

# Tagging, Folksonomy & Co – Renaissance of Manual Indexing?\*

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## **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 [Berners-Lee 1989], 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

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success, to information retrieval for more than 100 years, and that there exist an information retrieval literature beyond that of the computer science community.” [Lancaster 2003] 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<sup>1</sup> and browser search plug-ins 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 [Marlow et al. 2006] 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 [Hammond et al. 2005] and flickr (<http://flickr.com>, [Winget 2006]) 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>, [Hotho et al. 2006b,a]), Connotea (<http://connotea.org>, [Lund et al. 2005]), CiteU-Like (<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 cataloguing). In addition to librarian’s subject indexing the University of Pennsylvania Library allows users to tag records in their online catalog since 2005 (<http://tags.library.upenn.edu/>). Other systems to tag bibliographic data are LibraryThing (<http://www.librarything.com>) and Amazon’s tagging feature (<http://amazon.com/gp/tagging/cloud/>). The popular free encyclopaedia

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<sup>1</sup> To gain an insight on RSS, OAI-PMH, RDF, and OpenSearch see <http://en.wikipedia.org/>.

Wikipedia contains so called categories that are used as hierarchical tags to order the articles by topic [Voss 2006]. Apart from social software there is also a rise of manual indexing in other fields [Wright 2005, Maislin 2005].

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 and 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 [Shirky 2005], but it is more likely that there is no dichotomy [Crawford 2006] 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 20<sup>th</sup> century. At the 15<sup>th</sup> World Wide Web Conference there was a Collaborative Web Tagging Workshop<sup>2</sup>. The 17<sup>th</sup> SIG/CR Classification Research Workshop was about Social Classification<sup>3</sup>. One of the first papers on folksonomies is [Mathes 2004]. Shirky's paper [Shirky 2005] has reached huge impact. It is probably outdated but still worth to read. A good overview until the beginning of 2006 is given in [Macgregor & McCulloch 2006]. Some papers that deal with specific tagging systems are cited at the beginning of section 2. Trant and Smith describe the application of tagging in a museum [Trant & Wyman 2006, Trant 2006, Smith 2006]. Other works focus on tagging in enterprises [Farrell & Lau 2006, John & Seligmann 2006, Laurie Damianos 2006, Millen et al. 2006] or knowledge management [Wu et al. 2006]. Another application is tagging people to find experts [Toine Bogers & van den Bosch 2006, Farrell & Lau 2006]. Mathematical models of tagging are elaborated in [Tošić & Milićević 2006, Lambiotte & Ausloos 2005]. The usual model of tagging is a tripartite graph, the nodes being resources, users, and tags [Lambiotte & Ausloos 2005]. Several papers provide statistical analysis of tagging over time and evolution of tagging systems [Kowatsch et al. 2007, Cattuto et al. 2006, Dubinko et al. 2006, Hotho et al. 2006d, Lin et al. 2006]. Tagging behaviour is also topic of Kipp and [Campbell Kipp & Campbell 2006] and Feinberg [Feinberg 2006]. Types of structured and compound tagging are analyzed in [Bar-Ilan et al. 2006, Tonkin 2006, Guy & Tonkin 2006]. Like in traditional scientometrics you can find com-

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<sup>2</sup> <http://www.rawsugar.com/www2006/taggingworkshopschedule.html>

<sup>3</sup> <http://www.slais.ubc.ca/users/sigcr/events.html>

munities and trends based on tagging data [Jäschke et al. 2006, Hotho et al. 2006d]. Voss [Voss 2006] finds typical distributions among different types of tagging systems and compares tagging systems with traditional classification and thesaurus structures. Tennis [Tennis 2006] 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 [Aurnhammer et al. 2006, Hotho et al. 2006b,c, Schmitz 2006, Schmitz et al. 2006]. Heymann and Garcia-Molina [Heymann & Garcia-Molina 2006] 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. [Begelman et al. 2006] and Mika et al. [Mika 2005]. 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 [Campbell 2006] who applies Husserl’s theory of phenomenology to tagging).

### 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 [Lancaster, 2003, chapter 2], subject indexing involves two steps: conceptual analysis and translation (see figure 1).

