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Published in:

Proceedings: Workshop Information Retrieval 2008, 6.-8. October 2008, University of Würzburg, Germany

[Link to publication](#)

Citation for published version (APA):

Besser, J., Hofmann, K., & Larson, M. (2008). An exploratory study of user goals and strategies in podcast search. In T. Mandl, N. Fuhr, & A. Henrich (Eds.), Proceedings: Workshop Information Retrieval 2008, 6.-8. October 2008, University of Würzburg, Germany (pp. 27-34). Würzburg, Germany: Gesellschaft für Informatik, special interest group Information Retrieval.

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An Exploratory Study of User Goals and Strategies in Podcast Search*

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Abstract

We report on an exploratory, qualitative user study designed to identify users' goals underlying podcast search, the strategies used to gain access to podcasts, and how currently available tools influence podcast search. We employed a multi-method approach. First, we conducted an online survey to obtain broad information on overall trends and perceptions regarding podcasts in general and podcast search in particular. Second, we used a diary study and contextual interviews to gain more detailed insights into the goals and behavior of key users.

We find that goals underlying podcast search may be similar to those for blog search. Study participants report searching for podcasts to look for personal opinions and ideas, and favor topics like technology, news, and entertainment. A variety of search strategies is used to gain access to interesting podcasts, such as query-based search, directed and undirected browsing, and requested and unrequested recommendations. We find indications that goals and search strategies for podcast search are strongly influenced by perceptions of available tools, most notably the perceived lack of tools for online audio search.

1 Introduction

Podcasting, [Rose and Lenski, 2006; van Gils, 2008; Grossnickle *et al.*, 2005], syndicated online distribution of audio, has enjoyed growing popularity in recent years. Providing access to the podosphere, the totality of all podcasts on the internet, is a significant challenge for the field of information retrieval. Although established techniques for web search hold potential for success when extended to podcast search, we believe that the development of podcast search technology should be informed by a detailed understanding of user needs and user behavior. Our research investigates the question of whether searchers approach the podosphere differently than they approach the internet at large. We carried out a user study to determine what goals motivate users to search the podosphere and how perceptions of podcast search technology impact the way users find and obtain access to podcasts.

A podcast is a web feed that contains a series of feed items, each encoding an individual podcast episode. Web

feeds typically offer content that is frequently updated and encode this content in a standardized format readable by feed readers or aggregators. Delivery of content via web feeds is a form of syndication, i.e., the distribution of material from a single source supplied to multiple destinations. A podcast feed contains basic descriptive metadata (e.g., podcast title and description). It also contains feed items, consisting of metadata describing the individual podcast episodes (e.g., episode title, description, and episode publication date) as well as a link to the actual audio file. A typical syndication format is RSS and a typical audio file format of a podcast episode is mp3 [Matthews, 2006; Grossnickle *et al.*, 2005].

Podcast listeners have various options for accessing podcasts. A podcatcher (i.e., a podcast aggregator or reader) can be used to subscribe to a feed, which means that new episodes are downloaded to a specified location as they appear. Podcast episodes can also be downloaded separately. Many users load podcasts onto an mp3 player, but it is also common to listen to podcasts on the computer.

Publishers of podcasts – so-called *podcasters* – can be professionals or amateurs. Indeed a significant number of podcasts are considered user-generated content, published by non-professionals. A podcast can contain a broad spectrum of spoken audio content, including broadcast news, interviews, discussions, user-generated commentary, and chitchat. Typically, new podcast episodes are added to a podcast on regular basis. Podcasts can contain both speech and music and some definitions also include video content. In this paper we specifically focus on spoken audio podcasts.

Subscribing to a podcast feed or downloading a podcast episode requires knowing the target web address. The podosphere however is huge, and finding podcasts that are interesting and relevant is not trivial. One way to find interesting podcasts is through browsing. Some websites of newspapers, journals, radio stations, museums, or other organizations contain links to podcasts they publish. Another scenario is that friends recommend podcasts or podcast episodes. However, encountering interesting podcasts through browsing or recommendations does not provide the same possibilities as other targeted search methods.

An alternative way of accessing podcasts is through search engines. Search engines actively crawl online documents by following hyperlinks. They index the crawled resources and provide an interface that allows users to search this index. The current trend is that podcast search engines style themselves after mainstream web search engines, presenting the searcher with a single field for entering a textual query (cf., <http://audio.search.yahoo.com/audio>, <http://suche.podcast.de/>). Un-

* This research was supported by the E.U. IST programme of the 6th FP for RTD under project MultiMATCH contract IST-033104, and by NWO under project number 612.066.512.

der the hood however, a podcast search engine can operate on principles different from those employed by a conventional web search engine, as will be discussed in section 2.

