MedioVis – A User-Centred Library Metadata Browser

Christian Grün, Jens Gerken, Hans-Christian Jetter, Werner König, and Harald Reiterer

Workgroup Human-Computer-Interaction
Department of Computer and Information Science
University of Konstanz
78457 Konstanz, Germany
{gruen, gerken, jetter, koenigw, reiterer}@inf.uni-konstanz.de
http://hci.uni-konstanz.de

Abstract. MedioVis is a visual information seeking system which was designed especially for library data. The objective target was to create a system which simplifies and optimizes the user's information seeking process and thus further motivates the user to browse in the library stock. To enhance the motivation special attention was given to consider joy of use aspects during the design of the user interface. The primary user interface design is based on multiple coordinated views to offer a great variety of exploration possibilities in a direct-manipulative manner. To accomplish a self-explanatory usability of the system for non-expert users, the development was accompanied by continuous user tests with casual and regular library users. At the end of the development process a comprehensive summative evaluation was conducted, comparing efficiency and joy of use of the existing web-based catalogue system KOALA of the library of the University of Konstanz with the MedioVis system. The results of this comparative evaluation show a significant improvement of the efficiency of the information seeking process with the help of MedioVis. The users also rated MedioVis significantly better in all dimensions of its hedonic quality and appeal compared with KOALA.

1 Motivation

Retrieving relevant information on library catalogues has long time been quite a tedious job as the visual presentation of bibliographic metadata ignored most of the rules of usability and attractiveness which we are facing today and many systems did not match the users' retrieval behaviour as discovered by Borgman [1]. First improvements could be observed when early, purely text-based interfaces were replaced by graphical representations. Nevertheless, in most of the cases the internal systematic metadata structures were only visually reproduced, disregarding the user's need to get non-technical, more inviting views on the desired information. Moreover, as a means of retrieving information libraries have to compete with the internet. Although the internet is often criticised for its unreliable information space, especially by information experts, it should be accepted that more and more information seekers

A. Rauber et al. (Eds.): ECDL 2005, LNCS 3652, pp. 174 – 185, 2005.

choose the advanced retrieval technologies of web engines to get quick access to relevant information.

This observation was decisive for us to develop a JAVA-based application that motivates the user to explore the complete information space which a library has to offer. We are convinced that library stocks still have and will always have their very own qualities regarding the intellectual choice of relevant works and consistent metadata editing, and we tried to create a browser interface, enabling the user to work with a more web-oriented browsing paradigm instead of applying the simple search and finding strategy. Moreover, we took advantage of the broad availability of online sources to enrich the metadata of the library with additional textual and multimedia data.

Chapter 2 outlines the theories and concepts which have influenced the development of the application. Evaluation has played a central role during the development of MedioVis. The evaluations of our preceding projects INSYDER [2], INVISIP [3] and VisMeB [4] (all of them metadata browsers) represented a good base for crucial design decisions. All beta versions of the system were evaluated in order to get creative support from real users and to confirm or influence the design rules. The results of our evaluations, finalized by a summative evaluation, are worked out in Chapter 3. Conclusions are given in Chapter 4.

2 MedioVis System Design

2.1 Joy of Use

A usability aspect which plays a minor role in library catalogues is the attractiveness of user interfaces. However, the role emotion and aesthetics plays for people has already been pointed out as a central psychological issue by James in 1884 [5] and has widely been discussed since. Nevertheless it had not been applied to usability until Kurosu and Kashimura [6] noted that the ergonomic quality of a product does not implicitly coincide with the usability perceived by the user. Considering Glass' thesis from 1997, "I predict that joy of use will become an important factor in product development and development success." [7], we can observe that many commercial products like computers, cellular phones, operating systems, etc., are already very fun-oriented, aiming at the users' need for aesthetics and entertainment. Tractinsky even argues that "For many users, other aspects of the interaction [than aesthetics] hardly matter anymore." [8].