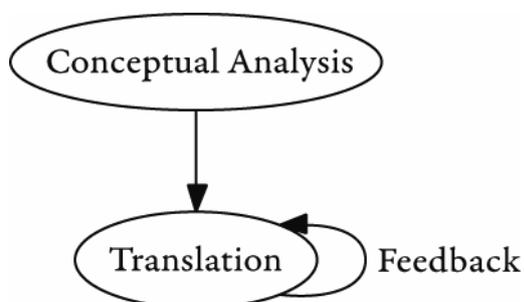


Figure 1: Steps in subject indexing

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 resource). 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 [Lancaster, 2003, 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) [Zeng & Chan 2004]. These systems have been studied and developed in library and information science for more than 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.

### **3.1 Typology of knowledge organization systems**

Hodge, Zeng, and Tudhope [Hodge 2000, Zeng 2000, Tudhope 2006] 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<sup>4</sup>, the microformats movement<sup>5</sup> 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 [Zeng & Chan 2004, Mayr 2006].

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<sup>4</sup> <http://www.w3.org/2004/02/skos/>

<sup>5</sup> <http://microformats.org/>

### 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 provides feedback.

A special kind of tagging system is the category system of Wikipedia. The free encyclopaedia is probably the first application of collaborative tagging with a thesaurus [Voss 2006]. The extend of contribution in Wikipedia is distributed very inhomogeneously (more precise it is a power law [Voss 2005]) – 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<sup>6</sup> thesaurus Milne et al. [Milne et al. 2006] 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 [Mathes 2004]. This phenomena is also known as emergent semantics or Wisdom of the crowds [Surowiecki 2004] (But you should keep in mind that masses do not always act wise – see Lanier's critic of 'Digital Maoism' [Lanier 2006]).

## 4 Typology of tagging systems

Based on Marlow's taxonomy of tagging systems [Marlow et al. 2006] 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. The best corresponding dimension of Marlow's typology is noted in brackets.

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<sup>6</sup> <http://www.fao.org/agrovoc>

**Tagging Rights** (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 Resource** (Source of material)

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?

**Representation of Resource** (Type of object)

What kind of resource is being tagged? How are resources presented while tagging (for instance autopsy principle)?

**Tagging Feedback** (Tagging Support)

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** (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** (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.)?

Marlow also includes social connectivity, but only the influence of this property on other dimensions like Tagging Feedback and Source of Resources is of interest. 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:

**Resource Author:** A person that creates or edits a resource

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

**Indexer or Tagger:** A person that tags resources

**Searcher:** A person that uses tags to search for resources

In a system that uses controlled vocabularies, the role of a Vocabulary Editor (a person that maintains the vocabulary) may be added. In most systems some of the roles overlap and people can fulfil different roles at different times (a large library with strict distribution of tasks 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). Existing applications of tagging can be described and classified with the typology above and the four roles. For instance author keywords are assigned by the author of a publication (Tagging Rights, Source of Resources, Representation of Resource), with no or little feedback (Tagging Feedback), other people may add their own keywords, but there is little or no aggregation (Tag Aggregation), keywords are free and unconnected (Vocabulary Control, Vocabulary Connectivity).

## **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 than in previous systems and the border between controlled and free in-

dexing 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. Further research is needed to find out under which circumstances which features (for instance vocabulary control) are needed and how they influence tagging behaviour, evolution of the tagging system, and benefits of tagging for searching and browsing. The typology of tagging systems and roles 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 [Tennis 2006] concludes — a catalyst for improvement and innovation in indexing.

## 6 References

- Aurnhammer, M., Steels, L., & Hanappe, P. (2006). Integrating collaborative tagging and emergent semantics for image retrieval. In Proceedings of the WWW 2006 Collaborative Web Tagging Workshop.
- Bar-Ilan, J., Shoham, S., Idan, A., Miller, Y., & Shachak, A. (2006). Structured vs. unstructured tagging: A case study. In Proceedings of the WWW 2006 Collaborative Web Tagging Workshop.
- Begelman, G., Keller, P., & Smadja, F. (2006). Automated tag clustering: Improving search and exploration in the tag space. In Proceedings of the WWW 2006 Collaborative Web Tagging Workshop.
- Berners-Lee, T. (1989). Information Management: A Proposal. Technical report, CERN.
- Campbell, D. G. (2006). A phenomenological framework for the relationship between

