation) conducted before commencing the construction of the prototype system. The initial understanding of the user requirements was based on previous research concerning information needs in general rather than the need for personalisation. However the development of the prototype did enable the researcher to identify in more detail the personalisation needs of the MS community.
- The lack of technical skills: the researcher had to develop technical skills from scratch as he had no previous skills in XML, XSLT and particularly the Apache Cocoon framework. Therefore, the researcher had to learn these technologies to build the prototype system. This process consumed a substantial amount of time during this project.
- The small number of participants involved (in terms of the number and the age group): although there are a large number of MS sufferers in the UK, the number that were locally available for interviewing were limited and those willing to take part in research fewer. Although the sample used to evaluate the prototype was as representative a sample as could be obtained, it can not therefore be guaranteed to reflect the attitudes of the larger MS population.

7.7. Further research

During the course of this research, a number of avenues were identified with potential for further research including:

• Identifying when to give users the opportunity to control/setup the personalisation options. It was found during the implementation that it was necessary to give users the ability to control personalisation options such as setting the desired level of complexity, font type and size, background colour and the inclusion of video or audio content. Although, some of these options

could be useful if users could control them before creating their profiles (such as font size and background colour), other personalisation options needed more investigation to identify when and how they should be controlled by users with MS.

- Incorporating an applicable map visualisation technique into the design of a future personalised system. The first implementation (Chapter 4, Section 4.5.3) noted that employing a map visualisation technique could help users to visualise and identify their location particularly if the hyperspace of the system is large. An investigation would be required to identify the most appropriate technique, and how technically it could be integrated within the design of a personalised system bearing mind the requirements of people with MS.
- It was found in the first implementation, and reinforced in the second, that users liked using videos. Users' responses indicted that using videos could be very beneficial as it could help MS suffers to easily acquire information about MS, especially during periods of fatigue. However, authoring content and particularly videos at three levels of complexity may be impractical and certainly time consuming for a developer of a future personalised system. This would be helped if the personalisation system could employ a metadata harvesting technique for incorporating new content including videos from external repositories. Therefore, it was proposed that a metadata harvesting technique using the OAI/PMH protocol could be used in the personalisation system to harvest video files from external repositories. A theoretical implementation of this approach was suggested in Chapter 6 (Section 6.4). However, more investigation would be required to identify how this could be incorporated effectively, particularly within the Apache Cocoon environment.
- Generally, it would be interesting to explore the applicability of personalisation and in particular the devised conceptual model in facilitating the access to information resources for other medical domains such as people with cancer or Alzheimer's. Patients with Alzheimer, for instance, suffering from cognitive impairment may benefit from acquiring information at a

particular level of complexity and change that as the condition changes. This could effectively be achieved using content personalisation.

This research has provided an excellent opportunity to explore personalisation and related technologies. It has led to concrete suggestions for implementing personalised information solutions for people with MS. It has also highlighted the complexity of the personalisation domain and the need for continued research in this area.

Bibliography

AbilityHub, 2001. http://www.abilityhub.com/general/stats.htm>, [accessed 12.4.04].

Accessibility 101, 2007. http://www.accessibility101.org.uk/tips/56.htm, [accessed 6.2.07].

Adomavicius, G. & Tuzhilin, A., 2005. Personalisation Technologies: A Process-Oriented Perspective. *Communications of the ACM*, 48(10), 83-90.

Albrecht, F., Koch, N. & Tiller, T., 2000. SmexWeb: An Adaptive Web-based Hypermedia Teaching System. *Journal of Interactive Learning Research*, 11(3-4), 367-388.

Amazon, 2007a.

<http://www.amazon.co.uk/gp/yourstore/ref=pd_irl_gw/026-5404116-7899657?pf_rd_m=A3P5ROKL5A1OLE&pf_rd_s=ilm&pf_rd_r=1NT532853AR SJ1EHNC0X&pf_rd_t=101&pf_rd_p=114970091&pf_rd_i=468294>, [accessed 9.5.07].

Amazon, 2007b.

, [accessed 10.5.07].">http://www.amazon.co.uk/s/ref=nb_ss_w_h_/202-3754636-8823855?url=search-alias%3Daps&field-keywords=XSLT>, [accessed 10.5.07].

Amazon, 2007c.

<http://www.amazon.co.uk/XSLT-2-0-Programmers-Reference-Programmer/dp/0764569090/ref=pd_bbs_sr_1/026-5404116-7899657?ie=UTF8&s=books&qid=1181650937&sr=8-1>, [accessed 10.5.07].

Andrews, K., 1998. Visualising Rich, Structured Hypermedia. *IEEE Computer Graphics and Applications*, 18(4), 40-42.

