

Leveraging EAD in a Semantic Web Environment to Enhance the Discovery Experience for the User of Digital Archives

Steffen Henniecke
Humboldt-Universität zu Berlin
Berlin School of Library and
Information Science
Dorotheenstr. 17, 10117 Berlin,
Germany
steffen.henniecke@ibi.hu-
berlin.de

ABSTRACT

The dissertation investigates what archival users are looking for in an archive in terms of reference questions and how they are searching for answers by applying those questions to digital archival finding aids within a specific archival information system. Patterns of questions and search behavior are modeled in an ontology representing the knowledge archival users expect from archival finding aids. This model is then compared to archival finding aids encoded with the *Encoded Archival Description* (EAD) standard to identify semantic gaps between both knowledge graphs. For this purpose the ARGUS information system of the Bundesarchiv and related reference questions are analyzed in a case study. The aim is to find out if information modeled in EAD matches the archival user's expectations and to formulate a model and a methodology which can be applied and validated in similar cases of digital archives and libraries in order to improve and facilitate access to archival information systems.

Categories and Subject Descriptors

E.1 [Data]: Data Structures – *Graphs and networks*; H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval – *Clustering, Query formulation, Search process*; H.3.7 [Information Storage and Retrieval]: Digital Libraries User issues – *Collections, Standards, User issues*; H.5.0 [Information Interfaces and Presentation]: General.

General Terms

Experimentation, Theory.

Keywords

information need, information-seeking behavior, archival user, archive, user study, EAD, semantic web, finding aid, holding guide, archival reference question

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1. RESEARCH INTEREST

Archives hold manifold traces and fragments from the past [23]. Those primary sources are part of our cultural memory and cultural heritage. To learn about our past and to understand our present it is crucial that archives and their holdings are accessible to researchers. As part of the advent of digital libraries also archives started to move towards digital archives in order to reach out to their users and facilitate access to their archival descriptions and materials.

1.1 Access to Archives

Commonly, the main means of access to primary sources in an archive are *finding aids* and *holding guides* supported by the expertise of archivists. Archival finding aids typically describe a holding and the records it contains according to the *principle of provenance*. This fundamental principle emphasizes custodial history and takes into account the institutional origin and original order of items and their context in a collection now deposited in the archive.¹ It is important to notice that a record described in an archival finding aid does not denote a single object like in library catalogues but the – possibly many and diverse – contents of a “box” and its context within the particular holding. The holding guide resembles “a finding aid for finding aids” by employing the same principle of provenance to the structure of the whole archive.

Those archival finding aids are only useful to a researcher if the user's cognitive representation of an archive converges with the archivist's cognitive representation of the holding. Only then, Yakel remarks, “the user is able to locate and utilize the archives and to identify primary sources that may hold the answer to his or her inquiry” [26]. This refers to one of the essential issues of the archive's relation to its users: The convergence of expectations and needs of archival users with the traditional archival documentation practice and customary archival access tools. Research clearly shows prevailing deficits in this area.²

¹ The *principle of pertinence* arranges items in collections according to their subjects.

² Please confer section “Current State of Research” for further details.

1.2 Archives in the Digital Age

The advanced “dawn of the digital age” [25] urges archives to increase online access to archival descriptions and materials in response to growing user expectations towards their services [10]. The “golden age of archival descriptive standards” [5] most recently yielded the *Encoded Archival Description* (EAD) standard which is the latest and most promising effort to bring standardization to archival finding aids and their online publication.

However, the development and implementation of online archival descriptions is still informed by only “modest knowledge of the use of archival materials” [5]. Studies on the implementation of traditional finding aids as EAD finding aids confirm that there is a prevailing divergence between users’ and archivists’ cognitive representations and expectations towards the way information is structured, ordered, and presented [6, 19]. It seems, traditional archival finding aids are merely mirrored to a digital environment and thereby take unresolved issues towards user needs with them.

One conclusion to be drawn from this situation is that archives are missing out on many great opportunities to considerably improve access to their archival descriptions and materials in terms of user needs. Regarding public responsibility of state archives this also concerns the question of proper investment of public resources into correspondent online projects.

In the light of such a desiderate it is imperative to gain deeper knowledge of the kind of questions archival users pose to an archive and how they are searching for answers to those questions. The study of reference questions sheds light on the *information needs* with which users approach archives [13]. The analysis of the *information-seeking behavior* of users – but also of archivists – in pursue of answers to those questions is a necessary second step if we want to thoroughly comprehend how information needs in the form of questions are applied to archival finding aids and how those aids actually support finding answers [12]. An important implicit question is how well the traditional hierarchical and provenance-oriented approach to archival descriptions fits those patterns of questions and search behavior.

