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Don't forget the users – Developing a portal for audiovisual media with a user-centred approach

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Abstract:
The Competence Centre for Non-Textual Materials at the German National Library of Science and Technology together with the Hasso-Plattner-Institut (HPI), the University Centre of Excellence in Systems Engineering affiliated to the University of Potsdam and usability.de, has developed a portal for audiovisual media that optimises access to scientific videos from the areas of science and technology. The key feature of the portal is the combination of state-of-the-art methods of multimedia retrieval and semantic analysis. Thanks to automated video analysis featuring scene, speech, text and image recognition, the TIB|AV Portal offers content-based access at the segment level and the ability to link data to new knowledge. The development is based on analyses of requirements and usage conducted in 2010. A semi-functional prototype of the TIB|AV Portal was developed in 2011; the system was further developed and a beta version created in 2012/2013. The portal became fully operational at TIB in spring 2014. In order to ensure the accessibility and usability of the portal, the development was accompanied by a human-centred design approach. This paper describes the user-centred design process, gives an overview of the different actions taken and introduces challenges and advantages of the respective steps.

Keywords: *Audiovisual Media, Audiovisual Portal, Usability, User-centred design, Eye tracking*

1 THE TIB|AV PORTAL[1]

In view of the sharply increasing number of digital audiovisual (AV) media in science and teaching, there is a need to significantly improve conditions of access and use. The aim of the developments undertaken at the Competence Centre for Non-Textual Materials (KNM)[2] of the German National Library of Science and Technology (TIB)[3] is to create an infrastructure and develop tools that actively support users in the scientific work process, enabling non-textual material such as AV media, 3D objects and research data to be published, found and made available on a permanent basis as easily as textual documents.

In a joint project with the Hasso-Plattner-Institut (HPI), the University Centre of Excellence in Systems Engineering affiliated to the University of Potsdam[4], and usability.de[5] – a specialist agency for usability and user experience – a portal for AV media was developed in this context that optimises access to scientific videos such as computer visualisations, learning material, simulations, experiments, interviews, and recordings of lectures or conferences from the realms of science and technology.

Videos in general and scientific videos in particular usually only have a few coarse-grained authoritative metadata, supplied by the providers during the uploading process. In the TIB|AV Portal, authoritative metadata is supplemented by fine-grained automatic indexing at the segment level of the video, enabling users to search the video collection in an accurate, segment-based manner.

The start of the TIB|AV Portal process chain involves uploading a video and the authoritative metadata supplied by the author, such as the title, author, publisher into a media management system. The video is then automatically segmented at the clipping boundaries on the basis of image characteristics. Key frames are extracted from the segments to create a visual index. After the completion of this structural analysis, text overlays (e.g. on slides) are analysed using intelligent character recognition and stored in the form of a transcript. Likewise, a transcript is generated from spoken language using automatic speech recognition (cf. Plank and Neumann 2014). In the next step, visual concept detection is used to classify visual content according to predefined specialist and multidisciplinary categories such as landscape, machinery, drawing, animation and lecture (cf. Hentschel and Blümel 2013).

On the basis of the metadata generated additionally from speech, text and image recognition, the videos contained in the TIB|AV Portal are automatically semantically tagged using a controlled vocabulary. Ambiguities in the classification process are resolved, where possible, by a disambiguation algorithm that uses context information from ontologies such as DBpedia and Wikipedia. By semantically tagging videos with entities, traditional key word-based searches can be enhanced, and the search results can be expanded (synonyms, hypernyms and hyponyms, English translations) and refined (faceted search) (cf. Sack and Plank 2014).

[1] av.getinfo.de
[2] http://www.tib-hannover.de/en/services/competence-centre-for-non-textual-materials/
[3] http://www.tib-hannover.de/en/the-tib/
[4] http://www.hpi.uni-potsdam.en
[5] http://www.usability.de/en

The use of the aforementioned technologies in the search for text enables not only the authoritative metadata, but also spoken text, text overlays and image information to be found. Automatically generated metadata enables accurate, segment-based searches to be made within a video. If, for example, the user is searching for the search term *wind power* and if this term is found in the audio transcript of a video, then the relevant segment of the video containing this term will be highlighted. Clicking on this segment takes the user directly to the place in the video where the search term appears. In this way, the user is able to search not only for entire videos, but also within videos. In addition, the scientific films are linked to additional information such as digital full texts and research data via TIB's portal GetInfo, widening the search space considerably.