A major question still to solve is how aesthetics can be measured and parameterized in general. Although we have a common idea that aesthetic objects should be symmetric, balanced or well proportioned, there is – fortunately? – no general instruction set prescribing how to create aesthetic interfaces. Jordan [9] proposes some helpful methods and guidelines for the design of pleasurable products whereas Hassenzahl et al. [10] underline the importance of hedonic quality (novelty, originality) of a software product. Other interesting, more formalized approaches are in progress to construct mathematical concepts [11] and find mathematical explanations [12] for accessing aesthetic phenomena, but they are still in an early stage.

Our aim was to create a simple attractive and pleasurable interface, for which we collaborated with communication designers of the University for Applied Sciences Konstanz. By regularly testing our prototypes with users we could quickly react on possible flaws of the system. A consistent colour and font range and animations were applied to give the system its own identity, and the results of our evaluations proved that users seem to appreciate and enjoy the overall appearance of MedioVis.

2.2 Visual Information Seeking

Most of the conventional library web catalogues offer three or four successive steps to control the user's information seeking process:

1. Search for Keywords (simple / advanced input forms)
2. Display of the results as overview (10 / 20 / 50 per page, tabular / list oriented)
3. Display of single results (list oriented / full text)
4. (Non-Standard) Overview of all selected results

All steps are normally visually separated from each other, i.e. the user is often forced to return to the first page to start a new search. This sequential approach reminds of real library visits: first the book titles are researched in the catalogue systems, then the correct book shelves have to be found in the library to finally review the book. It is interesting to see that real life drawbacks have been transferred to computer logics, as it may seem obvious that all steps can easily be combined. Although computer screens are limited by their resolution, the integration of all panels on one screen can easily be implemented, even in web sites, by cleverly partitioning the available space.

The approach to combine several views with semantically similar data is known as "Multiple Coordinated Views" (MCVs) [13] [14], and the visualizations in MedioVis follow several design principles expressed by Shneiderman [15]. As seen in Fig. 1, the input for query terms is located on the top area of the window. We used a table-based view to give an overview of all queried documents. Tables are a popular visualization concept as they can display a huge amount of data in a consistent way. We can establish an interesting analogy between browsing real and digital libraries by using tables [16]: real libraries can be browsed by walking along the shelves to spot material which is similar in content. Titles presented in a virtual table can be spatially separated in the library, but they can have other common attributes such as title keywords, media types or publication years. Hence one of the most important features of a table and a big advantage over physical libraries is the capability to sort data by specific attributes as the users can decide for themselves which attribute seems most important to them. The original shelf order can still be simulated by restricting the search to a certain subject area and sorting the titles by their signature. Columns can simply be sorted in MedioVis by clicking on the headers.

Following the principle of coordinated views, the dataset which is currently focused in the table is focused in all other visualizations. Detail-on-Demand is given by the "Title View" which lists all attributes of the focused title. If a relevant title is selected, it is moved into the "Selected Media" view. Titles in this view can be printed, saved on disk or sent via e-mail. Alternatively the Media Location is displayed in this area. The currently focused title is marked in a floor plan of the library which should help the user to locate it in the real library (Fig. 2). The user interactions in MedioVis were reduced to basic mouse actions. A title in the table view can be focused by simply moving the mouse across it. If the mouse button is clicked, titles are being selected.

An alternative view to the table is a scatterplot-like visualization which was termed "Graphical View" for simplification (see Fig. 2). As it was not included in the evaluation, it is not further described in this paper. An advanced zoomable version named ZUIScat will be integrated in the near future [17].

