

---

## Semantic People Tagging & Ontology Maturing: An Enterprise Social Media Approach to Competence Management

---

### Simone Braun

FZI Research Center for Information Technologies, Karlsruhe, Germany

### Christine Kunzmann

FZI Research Center for Information Technologies, Karlsruhe, Germany

### Andreas P. Schmidt

Karlsruhe University of Applied Sciences, Germany

**Abstract:** Semantic People Tagging is an Enterprise 2.0-style approach to making expertise and individual capabilities transparent. By combining it with a collaborative ontology editor and thus the possibility to construct a shared vocabulary and understanding, it can be a supplement for cumbersome competence management, or expert finder solutions, which lack acceptance among employees, and suffer from outdated data. It gives human resources a timely overview of available and required competencies based on peer reviews and actual usage. However, it also needs to be tailored to the cultural characteristics of a specific company. Therefore, we have developed a design framework for semantic people tagging.

We want to present the general approach based on the ontology maturing concept of gradual formalization and its implementation based on a social semantic bookmarking system. Focus group interviews with HR experts have further yielded insights into the wider context and validated the concept. The system has been introduced and evaluated at a company for career advising, and is being rolled out to additional contexts.

**Keywords:** Semantic People Tagging; Social Semantic Tagging; Competence Management; Knowledge Management

**Biographical notes:** *Simone Braun* has been working as senior researcher at FZI Forschungszentrum Informatik in Karlsruhe in several public and private funded research projects in the area of Enterprise 2.0, Knowledge Management and Technology-enhanced Learning. She has received her doctoral degree for her work on social semantic technologies for supporting knowledge workers. In her research she is also working on agile methods for competence management and the role of social structures in business collaborations.

*Christine Kunzmann* studied human resource management at the Pforzheim University of Applied Sciences in Germany. Now she is a freelance HR consultant with special focus on competence management, human resource development and inter-organizational process design for healthcare institutions. At the same time, she works as a researcher on technology-enhanced learning and competence-based approaches in two large-scale European projects MATURE and MIRROR.

*Andreas Schmidt* is professor for enterprise social media and mobile business at Karlsruhe University of Applied Sciences since March 2012. He was a senior researcher and department manager at FZI Research Center for Information Technologies in Karlsruhe, Germany and responsible for the competence area Knowledge and Learning. With a background in computer science and vocational pedagogy and a doctoral degree from University of Karlsruhe, his current research interests focus on workplace learning, application of semantic technologies to knowledge and competence management, and context-awareness in diverse fields. He is currently Scientific Coordinator the EU-FP7 Integrating Project MATURE on understanding and supporting knowledge maturing processes.

---

## 1 Introduction

Competence management (Schmidt & Kunzmann 2007, Biesalski & Abecker 2005, Becerra-Fernandez 2006) and recent trends towards talent management have put employees' capabilities and their development to the center of attention in HR management. Among the main drivers behind this are the anticipated demographic change and the resulting shortage of skilled employees. Competencies are the state-of-the-art conceptual approach for describing work-relevant human behavior in a variety of contexts (Braun et al. 2010). Within an organization, competencies enable instruments for more effective resource allocation (e.g., for team staffing), knowledge management and informal learning support, and human resource development in general. They aim at making transparent individual competencies and their relationship to organizational goals. Recently, this view has been complemented by the usage of competencies in employability processes, ranging from competencies as part of e-portfolios, via competency-based curricula up to competency-driven recruitment processes.

Mainstream competence management approaches are conceived as top-down instruments (see e.g. Biesalski & Abecker 2005, Harzallah et al. 2006) and are based on controlled vocabularies in the form of competency catalogs. In such approaches, a small expert group models such competency catalogs (Ley et al. 2010) and thus defines the vocabulary at irregular intervals (usually well more than yearly) or even as a one-time activity without scheduled updates. This catalog is then provided to the lower management and the employees in order to provide, update, and apply requirements and competency profiles.

However, especially on the level of individual employees, such competence management approaches have so far not been able to show sustainable success on a larger scale (Schmidt & Kunzmann 2007). The same applies to expert finder or

expert locator systems (Becerra-Fernandez 2006), which have often failed in the long run because of incomplete and outdated data, apart from social and organizational barriers. This affects both competency profiles of the individual employee and non-adequate and often also outdated competency catalogs used as a vocabulary for the profiles. A lack of participation of all employees has been identified as one of the key problems (Braun et al. 2010).

People tagging (Farrell et al. 2007b, Braun & Schmidt 2008) an enterprise social media approach to competence management and expert finding aim at identifying the capabilities of employees by using collaborative tagging, thus exploiting the wisdom of the crowds. This represents a paradigmatic shift, moving away from a top-down towards a bottom-up approach. While from a technology perspective, this is about transferring the idea of social (semantic) bookmarking (Braun et al. 2009) from bookmarking resources to bookmarking people, it is a much bigger step from a social and organizational perspective. Tagging resources is different from tagging people; the latter touches much more sensitive issues and there are mutual influences between culture and the people tagging approach.

In this contribution, we want to present the results of developing a semantic people tagging system that combines collaborative tagging of people with collaborative development of a shared vocabulary and its evaluations as part of a design research process. We shortly sketch two field experiments and additional expert interviews that explore the potential and risks of semantic people tagging and the design space for semantic people tagging solutions. Based on these, we have developed a conceptual design framework for semantic people tagging that describes the design aspects and possible design decisions for concrete implementation of semantic people tagging in an organization. We then go on to describe our system that supports semantic people tagging and its use in a career advising organization.

## 2 Related Work

### 2.1 Competence Management in General

Traditionally, competence management approaches are conceived as top-down instruments (see e.g. Berio & Harzallah 2005, Biesalski & Abecker 2005). The basis are competency catalogs (Sicilia 2005) modeled at irregular intervals by small expert groups and then to be used by the operational level in order to provide, update, and apply requirements and competency profiles.

However this method usually leads to communication and coordination problems between strategic and operational level. Schmidt & Kunzmann (2007) have proposed a closed-loop approach in which two-way communication between the different levels forms an integral (see Figure 1). This model is designed from a human resource development perspective. On the strategic level, the competence catalog and the requirement profiles for job roles are modeled in a continuous loop, taking into account corporate goals (in order to ensure that the catalog and the profiles are oriented toward the future) and feedback from the operational level. The operational level uses this vocabulary to describe the actual competency profiles of the individual employees. By comparing the actual competency profile with the requirements profile, it is possible to determine a competency gap, which can be

addressed by development measures. Their outcomes should then improve work performance, which provides the indicators for setting up competency profiles, but also competency aspects which are not yet included in the competence catalog and thus have to be fed back to the strategic level.



**Figure 1** Integrated Model of Competence Management: A closed loop approach  
Schmidt & Kunzmann (2007)

But even with a closed loop approach as outlined, there are still considerable problems when putting those approaches into practice. We will analyze in the following the competence modeling and diagnostics/assessment activities, which are in practice the most challenging ones.

## *2.2 Getting Competency Profiles*

On the operational level, the most obvious problem is getting the competency profiles. One fundamental issue is that competencies cannot be measured, sensed, or observed directly. What we can observe is performance in various forms (Lau & Sure 2002): assessment of learning outcomes, performance in every day job activities etc. All of these yield evidence from which a competency is usually deduced heuristically.