In addition, each video is given a digital object identifier (DOI), enabling scientific films and film segments to be cited as easily as texts. A DOI name clearly identifies the video, akin to the use of ISBN in books. In order to cite a video, its DOI link is simply copied and pasted into a document. In addition to DOI registration, the TIB|AV Portal offers a time-based citation link, enabling a citable DOI to be displayed for each video segment using the open standard media fragment identifier (MFID). The stock of visual material stored on the TIB|AV Portal is expected to grow steadily in the months and years to come. Producers of scientific films can also simply upload their video to the TIB|AV Portal free of charge.

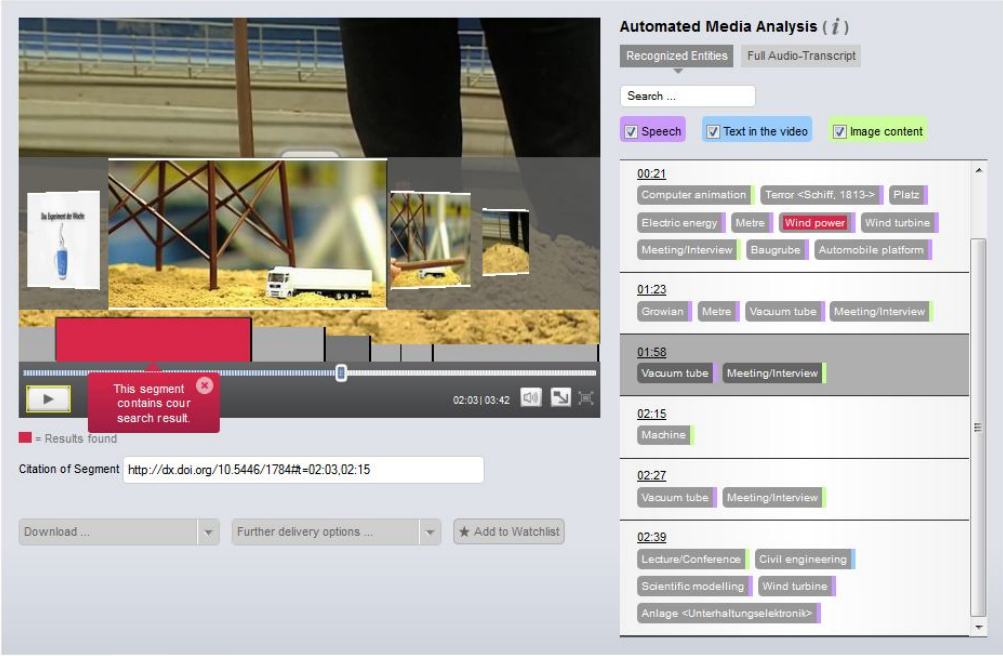

Figure 1: Detail page of the TIB|AV Portal: the automatic, content-based indexing of individual videos at the segment level enables users to search in an accurate, content-based manner.

2 HUMAN-CENTRED DESIGN IN THE TIB|AV PORTAL PROJECT

With the above mentioned innovative search and interaction techniques a strong focus on user demands was essential in the project. Therefore a human-centred design approach was

taken in order to give accessibility and usability issues the necessary attention throughout the development process.