A difficulty in developing effective algorithms for podcast search is that we know very little about searchers' goals, i.e. the reason they search for podcasts. Depending on the search goal, different algorithms may provide the best results. For example, when searching for a podcast of a particular radio show that was broadcast on a known station in a known time-frame, the most effective search strategy would use metadata published with the podcast. When searching for podcasts in which a specific actor is mentioned, algorithms that search the content of the audio file, i.e. that can recognize and index spoken words, may be more appropriate. Depending on users' perception of current tools for podcast search, different strategies may be employed to achieve search goals. A better understanding of currently used strategies and reasons for using these strategies can thus also inform the development of future podcast search technology.

In this paper we address the following research questions:

- What are users' goals that motivate podcast search?
- What strategies are used to search for podcasts?
- Do perceptions of currently available tools for podcast search influence search goals and strategies?

We address these questions in an exploratory, qualitative user study. First, we report on a survey designed to obtain insights into general trends and perceptions regarding podcast search and to recruit volunteers for a follow-up study. The follow-up study consisted of a diary study and contextual interviews in which specific situations of podcast seeking were discussed to develop a better understanding of goals and experiences in podcast search.

The remainder of the paper is organized as follows. Section 2 presents related work regarding podcast search and user goals in podcast and general web search. A detailed description of the study we conducted is given in Section 3, and we present results in Section 4. We conclude with a discussion of implications for podcast search engines and an outline of future work in Section 5.

2 Background

Our discussion of related work is divided in two parts. First we discuss the current state-of-the-art in podcast search engines and show how different (existing and future) search algorithms may address different types of information needs. Second, we give an overview of previous work regarding users' goals in online search. As there is little previous work on users' goals in podcast search, we also include work from related domains, namely general web and blog search.

2.1 Podcast Search Engines

Under the hood, a podcast search engine can operate on principles different from those employed by a conventional web search engine. In particular, a podcast search engine can derive indexing features from two different sources, metadata and transcripts generated through automatic speech recognition (ASR).

Metadata can be included in the podcast feed and includes basic information (e.g., title, description, date) for

the podcast as a whole as well as for the individual podcast episodes. Some podcast search engines index podcasts using metadata-derived indexing features only. A major shortcoming of this approach is that this information is not necessarily encoded in a unified standard and in many cases podcast publishers specify little or no metadata. As a result, the reliability of the metadata varies.

The second source of indexing features is audio content analysis via automatic speech recognition (ASR). ASR produces time-marked transcripts of the spoken content of an audio file, which can be indexed using conventional text retrieval methods. Few podcasters have the time and resources to include full transcripts of the spoken audio in their feeds. As a result, even the most conscientiously composed metadata descriptions risk missing information held within the spoken content. For this reason, ASR transcripts have great potential to improve performance of podcast search engines by reducing reliance on human-generated metadata.

A major challenge in using ASR transcripts as a source of indexing features for podcast retrieval is that the podosphere is characterized by heterogeneous spoken audio (multiple speakers, unpredictable subjects) that varies widely in quality (variable recording conditions, variable speaking styles). These factors are known sources of ASR errors. However, it has been demonstrated that it is possible to partially compensate for ASR-transcript errors during retrieval and that in some cases retrieval on ASR-transcripts approaches the performance of text-based retrieval [Garofolo *et al.*, 2000; Koumpis and Renals, 2005].

Also, although ASR transcript generation times have fallen in recent years largely due to hardware improvements, it is still computationally expensive to generate transcripts, especially with respect to the vast amount of audio content published on the web.

We believe that a better understanding of the information needs that are satisfied by podcast content can help inform the balance between metadata-based indexing features (i.e., derived from the podcast feed) and content-based indexing features (i.e., derived from speech recognition transcripts) for podcast search. Moreover, we expect that the results of our study will help inform the decision as to whether generating ASR-transcripts of podcasts is worth the computational effort.