In practice, you can observe two approaches (Biesalski & Abecker 2005): (1) self-assessment approaches in which employees themselves are asked to provide their competencies, sometimes mediated in a second step by their superior, and (2) external assessment approaches done by superiors or through formal assessment procedures.

While the latter approach is very expensive and cumbersome and thus can only be observed in limited areas, the first approach often fails because of missing motivation. This lack of motivation can be traced back to no immediate benefit for the employees. For instance, systems are hardly embedded into everyday work activities and have not proven their usefulness there. Or it can be even traced back to negative incentives; for instance, if you disclose your competencies, others will contact and perhaps disturb you or you will fear to appear not competent enough. As a result, employees might downplay or exaggerate their competencies as Becerra-Fernandez (2006) reports. Often, these competency profiles also do not contain information that is of high relevance to colleagues; for instance manually-updated repositories become particularly outdated (McDonald & Ackerman 2000). Thus, recent and usually very specialized topics are not yet contained in the competency catalog because of the long update intervals.

Several studies address this problem by automatically extracting profile information from data the user generates in her daily work; e.g. from publications (Crowder et al. 2002), documents (Reichling et al. 2007) or community contents (John & Seligmann 2006, Breslin et al. 2007). Ley et al. (2010) propose a competence performance approach that derives competencies from executed tasks. In this approach, a task competency matrix is created together with domain experts. This matrix relates a set of tasks, e.g. required for a position, to a set of competencies needed to fulfill these tasks successfully. Based on this model, the system can infer a user's competency from her successful performance of a task in her daily work.

## *2.3 Social Tagging for Gathering Competence Information*

Web 2.0 developments have also brought forth solutions for competence management. For instance, Schumacher et al. (2010) provide a framework to choose and apply Web 2.0 tools and techniques in the domain of competence management for virtual team building. Unfortunately, the authors don't elaborate on social tagging.

It's mainly social networking approaches that may be used for describing and augmenting employee profiles from the purpose of those profiles for expert finding and community formation. These platforms are mainly based on the self-promotion paradigm: People can represent themselves with a profile and indicate their connections to other users. Further, in some of these approaches, the principle

of social tagging and bookmarking is transferred to people; for instance Xing or theNTSH or Tagalag – the latter two meanwhile gone offline – were one of the first systems that allowed organizing your contacts with tags.

There also have been various people tagging applications on Facebook like Describe Me, Define Me or iDescribe (most of them have gone offline). These applications typically aim for entertaining rather than organizing and sharing knowledge on who knows what. The tagger stays anonymous and users can either choose a limited number of tags from a predefined list or create new tags to describe their friends.

An interesting approach focusing on the quality of tags and encouraging social connectedness has been Collabio. Collabio – short for Collaborative Biography – implemented ideas of Games with A Purpose (von Ahn 2006) to tag people within the Facebook social network (Bernstein et al. 2009, 2010). Users can tag their friends in a game. Therefore, the users only see the tags assigned to a friend in an obscured tag cloud. When they start to describe the friend, guessed tags are uncovered and new tags are added to the tag cloud. For each tag, the users accumulate points equal to the number the tag is assigned to the friend. Only the friend him-/herself can see the whole uncovered tag cloud, who assigned which tag and delete tags if needed. However, self-tagging is not possible. To prevent the cold-start effect of a completely empty tag cloud, seed tags are used from a person’s public profile.

In their evaluation, including a survey with 49 active users as respondents, the authors found that most tags capture affiliation, expertise, interests and hobbies. Uncommon tags describe miscellaneous and unusual information, nevertheless rated as fairly accurate descriptors. Whilst this evaluation shows that Collabio provides accurate and novel information about people, the authors mention three open design challenge: (a) motivate new users to join the game, (b) users stop using the system because of *tag exhaustion*; i.e. users do not know anymore what additional tags to add to their friends, (c) lack of semantics.

For the enterprise context, IBM’s Fringe Contacts (Farrell & Lau 2006, Farrell et al. 2007b) was the first system that implemented people tagging. Within IBM’s Fringe Contacts each employee can describe their colleagues, e.g. for contact management, or themselves, e.g. for self-presentation, by tagging them with arbitrary key words on their expertise and interests. Thus, step by step, a publicly visible tag cloud grows characterizing the individual employee. The authors indicate that this leverages network effects for setting up some sort of profile of the individual, and improves usefulness for the individual user of the system which, in turn, motivates to contribute. For instance, Farrell et al. (2007a) could state that tagging people was used to create communities.

Raban et al. (2011) from IBM Haifa studied self-tagging activity vs. tagging activity by and of others of a three-year-snapshot within their research enterprise employee directory. On the employees’ profile two tag clouds display the tags the employee was tagged with and respectively used to tag others. Self-assigned tags are shown separately. The results show that users who tag themselves are the most productive contributors; both tagging themselves and others. Self-tagged users receive significantly more tags from other users. The study revealed that the more users tag themselves the more they get tagged by others or vice versa and the more people users tag, the more people tag them or vice versa (causality could not be inferred). However, when users tag themselves very extensively, they are tagged less

by others and vice versa – there seem to be a saturation reached at 12-14 tags per user.

Razavi & Iverson (2009) extended OpnTag<sup>1</sup> (Iverson et al. 2008), an open source social bookmarking and note taking web tool, with a people tagging feature. The aim is to enhance relationship and personal privacy management for information sharing. By tagging people, users can categorize their contacts into different target groups to control access to their personal information; e. g. to share a specific memo with all contacts tagged with 'java expert'. For each tag assignment, the user can specify its visibility; tagger only, taggee, people tagged with the same tag by the tagger, or anyone. Altogether, personal privacy only relates to who can access which personal document. Wang & Jin (2009) came up with a similar idea of using tags assigned to people within Fringe Contacts in order to selectively distribute messages in an automated way.

Thielen (2010) have recently analyzed to what extend the characteristics of social tagging systems are applicable for e-HRM tasks; especially to acquire information usable to augment and describe employees' competency profiles. The author presents a conceptual framework with profiles, tagger and tags as the identified dimensions and some basic characteristics. Whereas there are some overlaps with our design framework, our framework presents a more fine granular reflection of the design characteristics together with their impact. Thielen (2010) additionally provide an analysis of the reliability and validity of the competency related information. The author concludes that the absence of guidelines and rules and the lack of semantics that allow different interpretations of tags are the main disadvantages. Nevertheless, social tagging systems might be useful to gather more hidden or multi-perspective information.

Overall, there are different existing approaches that allow their users to tag each other, however the resulting employee profiles lack legitimation and commitment by the organization, especially with respect to the vocabulary used. The approaches do not provide support to overcome the gap and leverage the bottom-up topics to an organizational competences vocabulary. But that is a prerequisite for organizational competence management - ranging from team staffing, via human resource development to organizational competence portfolios.