Apache Cocoon, 2005. http://cocoon.apache.org/2.1/>, [accessed 22.01.06].

Avison, D. E. & Taylor, V., 1997. Information Systems Development Methodologies: A Classification According to Problem Situation. *Journal of Information Technology*, 12(1), 73-81.

Bental, D. S., et al., 2000. Adapting Web-Based Information to the Needs of Patients with Cancer. <www.macs.hw.ac.uk/~diana/AH2000/patinfo.ps>

Bental, D. S., Casawy, A. & Jones, R., 1999. Patient Information Systems that Tailors to the Individual. *Patient Education and Counseling*, 36, 171-180.

Blaxter, L., Hughes, C. & Tight, M., 2001. *How to Research*, 2nd ed. Buckingham: Open University Press.

Bonett, M., 2001. Personalization of Web Services: Opportunities and Challenges. *Ariadne*, issue 28. http://www.ariadne.ac.uk/issue28/personalization/, [accessed 8.1.04].

Brailsford, T. J., et al., 2002. Autonavigation, Links and Narrative in an Adaptive Web-Based Integrated Learning Environment. <http://www2002.org/CDROM/alternate/738/>, [accessed 15.9.05].

Brusilovsky, P., 1996. Methods and Techniques of Adaptive Hypermedia. User Modeling and User-Adapted Interaction, 6(2-3), 87-129.

Brusilovsky, P., 1997, Efficient Techniques for Adaptive Hypermedia. In: Nicholas, C. & Mayfield, J., eds. Intelligent hypertext: advanced techniques for the World Wide Web. pp. 12-30.

Brusilovsky, P., Eklund, J. & Shwarz, E., 1998. Web-based Education for All: A Tool for Development Adaptive Courseware. *[Paper presented at the] Seventh International World-Wide Web Conference*, 14-18 April, Brisbane, Australia. http://www.sis.pitt.edu/~peterb/papers/www98.pdf , [accessed 15.7.04].

Brusilovsky, P. & Maybury, M. 2002. From adaptive hypermedia to the adaptive Web. Communications of the ACM, 45(5), 30-33.

Bryman, A. & Bell, E., 2003. Business Research Methods. Oxford: Oxford University Press.

Carpenter, L., 2003. *History and Development of OAI-PMH*. http://www.oaforum.org/tutorial/english/page2.htm, [accessed 20.10.06].

Clark, J., 2003. *Namespace Routing Language (NRL)*. http://www.thaiopensource.com/relaxng/nrl.html, [accessed 22.10.06].

Conallen, J., 2002. The Role of Functional Prototyping in the Development Process.

<http://www-

128.ibm.com/developerworks/rational/library/content/RationalEdge/sep02/RDNS ep02.pdf>, [accessed 15.4.06].

Cox, A., eds., 2006. Portals: People, Processing and Technology. London: Facet Publishing.

Cristea, A. & De Mooij, A., 2003. LAOS: Layered WWW AHS Authoring Model and their Corresponding Algebraic Operators. <http://www2003.org/cdrom/papers/alternate/P301/p301-cristea.pdf>, [accessed 1.11.04]. De Bra, P., et al., 2002. AHA! Version 2.0 More Adaptation Flexibility for Authors. http://www.s.win.tue.nl/~debra/elearn2002/debra.pdf, [accessed 9.9.06].

De Bra, P., Brusilovsky, P. & Houben, G., 1999. Adaptive Hypermedia: From Systems to Framework. *ACM Computing Surveys*, 31(4es), 1-6.

De Bra, P. & Calvi, L., 1998. *AHA: a Generic Adaptive Hypermedia System*. http://wwwis.win.tue.nl/ah98/DeBra.html, [accessed 12.7.04].

De Bra, P., Houben, G. & Wu, H., 1999. AHAM: A Dexter-based Reference Model for Adaptive Hypermedia. *[Paper presented at the] tenth ACM Conference on Hypertext and Hypermedia*, 21-25 February, Darmstadt, Germany. <http://portal.acm.org/results.cfm?coll=Portal&dl=Portal&CFID=21396247&CFT OKEN=10204966>, [accessed 26.7.04].

Denscombe, M., 1998. The Good Research Guide for Small-Scale Social Research Projects. Buckingham: Open University Press.

Diebold, B. & Kaufmann, M., 2001. Usage-Based Visualization of Web Localities. [Paper presented at the] Australian symposium on Information visualisation, Sydney, Australia.

<http://portal.acm.org/citation.cfm?id=564060&coll=portal&dl=ACM>, [accessed 25.4.06].