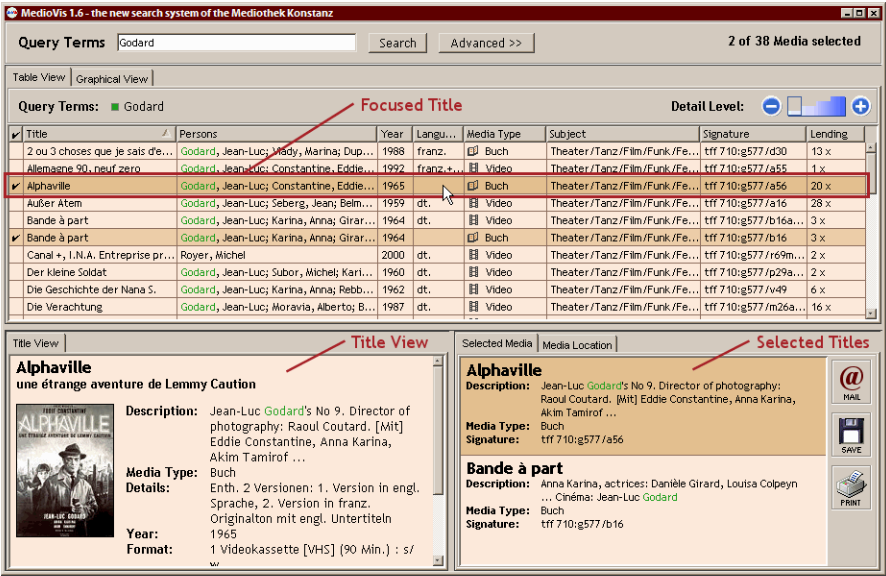

Fig. 1. MedioVis main screen

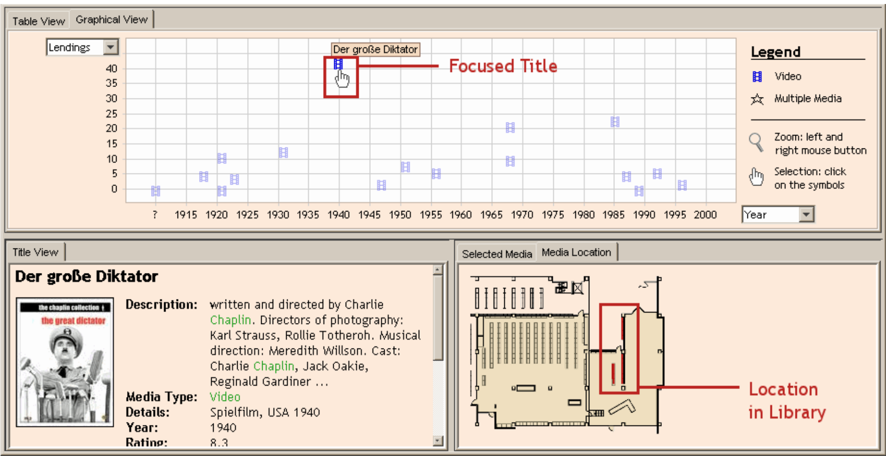

Fig. 2. Scatterplot, Location Panel

2.3 Information Retrieval

Many conventional library catalogues still cling to their internal meta-data structure and transfer its logic to the search forms which are to be handled by users that do not know about bibliographic issues and technical limitations which often are obsolete. To give an easy example, the existing local library catalogue KOALA expected a fixed format to search for names defined by "Surname, First Name", which was why some of our test persons did not manage to find any results at all. Today's retrieval operations should therefore be uncoupled from formal issues, allowing the user a high level of flexibility and freedom. Early tests of our prototypes confirmed the assumption that most users are accustomed to the presentation of one single search form as it is used in common web engines. In fact, many users used query terms like "DVD", "Movie" or an ISBN. So we implemented a single input area as standard which queries most important metadata attributes such as Title, Author, Year, Media Type, Full Text Description, etc. Whereas the amount of data which has to be checked by such a query would have disallowed such a procedure in the past, it makes no difference for today's technology and for indexing algorithms.