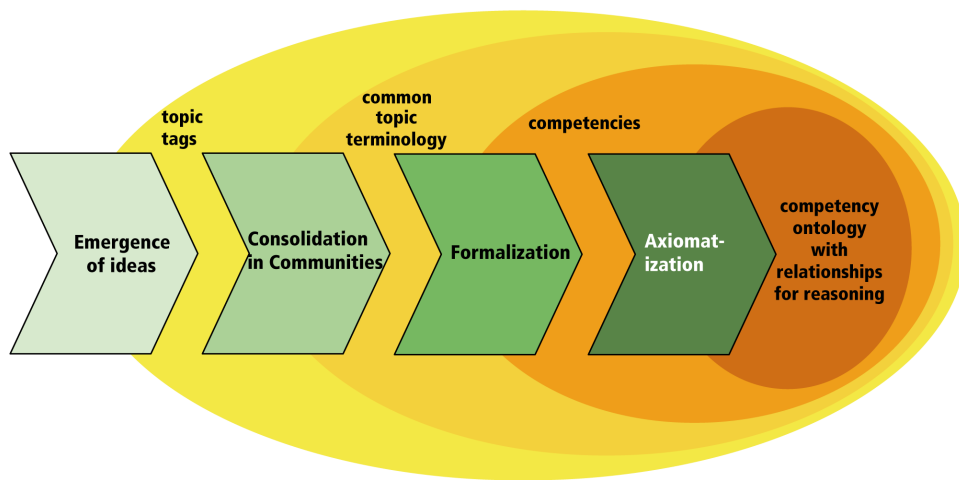
### **3 Concept**

#### *3.1 Overview of the Approach*

Semantic people tagging is based on a combination of the the principles of (a) collaborative tagging of persons (People Tagging after Farrell et al. (2007b)) and (b) social semantic bookmarking (Braun et al. 2008):

- Employees assign tags to each other (e.g., on entries in an employee directory, from their address book, or as a bookmark to social networking sites like LinkedIn<sup>2</sup>) referring to expertise or interests. This can complement self-assessment and the assignment of tags by superiors. These assignments are not restricted to a predefined competence catalog, but the employees can use (almost) any tags which they find appropriate, although tags are recommended based on those already used by others.

- Tags can be collaboratively developed towards a shared ontology, negotiated among the users of the system. This is achieved through a gradual formalization (as part of everyday usage) following the concept of ontology maturing (Braun et al. 2007), i.e., new tags are first added to a category of ‘latest topics’ from where users can merge synonyms and typos, or add translations, and put them in a structure of broader and narrower terms. More formal definitions can be added, too, so that the entries evolve from informal tags to more formal competency definitions usually found in competency catalogs (see Figure 2).



**Figure 2** Ontology maturing process for competencies by Braun et al. (2010)

This can serve several purposes and use cases:

- Colleagues can find each other more easily, e.g., for asking each other for help.
- Employees become aware of other colleagues with similar interests or experience to stimulate the formation of communities.
- It supports human resource development by providing information about the aggregated needs (e.g., by analyzing searches) and current capabilities of current employees (aggregated tagging data) to make the right decisions about training required.

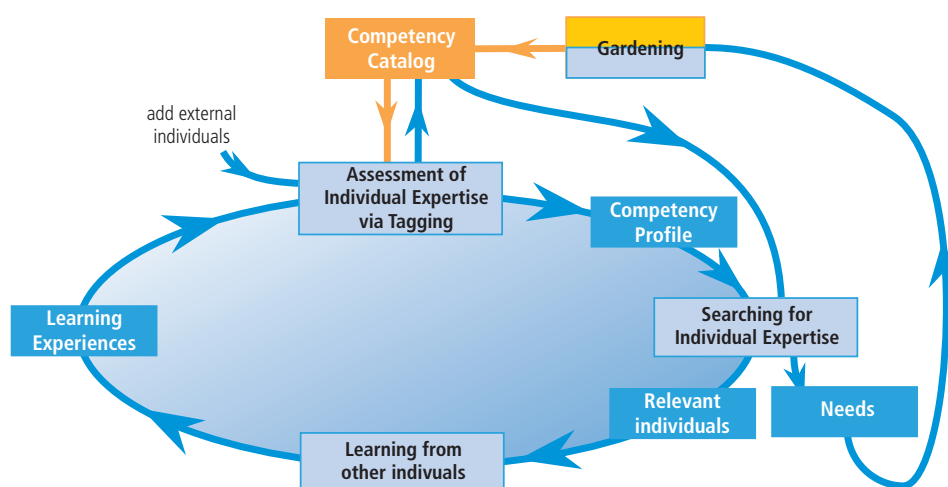
### 3.2 Process Model for People Tagging

The concept can be summarized in Figure 3, which is based on Figure 1. Individuals can assess each other by assigning tags (representing competency, experience, interest, or similar), which can be taken from a shared vocabulary (competence catalog), but can also be added to this catalog at the time of assigning a tag. This results in collaboratively developed competence profiles, which are no longer



based on precise assessments, but rather utilize the collective judgment of many. These profiles can be used for identifying other individuals associated with a given topic/competency. This can lead to a learning process by receiving help from the other individual. This leads (a) to refined assessment of the other individual's expertise and (b) refined personal expertise that becomes manifest in work practices.

Competency catalog is structured and iteratively refined in the process of gardening. The role of a gardener can be taken not only by a formal group of experts on a strategic level, but also by any participating individual on the operational level. Gardening can be informed by using the information what users are interested in, which they express by using search terms. This can yield information about topics not yet covered, or synonyms to be included in existing terms.



**Figure 3** Overview of people tagging

### 3.3 Data Quality and Provenance

It is obvious that moving from a centralised and controlled approach as in traditional competence management approaches to a social media approach poses challenges on how to make use of the collected data:

- Judgments of individuals vary, based on different perspectives, observations, backgrounds, or personality. Similar problems also exist for biases of assessment in traditional competence management approaches, both on the employee's and the superior's side. In the case of social media, this is addressed by using aggregates and not relying on individual assignments.
- Some individuals are more reliable in their assessment because of their prior experience. While for newbies, anyone who knows something about a topic they don't know about is worth tagging, experts in the subject will be much more selective. Therefore their judgment needs to have more weight, which

a simple aggregation of tag assignments does not reflect. This can be solved in two ways: (1) users can see who tagged whom to allow them to judge the reliability, or (2) give different weight depending on the expertise level. We will show in section 5 that we can address the first option with the design aspect *visibility of tag assignments* and the second option with the design aspect *search heuristics*.

- The democratic collaborative development of the vocabulary can lead to inconsistencies. While inconsistencies in earlier maturity phases are common and do not harm the use of tagging information for, e.g., searching, for the latter phases it can have a bigger impact. This can either be solved by social rules, or the design aspect *Control over and semantics of the vocabulary*.

### 3.4 Integrating with Traditional Competence Management

While the current approach concentrates on rather informal aspects of competence management, it can also support the more formal process, e.g., the human resource development process as shown in Figure 1. This is shown in Figure 4.

The key element is that the two use cases (finding people and human resource development) require different levels of maturity of the used concepts. This can be achieved by projection: while for finding people all parts of the competence catalog can be used (even those who were just assigned by a single individual), for HR development we use only those that have a certain level of maturity that is manually assigned to the stable parts of the competence catalog.

An interesting observation from Figure 4 is that people tagging strengthens the link between strategic and operational level by making the competence catalog a true boundary object both levels operate on.