Dix, A., et al., 2003. Human – Computer Interaction. 3rd ed. Harlow: Prentice Hall.

Dolog, P. & Henze, N., 2003. *Personalization Services for Adaptive Educational Hypermedia*. http://citeseer.ist.psu.edu/690583.html [accessed 20.10.04].

Dublin Core Metadata Initiative, 2006. http://dublincore.org/documents/dces/, [accessed 13.10.06].

DuCharme, B., 2003. *Transclusion with XSLT 2.0*. http://www.xml.com/pub/a/2003/07/09/xslt.html, [accessed 21.3.05].

Eirinaki, M., et al., 2004. Web Personalization Integrating Web Semantic and Navigational Patterns. [Paper presented at the] Sixth Annual ACM Workshop on Web Information and Data Management. Washington DC, USA.

Eirinaki, M. & Vazirgiannis, M. 2003. Web Mining for Web Personalization. ACM Transactions on Internet Technology, 3(1), 1-27.

Easterby-Smith, M., Thorpe, R. & Lowe, A., 1991. Management Research: an introduction. London: Sage Publications.

Fleishman, G., 1996. Web Log Analysis: Who's Doing What, When? <http://www.webdeveloper.com/management/management_log_analysis.html>, [accessed 5.4.04]. Francis, A., 2003. *Flexible Publishing with an XML/XSL System*. <http://poly.asu.edu/technology/dcst/Projects/pdf/FrancisAnil.pdf>, [accessed 21.6.06].

Halasz, F. & Schwartz, M., 1994. The Dexter Hypertext Reference Model. Communication of the ACM, 37(2), 30-39.

Hall, C., 2001. The Personalization Equations.

<http://www.findarticles.com/p/articles/mi_m0SMG/is_2_21/ai_74494357>, [accessed 10.3.04].

Hepworth, M., Harrison, J. & James, N., 2003. Information Needs of People with Multiple Sclerosis and the Implications for Information Provision Based on a National UK Survey. *Aslib Proceedings*, 55(5/6), 290-303.

Hepworth, M. & Harrison, J., 2004. A survey of the Information Needs of People with Multiple Sclerosis. *Health Informatics Journal*, 10(1), 49-69.

Hepworth. M., et al., 2006. Personalization Initiatives in the Public and Academic Domains. In: Cox, A., eds. Portals: People, Process and Technology, pp. 38-51.

Heylighen, F., 1999. Collaborative Filtering. <http://pcp.lanl.gov/COLLFILT.html>, [accessed 5.5.04].

Hillmann, D., 2005. Using Dublin Core. http://dublincore.org/documents/usageguide/#whatismetadata, [accessed 12.10.06].

Hirschheim, R., 1985, Information Systems Epistemology: an Historical Perspective. *In*: Mumford, E., et al., eds. *Research Methods in Information Systems*. pp. 13-36.

History of the Web, 2002. http://www.w3c.rl.ac.uk/primers/history/origins.htm, [accessed 4.8.06].

Hoepfl, C. M., 1997. Choosing Qualitative Research: A Primer for Technology Education Researchers. http://www.slis.ualberta.ca/cap04/judy/paper%20page%204.htm, [accessed 8.1.06].

Holman, G. K., 2000. What is XSLT? http://www.xml.com/pub/a/2000/08/holman/index.html, [accessed 21.01.06].

Hom, J., 2003. The Usability Methods Toolbox. http://jthom.best.vwh.net/usability/, [accessed 21.6.06].

Hudson, R., Weakley, R. & Firminger, P., 2005. An Accessibility Frontier: Cognitive disabilities and learning difficulties. http://www.usability.com.au/resources/cognitive.cfm, [accessed 2.7.06]. Hunter, D., et al., 2000. Beginning XML. Birmingham: Worx Press.

Hyldegaard, j. & Seiden, P., 2004. My E-Journal: Exploring the Usefulness of Personalised Access to Scholarly Articles and Services. *Information Research* [online], 9(3), paper 181. http://informationr.net/ir/9-3/paper181.html, [accessed 12.4.05].

Jones, S. & Hughes, J., 2004. An Exploration of the Use of Grounded Theory as a Research Approach in the Field of IS Evaluation. http://www.ejise.com/volume-6/issue1-art4.htm, [accessed 07.01.06].

Kendall, K. E. & Kendall, J. E., 1998. Systems Analysis and Design. Upper Saddle River, N. J.: Prentice Hall.