“Human-centred design is characterised by: the active involvement of users and a clear understanding of user and task requirements; an appropriate allocation of function between users and technology; the iteration of design solutions; multi-disciplinary design.- ISO 13407

Major actions taken included the following:

- A structured requirements engineering by means of expert interviews and surveys (cf. Plank 2012)
- Rapid prototyping techniques coming up with a first low-fidelity prototype of the AV-Portal that was being used for evaluation purposes
- Two focus groups to get a first valuable feedback from the target groups
- Integrating the results from the focus group in the prototype
- Conducting usability tests and an eye tracking study and optimising the prototype according to the results
- Onsite survey and web analytics

Following the human centred design approach made sure that the portal for audiovisual media does not just include what may be possible from a technical or scientific view. In addition “not forgetting the users” in the process subsequently lead to an easy-to-use portal offering only those services that are proven to provide target groups with additional value. Further information about the practical use of user experience (UX) methods in libraries, and their advantages and drawbacks, can be found in (Weichert and Plank 2012).

Since some of the available retrieval and analysis options are methods without standards that have not been fully tried and tested, the project focused on research questions concerning usability and usefulness. These research questions included:

- Which methods exist for the provision, processing, retrievability and citability of AV media, and how much experience do potential users of the TIB|AV Portal have in dealing with these methods?
- Which of these potential methods represent a benefit to the target groups and their tasks and objectives if integrated in the TIB|AV Portal?
- How must these methods be used in the portal and how should interaction be designed in order to ensure that users can achieve their objectives according to the definition of usability “effectively, efficiently and satisfactorily” (DIN 2010a)?

The development approach selected in the project was based on DIN EN ISO 9241-210 (DIN 2010b), in which the process of creating usable systems are described on the basis of four process stages. The focus is on users in the first step (understanding the needs) and keeps them actively involved during the entire project.

Figure 2 provides an overview of the process and the respective objectives. In addition to presenting the objectives of each individual phase, the figure also shows the classification of the methods used in the project, which are presented below:

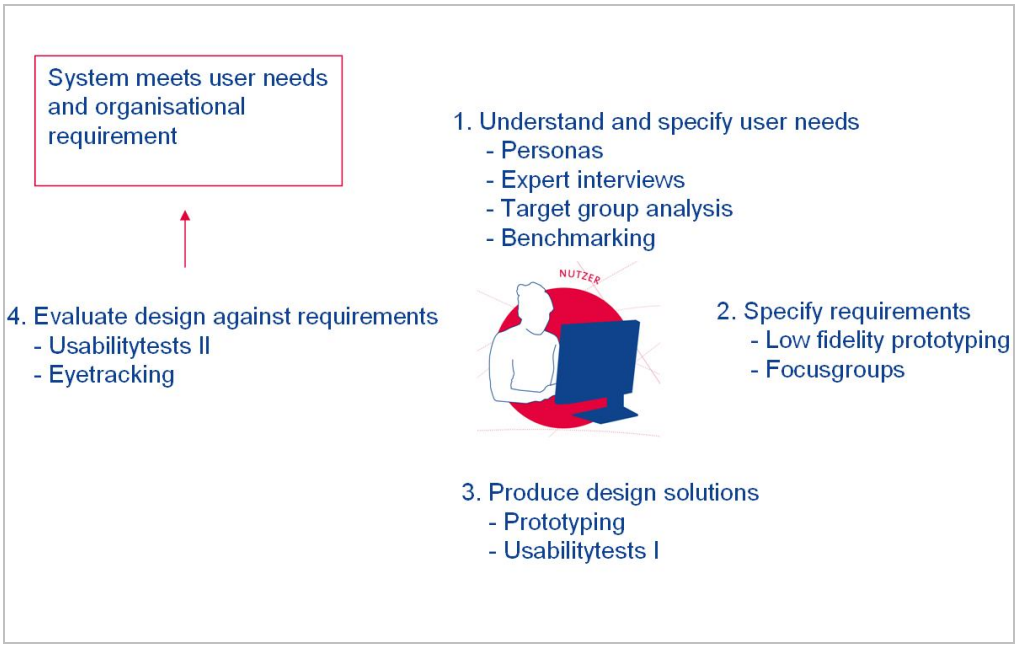

Figure 2: User-centred design process in accordance with (ISO 9241-210) and the tools used in the TIB|AV Portal project

The four phases and the methodology used in the TIB|AV Portal project can be described as follows:

Phase 1: Understanding users and the context of use

In this phase of the user-centred design (UCD) cycle, future users of the portal are examined and described. The central questions asked are:

- Who exactly are the future users?
- How can the target groups be differentiated distinctly?
- How can we exploit our knowledge about the target groups in the implementation of the project?
- Which functions will be of interest to the target groups?