One of the most striking advantages of library catalogues opposed to web indexes, as earlier mentioned, is the consistency and structure of the data behind. So it still makes sense to include an additional advanced search form to offer the user explicit searches for persons, titles, etc. Such a form is also implemented in MedioVis and can be invoked by an "Advanced" button. It allows searching for title keywords, persons, year ranges, media types, library sections and languages. Moreover search terms can be AND/OR combined ("Find all terms" / "Find at least one Term"), and the choice is given between querying for complete strings and substrings. The search form stays visible if the result set is returned and visualized.

3 Evaluation

No matter how usable a software system proves to be during formative evaluations, its usefulness in a real world environment depends on the alternative software systems available and of course on their quality. On this account it is essential to compare the developed software system with its competitors in order to be able to determine whether the development was successful and communicate this to possible customers. Accordingly we decided to conduct a quantitative Usability Experiment to compare MedioVis with KOALA which is the retrieval system of the library of the University of Konstanz currently in use. We put our main focus on the questions whether users were able to solve realistic tasks more efficiently (objective measurement) and how they would rate MedioVis in comparison to KOALA (subjective measurement).

3.1 Experiment

The Experiment took place within the scope of a lecture "Usability Engineering 2", given by Prof. Dr. Harald Reiterer, Workgroup HCI at the University of Konstanz, from December 2004 to January 2005. After some detailed training we selected four students of the lecture as test monitors. Each of them conducted six test sessions so that altogether we had 24 subjects. To avoid test monitor effects we standardized and structured the test procedure to the greatest possible extent. Since our test monitors had not been involved in the development of MedioVis we could furthermore exclude test monitor effects due to possible personal interests in specific results. We wanted to test two main hypotheses, expressed as null-hypotheses:

1. In terms of task completion time there is no significant difference between MedioVis and KOALA.
2. In terms of subjective user rating there is no significant difference between MedioVis and KOALA.

To check the first hypothesis we measured the time it took our 24 participants to complete realistic tasks with the help of either MedioVis or KOALA. The second hypothesis was checked with the help of two questionnaires, SUS [18] and Attrakdiff [19]. The latter does not only measure the pragmatic quality of a software product but furthermore hedonic quality and appeal – two aspects which are, in our understanding, extremely important for a software system which users like to work with. We did not especially concentrate on task accuracy since this is always to some extent contradictory to the measurement of task completion time, and this was where we put our main focus.

3.2 Method

3.2.1 Participants

We chose 24 students of the University of Konstanz as subjects, since they would be potential end-users. In addition we concentrated on students in the fields of "Literature, Art and Media Science" (11 subjects, 9 female & 2 male), as we expected them to be an above average part of our target group. Since one of our main aspects during the development of MedioVis was to develop an easy to learn system, we did not involve any students in the field of computer science. The subjects were between 18 and 28 years old, with the medium age at 22.

3.2.2 Software Systems

The benchmark for MedioVis (see chapter 2) was KOALA, a web based catalogue system, which allows the user to search the library stock of the University of Konstanz. It offers a "simple" and an "advanced" search dialogue. The "simple" mode asks the user to specify at least author or title, but does not include a general search field. The "advanced" mode includes more specific search fields such as signature or year. The result is presented in a list, showing ten hits per page. The user can get a detail view of each result or several results at once (see Fig. 3).

3.2.3 Data Base and Tasks

Our test data was based on a copy of the library stock of the Mediothek, a department of the library of the University of Konstanz. The data was enriched with additional heterogeneous data such as posters and movie ratings of the Internet Movie Database (IMDB). KOALA was restricted to the Mediothek inventory, but used the up-to-date data, which slightly differed from our copy used in MedioVis. We were able, however, to consider this aspect with our task design.