Khazanchi, D. & Munkvold, B., 2003. On the Rhetoric and Relevance of IS Research Paradigms: A Conceptual Framework and Some Propositions. [Paper presented at the] Thirty Sixth Hawaii International Conference on System Sciences, 6-9 January, Hilton Waikoloa, Village Island of Hawaii. <http://citeseer.ist.psu.edu/640726.html>, [accessed 14.12.05].

Ko, I., Yao, K. & Neches, R. 2002. Dynamic Coordination of Information Management Services for Processing Dynamic Web Content. [Paper presented at the] Eleventh International Conference on World Wide Web. Honolulu, Hawaii, USA.

Kobsa, A., Müller, D. & Nill, A., 1994. KN-AHS: An Adaptive Hypertext Client of the User Modeling System BGP-MS. [Paper presented at the] Fourth International Conference on User Modeling, 15-19 August, Hyannis, Massachusetts, USA. http://citeseer.ist.psu.edu/kobsa94knahs.html, [accessed 17.7.04].

Koch, N., 2001. Software Engineering for Adaptive Hypermedia Systems: Reference Model, Modeling Techniques and Development Process. PhD thesis, Munch University.

Koch, N. & Wirsing, M., 2002. The Munich Reference Model for Adaptive Hypermedia Applications. In: De Bra, P., Brusilovsky, P. & Conejo, R., eds. Lecture Notes in Computer Science: Second International Conference on Adaptive Hypermedia and Adaptive Web-Based. pp. 213-222.

Korth, H. F. & Silberschatz, A., 1997. Database Research Faces the Information Explosion. *Communications of the ACM*, 40(2), 139-142.

Kothari, B. & Claypool, M., 2001. Dynamic Web Pages: Performance Impact on Web Servers. *Internet Research: Electronic Networking Applications and Policy*, 11(1). 18-25.

Kreis, S., 2004. Auguste Comte, Course of Positive Philosophy. <http://www.historyguide.org/intellect/comte_cpp.html>, [accessed 14.12.05]. Kurniawan, S. H., et al., 2005. Personalising Web Page Presentation for Older People. *Interacting with Computers*, 18, 457-477.

Kyrnin, J., 2004. Font Families - Serif, Sans-Serif, Monospace, Script, Fantasy. http://webdesign.about.com/od/fonts/a/aa080204.htm>, [accessed 6.7.06].

Langham, M. & Ziegeler, C., 2003. Cocoon: Building XML Applications. London: Riders.

Legas, 1999. *Cost-Benefit Analysis Guide for NIH IT Projects.* http://irm.cit.nih.gov/itmra/cbaguide.html#3.1, [accessed 1.8.06].

Lehnerer, M., 2005. *Glossary*. <http://www.sociologycommission.org/docs/pdfs/GLOSSARY-%205-16-03.pdf>, [accessed 14.12.05].

Liang, T., Lai, H. & Ku, Y. 2006. Personalized Content Recommendation and User Satisfaction: Theoretical Synthesis and Empirical Findings. *Journal of Management Information systems*, 23(3), 45-70.

Liebel, G., 2006. Which is Better for Readability: a Serif or Sans Serif Font? http://usability.about.com/od/visualdesign/qt/serifvssans.htm>, [accessed 12.6.06].

Maciaszek, A. L., 2001. Requirements Analysis and System Design: Developing Information Systems with UML. Harlow: Addison-Wesley.

Manber, U., Patel, A. and Robison, J. 2000. Experience with Personalization on Yahoo! Communications of the ACM, 43 (8), 35-39.

Martine, E. W., et al., 2004. *Managing Information Technology*. 5th ed. London: Prentice Hall.

Melhem, M., 2003. An Introduction to Apache Cocoon 2.1. <http://www.developer.com/xml/print.php/3098661 >, [accessed 22.01.06].

Morrison, M., 2002. Teach Yourself XML in 24 Hours. Sams Publishing.

My Yahoo!, 2004. http://my.yahoo.com/, [accessed 1.3.04].

McGovern, G., 2003. Why Personalization Has Not Worked. <http://www.gerrymcgovern.com/nt/2003/nt_2003_10_20_personalization.htm>, [accessed 8.1.04].

Miller, S. & Jarrett, C., 2001. Should I use a drop-down? Four steps for choosing form elements on the Web. http://www.formsthatwork.com/ftp/dropdown.pdf, [accessed 8.6.06].

Mitchell, A. J., et al., 2005. Quality of Life and its Assessment in Multiple Sclerosis: Integrating Physical and Psychological Components of Wellbeing. *Lancet Neurol*, 4(9), 556-566.

Mukherjea, S., 2000. Information Visualisation for Hypermedia Systems. ACM Computing Surveys, 31(4es), 1-6.