2.2 Online Search Goals

Research in the area of podcast retrieval has its roots in well over a decade of research into retrieval of broadcast news content [Brown *et al.*, 1995; Hauptmann and Witbrock, 1997; Renals *et al.*, 2000; Garofolo *et al.*, 2000]. Indeed, some work on podcast search concentrates on broadcast news content in the podosphere [Molgaard *et al.*, 2007] and news and radio content remains an important area of application of audio search (e.g., <http://www.audioclippping.de/>). It is not surprising then that the new field of podcast retrieval research [Zhou *et al.*, 2006; Goto *et al.*, 2007; Ogata *et al.*, 2007], generally puts emphasis on spoken term detection and ad hoc retrieval of simple queries using the speech transcript alone, as is typical for the evaluation of broadcast news retrieval performance.

Although improving spoken term detection is without a doubt important in advancing podcast retrieval, we believe that a better understanding of user needs and behavior will provide valuable guidance to research in the area of podcast search. The fact that podcast search engines, for

example PodScope (<http://www.podscope.com/>), offer users an interface for textual queries strongly resembling that of a mainstream web search engine suggests that a dominant assumption is that users approach podcast search in the same way they approach conventional web search. In our study we approach podcast search as a type of web search but remain open to the possibility that podcast search may more closely resemble other forms of search.

In general web search, research on understanding goals with which users approach search systems and strategies used to obtain information go back to early research of user interaction with hypertext systems. Marchionini and Shneiderman [1988] describe searching and browsing as strategies used to achieve different search goals and find that the choice of search strategy depends, among other factors, on users' goals and mental model of a search system's features.

Current research towards understanding users' goals and motivations of performing a search is conducted to inform the design of new web search interfaces [Rose, 2006]. Web search studies often make use of search logs containing the queries issued against a search engine, and sometimes the result list and clicked results [Rose and Levinson, 2004]. User studies can also use online surveys, e.g., [Broder, 2002]. An important result of [Broder, 2002] is that user needs fall into three relatively distinct categories: *navigational*, *transactional* and *informational*. Further work reported in [Rose and Levinson, 2004] demonstrates that navigational type queries are rarer than expected and that users often pursue the goal of obtaining a particular resource.

A domain that has recently attracted research attention is blog search. Since both the podosphere and the blogosphere contain large amounts of unedited user-generated material we think that user goals in podcast search may be similar to those for blog search. Key research on blog search includes [Mishne and De Rijke, 2006] who use log analysis to gain insight regarding the motivations of blog search users. The results of the study show that blog search is different from conventional web search and that blog search mostly involves informational queries. Queries predominantly reflect a user searching for named entities, generally people or current events, or for posts that express an opinion on a particular topic.

Although various research methods such as laboratory experiments and qualitative and quantitative user studies have been employed to study user goals underlying web search (cf. [Marchionini and Shneiderman, 1988; Broder, 2002]), most recent studies have focused on log analysis [Broder, 2002; Rose and Levinson, 2004; Mishne and De Rijke, 2006]. Often, such approaches are the only feasible way of sampling a large number of search episodes, due to the characteristics of the web, such as its enormous scale and world-wide distribution.

Although a similar log analysis would without doubt be useful for the podcast domain, it would leave open the question of whether users actually fulfill their search goals with the strategies they employ for podcast search. For example, the relative novelty of podcast search engines on the internet (PodScope dates from 2005) suggests that user search strategies are not yet stabilized and many valid search goals will be expressed as queries that do not assure optimal performance.

A general drawback of methods involving on-line surveys, log analysis, or click analysis is that there is rel-

atively little interaction between the researcher and the user, making it difficult to access details on the goal that motivated the search. The difficulties of using log analysis to infer user goals are discussed by [Broder, 2002; Rose and Levinson, 2004]. Rose and Levinson [2004] partly alleviate this problem by including in their analysis a large amount of information from the user's clickstream, i.e. all sites that were visited after submitting a query, but note that ultimately only the user can provide information on the goals underlying a search.

3 Methodology

In this study, we aim to explore users' goals and strategies related to podcast search. We therefore employ a primarily qualitative approach, rather than a quantitative approach such as log analysis. We note the shortcomings of the employed approach. In particular, results obtained in this way should not be interpreted quantitatively, and we do not claim overall generalization beyond the study sample [Diefenbach, 2008].