- the semantic web and user-centered tagging systems. In Proceedings of the 17<sup>th</sup> SIG Classification Research Workshop.
- Cattuto, C., Loreto, V., & Pietronero, L. (2006). Collaborative tagging and semiotic dynamics.
- Crawford, W. (2006). Folksonomy and Dichotomy. *Cites & Insights*, 6 (4).
- Dubinko, M., Kumar, R., Magnani, J., Novak, J., Raghavan, P., & Tomkins, A. (2006). Visualizing tags over time. In Proceedings of the 15<sup>th</sup> Conference on World Wide Web.
- Farrell, S. & Lau, T. (2006). Fringe contacts: People-tagging for the enterprise. In Proceedings of the WWW 2006 Collaborative Web Tagging Workshop.
- Feinberg, M. (2006). An examination of authority in social classification systems. In Proceedings of the 17<sup>th</sup> SIG Classification Research Workshop.
- Guy, M. & Tonkin, E. (2006). Folksonomies tidying up tags? *D-Lib Magazine*, 12.
- Hammond, T., Hannay, T., Lund, B., & Scott, J. (2005). Social Bookmarking Tools (I): A General Review. *D-Lib Magazine*, 11.
- Heymann, P. & Garcia-Molina, H. (2006). Collaborative creation of communal hierarchical taxonomies in social tagging systems. Technical report, InfoLab, Stanford.
- Hodge, G. (2000). Systems of Knowledge Organization for Digital Libraries: Beyond Traditional Authority Files. CLIR Publications.
- Hotho, A., Jäschke, R., Schmitz, C., & Stumme, G. (2006a). Das entstehen von semantik in bibsonomy. In *Social Software in der Wertschöpfung*. Nomos.
- Hotho, A., Jäschke, R., Schmitz, C., & Stumme, G. (2006b). Emergent semantics in bibsonomy. In Proceedings of the 1st Workshop on Applications of Semantic Technologies.
- Hotho, A., Jäschke, R., Schmitz, C., & Stumme, G. (2006c). Information Retrieval in Folksonomies: Search and Ranking. In Proceedings of the 3rd European Semantic Web Conference, volume 4011 of Lecture Notes in Computer Science.
- Hotho, A., Jäschke, R., Schmitz, C., & Stumme, G. (2006d). Trend Detection in Folksonomies. In Proceedings of the 1st Conference on Semantics And Digital Media Technology.
- Jäschke, R., Hotho, A., Schmitz, C., & Stumme, G. (2006). Wege zur Entdeckung von Communities in Folksonomies. In Proceedings des 18. Workshop Grundlagen von Datenbanken, (pp. 80 – 84).
- John, A. & Seligmann, D. (2006). Collaborative tagging and expertise in the enterprise. In Proceedings of the WWW 2006 Collaborative Web Tagging Workshop.
- Kipp, M. & Campbell, G. (2006). Patterns and inconsistencies in collaborative tagging systems: An examination of tagging practices. In Proceedings of the ASIST Annual Meeting.
- Kowatsch, T., Muenster, T., & Maass, W. (2007). Social Economics and the Shift of Common Interests.
- Lambiotte, R. & Ausloos, M. (2005). Collaborative tagging as a tripartite network. *Lecture Notes in Computer Science*, 3993, 1114 – 1117.
- Lancaster, F. W. (2003). *Indexing and Abstracting in Theory and Practise* (Third edition ed.). facet publishing.