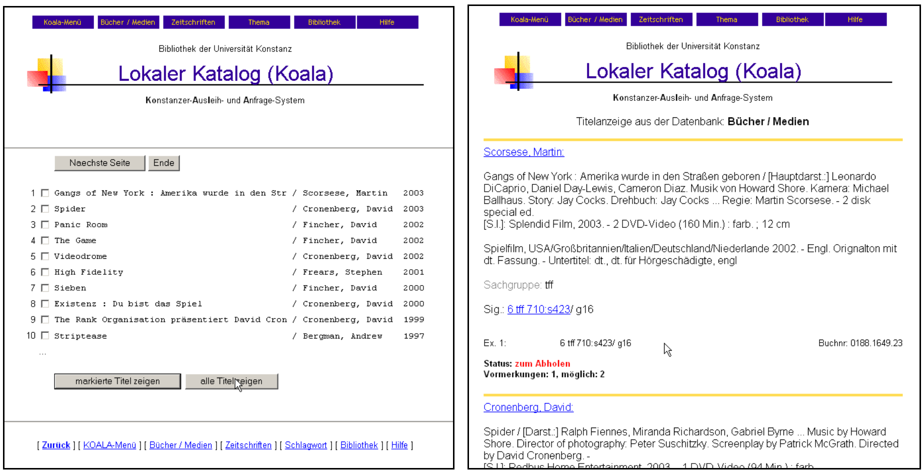

Fig. 3. KOALA: list-based overview, detail view

The main focus of our task design was to simulate realistic seeking processes which would appear in the Mediothek. In order to achieve this we consulted an expert of the Media Science faculty of the University of Konstanz. Together we developed twelve tasks which were separated into two task sets, each including six tasks. Each task set contained three specific fact finding tasks and three extended fact finding tasks [20]. All tasks were designed in a way that they could be solved with both systems in an appropriate time frame and without major problems. In addition we developed six introduction tasks (three for each task set), which weren't considered in the statistical analysis. The purpose of those was to assure that all test persons would start with a comparable knowledge of each system, especially since none of the users was familiar with MedioVis.

3.2.4 Procedure

The experiment was conducted in our HCI usability lab. We used an Intel Pentium IV with 3 GHz, 1 GB RAM and a 19" TFT display. Each session was recorded with the help of Techsmith Morae 1.1 recording software [21]. During the session three persons were present in the office: The test-subject, the test-monitor and one minute taker. The experiment started with a Pre-Test questionnaire. In the following each subject started to work with task set 1 and the first system and afterwards switched over to the second system and task set 2. In addition the order of the systems was alternated: Fifty per cent of the participants started with KOALA, the other half started with MedioVis. Task sets were not alternated (see Fig. 4). In front of each task set each subject concluded the introduction tasks to get to know the system. After having worked with a system, the subjects filled in the SUS and Attrakdiff questionnaires. Each session lasted about 45-60 minutes.

Subject	System 1	Task- Set	Questionnaire	System 2	Task-Set	Questionnaire
1	KOALA	1	SUS, Attr.	MedioVis	2	SUS, Attr.
2	MedioVis	1	SUS, Attr.	KOALA	2	SUS, Attr.
3	KOALA	1	SUS, Attr.	MedioVis	2	SUS, Attr.
4	MedioVis	1	SUS, Attr.	KOALA	2	SUS, Attr.

Fig. 4. Experiment Procedure, 4 example subjects, Attr. = Attrakdiff

3.2.5 Experimental-Design

We used a combination of repeated-measures design (for questionnaire analysis – "system" as within-subjects factor, "order" as between-subjects factor, questionnaire score as dependent variable) and between-subjects design (for task completion time analysis – "system" as between-subjects factor, task completion time as dependent variable). As a result, we had 24 subjects who rated both KOALA and MedioVis with SUS and Attrakdiff. For task completion time analysis we had 12 subjects working on task-set 1 with KOALA and 12 working on task-set 1 with MedioVis, analogue task-set 2. We did not choose a repeated-measures design for task completion time analysis since we think that working on the same or at least very similar task with two different systems can influence the results in a significant manner. Based on our hypothesis that this would not be the case with questionnaires, we designed the experiment in this way to combine the advantages of both designs.