We use a multi-method approach combining a survey and a follow-up part, consisting of diary study and contextual interview [Sommer and Sommer, 1997; Berg, 2001; Hyldegård, 2006]. This allows us to combine advantages of the three methods and corresponds to a narrowing-down strategy where each part of the study is used to gain deeper insights about the findings from the previous step. First, the survey is designed to obtain broad, high-level information about general trends and perceptions about podcast search in our target user group. Second, the diary study and interview of the follow-up part with a small number of key users allow us to gain more detailed insights into motivations underlying podcast search, current search strategies and perceptions about currently available search tools.

Our study was conducted among students of the Informatics Institute of the University of Amsterdam (UvA). We considered students to be an appropriate target group for the issues we are addressing, since they tend to be of the appropriate age as identified in [Bausch and Han, 2006]. According to the study, web users between the ages of 18 and 24 are twice as likely to download audio podcasts as the average web user. Further, the level of education and field of study of the participants corresponds to higher awareness and use of podcasting. We consider this advantageous for our study, since our goal is not to produce reliable quantitative results that would generalize to the general population, but to identify patterns among key users of podcasting.

The entire study was conducted in English, except for a small part of the interviews that included interaction with a Dutch podcast search engine. The choice of English was motivated by the intention to gain as many participants as possible, not only Dutch-speaking students. Furthermore, English does not appear to be a barrier for most students at the UvA, where advanced courses are taught in English. However, all participants of the follow-up study were Dutch, and thus interaction with a Dutch system was not creating any trouble.

3.1 Survey

The objective of the survey was to get a broad overview of users' perceptions related to podcasts. A second goal was to recruit volunteers that are aware of podcasting for the follow-up study.

The survey contained a total of 17 questions and included questions on the demographic background, previ-

ous experience in searching for podcasts, and experiences in podcast search. The survey was designed to be short in order to achieve high completion rates. The survey consisted of ten multiple-choice questions, five short-answer questions and two open questions. A few questions were optional. Depending on answers to earlier questions, questions that were not applicable to a subject were skipped automatically. Completion time for the survey was 5 to 10 minutes.

The survey was conducted electronically. Participants were recruited through email sent by the Board of Education to all 700 students of the UvA Informatics Institute. The email contained short information about the study and a link to the online survey.

Upon completing the survey, subjects were asked whether they would be willing to participate in a follow-up study, in which case they were asked to provide an email address. Participation in the survey was anonymous unless an email address was provided for the follow-up survey.

3.2 Diary Study and Interview

The follow-up study consisted of a diary study and contextual interviews. Subjects were recruited from the respondents of the survey. Both the design of the diary study and the interview protocol were revised several times during a small scale pilot study.

In the diary study subjects were asked to keep track of the query-based¹ online search tasks they performed during a time period of at least three days. For this they had to indicate their initial search goal, the queries and Web pages they used to find the information, and whether the search was successful. This information they could then email to us either immediately after every search or at the end of each day during the diary study. The diaries served several functions: they provided us with information about both general and podcast specific strategies of formulating queries and finding information. Furthermore, the diary entries could be used during the interviews to help people remember their searches. One of the key advantages of diaries is that they minimize the time between the occurrence of an event and its recording and thus the risk that details about the events will be forgotten before they are recorded [Hyldegård, 2006]. Finally, the diaries were intended to make study participants aware of their own searching behavior so that it would be easier for them to answer related questions during the interviews.

The interviews were conducted with the goal of obtaining more detailed, qualitative information about subjects' perceptions regarding podcast search. Open-ended questions were used in order to obtain as much information as possible and the interview followed a semi-structured protocol consisting of the following parts: The interview started with a detailed discussion of specific situations, in which the subjects sought a podcast and of the strategies they used to obtain it. This part served to identify real search goals and strategies to achieve them. Afterwards interview questions zoomed out to focus on subjects' general perception about podcasts, including questions about preferred situations for podcast listening, favorite topics, and advantages and disadvantages of podcasts and audio as opposed to other sources of information. Following this part, subjects were asked to describe how they would proceed in a hypothetical scenario where they wanted to find

a podcast on a topic they had previously indicated interest in. This way participants' strategies in podcast search were further examined. The descriptions also prepared for the discussion of the features and design that an ideal podcast search engine should have according to the subjects. This was further investigated in the last part of the interview by discussing the advantages and disadvantages of a Dutch podcast search engine [van Gils, 2008] that was presented to the subjects. In this part, participants were also asked to judge the relevance of different result lists to the same query that had been created by metadata, ASR-based retrieval, or a combination of them. The interviews were fully audio recorded.