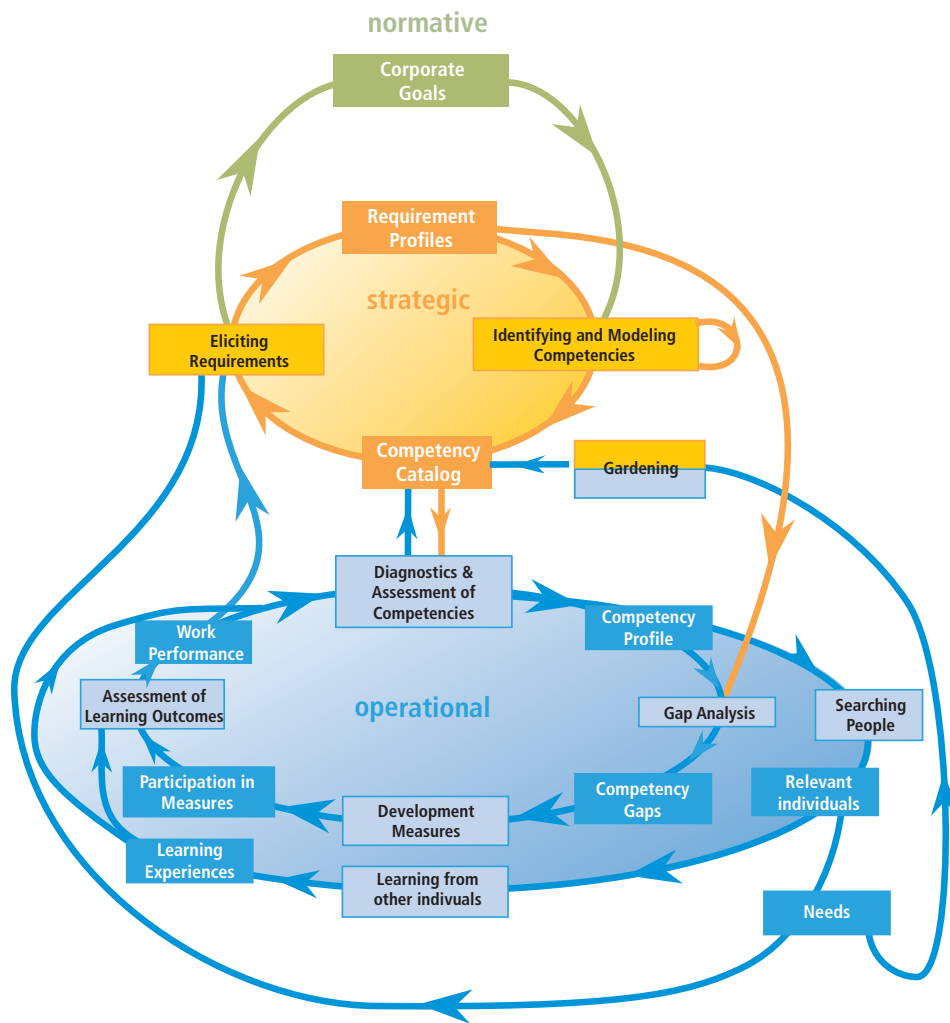
## 4 Initial Evaluation and Concept validation

By extending the group of people who can make competence and expertise assignments to encompass colleagues, semantic people tagging promises to achieve (1) a higher up-to-dateness and completeness of the employee profiles, (2) more realistic assessment of competencies and expertise than with self-assessment, and (3) additional awareness for the tagged person who can see his/her colleagues' perspective. At the same time, assignments by colleagues come with social risks, e.g. by the assignment of inappropriate tags.

In order to explore the potential and risks of semantic people tagging prior to implementation and an evaluation in real enterprise setting, we conducted two field experiments with pen-and-paper prototypes and a conceptual validation with experts. The first field experiment was targetted at the employee perspective, while the focus group was more targetted at the organizational perspective.

### 4.1 Field experiments: Individual Acceptance of People Tagging

For evaluating the acceptance of people tagging from an employee perspective, we have conducted two field experiments in two different environments (see Braun et al. (2010) for a more detailed description of the experiment) with 38 and 39



**Figure 4** Combining people tagging with the Integrated Competence Management models by Schmidt & Kunzmann (2007)

participants. We prepared paper-based posters for each group member. Each poster showed the name and photo of the person and blank lines to write down tags. Participants were asked to tag each other. Afterwards, participants were asked to fill out an online questionnaire, and a group discussion has taken place.

Overall, the participants of both experiments accepted people tagging and perceived it useful. The participants appreciated reflecting about others' interests and competencies and learning about others and getting new insights in this way. With the tags it was possible to get a quick overview and to see who works in the same area as oneself or has similar, also non-work related, interests. At the same time, there emerged some challenging issues:

- Cold start effect when starting tagging from scratch with empty profiles hampering the tagging process
- Missing tag (autocompletion) suggestion support
- Existing tag assignments led to tag reuse and hampered adding new tags
- Divided opinions on occurring non-professional and negative tags
- Uncomfortable feelings on the anonymity of the tagger
- Fear of transparency; e. g. being associated with non-confident topics
- Missing opt in and opt out opportunities
- Missing control of tags that were assigned to oneself and their visibility

It was also interesting to see that these issues could be observed differently in both cases so that we conclude that we need to be careful with – from a technical perspective – rather minor aspects, like e.g., control of the individual over assigned tags, guidance through tag suggestion, visibility of tagging information (who has tagged whom).

#### *4.2 HR Experts Focus Group: Organizational Dimension of People Tagging*

For the organizational perspective, we have chosen a focus group as a method where we asked HR experts. We presented the semantic people tagging approach to a focus group of two German professors specializing in human resource and competence management and organizational development as well as two practitioners from large organizations. We introduced the approach with a short presentation and demonstration of a first prototype. This was followed by a 2.5 hours of open discussion. During the discussion the following aspects emerged:

- People Tagging as a sub system in an organization has to be connected to other functions and systems (e. g. existing enterprise resource planning systems) - otherwise it may not yield full benefit.
- It should be integrated into everyday culture so that it lives; i. e. a system-culture-fit. For instance, the freedom of having everybody participating and transparency of changes across hierarchies might be alienating. This requires (1) flexibility and (2) a better understanding of culture and organization to

which software configuration options have to be mapped. The identifications of these options might depend on the understanding of the cultural aspects. Thus the introduction of people tagging should involve an organizational assessment, including a detailed examination of the culture.

- Restrictions to the vocabulary might be needed to map to a strategy-oriented competence management approach, where competencies are not only collected, but the company make conscious reductions i. e. , prioritizations of competencies. Thus giving a basic structure as a form of guidance, e. g. by limiting the top most level of the vocabulary. And leaving the freedom for the detailing by tagging (also as a kind of brainpool). In this way, new developments can inform revisions in a controlled manner. Additionally, having employees participate in the corporate strategy can lead to a different form of identification and transparency.
- Flexibility in search strategies is required. Based on the information that is available and seen as useful indicator; e.g. who is the tagger and what's his/her expertise? But not only to improve the usage experience of the individual, but also as an organizational constraint. For instance, the organization might not have everybody networked with everybody else. There are connections the organization wants to promote, e. g. sales and marketing or finance and sales, but sometimes there are unwanted connections: e. g. when sales representatives know someone in production - they might call the other and bypass the regular process to get something faster than others.
- Transparency of discussions and changes can interfere with organizational hierarchy, e. g. an employee always correcting and discussing his/her team leader's vocabulary changes might be interpreted as weakness of the team leader by other team leaders.
- Flexibility might be needed on different levels: on the individual (micro) level, e. g. one employee only wants self-assigned tags being displayed, the other any tags; on the department (meso) level, e. g. production department might get more restricted search and vocabulary editing functionality than the R&D department; and on the organization (macro) level, e. g. free vs. restricted vocabulary editing. Each can be different, but it could also lead to social effects if differences between departments are discovered - makes differences in culture and strategy transparent.

