Tagging, Folksonomy & Co -
Renaissance of Manual Indexing?[*]

Jakob Voß

January 2007
Common Library Network GBV
Göttingen, Germany
jakob.voss@gbv.de

Abstract

This paper gives an overview of current trends in manual indexing on the Web. Along with a general rise of user generated content there are more and more tagging systems that allow users to annotate digital resources with tags (keywords) and share their annotations with other users. Tagging is frequently seen in contrast to traditional knowledge organization systems or as something completely new. This paper shows that tagging should better be seen as a popular form of manual indexing on the Web. Difference between controlled and free indexing blurs with sufficient feedback mechanisms. A revised typology of tagging systems is presented that includes different user roles and knowledge organization systems with hierarchical relationships and vocabulary control. A detailed bibliography of current research in collaborative tagging is included.

1 Introduction

The World Wide Web, a framework originally designed for information management [4], has long ago become a heterogeneous, exponentially growing mass of connected, digital resources. After first, unsuccessful attempts to classify the Web with traditional, intellectual methods of library and information science, the standard to search the Web is now fulltext indexing – most of all made popular by Google's PageRank algorithm. The success of such automatic techniques is a reason why "many now working in information retrieval seem completely unaware that procedures other than fully automatic ones have been applied, with some success, to information retrieval for more then 100 years, and that there exist an information retrieval literature beyond that of the computer science community."[24] However in the recent years there is a renaissance of manual subject indexing and analysis: Structured metadata is published with techniques like RSS, OAI-PMH, and RDF. OpenSearch[1] and browser search plugins allow it to aggregate specialised search engines. Last but not least many popular social software systems contain methods to annotate resources with keywords. This type of manual indexing is called *tagging* with index terms referred to as *tags*. Based on [30] this paper presents a revised typology of tagging systems that also includes systems with controlled and structured vocabularies. Section 2 gives a short introduction to current tagging systems and its research. Afterwards (section 3) theory of subject indexing is pictured with the indexing process, typology of knowledge organization systems, and an unconventional look at vocabulary control. In section 4 the typology of tagging systems is presented with conclusion in section 5.

2 Tagging systems on the rise

Tagging is referred to with several names: *collaborative tagging*, *social classification*, *social indexing*, *folksonomy* etc. The basic principle is that end users do subject indexing instead of experts only, and the assigned tags are being shown immediately on the Web. The number of websites that support tagging has rapidly increased since 2004. Popular examples are del.icio.us (`http://del.icio.us`), furl (`http://furl.net`), reddit (`http://reddit.com`), and Digg (`http://digg.net`) for bookmarks [12] and flickr (`http://flickr.com`, [49]) for photos. Weblog authors usually tag their articles and specialized search engines like Technorati (`http://technorati.com/`) and RawSugar (`http://rawsugar.com`) make use of it. But tagging is not limited to simple keywords only: BibSonomy (`http://bibsonomy.org`, [16, 15]), Connotea (`http://connotea.org`, [27]), CiteULike (`http://citeulike.org/`), and LibraryThing (`http://librarything.com`) allow users to manage and share bibliographic metadata on the Web (also known as *social reference managing* or *collaborative cataloging*). The popular free encyclopedia Wikipedia contains so called categories that are used as hierarchical tags to order the articles by topic [48]. Apart from social software there is also a rise of manual indexing in other fields [50, 29].

---

[1]To gain an insight on RSS, OAI-PMH, RDF, and OpenSearch see `http://en.wikipedia.org/`.

The details of tagging vary a lot but all applications are designed to be used as easy and as open as possible. Sometimes the greenness in theory of users and developers let you stumble upon known problems like homonyms an synonyms but on the other hand unloaded trial and error has led to many unconventional and innovative solutions.