First of all, a target group analysis and extensive benchmarking were performed to clarify these questions. Based on this collection of existing technologies and examples for realisation in graphic user interfaces, expert interviews were conducted with six representatives from scientific research facilities, film institutes, scientific libraries and universities. These interviews focused on the issue of state-of-the-art technologies (innovative retrieval) and the expected acceptance by the target groups.
In order to document the results of the analysis phase for all of the project participants, and to make them usable, personas were developed at the next stage. Personas are fictitious, specific, very concrete representatives of users (cf. Pruitt 2005: 11). Knowledge about the user groups was aggregated in the personas, and visualised on the basis of typical characteristics of a concrete person. This knowledge is usually either collected by way of user research methods (interviews, usability tests, and so on) or pooled in a workshop involving

users or direct interfaces to users. In the TIB|AV Portal project, the personas were initially developed during the user needs phase at the start of the project on the basis of the knowledge of the TIB representatives and the outcomes from the expert interviews conducted. In the following phases of the project, involving the increasingly closer integration of the "real" user community, the personas were then further refined or corrected.

The personas helped to ensure that all of the project participants – from the library management and project management to programmers and those responsible for IT – have the same understanding of future users. The aim of the persona method was to avoid the use of general formulations and hypotheses about user groups such as "Our users need…" or "The user does not know whether…", and instead to focus on a small number of personas in the conceptual design of the system.

Phase 2: Specifying requirements applying to the system:

In this phase of the project, the knowledge about users was further specified and emphasis placed on the technical possibilities for innovative searching, ascertained with the experts. The central issues clarified during this phase were:

- Which of the technical possibilities are actually of interest to the target groups?
- In what form must the technologies be offered in order to ensure that users actually use them?
- Which technologies and functions are rejected by the target group so vehemently that resources should not be invested in their implementation in the first place?

In order to provide answers to these questions, 15 potential users of the portal to be developed were surveyed in two focus groups as to their desires, requirements and concrete working practices. The focus groups were composed of research staff (3), PhD students (2), a full-time lecturer (1), a senior teaching assistant (1), students (3), a technical staff member (1), a *Diplom*-librarian (1) and engineers (3).

The use of first prototypes was found to be very expedient. These ideas, roughly sketched in some cases, or functions for the TIB|AV Portal suggested in initial semi-interactive prototypes were demonstrated in the focus groups, and feedback was obtained from users.

In addition to the generally positive expectations of the focus group participants, it was possible to identify aspects that were classified as less relevant, which were therefore not pursued further in later prototypes. Examples of such aspects included community features to enable users to exchange videos amongst themselves as well as the online editing, tagging and rating of videos.

In addition, the participants specified scopes of content and functions that they liked and those that they thought were missing in the prototype. The key findings were:

- All of the participants would like to use the planned TIB|AV Portal
- Quantity and quality of the content are decisive for acceptance
- Unique citability of videos is a great incentive
- Additional access options on the home page (e.g. browse, access by subjects/target groups/...) should be integrated
- Thumbnail/preview image of the video should be expanded

- Easy uploading of own videos, including the granting of right of use was highly rated
- Linking of the media with the context, e.g. full texts or research data and the option of a cross-media search was seen to be very important
- Subject channels are of real added value, especially for students, and should be integrated
- Visual index (of contents) is seen to be useful
- Information about the size of the file in the results list is lacking
- Navigation capabilities via audio text within a video is highly rated
- Faceted search was evaluated positively