This has further confirmed that each target context of a people tagging system will require a different "configuration", which depends on cultural aspects as well as the actual goals that are associated with introducing people tagging. An analysis of the state of the art has shown that there has been little research on identifying design options in a systematic way so that we have developed a framework for engineering people tagging systems, which is described in the following section.

Further research will be based on an extensive data set from real world usage of the system. We will investigate additional strategies for gardening support and search heuristics. Furthermore, we will investigate the link to traditional competence management systems.

## 5 A Design Framework for Semantic People Tagging Systems

The results and experiences with the field experiments and the expert focus group together with an analysis of the design of folksonomy-based systems in general in the literature (Marlow et al. 2006, Sen et al. 2006, Wal 2005, Golder & Huberman 2006, Heckner et al. 2008, Trant 2009) and an analysis of social semantic bookmarking systems (Braun et al. 2009) led us to the development of a conceptual design framework for semantic people tagging.

Our experience has shown that there is no universal design for the sensitive subject of people tagging and we need a system that is flexible enough to adapt to each individual organization. In this way this framework brings together of what has been perceived to be useful with focus on tagging people to the best of our knowledge but might be extended for further application and organizational contexts.

We could identify five main aspects: (a) involved people, (b) control and semantics of the vocabulary, (c) control of tag assignments, (d) visibility of tag assignments, and (e) search heuristics for flexible search strategies. In the following we elaborate the first four aspects with basic design questions and possible design decisions and the fifth aspect with indicators and the underlying assumptions.

### 5.1 Design Aspect I: Involved people

The first design aspect to be discussed and shown in Table 5.1 is about the involved people in the tagging process. This includes (a) restrictions about the tagger (who is allowed to assign tags) and (b) restrictions about the taggee (who is allowed to be tagged).

The first question to be answered is **who is allowed to assign tags**. While social media approaches largely benefit from the openness, limiting the group of authorized people does make sense under certain circumstances:

- Self-annotation can be ambivalent: On the one hand it can be used for seeding in order to avoid cold start difficulties, and the study by Raban et al. (2011) also indicated that self-tagged users are the more productive contributors. On the other hand, it may be seen as distasteful self-marketing, and results may be distorted by the different level of self-marketing of different personality types.
- Allowing users to tag who only know little about the other person or about the topic they assign would result in a lower quality of tagging.
- Restriction to certain groups can have a positive effect on trust and sharing behavior in specific cultural environments, as indicated by Kaschig et al. (2010).

Following these arguments, restrictions can range from anyone being allowed to tag, over a limited group of persons defined either by organizational structures (e.g., team colleagues) or individual relationships (e.g., friends, or approved contacts in a social networking service), to only self-annotation. These options may be combined with each other.

The second question is **which persons can be tagged**; only colleagues within the organization / department or also external contacts. Including external contacts

**Table 1** Involved People

Design Question	Design Decisions
Who can tag?	<ul style="list-style-type: none"> <li>• Self-tagging is possible</li> <li>• Others can tag <ul style="list-style-type: none"> <li>– Restricted to specific persons/group, e.g. friends or team colleagues</li> </ul> </li> </ul>
Who can be tagged?	<ul style="list-style-type: none"> <li>• Only internal/external contacts</li> <li>• Taggee may opt out</li> <li>• Taggee must opt in</li> </ul>

might enrich the search for potential contact persons on the one hand; on the other hand people might not want to share their personal social network. This also depends on the purpose of introducing a people tagging system.

Another issue to be clarified is whether we need consent of the taggee. This can be implemented using an opt-in model (only those who agreed to participate can be tagged) or an opt-out model (everyone can be tagged unless the individual opts out explicitly). The opt-in model might limit the use when Semantic People Tagging is introduced in a smaller group with the aim for incremental spreading. The opt-out model implies that everyone is forced to participate at the beginning or when you start on a small scale that people are tagged without having the opportunity to object.

## 5.2 Design Aspect II: Control over and Semantics of the Vocabulary

The second design aspect (see Table 5.2) we need to consider refers to the vocabulary. How much control do we need to impose on the vocabulary development? And how semantically differentiated can this vocabulary be applied as part of the tagging?

As for the **level of control**, there are various aspects to consider:

- *Organizational guidance.* While we already mentioned the difficulties with a completely controlled vocabulary, our expert interviews have also shown that it might be necessary from an organizational and strategic perspective to fix a specific part of the vocabulary as a core, for instance the top level categories, around / beneath which the employees continue developing the vocabulary. This ensures that priorities can be set by the organization's management with respect to competence development, which is necessary for a more strategic perspective.
- *Avoidance of inappropriate tags.* Free tagging always has the risk that tags are used which the community or the taggee finds inappropriate or offending. This has already been found in our field experiments. This can be achieved in various ways: A black list of tags can be implemented by automatic system checks, i.e., a priori before at the time of tag assignment. But it can be also

left to a manual gardening processes (a posteriori) where inappropriate tags are eliminated. Or it can also happen completely outside the system by social rules of non-usage (implicit or explicit as guidelines).

- *Scope of tagging.* Similarly to the previous aspect, another issue that turned out to be very crucial from our field experiments is the regulation and control of non-professional tags. While this can be beneficial for promoting social networks, it can also create irritations with the taggees.
- *Promotion of convergence.* While free tagging is good for timely inclusion of new topics in the vocabulary, it hampers the quality of search and especially the aggregation of data. The vocabulary might be further influenced and controlled by tag suggestions. Thus the recommendation of existing tags in the vocabulary might foster reuse and consolidation (cf. Sen et al. 2006), whereas recommendations of tags e.g. extracted from document contents might encourage including new tag ideas.

Additionally to the control of the vocabulary, we need to answer **how semantically differentiated tagging is**, i.e., what does it mean when a tagger assigns a tag, and can the tagger specify a concrete semantics. Traditional competence management relies on very differentiated assignments by specifying 'having a competence at a certain level' ('beginner', 'intermediate', or 'expert'). This allows for a very differentiated reasoning (competence gap analysis, high quality aggregation). On the one hand, such differentiated semantics require a high cognitive effort and in many cases exceed the ability to judge. This has been particularly observed in the evaluation, which is described in section 4. Here, dealing with unspecified semantics (like, e.g. , being associated with a topic) facilitates the assignment of tags. The users can simply choose the tags they associate with the other person without being required to think about the differences between competences and skills etc. or different levels. Still, it might be a good idea to offer users the possibility to differentiate between 'having expertise in', 'being interested in', or 'being occupied with'.

### 5.3 Design Aspect III: Control of Tag Assignments

Not only the vocabulary used for a tag assignment is important, but also the tag assignment by a concrete tagger to a concrete taggee (see Table 3): do they need approval before being published? Who is allowed to delete them?

The field experiments have shown that some people fear the transparency, especially of being associated with topics they don't feel confident enough. However, the upfront approval requires additional work for the taggees and might result in a time lag till tags get visible, which again is demotivating for the taggers. There might also be an automatic approval mechanism based on a black list in order to block potentially inappropriate or unwanted tags.

Regarding the control of tag assignments, it's also interesting to think about if and how the process is influenced. Thus showing already assigned tags can foster the reuse of tags. Seeding from external sources can help especially at the beginning to overcome cold start difficulties. On the other hand, our field experiments have shown that people might feel biased by the displayed tags towards confirming these instead of adding new ones.