Multiple Sclerosis International Federation, 2006.

http://www.msif.org/en/symptoms_treatments/ms_by_topic/cognitive_problems/index.html, [accessed 11.7.06].

Mumford, E., et al., eds., 1985. *Research Methods in Information Systems*. Amsterdam: Elsevier Science.

Myers, M. D., 2005. *Qualitative Research in Information Systems*. http://www.qual.auckland.ac.nz/, [accessed 14.12.05].

Nandhakumar, J. & Avison, D. E., 1999. The Fiction of Methodological Development: A Field Study of Information Systems Development. *Information Technology and People*, 12(2), 176-191.

Nicholas, C. & Mayfield, J., eds., 1997. Intelligent Hypertext: Advanced Techniques for the World Wide Web. London: Springer-Verlag.

Nielsen, J., 1998. *Personalization is Over-Rated.* http://www.useit.com/alertbox/981004.html/, [accessed 8.1.04].

Nielsen, J., 2000. Drop-Down Menus: Use Sparingly. http://www.useit.com/alertbox/20001112.html, [accessed 8.6.06].

Nielsen, J., 2003. *The Ten Most Violated Homepage Design Guidelines*. http://www.useit.com/alertbox/20031110.html, [accessed 2.5.06].

Nielsen, J., 2005. *Ten Usability Heuristics*. http://www.useit.com/papers/heuristic/heuristic_list.html, [accessed 2.3.06].

Nunamaker, J. F. & Chen, M. 1990. Systems Development in Information Systems Research. *[Paper presented at the] Twenty-Third Annual Hawaii Conference*, 2-5 Jan, Kailua-Kona, HI, USA. <http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=205401>, [accessed 21.07.07].

Nuñez, R., 2003. *Web Forms Page Processing Stages*. <http://authors.aspalliance.com/aspxtreme/webforms/webformspageprocessing.as px>, [accessed 22.2.04].

Owen, C. L., 1997. Design Research: Building the Knowledge Base. Journal of the Japanese Society for Science of Design, 5(2), 36-45.

Patterno, F. & Mancini, C., 1999. Designing Web User interfaces Adaptable for Different Types of Use. <http://www.archimuse.com/mw99/papers/paterno/paterno.html>, [accessed 4.9.04].

Payne, C., 2000. Everything You Need to Know About Personalization. http://www.wdvl.com/Authoring/ASP/Personalization/, [accessed 5.2.04].

Personalization Consortium, 2000. http://www.personalization.org/questionone>, [accessed 26.1.04].

Punte, S., 2002. *Getting Started with Cocoon*. http://www.xml.com/pub/a/2002/07/10/cocoon2.html, [accessed 10.12.05].

Reading the log files, 2002.

http://www.searchengineethics.com/logfiles.htm>, [accessed 25.3.04].

Rossi, G., Schwabe, D. & Guimarães, R., 2007. *Designing Personalized Web Application*. http://www10.org/cdrom/papers/pdf/p395.pdf>, [accessed 12.2.07].

Rudd, J., Stren, K. R. & Iseness, S., 1996. Low vs. High-Fidelity Prototyping Debate. *Interactions*, 3(1), 76-85.

Sadoski, D., 1997. *Three Tier Software Architectures*. < http://www.sei.cmu.edu/str/descriptions/threetier.html>, [accessed 20.6.06].

Seadle, M., 2001. A Love Affair with Markup. Library Hi Tech, 19(3), 207-209.

Searby, S., 2003. Personalisation: An Overview of its Use and Potential. *BT Technology journal*, 21(1), 13-19.

Schwartz, C. E., Coulthard-Morris, L. & Zeng, Q., 1996. Psychosocial Correlates of Fatigue in Multiple Sclerosis. *Archives of Physical Medicine and Rehabilitation*, 77(2), 165-170.

Skills for Access, [n.d.]. < http://www.skillsforaccess.org.uk/howto.php?id=145>, [accessed 5.8.06].

Skinner, C. S., Strecher, V. J. & Hospers, H., 1994. Physicians' Recommendations for Mammography: Do Tailored Messages Make a Difference? *American Journal of Public Health.* 48(1), 43-49.

Starling, A., 2001. Usability and Navigation. <http://wdvl.internet.com/Authoring/Design/Basics/nav2.html>, [accessed 8.9.06].

Tsandilas, T. & Schraefel M. C., 2004. Usable Adaptive Hypermedia Systems. *New Review of Hypermedia and Multimedia*, 10(1), 5-29.
Vaishnavi, V. & Kuechler, W, 2004. *Design Research in Information Systems*. http://www.isworld.org/Researchdesign/drisISworld.htm>, [accessed 21.7.07].