2.1 Research on Tagging

The astonishing popularity of tagging led some even claim that it would overcome classification systems [38], but it is more likely that there is no dichotomy [7] and tagging just stresses certain aspects of subject indexing. Meanwhile serious research about collaborative tagging is growing — hopefully it will not have to redo all the works that has been done in the 20th century. At the 15th World Wide Web Conference there was a *Collaborative Web Tagging Workshop*[2]. The 17th SIG/CR Classification Research Workshop was about *Social Classification*[3]. One of the first papers on folksonomies is [31]. Shirky's paper [38] has reached huge impact. It is probably outdated but still worth to read. A good overview until the beginning of 2006 is given in [28]. Some papers that deal with specific tagging systems are cited at the beginning of this section at page 2. Trant and Smith describe the application of tagging in a museum [45, 44, 39]. Other works focus on tagging in enterprises [9, 20, 25, 34] or knowledge management [51]. Another application is tagging people to find experts [41, 9]. Mathematical models of tagging are elaborated in [43, 23]. The usual model of tagging is a tripartite graph, the nodes being resources, users, and tags [23]. Several papers provide statistical analysis of tagging over time [6, 8, 22, 18, 26]. Tagging behaviour is also topic of Kipp and Campbell [21] and Feinberg [10]. Types of structured and compound tagging are analyzed in [2, 42, 11]. Like in traditional scientometrics you can find communities and trends based on tagging data [19, 18]. Voss [48] finds typical distributions among different types of tagging systems and compares tagging systems with traditional classification and thesaurus structures. Tennis [40] uses framework analysis to compare social tagging and subject cataloguing. Tagging is manual indexing instead of automatic indexing. Ironically a focus of research is again on automatic systems that do data mining in tagging data [1, 16, 17, 37, 36]. Heymann and Garcia-Molina[13] presented an algorithm to automatically generate hierarchies of tags out of flat, aggregated tagging systems with del.icio.us data. Similar approaches are used by Begelman et al. [3] and Mika et al. [33]. Research on tagging mostly comes from computer science and library science — obviously there is a lack of input from psychology, sociology, and cognitive science in general (an exception from philosophy is Campell [5] who applies Husserl's theory of phenomenology to tagging).

---

[2]http://www.rawsugar.com/www2006/taggingworkshopschedule.html
[3]http://www.slais.ubc.ca/users/sigcr/events.html

3 The indexing process

The main purpose of subject indexing is to construct a representation of a resource that is being tagged. According to Lancaster [24, chapter 2] subject indexing involves two steps: conceptual analysis and translation (see figure 1). These are intellectually separate although they are not always clearly distinguished. The semiotic triangle can be applied to indexing to demonstrate the distinction between object (resource), concept (what the resource is about), and symbol (set of tags to represent the res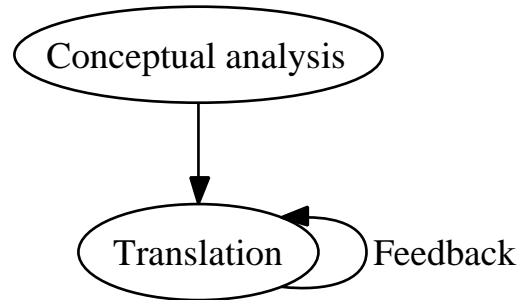ource). *Conceptual analysis* involves deciding on what a resource is about and what is relevant in particular. Note that the result of conceptual analysis heavily depends on the needs and interests of users that a resource is tagged for — different people can be interested in different aspects. *Translation* is the process of finding an appropriate set of index terms (tags) that represent the substance of conceptual analysis. Tags can be extracted from the resource or assigned by an indexer. Many studies have shown that high consistency among different indexers is very difficult to achieve and affected by many factors [24, chapter 3]. One factor is control of the vocabulary that is used for tagging. Synonyms (multiple words and spellings for the same concept) and homonyms/homographs (words with different meanings) are frequent problems in the process of translation. A controlled vocabulary tries to eliminate them by providing a list of preferred and non-preferred terms, often together with definitions and a semantic structure. Controlled vocabularies are subsumed as knowledge organization systems (KOS) [53]. These systems have been studied and developed in library and information science for more then 100 years. Popular examples are the Dewey Decimal Classification, Ranganathan's faceted classification, and the first thesauri in the 1960s. Beginning with the 1950s library and information science has lost its leading role in the development of information retrieval systems and a rich variety of KOS has come into existence. However it is one of the constant activities of this profession to summarize and evaluate the complexity of attempts to organize the world's knowledge.