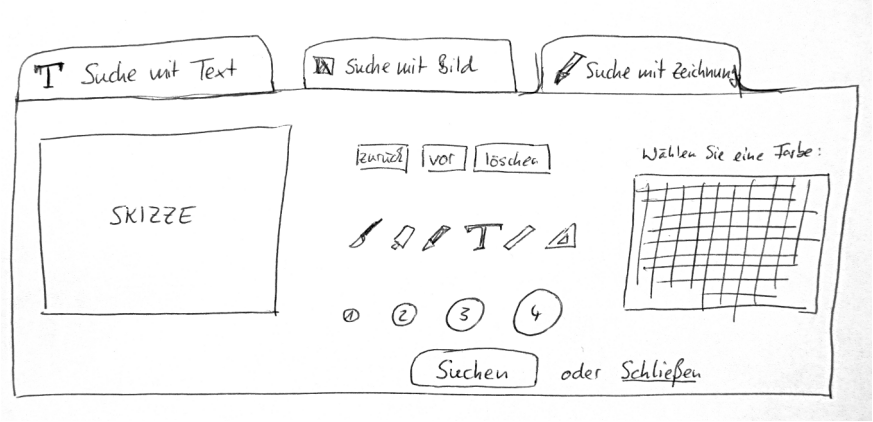

Figure 3: Paper prototype for the query-by-sketch function as a basis for discussion in focus groups (source: usability.de/TIB)

The main reprioritisation in the context of the functions intended for the portal occurred after the focus groups for the search technologies: whilst the integration of a query by sketch and a query by example were favoured at the start of the project and after the expert interviews had been conducted, this approach was discussed in a sceptical or even dismissive manner by all users in the focus groups. The users agreed that they would not sketch or upload sample images to search for videos. The only use case imaginable by the participants in this context that was mentioned was drawings of chemical formulae. For this reason, it was decided to integrate a traditional keyword-based search with a simple search slot and an entity-based search via facets instead of this function. Work and implementation effort was rather invested in the ability to search and cite at the segment level and in semantically linking data – a possibility that met with considerable interest among users (cf. project overview).

Phase 3: Producing design solutions

Whilst the previous phases focused on the target groups' basic requirements, it was now important to clarify the details concerning the user interface. The issues addressed during this phase of the project were:

- How must the functions be integrated in the graphic user interface so that they can be found and understood?
- Which layout should be used in order, for example, to be able to portray a large amount of information clearly?
- Which navigation structure should be used?

Building on the results generated from the focus groups and expert interviews, a variety of optimisations were made to the previously developed prototypes, and the level of detail concerning interaction possibilities was raised: the search options offered to date were linked and additional means of accessing results were integrated on the welcome page (for example, browsing, access by subject/target groups/…). The channels which users in the focus groups considered to be missing were included in the concept and the prototypes, and a basic layout of the individual pages (welcome page, search result, video detail page) was designed.

In order to embrace the user-centred approach selected in the project, it was decided to carry out a usability test with users even in this early development stage. The usability of an interactive prototype was tested on 12 participants (3 PhD students, 1 research staff member (with a PhD), 2 research staff members (without a PhD) and 6 students).

In this way, it was possible to correct interaction concepts that had been misunderstood, and eliminate confusion, at a very early stage. For example, the test revealed that faceted search in the videos was not yet functioning optimally, and even led to false assumptions by users. For instance, virtually none of the participating test subjects noticed, when submitting a new search request, that the previously set filter (e.g. set to a field of research) was still set. After the test had been evaluated, therefore, the faceted search display and, in particular, the selected filters were revised once more.

Since users also misunderstood the categorisation of facets ("What does genre mean? Is that the subject from which the video originates?" or "What is the difference between organisation and publisher"?), particular attention was also paid to the "wording" aspect again as a follow-up to the test, the number of filter categories was reduced, and they were designated more clearly.

Phase 4: Evaluating the solutions developed (usability tests with eye tracking):

Finally, the prototype was further optimised on the basis of the test results, and fidelity (closeness to a finished system) was continuously increased. Before launching the portal, another usability test was carried out that centred around the following questions:

- Does the revised faceted search work better?
- Has the relevance and composition of the results list been understood?
- Which of the two potential design variants for portraying the automatically detected entities works better?
- Do users notice important functions and content in good time?
- What content is read, and what is disregarded?