1.3 Exploiting the Richness of Archives

Regarding current implementations of online archival descriptions Dow remarked that the future will bear more sophisticated solutions where the EAD elements encoded today “will become the raw materials of any [future] data-centric high technology (...). If properly done now, our EAD-encoded finding aids will not need redoing later” [9]. Indeed, finding aids and holding guides encoded with EAD constitute rich sources of implicit knowledge and are proven means of access to records. They rest on a well-established archival documentation tradition which now eventually found a widely accepted description standard in the form of EAD. Therefore the aim should not be to reinvent archival descriptions or to replace archival finding aids but to supplement them in order to better exploit the latent knowledge they contain informed by a thorough analysis of user needs and behavior. If we better understood those patterns we could improve access to archival descriptions and materials by taking proper advantage of new ways of data representation.

The graph-based approach of the *Semantic Web*³ models information as statements about resources⁴ in the form of triples (Subject - Predicate - Object). This technique allows to interconnect resources in a meaningful way and to create open networks of knowledge. Ontologies define classes of resources and types of semantic relations between them. This allows to model patterns of questions and of search behavior into an ontology which can be applied as an additional layer to EAD-encoded archival finding aids. Such an ontology explicitly represents the implicit knowledge we find at the various levels of archival finding aids but also the latent knowledge of archivists. Furthermore, it structures and contextualizes this knowledge according to users’ patterns of information needs and behavior.

Furthermore, such an ontology would constitute a richer context layer around EAD-encoded archival finding aids providing records with “anchors” for further contextualization via external knowledge resources. By opening up the self-contained archival information space the archival descriptions can benefit from veritable external sources in many ways. Authority files, for example, on geographical entities⁵ or persons⁶ would help to disambiguate meaning of concepts. The connection of less well described records into a “global network of knowledge” [8] would elevate their visibility and meaning without giving up crucial archival principles like provenance or custody.

Yakel added to her statement about the importance of converging cognitive representations that it would be key to create “finding aids that are true boundary objects” [26]. An ontology which models typical patterns of questions and search behavior and which is applied to archival descriptions might very well be such a boundary object and facilitate access and discovery in archival holdings. Maybe this is a “sophisticated solution” as imagined by Dow which could help “in unlocking the full value of archival resources” [21] building upon EAD-encoded archival finding aids.

2. CURRENT STATE OF RESEARCH

This section gives a selected and brief overview of some of the more important work related to the topic of this dissertation. The discussion will further deepen and locate the research problem.

Numerous studies exist on information needs and digital information-seeking behavior of humanists especially in the library domain. The literature on archives and its users is still not comparable neither in size nor quality. This is also the case for technological discussions on how to present and model archival data in the digital age. In the end, most studies agree on the fact that current implementations of archival information systems are probably not the best way to make archival descriptions and materials accessible to users.

³ For further details please confer:
<http://www.w3.org/standards/semanticweb/> [2011/03/25].

⁴ A resource can represent anything: web documents, real-world objects, or abstract concepts.

⁵ E.g. “Thesaurus of Geographic Names” (TGN):
<http://www.getty.edu/research/tools/vocabularies/tgn/>
[2011/03/25].

⁶ E.g. “Virtual International Authority File” (VIAF):
<http://viaf.org/> [2011/03/25].

2.1 Study of Archival Reference Questions

Only a few studies specifically looked at reference questions posed to archives. The most important one has been conducted by Duff et al. [13] who analyze email reference questions to archives in order to find out about the unfiltered information needs of the users. The study focuses on the types of questions and the elements used differentiated by “givens” and “wanted”. Mostly in accordance with previous studies they find out that user inquiries mainly focus on resource discovery (material finding, specific form, and known item), service requests, user education, administrative/directional, fact finding and consultation, while terms used include proper names, dates, places, subject, form, and partly events. General subject terms were less important.

Similar studies focus primarily on reference questions as communication channels to archives but not so much on the structure of those questions [3, 18]. Especially, no research explicitly made the connection between “asking a question” and “finding an answer” to the question. Conway's [4] large-scale study on how researchers communicate with archives is noteworthy in so far as he also considers the research question elements in more detail. He identifies elements like date, place, medium, personal name, and broad subject as the most frequently used ones. However, no study analyzed the semantic relations between the elements within reference questions yet.