Figure 1: Steps in subject indexing

3.1 Typology of knowledge organization systems

Hodge, Zeng, and Tudhope [14, 52, 46] distinguish by growing degree of language control and growing strength of semantic structure: term list, classifications and categories, and relationship groups. Term lists like authority files, glossaries, gazetteers, and dictionaries emphasize lists of terms often with definitions. Classifications and categories like subject headings and classification schemes (also known as taxonomies) emphasize the creation of subject sets. Relationships groups like thesauri, semantic networks, and ontologies

emphasize the connections between concepts. Apart from the training of what now may be called *ontology engineers* the theoretical research on knowledge organization systems has had little impact on technical development. Only now common formats are being standardized with SKOS[4], the microformats movement[5] and other initiatives. Common formats are a necessary but not sufficient condition for interoperability among knowledge organization systems — an important but also frequently underestimated task [53, 32].

3.2 Vocabulary control and feedback

In the process of indexing the controlled vocabulary is used to supply translation via *feedback* (figure 1). The indexer searches for index terms supported by the structure of the knowledge organization systems until he finds the best matching tag. Also search is supported by the structure of the knowledge organization systems. Collaborative tagging also provide feedback.

A special kind of tagging system is the category system of Wikipedia. The free encyclopedia is probably the first application of collaborative tagging with a thesaurus [48]. The extend of contribution in Wikipedia is distributed very inhomogeneously (more precise it is a power law [47]) — this also applies for the category system. Everyone is allowed to change and add categories but most authors only edit the article text instead of tagging articles and even less authors change and add the category system. Furthermore each article is not tagged independently by every user but users have to agree on a single set of categories per article. So tagging in Wikipedia is somewhere between indexing with a controlled vocabulary and free keywords. Most of the time authors just use the categories that exist but they can also switch to editing the vocabulary at any time. The emerging system may look partly chaotic but rather useful. With a comparison of Wikipedia and the AGROVOC[6] thesaurus Milne et al. [35] show that domain-specific thesauri can be enriched and created with Wikipedia's category and link structure.

We can deduce that the border between free keyword tagging on the one hand and tagging with a controlled vocabulary is less strict. Although most tagging systems do not implement vocabulary control there is almost always some feedback that influences tagging behaviour towards consensus: the Folksonomy emerges [31]. The phenomena is also known as *emergent semantics* or *Wisdom of the crowds*.

---

[4]http://www.w3.org/2004/02/skos/
[5]http://microformats.org/
[6]http://www.fao.org/agrovoc

4 Typology of tagging systems

Based on Marlow's taxonomy of tagging systems[30] I provide a revised typology. The following key dimensions do not represent simple continuums but basic properties that should be clarified for a given tagging system — so they are presented here as questions.

Tagging Rights Who is allowed to tag resources? Can any user tag any resource or are there restrictions? Are restrictions based on resources, tags, or users? Who decides on restrictions? Is there a distinction between tags by different types of users and resources?

Source of Resources Do users contribute resources and have resources been created or just supplied by users? Or do users tag resources that are already in the system? Who decides which resources are tagged?

Resource Representation What kind of resource is being tagged? How are resources presented while tagging (autopsi principle)?

Tagging Feedback How does the interface support tag entry? Do users see other tags assigned to the resource by other users or other resources tagged with the same tags? Does the system suggest tags and if so based on which algorithms? Does the system reject inappropriate tags?

Tag Aggregation Can a tag be assigned only once to a resource (set-model) or can the same tag can be assigned multiple times (bag-model with aggregation)?

Vocabulary control : Is there a restriction on which tags to use and which tags not to use? Are tags created while tagging or is management of the vocabulary a separated task? Who manages the vocabulary, how frequently is it updated, and how are changes recorded?

Vocabulary Connectivity Are tags connected with relations? Are relations associative (authority file), monohierarchical (classification or taxonomy), multihierarchical (thesaurus), or typed (ontology)? Where do the relations come from? Are relations limited to the common vocabulary (precoordination) or can they dynamically be used in tagging (postcoordination with syntactic indexing)?