4 Results

4.1 Survey

The survey was completed by 70 respondents, corresponding to a response rate of 10%. The respondents were university students with a few exceptions, since recent graduates also received the email invitation. Respondents were aged between 18 and 38, an age group where listening to podcasts appears to be particularly popular [Bausch and Han, 2006]. As some questions were skipped automatically based on previous answers, not all respondents completed the same set of questions. The full 17 questions were completed by 22 respondents.

The survey started with introductory questions about people's general habits in downloading and listening to audio files, and about their access to relevant technical equipment. By this we wanted to exclude that subsequent responses were due to a general unawareness of audio downloading or lack of devices for listening. Answers to these questions showed that the vast majority of the respondents download audio files from the Internet and owns devices to play them (Table 1).

Survey question	Yes	No
Do you own an mp3 player?	78%	22%
Do you listen to audio files via your computer?	96%	4%
Do you download audio files from the Internet?	88%	12%

Table 1: The vast majority of the respondents download audio files from the Internet and owns devices to play them.

Most respondents of our survey had previously heard of podcasting (90%). Their habits in downloading podcasts are shown in Table 2. A third of these respondents also thinks that podcasting is an important trend.

People who ever downloaded a podcast (<i>listeners</i>)	51%
Listeners who download podcasts at least monthly	27%
Listeners who subscribe to podcasts	62%

Table 2: People's habits in downloading podcasts.

Respondents reported subscribing to up to 12 podcasts, with 1-2 subscriptions being the most frequent, as shown in Figure 1.

Both awareness of podcasting and use of podcasts reported by our respondents is substantially higher than reported elsewhere [Grossnickle *et al.*, 2005; Rose and Lenski, 2006; Madden, 2006; Bausch and Han, 2006]. We attribute these differences to characteristics of our respondent population, such as age group, level of education, and field of study.

¹Throughout, we use the term *query* to refer to textual queries.

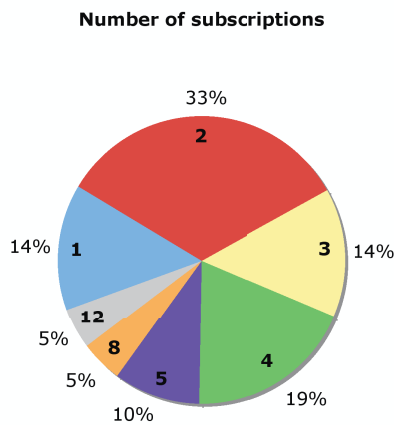


Figure 1: Answers to the question “How many podcasts do you subscribe to?” of people subscribing to at least one podcast.

The most common topics respondents listen to are technology and music. This question was answered by all participants who download podcasts at least once in a while. A list of the five most popular topics is given in Figure 2. Other topics participants reported listening to are culture, sports, history, religion, business, and society.

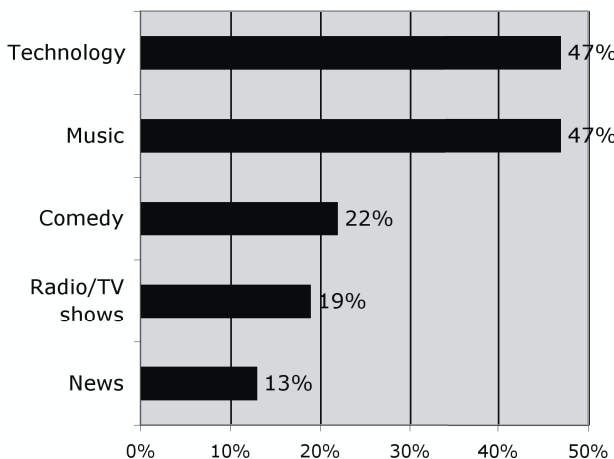


Figure 2: The five most popular topics of podcasts to which respondents listen.

Most of the subjects’ favorite podcasts are provided by professional broadcasters rather than private distributors. This might be a relevant indication for the usefulness of content-based search engines, since the recording quality has an impact on the quality of the content analysis. Furthermore it should not be assumed that the amount and quality of metadata is higher for professionally distributed podcasts. In fact, there are indications that private podcasters take more effort in providing high quality metadata.

When asked about how they find podcasts, most of the participants indicated that they did so via browsing through websites (50%) and recommendation (41%). About one quarter of the respondents also use podcast search engines (see Figure 3).