**Table 2** Control and Semantics of Vocabulary

Design Question	Design Decisions
How is the vocabulary controlled?	<ul style="list-style-type: none"> <li>• Fixed controlled vocabulary</li> <li>• Black list               <ul style="list-style-type: none"> <li>– Blocking vs. suggesting more friendly alternatives</li> <li>– A priori vs. a posteriori checking</li> </ul> </li> <li>• Tag suggestions               <ul style="list-style-type: none"> <li>– Only tags in vocabulary</li> <li>– Other suggestions</li> </ul> </li> <li>• Social rules               <ul style="list-style-type: none"> <li>– Only professional tags</li> <li>– Also non-professional tags</li> <li>– Negative tags allowed</li> </ul> </li> </ul>
How semantically differentiated is the tagging?	<ul style="list-style-type: none"> <li>• Tagging without any further semantics</li> <li>• Tagging with specific semantic relationship               <ul style="list-style-type: none"> <li>– 'interested in'</li> <li>– 'has competence'</li> <li>– 'occupied with'</li> <li>– additional weighting (on level XY)</li> </ul> </li> </ul>

**Table 3** Control of tag assignments

Design Question	Design Decisions
Is there a need for approval?	<ul style="list-style-type: none"> <li>• Tags need to be approved by the respective person before getting published</li> <li>• Automated blocking by individual black list</li> <li>• Immediate visibility</li> </ul>
Which kind of delete options are available?	<ul style="list-style-type: none"> <li>• Taggee can delete</li> <li>• Tagger can delete</li> <li>• Gardener<sup>a</sup> can delete</li> <li>• Everyone can delete</li> <li>• System can delete based on black list</li> </ul>
How to influence the tagger?	<ul style="list-style-type: none"> <li>• Showing existing tags for a person</li> <li>• Seeding from external sources (e.g. publications)</li> </ul>

<sup>a</sup> Gardeners are people who devote themselves especially to cleaning and structuring the knowledge base. They can establish themselves out of the community or explicitly be nominated by the organization.

#### 5.4 Design Aspect IV: Visibility of Tag Assignments

The next design aspect we like to discuss is the visibility of tag assignments (see Table 5.4) which constitutes the degree of transparency introduced. As transparency has a huge impact on culture of an organization(al unit), it is important to consider this aspect. This has two components: (a) the group of people to whom the visibility applies (only taggee, a limited group, everyone), and (b) the level of detail that is visible. The latter is important as different levels of detail have different levels of sensitivity. This can range from full visibility, i.e., everyone can see who has assigned which tag to whom with which kind of semantics (at which point in time). The other extreme is to make individual tag assignments not visible at all, but only display aggregated information (as an individual's profile or even only as team profile). Having an anonymized view, i. e. information about the person who made a tag assignment is not visible, can lead to more 'honest' and more tag assignments on the one hand. On the other hand, anonymity might also foster mobbing or hamper evaluating the expressiveness of tag assignments. For instance, people rather might trust the assessment of experts and thus tag assignment they made than beginners.

**Table 4** Visibility of Tag Assignments

Design Question	Design Decisions
To whom are tags visible?	<ul style="list-style-type: none"> <li>• Only to the taggee</li> <li>• To a limited group of people</li> <li>• To everyone</li> </ul>
At which level of detail are tags visible?	<ul style="list-style-type: none"> <li>• Not visible at all</li> <li>• Only aggregated and anonymous (both tagger and taggee are not visible)</li> <li>• Only aggregated and anonymous with respect to the tagger</li> <li>• Tagger is visible</li> <li>• Specific semantics (e.g. beginner, intermediate, expert) is visible</li> </ul>

#### 5.5 Design Aspect V: Search heuristics for Flexible Search Strategies

Finding the right person based on the query of a user is a non-trivial task. The ranking algorithm incorporates heuristics that are based on certain assumptions and depend on the previous design decisions, which may apply in one organizational context, but not in the other. In the following we present a list of indicators and the underlying assumptions and reasons.

- **Tags of the taggee** This is the most obvious assumption: if a person gets tagged, we assume that the person is somehow associated with the tag and thus relevant if someone searches for the tag. Differentiation can be done between self-assigned tags and tags by others.

- **Frequency of tags** The more often a tag is assigned, the more relevant the person is for a specific tag. This leverages collective judgment.
- **Timestamp of the tag assignment** The more recent a tag assignment is, the more relevant it is. This especially true for people since a person could have thematically reoriented.
- **Tags of the tagger** If the tagger is tagged with the same tag as he/she assigns to another person, then it gets more weight. Example: If a Google Web Toolkit (GWT) expert assigns the tag GWT to someone else, this is a more meaningful judgment than that of a person, who hardly knows what GWT means, assigning this tag.
- **Tagging activities of the tagger** If the tagger is a highly active user and makes differentiated assignments, then the taggers assignments get more weight.
- **Tagging activities of the taggee** We may conclude on the taggees expertise from his/her tagging activities. Therefore, if the taggee is a highly active user for a specific topic and makes differentiated assignments, then it gets more weight.
- **Current availability of the taggee** If the request is urgent, taggee who are available in time and / or location get a higher ranking.
- **Social connectivity between searcher and taggee** Tagger who are closer connected with the searcher; i. e. have a shorter or strategically preferred path in the searchers social/organizational network, get higher ranking because they are likely to have more commonalities like similar interests and viewpoints.
- **Social connectivity between tagger and taggee** The social relationship between tagger and taggee might influence the tag assignments. Example: If close colleagues assign a tag, it's more meaningful, because they know the taggee better than other colleagues with loose contact.
- **Background knowledge on the structure of tags** If a taggee is assigned with broader or narrower tags, it gets less weight in comparison with exact matching tags.
- **Additional activities of the tagger** If the created, edited or interacted with documents or contributed to discussions etc. for a specific topic, then it gets more weight.
- **Additional activities of the taggee** Similarly to the activities of the tagger, if the taggee created, edited or interacted with documents or contributed to discussions etc. for a specific topic, then it gets more weight.

## 5.6 Concluding Remarks

For the organizational implementation it is necessary to analyze and specify the different design aspects according to the respective organizational context in the sense of a system-culture-fit. This should include an organization analysis. Hereby we have to consider that the different design possibilities are partly dependent on each other and might limit the utilization of the information afterwards, e. g. not storing the information of the tagging person excludes the tags of the tagger as an indicator for the search.

## 6 Evaluation: A Real-World Instantiation

### 6.1 Functionalities of the People Tagging Tool

As part of a design-based research approach, a web-based application has been developed iteratively that offers the flexibility of configuring the system according to the design framework for a specific target context. The application supports employees in jointly creating a shared directory of people and a shared vocabulary that is used for tagging people. It offers a tagging tool, a collaborative real time editor for the vocabulary, overviews on people and profiles, a semantic search and explorative navigation through the directory of people and the vocabulary.

The *tagging tool* can be invoked via a browser bookmarklet similar to state-of-the-art social bookmarking applications. It offers tag recommendations based on the shared vocabulary, but allows also for free tagging (see Figure 5).

The *collaborative real time editor* allows for gradual structuring of the assigned tags using broader and narrower concepts, synonyms and typos. This is achieved through an SKOS-based ontology formalism. Furthermore, recommendations for gardening the vocabulary are provided based on usage, co-occurrence and other forms of semantic analysis (see Figure 6). Users also have the possibility to discuss about changes to the vocabulary in real time.