Resource Connectivity How are resources connected to each other with links or grouped hierarchically? Can resources be tagged on different hierarchy levels? How are connections created?

Automatic Tagging Is tagging enriched with automatically created tags and relations (for instance file types, automatic expansion of terms etc.)?

The analysis shows that the classic tripartite model of tagging with resources, users, and tags is too simplified to cover the variety of tagging system. Depending on the application you can distinguish different kind of resources, tags, and users. At least you should distinguish four user roles:

1. **Resource Author** A person that creates or edits a resource

2. **Resource Collector** A person that adds a resource to a tagging system

3. **Indexer or Tagger** A person that tags resources

4. **Searcher** A person that uses tags to search for resources

In most systems some of the roles overlap and people can fullfill different roles at different times (large libraries may be a counterexample). For instance the author of a private blog combines 1, 2, and 3, a user of del.icio.us combines either 2 and 3 (tagging a new webpage) or 3 and 4 (copying a webpage that someone else has already tagged), and a Wikipedia author combines either 1 and 2 (new articles) or 1 and 3 (existing articles).

5 Conclusion

The popularity of collaborative tagging on the Web has resurged interest in manual indexing. Tagging systems encourage users to manually annotate digital objects with free keywords and share their annotations. Tags are directly assigned by anyone who likes to participate. The instant visibility is motivation and helps to install feedback mechanism. Through feedback the drawbacks of uncontrolled indexing are less dramatic then in previous systems and the border between controlled and free indexing starts to blur. Vocabulary control and relationships between index terms should not be distinctive features of tagging systems and traditional knowledge organization systems but possible properties of manual indexing systems. The typology of tagging systems that was presented in section 4 combines all of them. The possibility to allow non-experts to add keywords has made collaborative tagging so popular — but it is nothing fundamentally new. Perhaps the most important feature of tagging systems on the Web is its implementation or how Joseph Busch entitled his keynote speech at the ASIST SIG-CR workshop: "It's the interface, stupid!" Today's tagging websites make many traditional knowledge organization systems look like stone age technique: effective but just too uncomfortable. Some of the costly created thesauri and classifications are not even accessible in digital form at all (because of licensing issues grounded in a pre-digital understanding of copyright or because of a lack of technological skills)! But also computer scientists tend to forget that a clever interface to support tagging can be worth much more than any elaborated algorithm. Anyway the art of creating interfaces for developed tagging systems is still in its infancy. Knowledge organization will always need manual input so it is costly to manage — but Wikipedia showed that groups of volunteers can create large knowledge resources if a common goal and the right toolkit exist! And obviously there is not one way of indexing that fits for all applications. Collaborative Tagging is neither the successor of traditional indexing nor a short-dated trend but — like Tennis [40] concludes — a catalyst for improvement and innovation in indexing.

References

[1] Melanie Aurnhammer, Luc Steels, and Peter Hanappe. Integrating collaborative tagging and emergent semantics for image retrieval. In *Proceedings of the WWW 2006 Collaborative Web Tagging Workshop*, 2006. Online: `http://www.rawsugar.com/www2006/17.pdf`.

[2] Judit Bar-Ilan, Snunith Shoham, Asher Idan, Yitzchak Miller, and Aviv Shachak. Structured vs. unstructured tagging: A case study. In *Proceedings of the WWW 2006 Collaborative Web Tagging Workshop*, 2006. Online: `http://www.rawsugar.com/www2006/12.pdf`.

[3] Grigory Begelman, Philipp Keller, and Frank Smadja. Automated tag clustering: Improving search and exploration in the tag space. In *Proceedings of the WWW 2006 Collaborative Web Tagging Workshop*, 2006. Online: `http://www.rawsugar.com/www2006/20.pdf`.

[4] Tim Berners-Lee. Information Management: A Proposal. Report, CERN, 1989. Online: `http://www.w3.org/History/1989/proposal-msw.html`.

[5] D. Grant Campbell. A phenomenological framework for the relationship between the semantic web and user-centered tagging systems. In *Proceedings of the 17th SIG Classification Research Workshop*, 2006. Online: `http://www.slais.ubc.ca/users/sigcr/sigcr-06campbell.pdf`.