In order to explore the issue of how content and functions are perceived, eye tracking was used in this usability test, and the test subjects' eye movements were recorded and assessed in detail. Eye tracking is a method applied to monitor eye movements on a screen. A special monitor featuring integrated infrared technology enables eye movements to be tracked inconspicuously in order to identify which areas of an application attract interest. Additional knowledge about user perception can therefore be gained from a usability test.

A rather simple method was chosen for recruiting participants. Since the prototype had by then reached a stage where it could be presented at a trade fair, the usability test was carried out at a trade fair (CeBIT). Staff manning the TIB booth approached visitors to the booth to ask them whether they had the time and inclination to take part in a test to check the usability of the portal. In this way, it was possible to spontaneously recruit a total of 30 participants, including a target group that is rather difficult to recruit (employed researchers and teaching staff). Once again, the test evaluation revealed valuable findings concerning further potential for optimisation.

One of the most important test results was that users were unable to adequately assess the relevance of the videos detected on the basis of their search request ("Why is this video being displayed for my search request?"). The search terms were not highlighted in the results list, meaning that they were unable to assess whether the video was of interest for their search. However, this form of highlighting terms in the results list is only possible if the search term is found in the authoritative metadata, e.g. in the abstract. If the search term is found in the spoken text, it could not be presented in the current layout.

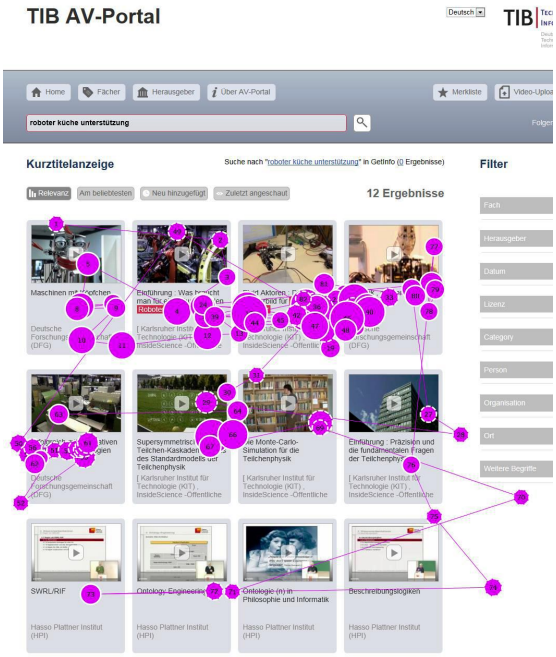

Figure 4: Analysis of eye movements over the short title list

Result

TP10 takes 40 seconds to decide on a video that matches her search terms. In particular, the titles of the videos in the results list are scanned. TP10 then opts for Video Number 2 due to the fact that the search term is highlighted in colour in the title. Little attention is paid to the video that comes top, which actually matches the search terms perfectly. This is because the user fails to recognise that the search term was also found in this case (source: usability.de/TIB).

Optimisation

As the test demonstrated, users expect a clear indication in the results list as to why these very results are displayed in the respective order. To achieve this, the information is now displayed dynamically below the video thumbnails, irrespective of whether the search term was found in the metadata, in the voice-over, in the frame or in text overlays in the frame. In

addition, the visual impact of the designation of search hits in the title of the video was diminished. Another usability test will be carried out to check whether the problem has been fully resolved following the action taken.