- Lanier, J. (2006). Digital maoism: The hazards of the new online collectivism. Edge.
- Laurie Damianos, John Griffith, D. C. (2006). Onomi: Social bookmarking on a corporate intranet. In Proceedings of the WWW 2006 Collaborative Web Tagging Workshop.
- Lin, X., Beaudoin, J. E., Bui, Y., & Desai, K. (2006). Exploring characteristics of social classification. In Proceedings of the 17<sup>th</sup> SIG Classification Research Workshop.
- Lund, B., Hammond, T., Flack, M., & Hannay, T. (2005). Social Bookmarking Tools (II): A Case Study - Connotea. D-Lib Magazine, 11.
- Macgregor, G. & McCulloch, E. (2006). Collaborative tagging as a knowledge organisation and resource discovery tool. Library Review, 55, 291 – 300.
- Maislin, S. (2005). The indexing revival. intercom, 6 – 8.
- Marlow, C., Naaman, M., Boyd, D., & Davis, M. (2006). Position paper, tagging, taxonomy, flickr, article, toread. In Proceedings of the WWW 2006 Collaborative Web Tagging Workshop.
- Mathes, A. (2004). Folksonomies - Cooperative Classification and Communication Through Shared Metadata. Technical report, Graduate School of Library and Information Science, Illinois Urbana-Champaign.
- Mayr, P. (2006). Thesauri, Klassifikationen & Co – die Renaissance der kontrollierten Vokabulare? In Vom Wandel der Wissensorganisation im Informationszeitalter (pp. 151 – 170). Bock und Herchen.
- Mika, P. (2005). Ontologies are us: A unified model of social networks and semantics. In Proceedings of the 4<sup>th</sup> International Semantic Web Conference.
- Millen, D. R., Feinberg, J., & Kerr, B. (2006). Social bookmarking in the enterprise. In Proceedings of the SIGCHI conference on Human Factors in computing systems.
- Milne, D., Medelyan, O., & Witten, I. H. (2006). Mining Domain-Specific Thesauri from Wikipedia: A case study. In Proceedings of the Conference on Web Intelligence.
- Schmitz, C., Hotho, A., Jäschke, R., & Stumme, G. (2006). Mining Association Rules in Folksonomies. In Proceedings of the 10<sup>th</sup> IFCS Conference.
- Schmitz, P. (2006). Inducing ontology from flickr tags. In Proceedings of the WWW 2006 Collaborative Web Tagging Workshop.
- Shirky, C. (2005). Ontology is overrated.
- Smith, M. K. (2006). Viewer tagging in art museums: Comparisons to concepts and vocabularies of art museum visitors. In Proceedings of the 17<sup>th</sup> SIG Classification Research Workshop.
- Surowiecki, J. (2004). The Wisdom of Crowds: Why the Many Are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies and Nations. Little Brown.
- Tennis, J. T. (2006). Social tagging and the next steps for indexing. In Proceedings of the 17<sup>th</sup> SIG Classification Research Workshop.
- Toine Bogers, W. T. & van den Bosch, A. (2006). Expertise classification: Collaborative classification vs. automatic extraction. In Proceedings of the 17<sup>th</sup> SIG Classification Research Workshop.

- Tonkin, E. (2006). Searching the long tail: Hidden structure in social tagging. In Proceedings of the 17<sup>th</sup> SIG Classification Research Workshop.
- Tošić, M. & Milićević, V. (2006). The Semantics of Collaborative Tagging System. In Proceedings of the 2nd Workshop on Scripting for the Semantic Web.
- Trant, J. (2006). Social classification and folksonomy in art museums: Early data from the steve.museum tagger prototype. In Proceedings of the 17<sup>th</sup> SIG Classification Research Workshop.
- Trant, J. & Wyman, B. (2006). Investigating social tagging and folksonomy in art museums with steve.museum. In Proceedings of the WWW 2006 Collaborative Web Tagging Workshop.
- Tudhope, D. (2006). A tentative typology of KOS: towards a KOS of KOS? In Proceedings of the 5<sup>th</sup> European NKOS Workshop.
- Voss, J. (2005). Measuring wikipedia. In Proceedings of the 10<sup>th</sup> Conference of the International Society for Scientometrics and Informetrics.
- Voss, J. (2006). Collaborative thesaurus tagging the wikipedia way. Technical report, Wikimetrics.
- Winget, M. (2006). User-defined classification on the online photo sharing site flickr. In Proceedings of the 17<sup>th</sup> SIG Classification Research Workshop.
- Wright, I. (2005). The future of indexing? WritersUA.
- Wu, H., Zubair, M., & Maly, K. (2006). Harvesting social knowledge from folksonomies. In Proceedings of the 17<sup>th</sup> conference on Hypertext and hypermedia.
- Zeng, M. L. (2000). Taxonomy of knowledge organization sources/systems.
- Zeng, M. L. & Chan, L. M. (2004). Trends and issues in establishing interoperability among knowledge organization systems. *Journal of the American Society for Information Science and Technology*, 55 (5), 377 – 395.