[6] Ciro Cattuto, Vittorio Loreto, and Luciano Pietronero. Collaborative tagging and semiotic dynamics, 2006. Online: `http://arXiv.org/abs/cs/0605015`.

[7] Walt Crawford. Folksonomy and Dichotomy. *Cites & Insights*, 6(4), 2006. Online: `http://cites.boisestate.edu/v6i4a.htm`.

[8] Micah Dubinko, Ravi Kumar, Joseph Magnani, Jasmine Novak, Prabhakar Raghavan, and Andrew Tomkins. Visualizing tags over time. In *Proceedings of the 15th Conference on World Wide Web*, 2006. Online: `http://www2006.org/programme/files/pdf/25.pdf`.

[9] Stephen Farrell and Tessa Lau. Fringe contacts: People-tagging for the enterprise. In *Proceedings of the WWW 2006 Collaborative Web Tagging Workshop*, 2006. Online: `http://www.rawsugar.com/www2006/25.pdf`.

[10] Melanie Feinberg. An examination of authority in social classification systems. In *Proceedings of the 17th SIG Classification Research Workshop*, 2006. Online: `http://www.slais.ubc.ca/users/sigcr/sigcr-06feinberg.pdf`.

[11] Marieke Guy and Emma Tonkin. Folksonomies tidying up tags? *D-Lib Magazine*, 12, 2006. Online: `http://www.dlib.org/dlib/january06/guy/01guy.html`.

[12] Tony Hammond, Timo Hannay, Ben Lund, and Joanna Scott. Social Bookmarking Tools (I): A General Review. *D-Lib Magazine*, 11, 2005. Online: `http://www.dlib.org/dlib/april05/hammond/04hammond.html`.

[13] Paul Heymann and Hector Garcia-Molina. Collaborative creation of communal hierarchical taxonomies in social tagging systems. Report, InfoLab, Stanford, 2006. Online: `http://heymann.stanford.edu/taghierarchy.html`.

[14] Gail Hodge. *Systems of Knowledge Organization for Digital Libraries: Beyond Traditional Authority Files.* CLIR Publications, 2000. Online: `http://www.clir.org/pubs/abstract/pub91abst.html`.

[15] Andreas Hotho, Robert Jäschke, Christoph Schmitz, and Gerd Stumme. Das entstehen von semantik in bibsonomy. In *Social Software in der Wertschöpfung*. Nomos, 2006. Online: `http://www.kde.cs.uni-kassel.de/stumme/papers/2006/hotho2006entstehen.pdf`.

[16] Andreas Hotho, Robert Jäschke, Christoph Schmitz, and Gerd Stumme. Emergent semantics in bibsonomy. In *Proceedings of the 1st Workshop on Applications of Semantic Technologies*, 2006. Online: `http://www.kde.cs.uni-kassel.de/stumme/papers/2006/hotho2006emergent.pdf`.

[17] Andreas Hotho, Robert Jäschke, Christoph Schmitz, and Gerd Stumme. Information Retrieval in Folksonomies: Search and Ranking. In *Proceedings of the 3rd European Semantic Web Conference*, volume 4011 of *Lecture Notes in Computer Science*, 2006. Online: `http://www.kde.cs.uni-kassel.de/stumme/papers/2006/hotho2006information.pdf`.

[18] Andreas Hotho, Robert Jäschke, Christoph Schmitz, and Gerd Stumme. Trend Detection in Folksonomies. In *Proceedings of the 1st Conference on Semantics And Digital Media Technology*, 2006. Online: `http://www.kde.cs.uni-kassel.de/stumme/papers/2006/hotho2006trend.pdf`.

[19] Robert Jäschke, Andreas Hotho, Christoph Schmitz, and Gerd Stumme. Wege zur Entdeckung von Communities in Folksonomies. In *Proceedings des 18. Workshop Grundlagen von Datenbanken*, pages 80–84, 2006. Online: `http://www.kde.cs.uni-kassel.de/jaeschke/pub/jaeschke2006wege_gvd.pdf`.