Finally, the *semantic search* allows users to find others (see Figure 7). The semantic search makes use of the additional relations between tags (synonyms, typos, broader, and narrower) by both automatic and manual query expansion or refinement, thus delivering immediate benefit of structuring the vocabulary to users.

### 6.2 Piloting Target Context

As a piloting institution, we have worked with a British career advising organization. The organization is a local service for young people aged 13-19 years (up to age 25 for people with special needs) with 60 employees geographically distributed over a whole county. It helps with decision making about study, jobs and careers by offering impartial information, advice, guidance and personal support. Because of the geographical distribution, the people's knowledge about the specialties and expertise of their colleagues is very limited cross the offices and finding the right colleague to talk to is difficult. Additionally the Human Resource development needs to have sufficient information about the needs and current capabilities of current employees to make the right decisions. In service delivery contexts that

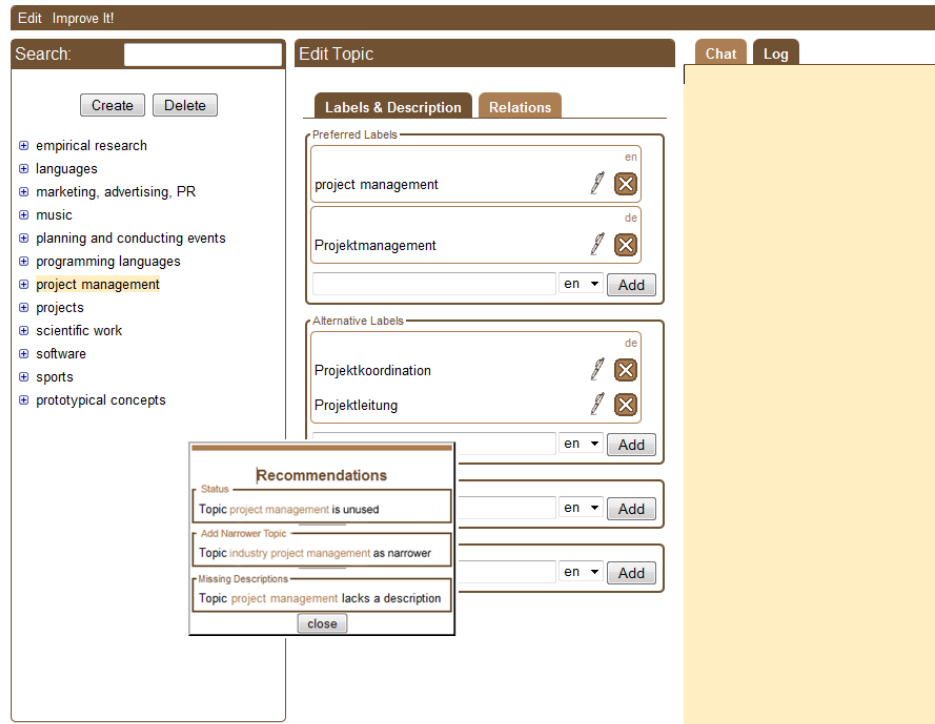


**Figure 5** Annotating a person

must be responsive to the changing needs of clients, like career advising services, it is necessary to establish precisely what additional skills and competencies are required to keep up with new developments. Thus the HR development wishes to get a better overview on dynamics, especially new emerging topics.

We elaborated the organization specific instantiation of the design framework together with a team of Human Resource, training, and knowledge management and team managers of the career advising organization in an iterative process of discussions and system demonstrations, tests and adaptations.

In the final concrete instantiation, employees are allowed to tag themselves and their colleagues without any further restrictions. The organization's focus is on its own employees, tagging of external contacts is not envisioned. Every employee is seen as a participant and we created (empty) profiles for all employees beforehand; i. e. it is allowed to tag any colleague without the taggee's explicit opt-in. The employees are supposed to develop and modify the vocabulary used for tagging on their own. Thus, the system automatically adds new key words used during the tagging process to the vocabulary and changes to the vocabulary (e.g. by adding relations between tags) are immediately visible and effective (e.g. to the search). The before mentioned team seeded the vocabulary with some topics in order to avoid cold start effects. There's no limitation or black list of terms. But the employees are not supposed to use negative or non-professional tags. During the tagging process, the system suggests existing tags from the vocabulary in order

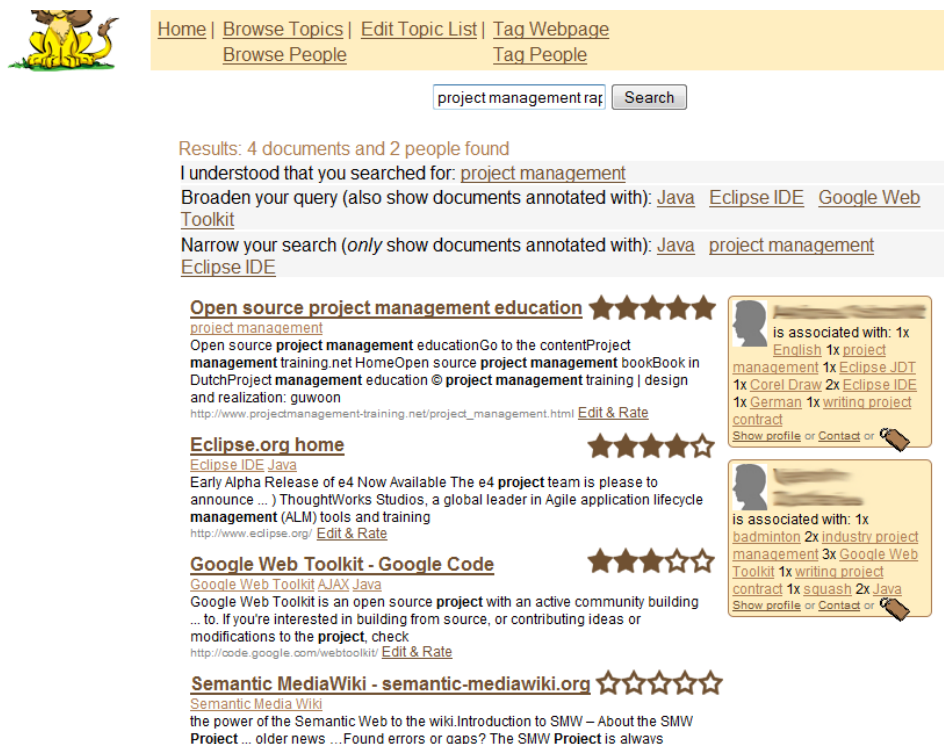


**Figure 6** Ontology editor

to foster reuse and thus the consolidation of the vocabulary. Tags are assigned without any further semantic differentiation. Assigned tags are immediately visible without previous approval by the taggee. The system does not block or delete specific tags automatically. Only the taggers can remove their tag assignments. During the tagging process, the user can see the tags assigned by other users. We did not make a seeding of the profiles. Every user of the system can see the tags in an aggregated (by frequency) and anonymous representation without level differentiation. The search ranking is based on the tags of the taggee and their frequency. We additionally take into account the structure of the tags.

The Semantic People Tagging system has been evaluated in a first cycle. We introduced the system in a hands-on workshop to ten employees. Additional employees have shown and explained the system to their colleagues so that they started using the system as well. In the introductory workshop we presented a short demonstration that was followed by an initial questionnaire on expectations and a user trial session with guided tasks. Then the employees used the system in an unsupervised way. After four weeks, a second workshop was held where we collected the experiences with using the system.