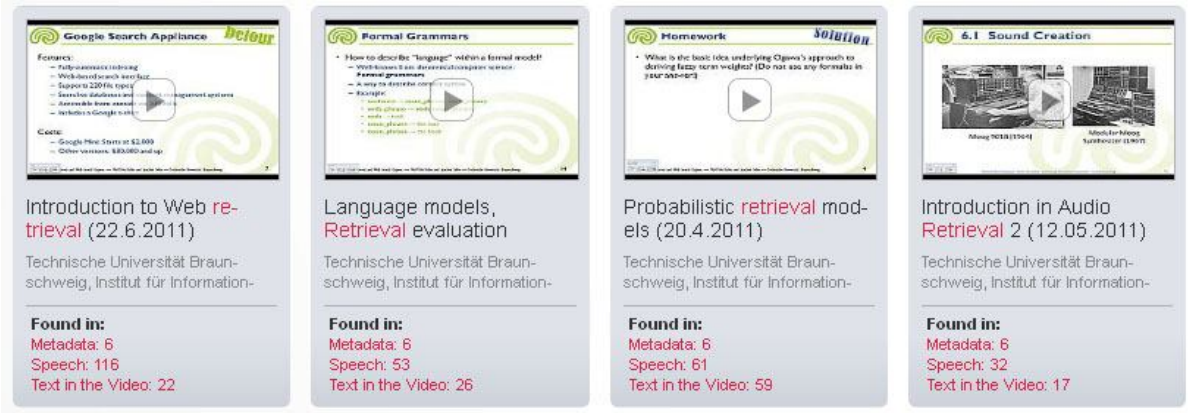

Figure 5: Display of hits in the short title list

Other results generated from the tests above and beyond the adaptation described also contributed to the future optimisation of the system; in particular, the usability problems classified as being major were resolved prior to the launch of the TIB|AV Portal in April 2014.

3 ASSESSMENT OF THE USER-CENTRED APPROACH IN THIS PROJECT

Due to the methods described, the user-centred approach in the TIB|AV Portal project created a system that relies on innovative retrieval techniques, whilst optimally taking into account different user groups' requirements concerning the system's range of functions. Particularly in a setting such as that of a library, in which the developers and users of a system are often located in the same premises, it is difficult to justify not placing the focus on users at the decisive points. Whilst therefore it is basically recommended to pursue user-centred development in the library context, careful consideration should be given to which methods are to be used.

One major advantage of the user-centred approach is the diversity of methods involved, ranging from very simple, stand-alone approaches to expert methods. The question we need to ask is therefore not so much whether a user-centred approach is appropriate and feasible in the first place, but whether suitable methods can be selected for the respective project, achieving familiarity in their handling.

4 FURTHER DEVELOPMENT

The development continues to be flanked by methods of user-centred design. In order to gain an impression of user behaviour, web analytics will be applied to record interaction data on the TIB|AV Portal. In this way, any possible weak points and potential for further development are to be determined. A program code (JavaScript) was integrated in the websites to this end, so as to collect detailed data on predefined pages and events. Examples include the time spent visiting each page (visit duration), the number of page views, the

frequency with which a page is left immediately (bounce rate), the websites from which users accessed the portal, the search terms entered in search engines, language settings and users' technical equipment, such as the browser version or mobile device. Click paths, i.e. the way in which users navigate through the portal, are particularly interesting for the further development, as well as clicks on events such as downloading, watch list and uploads. On the basis of this information, it can be determined which content and features are of particular interest to users, and what potential exists for further development. Where appropriate, the results will also be analysed and discussed with the involvement of users, and suitable measures derived from this accordingly.

Users wishing to communicate their, or other users', requests and recommendations for the next release of the TIB|AV Portal can do so easily via the feedback button integrated in the portal. Thus a ranking list of the most popular ideas is created automatically, which can then be used to further develop the system. For example, several users would like the possibility to filter by creative commons licences. Others would like to see an Open Archives Initiative (OAI) interface to be able to reuse the data.

Another usability test is to be carried out once the market launch phase has come to an end in order to observe users' actual behaviour in a concrete situation and to determine acceptance of the portal. To achieve this, realistic tasks will be assigned, such as uploading films, citing a video, navigating in the video using the automatically generated metadata. TIB is for exemple interested in determining whether users would be prepared to contribute towards improving the automatically generated metadata, the quality of which is, of course, lower than in the case of authoritative metadata. Only if there is acceptance for this, the possibility of the user-based correction of content-based metadata and backflow into the semantic analysis chain (contextual refinement) would be considered.

Given our positive experience, the further development of the TIB|AV Portal will continue to be constantly flanked by user-cent red approaches with the aim of securing optimum usability.

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