[20] Ajita John and Dore Seligmann. Collaborative tagging and expertise in the enterprise. In *Proceedings of the WWW 2006 Collaborative Web Tagging Workshop*, 2006. Online: `http://www.rawsugar.com/www2006/26.pdf`.

[21] Margaret Kipp and Grant Campbell. Patterns and inconsistencies in collaborative tagging systems: An examination of tagging practices. In *Proceedings of the ASIST Annual Meeting*, 2006. Online: `http://eprints.rclis.org/archive/00008315/`.

[22] Tobias Kowatsch, Timo Muenster, and Wolfgang Maass. Social Economics and the Shift of Common Interests. In *Proceedings of the 30th ACM SIGIR Conference*, 2007. Online: `http://kowatsch.org/master/fopro/kmm07.pdf`.

[23] Renaud Lambiotte and Marcel Ausloos. Collaborative tagging as a tripartite network. *Lecture Notes in Computer Science*, 3993:1114–1117, 2005. Online: `http://arXiv.org/abs/cs/0512090`.

[24] F. W. Lancaster. *Indexing and Abstracting in Theory and Practise.* facet publishing, third edition edition, 2003.

[25] Donna Cuomo Laurie Damianos, John Griffith. Onomi: Social bookmarking on a corporate intranet. In *Proceedings of the WWW 2006 Collaborative Web Tagging Workshop*, 2006. Online: `http://www.rawsugar.com/www2006/28.pdf`.

[26] Xia Lin, Joan E. Beaudoin, Yen Bui, and Kaushal Desai. Exploring characteristics of social classification. In *Proceedings of the 17th SIG Classification Research Workshop*, 2006. Online: `http://www.slais.ubc.ca/users/sigcr/sigcr-06lin.pdf`.

[27] Ben Lund, Tony Hammond, Martin Flack, and Timo Hannay. Social Bookmarking Tools (II): A Case Study - Connotea. *D-Lib Magazine*, 11, 2005. Online: `http://www.dlib.org/dlib/april05/lund/04lund.html`.

[28] George Macgregor and Emma McCulloch. Collaborative tagging as a knowledge organisation and resource discovery tool. *Library Review*, 55:291–300, 2006. Online: `http://eprints.rclis.org/archive/00005703/`.

[29] Seth Maislin. The indexing revival. *intercom*, pages 6–8, 2005. Online: `http://taxonomist.tripod.com/ftp/IndexingRevival.pdf`.

[30] Cameron Marlow, Mor Naaman, Danah Boyd, and Marc Davis. Position paper, tagging, taxonomy, flickr, article, toread. In *Proceedings of the WWW 2006 Collaborative Web Tagging Workshop*, 2006. Online: `http://www.rawsugar.com/www2006/29.pdf`.

[31] Adam Mathes. Folksonomies - Cooperative Classification and Communication Through Shared Metadata. Report, Graduate School of Library and Information Science, Illinois Urbana-Champaign, 2004. Online: `http://www.adammathes.com/academic/computer-mediated-communication/folksonomies.h`

[32] Philipp Mayr. Thesauri, Klassifikationen & Co – die Renaissance der kontrollierten Vokabulare? In *Vom Wandel der Wissensorganisation im Informationszeitalter*, pages 151–170. Bock und Herchen, 2006.

[33] Péter Mika. Ontologies are us: A unified model of social networks and semantics. In *Proceedings of the 4th International Semantic Web Conference*, 2005. Online: `http://www.cs.vu.nl/~pmika/research/papers/ISWC-folksonomy.pdf`.

[34] David R. Millen, Jonathan Feinberg, and Bernard Kerr. Social bookmarking in the enterprise. In *Proceedings of the SIGCHI conference on Human Factors in computing systems*, 2006.

[35] David Milne, Olena Medelyan, and Ian H. Witten. Mining Domain-Specific Thesauri from Wikipedia: A case study. In *Proceedings of the Conference on Web Intelligence*, 2006. Online: `http://www.cs.waikato.ac.nz/~olena/publications/milne_wikipedia_final.pdf`.