2.2 Study of Archival Information-Seeking Behavior

A range of studies took a broader perspective by studying the digital information-seeking behavior of certain archival user groups. This includes information needs but foremost aspects of search, presentation, and use of archival finding aids and materials. All studies identify a range of issues concerning the information-seeking behavior within current archival information systems and make suggestions on how to improve access to and presentation of archival descriptions and materials.

Chapman's [1] analysis of user interaction with online finding aids indicates severe deficiencies of current systems as users heavily rely on browser search functions. Tibbo [24, 25] looks at historians and how they locate primary sources in the digital age. She concludes that multiple pathways into the digital material are necessary and that there is user wariness regarding electronic search methodologies. Duff et al. [11] specifically look at genealogists as one of the most frequent users of archives. Based on their findings they give suggestions on how to improve access to archival information systems. Nimer et al. [20] conducted user studies to gain a better understanding of the user perspectives and needs towards archival collections. This was done for an archival project which specifically tried to improve the “usefulness” of an archival information system by introducing a concept model, i.e. an additional layer on top of the finding aid which is tailored towards typical user needs and tasks.

2.3 Archival Implementations of EAD

Gilliland-Swetland's [14] study is one of the very few ones which advocates the same general idea as this dissertation of going beyond the traditional conceptualization of the finding aid structure in order to exploit EAD for better discovery and user satisfaction. She adapts Bates “berrypicking” approach and outlines a couple of search capabilities to enhance browsing and retrieval in EAD-based archival finding aids. She draws user

requirements from the general information behaviors and practices within different disciplines. While her analysis does not go beyond the boundaries of EAD and its data representation this study specifically expands those boundaries by introducing an additional knowledge structure based on a graph-based data representation.

The usability study of EAD interfaces by Yakel [27] indicates that users urge for better interfaces with less archival jargon or prior understanding of archival hierarchical documentation traditions. She identifies issues with search functions and content display. Kim [17] analyzes a variety of EAD-encoded finding aids regarding their usability and concludes that better navigational aids, browsing and navigational functions are needed as well as controlled access points via person names, place names, or general topics. Generally, studies about EAD and its implementation predominantly suggest that access to archival descriptions did not significantly improve [5]. However, as Coats [2] points out in her literature review on user studies of archival finding aids, more broader-based user studies on EAD finding aids are necessary to determine if this lack of improvement is really the fault of EAD.

Recently, Sinn [22] looked at archival users and how they perform research about a specific topic in an archival collection and how they perceive the importance of the found material for their work. The results show research patterns which differ from the typical assumptions of archivists indicating divergence of cognitive representations and that we probably do not need changes in EAD but have the necessity of a boundary object to close the gap.⁷

3. RESEARCH QUESTIONS AND HYPOTHESES

This dissertation looks at the process of stating and satisfying archival information requests. In particular, its focus lies on the semantic patterns of reference questions posed to archives and the patterns of how answers are found to those questions within an online archival information system encoded with EAD. Furthermore, the study looks at how these two essential aspects relate to each other. The results will be a deepened understanding of information needs and information-seeking behavior of archival users. All research done so far indicates that those user expectations towards archival information system are not properly satisfied.

This leads to the following main research question:

- Does information encoded in EAD have semantic gaps that impede matching users' information needs to archival records?

Secondary (implicit) research questions are:

- What information needs do archival users articulate towards archives in the form of reference questions?
- How do archival users and archivists seek for answers in digital archival finding aids?
- How do archival users apply their information needs to an archival information system?

⁷ At the time of writing no studies which deal with the particular topic of semantic web and EAD were known to the author.

- How can Semantic Web technology enhance and facilitate discovery and retrieval in archival information systems?
- Are hierarchical archival description and documentation practice compatible with graph-based representations?

The general hypothesis is that graph-based approaches to archival information systems allow for modeling patterns of questions, search, and discovery and that they are in fact suitable for the hierarchical archival documentation practice. The knowledge which EAD is able to accommodate compared to the knowledge which is expected by the users from archival finding aids will show semantic gaps. At the same time, those gaps can be closed by modeling user expectations into an ontology. The outcome of this study, therefore, will be the suggestion of an ontology which is meant to facilitate research in terms of searching, finding, and discovering information in archival information systems.

4. RESEARCH PLAN AND METHODOLOGY

4.1 Research Data

Reference questions are provided by the German Federal Archive, the Bundesarchiv⁸. Every analog or electronic query submitted to the Bundesarchiv is collected in a central register in one file for each user. Those files contain every reference question a user ever poses to the Bundesarchiv, the archive's responses, and the user management form, if the user decides to visit the archive in person. Furthermore, the reference questions are classified according to year, user's background, and the general topic.