Welcome to the Multiple Sclerosis Society, 2004. <http://www.mssociety.org.uk/about_ms/what_is_ms/index.html >, [accessed 25.2.05].

Whitten, J. L., Bentley, L. D. & Dittman, K. C., 2004. Systems Analysis and Design Methods. London: McGraw-Hill/Irwin.

Wisker, G., 2001. The Postgraduate Research Handbook: Succeed with Your MA, MPhil, EdD and PhD. London: Palgrave.

Wu, H., 2002. A Reference Architecture for Adaptive Hypermedia Applications. PhD thesis, Eindhoven University.

W3C Recommendation, 1999. http://www.w3.org/TR/WCAG10/wai-pageauth.html#tech-icons, [accessed 13.7.06].

W3C Recommendation, 2004. http://www.w3.org/TR/REC-html40/interact/h-17.1, [accessed 13.2.04].

W3C Recommendation, 2006. http://www.w3.org/TR/xinclude/#intro, [accessed 20.5.05].

XML.ORG, 2006. http://www.xml.org/xml/resources_focus_sax.shtml, [accessed 10.10.05].

Zhang, D., 2007. Web Content Adaptation for Mobile Handheld Devices. *Communications of the ACM*, 50(2), 75-79.

Other sources consulted

Abras, C., Krichmar-Maloney, D. & Preece, J., 2004. User-Centered Design. http://www.ifsm.umbc.edu/~preece/Papers/User-centered design encyclopedia chapter.pdf>. [accessed 10.5.06].

Brusilovsky, P., 2001. Adaptive Educational Hypermedia. <http://www2.sis.pitt.edu/~peterb/papers/PEG01.html>, [accessed 20.10.05].

Galliers, R., 1985. In Search of a Paradigm for Information Systems Research. In: Mumford, E., et al., eds. Research Methods in Information Systems. pp. 281-297.

Galliers, R., 1992. Information Systems Research: Issues, Methods and Practical Guidelines. Oxford: Blackwell Scientific.

Google Analytics, 2007. <http://www.google.com/support/analytics /bin/answer.py?answer=26803&topic=7196>, [accessed 1.5.07].

Greenberg, S., 2005. User-Centered Design and Prototyping. <http://pages.cpsc.ucalgary.ca/~saul/hci_topics/topics/prototyping.html>, [accessed 15.5.06].

Karat, J., 1997. Evolving the Scope of User-Centered Design. *Communication of the ACM*. 40(7), 33-38.

Katz-Haas, R., 1998. User-Centered Design and Web Development. <http://www.stcsig.org/usability/topics/articles/ucd%20_web_devel.html>, [accessed 14.5.06].

Kumar, R., 2005. Research methodology: a Step-by-Step Guide for Beginners. London: Sage.

Moore, A., Brailsford, T. & Stewart, C., 2001, Personally Tailored Teaching in WHURLE Using Conditional Transclusion. *[Paper presented at the] twelveth* ACM conference on Hypertext and Hypermedia, 14-18 August, 2001, Århus, Denmark.

http://portal.acm.org/citation.cfm?id=504259&dl=ACM&coll=portal, accessed [21.3.05].

Nachmias-Frankfort, C. & Nachmias, D., 2000. *Research Methods in The Social Sciences*. New York : Worth Publishers.

Puig, C. T., 1999. From Hypertext to Hypermedia: Overview of the Development of Open-Ended Works. http://www.iua.upf.es/formats/formats2/tom_a.htm, [accessed 25.6.04].

Punch, F. K., 1998. Introduction to Social Research: Quantitative and Qualitative Approaches. London: Sage.

SmartDraw, 2004.

<http://www.smartdraw.com/tutorials/software-uml/uml2.htm>, [accessed 2.11.04].

Taskz.com, 2000. <http://www.taskz.com/ucd_summary.php>, [accessed 8.4.06].

Trochim, M. K., 2005. Survey Research. http://www.socialresearchmethods.net/kb/survey.htm, [accessed 07.01.06].