[36] Christoph Schmitz, Andreas Hotho, Robert Jäschke, and Gerd Stumme. Mining Association Rules in Folksonomies. In *Proceedings of the 10th IFCS Conference*, 2006. Online: `http://www.kde.cs.uni-kassel.de/stumme/papers/2006/schmitz2006mining.pdf`.

[37] Patrick Schmitz. Inducing ontology from flickr tags. In *Proceedings of the WWW 2006 Collaborative Web Tagging Workshop*, 2006. Online: `http://www.rawsugar.com/www2006/22.pdf`.

[38] Clay Shirky. Ontology is overrated, 2005. Online: `http://shirky.com/writings/ontology_overrated.html`.

[39] Martha Kellogg Smith. Viewer tagging in art museums: Comparisons to concepts and vocabularies of art museum visitors. In *Proceedings of the 17th SIG Classification Research Workshop*, 2006. Online: http://www.slais.ubc.ca/users/sigcr/sigcr-06smith.pdf.

[40] Joseph T. Tennis. Social tagging and the next steps for indexing. In *Proceedings of the 17th SIG Classification Research Workshop*, 2006. Online: http://www.slais.ubc.ca/users/sigcr/sigcr-06tennis.pdf.

[41] Willem Thoonen Toine Bogers and Antal van den Bosch. Expertise classification: Collaborative classification vs. automatic extraction. In *Proceedings of the 17th SIG Classification Research Workshop*, 2006. Online: http://www.slais.ubc.ca/users/sigcr/sigcr-06bogers.pdf.

[42] Emma Tonkin. Searching the long tail: Hidden structure in social tagging. In *Proceedings of the 17th SIG Classification Research Workshop*, 2006. Online: http://www.slais.ubc.ca/users/sigcr/sigcr-06tonkin.pdf.

[43] Milorad Tošić and Valentina Milićević. The Semantics of Collaborative Tagging System. In *Proceedings of the 2nd Workshop on Scripting for the Semantic Web*, 2006. Online: http://www.semanticscripting.org/SFSW2006/Paper6.pdf.

[44] Jennifer Trant. Social classification and folksonomy in art museums: Early data from the steve.museum tagger prototype. In *Proceedings of the 17th SIG Classification Research Workshop*, 2006. Online: http://www.slais.ubc.ca/users/sigcr/sigcr-06trant.pdf.

[45] Jennifer Trant and Bruce Wyman. Investigating social tagging and folksonomy in art museums with steve.museum. In *Proceedings of the WWW 2006 Collaborative Web Tagging Workshop*, 2006. Online: http://www.rawsugar.com/www2006/4.pdf.

[46] Douglas Tudhope. A tentative typology of KOS: towards a KOS of KOS? In *Proceedings of the 5th European NKOS Workshop*, 2006. Online: http://www.ukoln.ac.uk/nkos/nkos2006/presentations/tudhope.ppt.

[47] Jakob Voss. Measuring wikipedia. In *Proceedings of the 10th Conference of the International Society for Scientometrics and Informetrics*, 2005. Online: http://eprints.rclis.org/archive/00003610/.

[48] Jakob Voss. Collaborative thesaurus tagging the wikipedia way. Report, Wikimetrics, 2006. Online: http://arXiv.org/abs/cs/0604036.

[49] Megan Winget. User-defined classification on the online photo sharing site flickr. In *Proceedings of the 17th SIG Classification Research Workshop*, 2006. Online: http://www.slais.ubc.ca/users/sigcr/sigcr-06winget.pdf.

[50] Ian Wright. The future of indexing? *WritersUA*, 2005. Online: http://www.winwriters.com/articles/indexing_future/.

[51] Harris Wu, Mohammad Zubair, and Kurt Maly. Harvesting social knowledge from folksonomies. In *Proceedings of the 17th conference on Hypertext and hypermedia*, 2006.

[52] Marcia Lei Zeng. Taxonomy of knowledge organization sources/systems, 2000. Online: `http://nkos.slis.kent.edu/KOS_taxonomy.htm`.

[53] Marcia Lei Zeng and Lois Mai Chan. Trends and issues in establishing interoperability among knowledge organization systems. *Journal of the American Society for Information Science and Technology*, 55(5):377–395, 2004.