The Bundesarchiv also agreed to the usage of their ARGUS⁹ information system which is the first archival information system in Germany which utilizes EAD for encoding archival finding aids. The contents primarily include records from contemporary German history: Federal Republic of Germany (FRG) and Western Occupied Zones 1945 ff., Deutsches Reich 1495 to 1945, German Democratic Republic (GDR) and Soviet Occupied Zone 1949-1990, Military Archive, and Archive of the Political Parties and Mass Organizations of the GDR.

The system contains the complete holding guide of the Bundesarchiv with 6000 short descriptions and 1.600+ finding aids with 1,5+ million records, all of which have been integrated into a common search engine and search interface. Additionally, about 3000 files from 14 holdings have been digitized amounting to 660.000 digitized pages encoded in METS (partly with OCR texts attached). Those METS are linked to the records in the finding aids.

The ARGUS system will be cloned to a server provided by startext¹⁰ and therefore can be easily modified with logging software¹¹ and other means necessary for the intended research.

⁸ <http://www.bundesarchiv.de/> [2011/05/25]

⁹ "Archivgutsuche": <http://startext.net-build.de:8080/barch/MidosasSEARCH/search.htm> [2011/03/20].

¹⁰ Technical developer and host of the ARGUS system: <http://www.startext.de/> [2011/03/20].

¹¹ Provided by Delving: <http://www.delving.eu> [2011/03/20].

4.2 Information Needs of Archival Users: Asking Questions

The first part of the dissertation consists of two steps. The first step consists of a literature review in order to get a clear picture of the current state of research and to extract results concerning the general information needs and the digital information-seeking behavior of archival users into a compiled list with user requirements towards archival information systems.

The second step is an analysis of a set of reference questions in order to support findings concerning term patterns used in inquiries to an archive reflecting the information need of a user. By analyzing reference questions it is possible to find out about the unfiltered information needs of the users. Only questions that aim at resource discovery (material finding, specific form, and known item) and fact finding and that are oriented towards collections will be considered. The aim of this analysis is to find out about which kind of questions users pose to an archive. In particular: Which types of questions occur, which terms are used in those questions, in which semantic relation do these terms stand, and, finally, how many steps do relations span that further qualify or specify a request?

The method adapts the approach of Duff and Johnson [13] who themselves follow Grogan's schema for categorizing reference questions asked in libraries [15] and Jahoda's taxonomy of reference queries [16] as discussed by Grogan. Questions are coded according to type of request, "wanted" information, and "given" information. This approach will be expanded by introducing the dimension of semantic relation between terms.

This first part will give a clear picture of the information needs of archival users of the Bundesarchiv.

4.3 Information-Seeking Behavior of Archival Users: Finding Answers

The second part will be validated and complemented the results of the first part by an experiment which focuses on the information-seeking behavior within the specific archival information system ARGUS. The analysis will be guided by the previously compiled user requirement list.

Conway [4] identified the four broad user categories academic, occupational, avocational, and personal each of which accommodates several user groups. These categories will be used to classify different user groups which could include, for example:

- Academic historians as the most prominent academic users.
- Archivists or more general institutional administrators as occupational users.
- History teachers or genealogists as avocational users.

The experiment includes three different tasks:

- Participants have to find the answer to a given question. Typical questions are derived from the previous analysis of reference questions.
- Participants are provided an "ideal" result to a given question and have to find the same result. The "ideal" result resembles the professional answer of an archivist to a question.

- Participants are asked to “play” with the system and to explore it. This task aims at finding out about the discovery aspect of an information system which is a crucial aspect of any research process.

In order to keep the experiment manageable it will be limited to a certain subset of the whole system. Data collection methods will include a transaction log analysis. For this purpose, the ARGUS system will be cloned and prepared with special logging software. Access will be provided via Internet. The data collection method will be supplemented by a short survey for biographical data.

The aim is to discover trends in the information-seeking behavior and specifically to find out about term patterns in query formulation (e.g. term co-occurrence) and navigational patterns within the archival aid structure and the search results. How do users perform their searches in a system based on a concrete starting question? How do users “translate” questions into queries to the system? Which kind of resourcefulness do they employ to deal with the restrictions of the system? Regarding the archival finding aids: Which structural and descriptive parts of those finding aids do users utilize?

The first part of this dissertation on the user’s information needs and the second part on the user’s information-seeking behavior provide the data for conducting the third part.