3.3 Results

3.3.1 Task Completion Time and Task Accuracy Overview

The average task completion times were 87 seconds (task set 1) and 96 seconds (task set 2) for KOALA users. In contrast it took our MedioVis subjects on average 49 seconds (task set 1) and 40 seconds (task set 2) respectively. This difference is highly significant ($p<0.01$). Levene's Test for the homogeneity of variances furthermore showed that the assumption made by the Oneway ANOVA, that variances of the groups are all equal, is justified (p=not significant, n.s.).

3.3.2 Task Completion Time in Detail

Since the time differences were that significant, we were primarily interested if this was caused by a specific type of tasks or if it was just based on the different systems. We will look at the two task sets separately in order to keep everything in mind.

As mentioned above, we clustered the tasks in specific fact finding and extended fact finding tasks, the latter being expected to be the more complex tasks. Regarding task set 1, the average completion time for specific fact finding tasks was 78 seconds for KOALA users and 35 seconds for MedioVis users (significant, $p<0.01$). Extended fact finding tasks took KOALA users 95 seconds on average and MedioVis users 62 seconds. Although this seems slightly closer, the difference is still highly significant ($p<0.01$). Analyzing every task of the specific fact finding tasks for itself, we again have significant differences for each of them (at least $p<0.05$). Especially task 3 was outstanding, taking KOALA users on average 139 seconds and MedioVis users only 50 seconds to complete it. The task demanded the users to search for a film, available on a multilingual video cassette. Since KOALA users could not limit their search on video cassettes nor multilingual versions, they had to check each search result manually (see Fig. 3). MedioVis users could benefit from the table visualization, the sorting features and the multi coordinated views (see chapter 2.2). They could directly decide whether they found the correct film or not by checking out the searched attributes (see Fig. 3).

The second task set took the subjects 50 seconds on average to complete the specific fact finding tasks with KOALA and 29 seconds with MedioVis (significant, $p<0.01$). Looking at the extended fact finding tasks, this gets even more explicit, taking KOALA users 143 seconds on average and MedioVis users only 51 seconds (significant, $p<0.01$). A detailed analysis reveals that the same advantages as in task set 1 are responsible for the better performance of MedioVis. However, there were two tasks were both systems performed nearly equal (p=n.s.). In both cases the user did not have to formulate a new search query but could work on the prior result set. The extended fact finding task asked the users to find out the screenplay author for three of the films in the result set. Although KOALA users had to load a new web page with the detailed information, they were nearly as fast as the MedioVis users (87 seconds vs. 77 seconds). It seems to be the case that it takes MedioVis users more time to find a specific title in the result set, probably due to the rather small fonts within the table view.

Next we tried to identify other variables which might have an effect on the results. We conducted multivariate ANOVAs with gender (male, female), semester (first semester, higher semester) and field of study (seven characteristics) but could not detect any significant impact of those variables on our dependent variable task completion time. Another interesting aspect is the use of the scatterplot. We did not include the scatterplot specifically in our test design but did not bar our users from trying and using it. Although most of the users were confused by the mathematical appearance, five subjects used it successfully for some tasks. This shows that we still have to work on the appearance of the scatterplot to get it used by more people.

3.3.3 Questionnaire Analysis

As stated before we used a repeated-measures ANOVA to analyze the results of our two questionnaires, Attrakdiff and SUS. The analysis revealed that the system order had no significant effect on the results, which proved our hypothesis that such a design is suitable for questionnaires. Analyzing the Attrakdiff scores we noticed that MedioVis scores significantly higher on each of the four scales ($p<0.01$) – with particular high scores on the pragmatic quality (PQ) and on the appeal scale (APP, both times 5.5 compared to 3.9 and 3.7 for KOALA on average on a 7 point scale). The values of hedonic quality (HQ) measurement are also clearly above KOALA with 5.0 on average on the identity (HQ-I, KOALA 3.8) and 4.7 on average on the stimulation scale (HQ-S, KOALA 3.0). This is remarkable since it clearly proves our initial design concept of a system which is easy to learn, to use and which has a high aesthetic value.