The most well-known and popular engine is iTunes,

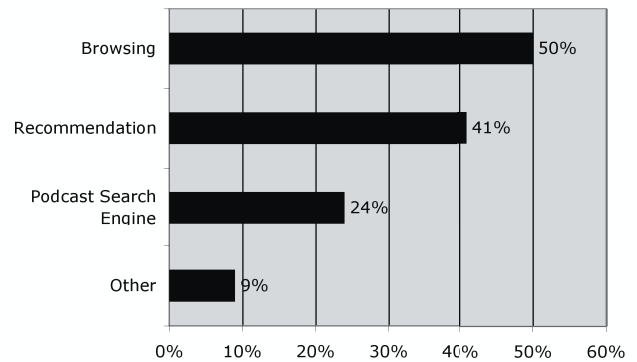


Figure 3: Answers to the question “How do you find the podcasts you listen to?”

which uses category-based search, i.e. search based on metadata information. iTunes was known by two thirds of the respondents who have heard of podcasting and was also indicated to be the most popular search engine by more than 75% of the respondents who indicated a preference. Beyond this, search engines seem to be mostly unknown. However, some respondents indicated knowing other engines, as shown in Figure 4.

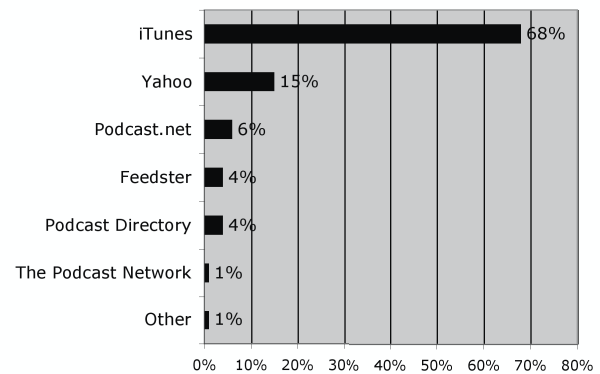


Figure 4: Answers to the question “What podcast search engines have you heard of?” (multiple answers possible)

The two open questions on what they liked or would improve about their favorite podcast search engine were answered by 11 respondents. Some features people generally liked about their favorite search engine were its speed, ease of use, and well designed graphical user interface. For iTunes people also liked that it is integrated with the iPod, which makes it easy to transfer files to the portable player. What they disliked about iTunes was the way search categories and subgenres were defined. They also criticized the selection of available podcasts and thus the small number of results. Table 3 lists the answers to these two questions, excluding responses indicating that there was nothing to improve.

4.2 Diary Study and Interviews

Subjects for the diary study and interviews were mostly recruited from the survey participants. All subjects that initially volunteered responded positively about participating in the follow-up study but four dropped out due to scheduling conflicts.

Seven subjects completed both diary study and follow-up interviews. Subjects included five current university stu-

What do you like about your favorite podcast search engine?
easy to use (mentioned by 4 respondents)
fast (3)
integrated (with mp3 player) (2)
can see what else listeners of my podcast are listening to (1)
nice user interface (1)
broad selection of podcasts (1)
What should be improved on your favorite podcast search engine?
more results (about a specific topic) (2)
more results (in general) (1)
better definition of categories (1)
would like to see what other listeners of this topic are listening to (1)

Table 3: Respondents' preferences and suggestions for improvements of podcast search engines indicate that speed, convenience of use, and broad coverage are important.

dents and two recent graduates, all in informatics or related fields. All subjects had used computers and the internet for several years and used web search several times a week to daily. We found that subjects almost exclusively used major commercial web search engines.

All subjects were aware of podcasting, but one subject had never listened to a podcast. Another subject was planning to listen to a certain podcast but had at that point not yet started with it. One subject reported usually not listening to podcasts but having made several searches on existing content-based search engines to test their performance. Two subjects reported listening to podcasts regularly but downloading individual episodes without subscribing to any podcasts. Two subjects indicated currently being subscribed to podcasts and additionally listening to individual episodes of other podcasts.

The topics of podcasts subjects listened to included science & technology, comedy, politics, music, and general news issues and events. These topics correspond to the topics ranked highest in our survey. Subjects reported listening to both podcasts from professional and from private podcasters. The distinction was not judged very important and subjects indicated they would listen to either type if the desired content was provided.

Subjects stated that they appreciate podcasts for combining information and entertainment, for giving in-depth information about a topic, and for containing more personal information. In particular, podcasts were judged more personal because listening to people speaking was perceived as a more personal experience, and because subjects expected podcasts to express individuals' opinions and ideas. Consequently subjects indicated they would consult other sources of information for factual, objective, and up-to-date information.