Appendices

Appendix 1 – Task-sheet(1) steps and questions

| | Steps | | | Questions | |
|----|---|---------|---|---|---|
| 1. | Open the Internet explorer. | <u></u> | <u></u> | | <u></u> |
| 2. | Select "Register" link. | | <u> </u> | · | |
| 3. | Decide on an easy to memorise username and password and: 3.1. Enter a proper username in the "Username" input field. 3.2. Enter a proper password in the "Password" input field. | | | · · · · · · · · · · · · · · · · · · · | |
| 4. | Select problems that are being experienced by selecting one of the radio buttons on the page. | | | | |
| 5. | On completion, select "Register" button. | | | | |
| 6. | Review the entered values on the screen and either: 6.1. Select "Create profile" button to create the user's profile and proceed to step 9. 6.2. Or select "back" button to alter the designated values and repeat steps 3-8. | | | | |
| 7. | Click "Login" link. | | | | <u> </u> |
| 8. | Enter the user username and password created in step 3. 8.1. If error occurs, click "Login" link and check that you correctly type in the username and password. | | | | |
| 9. | Review your preferences in the table. | • | Does the intuser aware of staring the of Do you have improvement | formation on the formation on the formation of the formation? The any suggestion of the formation of the for | his page make the oing to get before on for |

Table 1 Task-sheet (1) Steps and Questions

| Steps | Questions |
|---|--|
| Click "Start orientation" link. | What do you think about the level of content (level of information) and the presentation style (font size and background colour) being displayed with regards to the problem being selected? Do you have any suggestion for improvement? |
| Look at links located under the "Available levels of information" heading. | • What do you think these links will get to you? |
| Explore different levels of information of the current page being displayed using links located under the "Available levels of information" heading 3.1. When finish exploring, click "Back" link. | Do you think these links clearly indicate the type of document in terms of its level of information? Why do you think that? Or, why do not you think that? How could you differentiate between the available levels of information? Or, why could not you differentiate between the available levels of information? Or, why could not you differentiate between the available levels of information? What do you think about the amount of content being used on basic, intermediate and detailed pages? What do you think about the way of presenting figures on basic, intermediate and detailed pages (i.e., full size for basic, thumbnail for intermediate and links lead to the figure for detailed)? Do you have any suggestion for improvement? |
| Look at the links located under the "Appropriate links" heading. | • What do you think these links will get to you? |
| Follow some of the links located under the "Appropriate links" heading. When finish, close the new opened window. | Do you think these links clearly indicate their functionality to the user? Why do you think that? Or, why do not you think that? What do you think about opening these links in a new window? Do you have any suggestion for improvement? |
| 6. Click "Personalise" link and: 6.1. Change the background colour (anything your prefer from the list). 6.2. Change the font size (anything you prefer from the list). 6.3. Change the level of information to be "detailed". | What do you think about the feature of changing the background colour and font size for people with sight problems? What do you think about the feature of changing the level of information for people who with fatigue symptoms? Do you have any suggestion for improvement? What other personalisation features would you consider them useful to be included in the system? In what ways do you think they could be useful? |

Table 2 Task-sheet (2) Steps and Questions

| 7. Click "Change" button. | |
|--|--|
| Click "Apply changes" link to confirm the previous changes or: 8.1. Click "Back" link and repeat steps 6.1-8. | |
| 9. Use "show more", "Hide more", "Show explanation" and "Hide explanation" links to show and hide further content. | • What do you think about using these links inside the current page being displayed? |
| 10. Click any "See Figure" link to view the figure 10.1. When finish, close the new opened window. | |
| 11. When desired to terminate the interaction and to constantly save your changes, click "Logout" link, | |

Appendix 2 – Individual interviews and focus group questions

Table 3 Individual interviews questions

| | Questions |
|---|---|
| | |
| • | What do you think about the degree of personalisation implemented in the Website? |
| • | What other problems do you think are important to be taken into account when designing for people with MS? |
| • | What do you think about providing personalised content and presentation according to the user's age group? |
| • | What do you think about providing personalised content according to the user's gender? |
| • | What do you think of providing personalised materials (different information) according to the role of user i.e. personalised materials will not only be provided to MS people but also for their carers, family members, health workers, etc.? |
| • | After taking this orientation, what do you think about personalisation? |

Table 4 Focus group questions

| | Questions |
|---------------|---|
| • H c | How suitable do you find the information presented to you for a person with: Sight problems? Fatigue problems? |
| • E | How suitable is the background colour and font size for a person with sight problems? |
| • E iı | Do you think people will find it useful to have different levels of information i.e. basic, ntermediate and detailed? |
| • F | How useful do you find the options provided within the personalisation form? |
| • H s v | Iow comfortable are you with providing all information, in terms of mobility, sight, tate of condition, type of condition, year of diagnosis, where this could influence the vay you provided with information? |
| • E ii | Based on the registration you have seen, would you be able would willing to provide nformation such as username, password and the symptoms? |

Appendix 3 – Cost benefit analysis (CBA)

Undertaking a CBA would help stakeholders of a future personalised system to take more accurate decisions about whether the money and effort required to design a complete personalised system, for MS community, is worth worthwhile. To undertake the CBA effectively, one should think carefully of what are the costs and the benefits. Determining the costs and benefits of a personalised system would need further research. However, the following discussion could outline some costs and benefits elements (see Table 5).