The SUS scores were again very clear in favour of MedioVis with a score of 83 compared to 55 for Koala on a scale from 0-100. This difference is highly significant ($p<0.01$) and confirms the PQ score of Attrakdiff. Altogether the subjective user ratings with our two questionnaires underline the clear performance results once more and lead to the definite statement that MedioVis is superior to KOALA in nearly all aspects of our experiment.

4 Conclusion

MedioVis was developed with the aim to proof the concept of a new user interface paradigm for online library catalogue systems. To reach this goal the design of the system was based on the following principles:

- Design of an **easy to learn** system that allows novice users a quick use without any training.
- Design of an **easy to use** system that supports all information seeking activities in an effective and efficient manner.
- Design of an aesthetical pleasing system offering **joy of use** experiences.
- Simple **formulation of the query** following the well established convention of web search engines, extended by an advanced search.
- Offer a quick and insightful **overview** about all search results to find the "needles in the haystack".
- Offer the right **amount of information** in the **context** where the users need it.
- Present **different aspects** of interest at the **same time** to compare them or to get more information at a glance.
- Offer possibilities of **restricting** the amount of **information** to selected topics of interest.
- Offer the possibility to **customize the system** reflecting the user's personal needs (e.g. kind of result presentation, placement or amount of information).

To fulfil all these principles we followed a multiple coordinated view approach, offering the user a simple and advanced search view known from web search engines, a powerful table and a simple graphical view for the presentation of the search results, a title, a selected media and a media location view to present more details about selected titles. Special attention was given to the aesthetic appearance of the system, replacing default widgets by graphical ones and improving the consistency of used colours, font sizes, etc.

The results of our extensive evaluation experiment lead to the conclusion that MedioVis is clearly superior to conventional web-based retrieval system like KOALA (online catalogue system of the University of Konstanz). Our test users completed nearly all tasks significantly faster working with MedioVis. In addition the results of the Attrakdiff questionnaire (measuring the appeal of the system) and the comments made by the users during the experiment (e.g.: "I would have preferred to work on all tasks with MedioVis", user after working on the second task-set with KOALA) also confirm that users seemed to like the appearance of MedioVis and were comfortable working with it although they had never seen or used it before. We will continue to work with communication designers in order to further improve the visual appearance of MedioVis and talk to library users in order to find out which features are still missing but would be welcome.

If you take a look at the range of products available for internet search, list-based approaches are clearly in the lead. Nowadays users even expect Google-like interfaces and result presentation whenever searching information with their PC. Nevertheless our results show that a table based result presentation is superior to list-based approaches, and that users are able to quickly adapt to our new interface resulting in an immediate enhancement of the time needed to complete typical search tasks. Since the market of internet search systems has become a multi-billion dollar business, innovations are not easy to introduce. In our opinion, libraries offer the perfect sub-market to slowly establish alternative forms like our table-based MedioVis and thus could lead to a paradigm shift.