The strategies subjects reported to find or obtain access to podcasts or podcast episodes included query-based search, directed and undirected browsing, and requested or unrequested recommendations; see Table 4 for detailed descriptions. We distinguish between *explicit search goals* and *implicit search goals*. The first refers to consciously sought information, in this case a podcast, resulting in an active search for it. The latter implies the user's unawareness of seeking a certain information up to the point where it is found.

All of these scenarios were described by interview subjects. For example, one subject discussed a situation where both requested recommendation and query-based search were used. The subject was looking for very specific information on constructing model planes. First, a colleague who was judged to know a lot about the question was consulted, and recommended a podcast on the topic. The col-

Strategy	Description
Query-based search	Use of a textual query directed at a search engine or any other website. Used with explicit search goals for which the best source of information or its exact location is yet unknown.
Directed browsing	Used with explicit search goals. Does not include the use of queries but browsing through sites that are known or believed to contain or link to the desired information, e.g. a specific podcast episode.
Undirected browsing	Implies an implicit search goal. An possible scenario is a user browsing for other reason and incidentally encountering a podcast they decide to download.
Requested recommendation	Used with explicit search goals. The user asks another person where an appropriate source of information can be found, before consulting the internet.
Unrequested recommendation	Implies an implicit search goal. The user does not actively search for an item but receives a recommendation from another person and decides to follow it.

Table 4: Search strategies that subjects reported during the interviews.

league provided very specific information on a podcast he was aware of. The subject then used a general web search engine to search the particular website mentioned by the colleague for keywords related to the podcast episode. The subject was able to find the relevant episode and continued to regularly listen to the podcast. A similar search strategy was reported by a subject who occasionally listens to episodes of a radio show that is also provided as a podcast on the radio station's website. In these cases the subject typically hears a show on the radio and wants to hear it again. The search strategy consists of visiting the radio station's website and searching for podcasts in the approximate time-frame in which the show was broadcast. Two subjects reported having found podcasts via recommendations in blogs they are reading regularly. This corresponds to the scenario of unrequested recommendation, even if the recommender might not be a personal acquaintance of the user. A similar example for requested recommendation is the use of the suggest function of a search engine, which gives personalized recommendations based on the users' search history. This was reported by one subject in the context of other multimedia search.

One subject stated that they would use different strategies depending on whether they were looking for a whole podcast or an episode on a specific topic. In the first case they would use search on a podcast directory. In the second case they would do a query-based search on a general web search engine to get links to forums and blogs discussing possibly relevant episodes. This way the subject wants to learn about other people's opinions about an episode before downloading it.

Subjects also reported on having to use a disfavored search strategy for lack of specific tools for podcast search or because they did not believe query-based search for audio content to be possible. For example, one subject reported a case where they were looking for a speech by someone, containing a certain quotation. To find it the subject went to a website that usually publishes similar material. According to the subject it would have been easier to use parts of the quotation as a search query. The subject stated that this would require analysis of audio content online and thought this to be currently impossible.

In the second part of the interview subjects were asked to explore a hypothetical situation in which they would search for podcasts. Four different strategies for podcast search were identified: query-based search on a specialized podcast search engine, query-based search on a general web search engine, browsing a podcast directory, and browsing a website that is known to provide related information. All subjects agreed on the usefulness of audio search func-

tionality, either as one option in a general search engine or as an external search engine. Most subjects indicated that, to find podcasts on broad topics, they would use a general web search engine and add terms like "podcast", "audio", or "mp3" to their queries. Specific features that subjects would like to see in podcast search engines are listed in Table 5.