 Table 5 Some of the expected cost elements in the software development life cycle (adapted from (Legas, 1999))

| Phase | Cost elements |
|-----------------------|---|
| System design | System Analysts, programmers, MS experts and a writer |
| System implementation | System Analysts, programmers and MS experts |
| Evaluation | System Analysts, programmers, MS experts and MS users |
| Maintenance | System Analysts, programmers, MS experts and a writer |

Table 4 shows some of the expected cost elements. These elements only represent aspects from the software development life cycle (SDLC). As seen in the above table, these costs elements are associated with each step/phase within SDLC including system analysis, programmers, MS experts, a writer and MS users. The involvement of these elements may vary within the phases of SDLC (i.e. they may not necessarily follow the representation in Table 4). It should be noted that the phase of users needs analysis was not included (in Table 4) assuming that these were already provided from other research. Other elements of costs result from using hardware (e.g. computers) and software (e.g. commercial XML editors such as Stylus Studio). These are only some sources of the expected costs, and therefore further investigation aimed at determining the elements of costs is required.

Identifying the benefits in this context would be more elusive. However, the benefits could be: access, efficiency and satisfaction. The access element addresses the question: do users with MS, with different conditions, have better access to information resources using a personalised system? Efficiency represents the

question: does the provision of personalised information empower users with MS to manage their conditions more efficiently? Finally, satisfaction considers the question: do users with MS acquire relevant content in a relevant format using a personalised system? Certainly, there are more benefits that can be identified using a personalised system which would need further investigation.

The elements of benefits are not entirely intangible, they can be quantified using a subjective, qualitative rating system – e.g. using rating from 1 to 5. Consequently, a normalisation of the costs and benefits is required in order to do the analysis¹ more easily (Legas, 1999).

¹ These are only very general steps for undertaking CBA, more comprehensive details can be found at: <u>http://irm.cit.nih.gov/itmra/cbaguide.html</u>

Appendix 4 – Using the 'meaning condensation' approach

| Meaning units | Domin | ant theme | |
|--|---|--|--|
| "I think it is good. There is just a little bit of explanation and I think that is ideal. If you got a lot of writing, you would get fed up with reading it, but this is just little paragraphs which I think is very good." | The preference to have succinct presentation of information (i.e. at basic level of complexity) | The suitability of the inferences: the | |
| "I am less convinced about the system choosing it for you based on criteria that you set. I think it is good if you set it for yourself. I think it is best if you know what the choices are and what the consequences of those choices are, so if you say: you can choose the font size and that will make the screen easier to read; you can choose the information complexity and that will mean how much text is presented to you, and then the user makes the choice and personalise it to the preferences. There is very much variation even between people with sight and fatigue problems in terms of what makes things easy for them to read; so, in a way it is better let users find their comfortable set of parameters and then to be able to tailor that." | The preference to choose the level of complexity rather than it being set by the system. | The suitability of the inferences: the assigned level of complexity based on symptoms. | |
| Meaning units | Domina | ant theme | |
| "You can always do sounds as well of course which you do not have here. That is something I quite enjoy on other sites every now and then instead of reading through loads of explanation – just click on it and see a film. On the BBC you can watch a | The desire to have videos in addition to the text. | | |

Table 6 Examples of using the 'meaning condensation' approach to analyse the users' responses

| | snippet of news instead of reading about what is happening in Palestine at the moment; you just click on it and there is a little film and you can listen to what is the reporter saying – it is a lot easier. Going back to my fatigue I find it a lot easier to listen rather than to read through all of this writing; so to my mind you can incorporate those; I like to see something like that; it would make it good " | | |
|---|---|--|--|
| | "Some people have problems with sight, so what about a bit of talk? I use a programme on the computer that reads the text for me." | The desire to have audios in addition to the text. | Using other media types including videos and audios. |
| | Meaning units | Domina | ant theme |
| • | If you are going too deep to start with it goes over your head and you don't take anything in, and here it is useful that you feed it in at different levels." | Positive feeling towards having the information at progressive levels. | |
| | "That is a progressive thing; start with basic [and then view intermediate and detailed]. [For instance, if you have a sight problem] you will say 'why have I got a sight problem with MS? Why does MS cause my sight problem?' It is like a progressive thing isn't it. You follow like a sort of basic mode then why I got it, and why is it causing this then you want to delve into more of it don't you? So, progressively you want to get more and more details as you progress." | Contextualise the use of information, by a person with MS, at progressive levels. | Using different levels of information complexity. |

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