4.4 Identifying Semantic Gaps

The results of the first and second part are formalized in the third part of the dissertation. The leading research question is if the information that can be encoded in EAD, i.e. is encapsulated in its very structure, is sufficient to answer to the user questions and if it does meet user expectations.

First, EAD must be converted to a graph-based representation in order to enable a comparison with the CIDOC-CRM modeled knowledge structures users expect from an EAD finding aid. An appropriate ontology to accommodate EAD is yet to be determined. A candidate is the Europeana Data Model (EDM).¹²

Secondly, a suitable ontology must be found which is able to accommodate the identified entities and relations, i.e. the knowledge expected by users. The most promising candidate at the moment is CIDOC-CRM¹³ which is a high-level ontology to enable information integration for cultural heritage data and their correlation with library and archive information. It abstracts from the common conceptualizations behind data and metadata structures to support data transformation, mediation, and merging [7].

Such a model would make explicit the knowledge which is implicitly available in the EAD-encoded archival finding aids including latent knowledge from “external” sources like the professional knowledge of archivists. It structures the knowledge according to the user needs and behavior and shows how the expected knowledge would look like. By comparing the model with EAD-encoded finding aids we can identify missing key elements, i.e. semantic gaps, in EAD and shortcomings in its traditional hierarchical structure as it is. This comparison will be

conducted as a case study using a limited selection of finding aids from the ARGUS information system.

An example for a semantic gap on a higher conceptual level would be what Yakevitch described as divergent cognitive representations: the idea different user groups have of archival finding aids and an archival record and its functions or even archives as whole.

A concrete example for a semantic gap would be a search for the name of a municipality which might be present in the full text of an EAD element but in a different or outdated spelling or language than the user typed in. In such a case the municipal name and corresponding records would not be found. Also the territory or the national ownership of the municipality itself could have changed during the course of history. Named entity recognition and semantic enrichment and alignment to a controlled vocabulary – which very well could be represented in an EAC file – could help to close such a semantic gap. To expand this idea a bit further, geo-based discovery could allow picking a region on a map and limit the search to a certain time period in order to find records from this time and region. Again, the necessary information is available but only in rudimentary form in different parts of the archival finding aid structure and/or external knowledge sources.

Another case would be when the user found a record, for example about a person, and now the user is interested in records which are related to the person mentioned in the initial record, for example by occupation, profession, family, birth/death date/place etc. The user could also be interested in similar relations to the record itself, for example by creator, creation date, provenance, custody etc.

Such connections might be implicitly available in the EAD knowledge structure located at different levels of the descriptive hierarchy but without being explicitly expressed they cannot be exploited. Such missing connections are semantic gaps which can be closed by applying a knowledge structure on top of EAD. Full text search fails to discover such connections and to place the information into context found in the descriptive hierarchy.

5. SUMMARY: AIMS AND VALUE OF THE STUDY

This dissertation is a case study which utilizes the archival information system ARGUS of the German Federal State Archive Bundesarchiv. The system is the first archival information system in Germany which encodes archival finding aids in EAD and integrates them into a common search engine and search interface.

The study focuses on the main research question if information encoded in EAD has semantic gaps that impede matching users’ information needs to archival records.

In order to answer this question the study analyzes the information needs and information-seeking behavior with respect to the search process – searching, finding, and discovering – in the archive and thereby contributes to the deficient understanding of the archival user needs. The study particularly combines an analysis of information needs, i.e. terms used in reference questions and their semantic relations, with an analysis of information-seeking behavior, i.e. patterns of query formulation and navigation in archival finding aid structures and the search results. The study specifically looks at how users translate

¹² <http://version1.europeana.eu/web/europeana-project/technicaldocuments/> [2011/03/20].

¹³ <http://www.cidoc-crm.org/> [2011/03/20].

information needs to an archival system, i.e. compares queries and logs. The outcome of these two parts is a more comprehensive picture of user requirements towards an archival information system.

The third part draws from the results of the two previous ones by modeling the knowledge users expect from an archival information system in order to compare this model with the knowledge graph of EAD and to identify semantic gaps. Thereby the study also gives suggestions on how to apply semantic web concepts to archival information systems encoded in EAD and how to apply graph-based representations to archival descriptions.

The result is a suggestion of a model which enhances and facilitates information discovery in archival information systems by closing semantic gaps between EAD encoded archival descriptions and information needs and seeking behavior of archival users. It is important to note that this research does not try to define a new archival description standard or to revise an existing one but to formulate a mediator, i.e. a boundary object, to put on top of existing EAD-encoded ontologies. Furthermore, a methodology will be defined which can be applied to and/or validated in similar contexts of different digital archives/libraries.

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