Name	Description
Description	Full text transcripts of the podcast should be provided with every result item. If this is not possible, coherent text describing the content of the podcast should be displayed. (6)
Meta information	Several kinds of information should be displayed along with result items. Subjects mentioned: length of the file, genre (e.g., serious vs. comedian), language, source (URL of broadcaster), date of publication, name of speaker, link to full podcast rather than single episode, a keyword cloud, a tracklist (for music podcasts), and estimated download time. (5)
Search method	Possibility to choose between metadata and content search should be provided. (5) One subject also wanted to choose between searching full descriptions or titles only. Other opinions were that both methods should be applied for searching but for every result item only the more relevant information should be displayed, or it should be indicated whether the search terms appeared in the metadata of the content of the podcast. One subject thought that the user should be able to choose between query-based search and search by browsing categories at every point.
Audio snippets	Short audio snippets containing the search term should be available. (3)
Search options	It should be possible to set flags when searching, e.g. choose language, user rating, length (preferably as range from min to max), etc. (3).
Ranking options	It should be possible to rank search results by different criteria. Criteria mentioned were: most clicked, best according to user reviews, date, source, size or length, language, country of origin, and music vs. speech. (1)
User comments	One subject would want the engine to combine search functionality with social network features. Thus it should provide the possibility to give ratings and write comments about podcasts. The subject also would like to see what other podcasts subscribers of a certain podcasts listen to. (1)

Table 5: Features that interview subjects would like to see in a podcast search engine.

When asked whether they would like to be able to search the spoken content of podcasts, subjects stated that they thought that audio content search was not available or even possible. An exception to this was one subject who knew about existing engines for content search due to a class they had followed for their university studies. One subject said that they were not aware of content search being available but that they would expect any (hypothetical) search engine to apply it because they believed that pure metadata search could be done equally well by general search engines. All of the subjects stated that content search of audio would be useful. They identified content search as the most appropriate method for situations in which they had very specific information needs and were not looking for a broad topic. One subject stated that content search might be particularly well suited for identifying the desired information in highly structured spoken audio such as news items, or when the data is known to contain a certain piece of information, which then only has to be located. Some of the subjects were concerned that content search could deliver too many results for common word queries. Therefore they would appreciate the possibility of choosing the search method. The subject who had been using content-based search engines before found that this method holds the risk of retrieving podcast episodes that contain the query term but do not really discuss the sought topic. The subject there-

fore thought that counting the occurrences of the search term could help to estimate the relevance of the episode to the query, where a higher amount of occurrences would indicate higher relevance.

During the search engine interaction part of the interview subjects were presented with results to the query "Netherlands", which is a very general search term. The query was executed both with metadata search and with content search. All subjects found the results of the content search to be generally more relevant.

5 Conclusion and Future Work

In this study we report on an exploratory user study of podcast search. Specifically, our goals are to identify what kind of podcasts users are searching for, what search strategies they employ, and whether perceptions of available search tools influence podcast-related search goals and strategies.

We approach these questions with a two-stage study. First, we conducted a survey to get a broad overview of general perceptions of podcast search, and to recruit subjects for a follow-up study. The follow-up study consisted of a short-term diary study and an interview.

Study participants were students and recent graduates of a university's informatics institute and as expected we found respondents to be more aware of podcasting and listening to podcasts more frequently than is expected among the general population.

The goals when searching for or listening to podcasts appear to be different from those of web search in general but similar to user goals in blog search. Podcasts are preferred when personal opinions or ideas are sought, for in-depth information about very specific topics, or to combine information and entertainment. Accordingly, the most frequently listened-to podcasts are centered on topics like technology, science, music, and comedy.

A lot of different strategies are used to find podcasts, including query-based search, directed and undirected browsing, and requested and unrequested recommendations. Survey respondents indicated having used browsing most frequently, followed by recommendations and search. Interview subjects provided example scenarios for each of the different strategies as well as combinations of several strategies.

Subjects of our study use a variety of strategies and these strategies appear to be very much influenced by perceptions about available tools. For example, subjects reported using disfavored strategies because they thought content search was not possible. Most subjects indicated that they would like to be able to use content-based search, but thought it was technically impossible. Also, some of the most frequently mentioned features of an ideal podcast search engine require audio transcripts of the spoken podcast content.

Due to the small scale and exploratory nature of our study, our results may not generalize to other populations and future work includes larger scale quantitative studies to complement our initial results. As a next step, we plan a relevance assessment study exploring whether metadata- or content-based search is better suited to meet the individual search goals identified in our study. This way, we hope to identify search-goal-specific characteristics that can be used for future research on query-dependant search method adaptation. Also, our findings about preferences in search engine features will influence further development of the

search engine used in the interviews' interaction part. Generally, we believe that the results of our study will be beneficial in informing the design of future studies in the field and the development and evaluation of algorithms and interfaces for podcast search.

Acknowledgments

We would like to thank all people who volunteered to participate in our study. We are also grateful to Frank van Gils for allowing us to use his podcast retrieval system Podvinder in our study, and providing us with the relevant software and instructions.

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