References

1. Borgman, C.: Why are online catalogs still hard to use? Journal of the American Society for Information Science 47(7) (1996) 493–503
2. Reiterer, H., Tullius, G., Mann, T. M.: INSYDER: a content-based visual-information-seeking system for the Web. Springer-Verlag GmbH , International Journal on Digital Libraries (2005). http://www.springeronline.com/sgw/cda/frontpage/0,11855,5-148-70-1118744-0,00.html, 2005/02/25
3. Klein, P., Müller, F., Reiterer, H., Eibl, M.: Visual Information Retrieval with the Supertable + Scatterplot. In: Sixth International Conference on Information Visualisation IV02 (2002) 70-75
4. Klein, P., Reiterer, H., Müller, F., Limbach, T.: Metadata Visualization with VisMeB. IV03, 7th International Conference on Information Visualization, London (2003)
5. James, W.: What is an Emotion? Mind, 9 (1884) 188-205. http://psychclassics.yorku.ca/James/emotion.htm, 2005/02/25
6. Kurosu, M., Kashimura, K.: Apparent usability vs. inherent usability. In: Companion of CHI '95 Conference on Computer Human Interaction (1995) 292-293
7. Glass, B.: Swept Away in a Sea of Evolution: New Challenges and Opportunities for Usability Professionals. Software-Ergonomie '97. Usability Engineering: Integration von Mensch-Computer-Interaktion und Software-Entwicklung, R. Liskowsky, B.M. Velichkovsky, and W. Wünschmann, eds., B.G. Teubner, Stuttgart, Germany (1997) 17-26
8. Tractinsky, N.: Towards the Study of Aesthetics in Information Technology, 25th Annual International Conference on Information Systems, Washington, DC, December 12-15 (2004). http://www.ise.bgu.ac.il/faculty/noam/papers/04_nt_icis.pdf, 2005/02/25
9. Jordan, P. W.: Designing Pleasurable Products – An Introduction To The New Human Factors. Taylor & Francis, London (2000)
10. Hassenzahl M., Platz A., Burmester M., Lehner K.: Hedonic and Ergonomic Quality Aspects Determine a Software's Appeal. Proceedings of CHI'2000. ACM, The Haague (2000)
11. Ngo., D. C. L., Teo, L. S., Byrne, J. G..: A Mathematical Theory of Interface Aesthetics. Visual Mathematics N 1 (2001). http://www.mi.sanu.ac.yu/vismath/ngo, 2005/02/25
12. Bálek, M., Nešetřil, J.: Towards Mathematical Aesthetics. ITI-Series 2004, Institute for Theoretical Computer Science (2004)
13. North, C., Shneiderman, B.: A Taxonomy of Multiple-Window Coordination. University of Maryland, Computer Science Dept, Technical Report #3854 (1997)
14. North, C., Shneiderman, B.: Snap-together Visualization: Can Users Construct and Operate Coordinated Visualizations?. Int. J. Human-Computer Studies 53 (2000) 715-739
15. Shneiderman, B.: The Eyes have it: A Task by Data Type Taxonomy. In: Proc. of IEEE Symp. Visual Languages 96 (1996) 336-343
16. Wake, W., Fox, E.: SortTables: A Browser for a Digital Library. In: Proc. 4th Int. Conf. on Information and Knowledge Management, CIKM'95, Baltimore, MD (1995) 175-181

17. Buering T., Reiterer H.: ZuiScat - Querying and Visualizing Information Spaces on Personal Digital Assistants. In MobileHCI 2005. Human Computer Interaction with Mobile Devices and Services, ACM Press (2005)
18. Brooke, J.: SUS: A Quick and Dirty Usability Scale. In: Jordan, P.W., Thomas, B., Weerdmeester, B.A. & McClelland, I.L. (Eds.), Usability Evaluation in Industry. London: Taylor & Francis (1996)
19. Hassenzahl, M., Burmester, M., & Koller, F.: AttrakDiff: Ein Fragebogen zur Messung wahrgenommener hedonischer und pragmatischer Qualität. In J.Ziegler & G. Szwillus (Eds.), Mensch & Computer 2003. Interaktion in Bewegung (2003) 187-196
20. Shneiderman, Ben: Designing the User Interface. Strategies for Effective Human-Computer Interaction. 3rd edition Reading, MA, Addison-Wesley (1998)
21. Techsmith Morae 1.1: The Digital Solution for Usability Analysis. http://www.techsmith.com/products/morae/default.asp, 2005/02/25