There the participants stated that they appreciated the systems simplicity and ease of use. They also liked the way it can give them lots more information than they currently have and the basic philosophy of democracy which empowers the individual and where nobody is in charge but has all possibility to contribute



Home | [Browse Topics](#) | [Edit Topic List](#) | [Tag Webpage](#)  
[Browse People](#) | [Tag People](#)

project management raj Search

Results: 4 documents and 2 people found  
 I understood that you searched for: [project management](#)  
 Broaden your query (also show documents annotated with): [Java](#) [Eclipse IDE](#) [Google Web Toolkit](#)  
 Narrow your search (only show documents annotated with): [Java](#) [project management](#) [Eclipse IDE](#)

**Open source project management education** ★★★★★  
[project management](#)  
 Open source **project management** educationGo to the contentProject management training.netHomeOpen source **project management** bookBook in DutchProject management education © **project management** training | design and realization: guwoon  
[http://www.projectmanagement-training.net/project\\_management.html](http://www.projectmanagement-training.net/project_management.html) [Edit & Rate](#)

**Eclipse.org home** ★★★★★  
[Eclipse IDE Java](#)  
 Early Alpha Release of e4 Now Available The e4 **project** team is please to announce ... ) ThoughtWorks Studios, a global leader in Agile application lifecycle **management** (ALM) tools and training  
<http://www.eclipse.org/> [Edit & Rate](#)

**Google Web Toolkit - Google Code** ★★★★★  
[Google Web Toolkit AJAX Java](#)  
 Google Web Toolkit is an open source **project** with an active community building ... to. If you're interested in building from source, or contributing ideas or modifications to the **project**, check  
<http://code.google.com/webtoolkit/> [Edit & Rate](#)

**Semantic MediaWiki - semantic-mediawiki.org** ★★★★★  
[Semantic Media Wiki](#)  
 the power of the Semantic Web to the wiki.Introduction to SMW – About the SMW **Project** ... older news ... Found errors or gaps? The SMW **Project** is always

is associated with: 1x English 1x **project management** 1x Eclipse JDT 1x Corel Draw 2x Eclipse IDE 1x German 1x writing project contract  
[Show profile](#) or [Contact](#) or [Add tag](#)

is associated with: 1x badminton 2x industry **project management** 3x Google Web Toolkit 1x writing project contract 1x squash 2x Java  
[Show profile](#) or [Contact](#) or [Add tag](#)

Figure 7 Search for people

(currently they often feel out of control because there is no possibility to easily contribute to a shared knowledge base like e. g. the intranet).

At the same time we identified some areas of concern. The participants stated that it might be difficult for some colleagues to identify areas of expertise with which they feel comfortable being identified; and it would be important that a person tag is time-bound, so people do not feel they are making a completely open-ended commitment. Another concern was that some practitioners may abuse the system – e. g. 'lazy' colleagues may resist entering details about themselves and may tag others with expertise they may have (to deflect additional queries). Thus editing the own profile, i. e. removing tags that are inappropriate or in order to avoid being contacted, is important.

In contrast to the organization's focus at the beginning, it was also mentioned that the system could increase the efficiency of working with outside agencies by allowing them search for personal advisers expertise easily and quickly. On the other hand there were concerns about sharing whole people tagging information with other services in general because it could also increase the workload.

In addition to the qualitative feedback, a usability evaluation based on a standardized questionnaire on user satisfaction with a five point Likert scale (1 = disagree, 5 = agree) was also conducted, which yielded very positive results, e.g., understandability (mean of 4.75), ease of use (mean of 4), or usefulness (mean of 4.25).

The organizations currently continues to use the system, and we are collecting usage logs to study the tagging behavior more closely. Furthermore, the system is – with different configurations based on the design framework and integration with other systems – currently rolled out to three other contexts: one additional career advising organization in the UK, a professional learning community in the construction sector in Spain, and a big software company in Germany.

## 7 Conclusions

Semantic people tagging is a new approach to making transparent the expertise of employees in organizations. It combines the principles of collaborative people tagging and semantic social bookmarking by supporting the collaborative development of a shared vocabulary. It promises to increase the level of participation in the process, both for creating expertise profiles of individuals and for defining a shared vocabulary. As initial evaluations have shown, people tagging is much more sensitive than other collaborative tagging approaches so that social and cultural aspects (professional culture, team culture, or organizational culture) have to be taken into account when designing a people tagging system.

Engineering people tagging systems is about engineering socio-technical systems for which no one-size-fits-all approach is appropriate, but we need possibilities for customization. Any implementation of people tagging must be flexible enough to adapt to a particular organization culture and should include an organizational analysis. To simplify the process of analyzing the requirements of a concrete target context and to reduce the effort associated with customizations, we have developed a design framework and implemented in a web-based application. The design framework is based on a literature review, two initial field experiments, a conceptual validation focus group with HR experts, and the iterative development with a piloting career advising company.

The developed system is currently in use and has been well received by the employees in the piloting company. Currently it is being rolled out to further target contexts from where we intend to gather additional data about tagging behavior and the relationship between design decisions within the design framework and contextual factors that influence those decisions, including culture, structure, and attitudes.

## Acknowledgements

This work has been the result of the MATURE project (<http://mature-ip.eu>), which has been co-funded by the European Commission within the Seventh Framework Programme under contract no. 216356. We wish to thank the other partners for their support of the evaluation.

## References

- Becerra-Fernandez, I. (2006), ‘Searching for experts on the web: A review of contemporary expertise locator systems’, *ACM Transactions on Internet Technologies* **6**(4), 333–355.



- Berio, G. & Harzallah, M. (2005), 'Knowledge management for competence management', *Journal of Universal Knowledge Management* **0**(1), 21–38.
- Bernstein, M. S., Tan, D. S., Smith, G., Czerwinski, M. & Horvitz, E. (2010), 'Personalization via friendsourcing.', *ACM Trans. Comput.-Hum. Interact.*
- Bernstein, M., Tan, D. S., Smith, G., Czerwinski, M. & Horvitz, E. (2009), Collabio: a game for annotating people within social networks., in A. D. Wilson & F. Guimbretire, eds, 'Proceedings of the Annual ACM Symposium on User Interface Software and Technology (UIST'09)', ACM Press, pp. 97–100.
- Biesalski, E. & Abecker, A. (2005), Human resource management with ontologies., in K.-D. Althoff, A. Dengel, R. Bergmann, M. Nick & T. Roth-Berghofer, eds, 'Proceedings of WM2005, Workshop on IT Tools for Knowledge Management Systems: Applicability, Usability, and Benefits (KMTTOOLS)', Vol. 3782 of *Lecture Notes in Computer Science*, Springer, pp. 499–507.
- Braun, S. & Schmidt, A. (2008), People tagging and ontology maturing: Towards collaborative competence management, in '8th International Conference on the Design of Cooperative Systems (COOP '08), Carry-le-Rouet, France, May 20-23, 2008'.
- Braun, S., Kunzmann, C. & Schmidt, A. (2010), People tagging & ontology maturing: Towards collaborative competence management, in D. Randall & P. Salembier, eds, 'From CSCW to Web2.0: European Developments in Collaborative Design', Computer Supported Cooperative Work, Springer, Berlin/Heidelberg, pp. 133–154.
- Braun, S., Schmidt, A., Walter, A., Nagypal, G. & Zacharias, V. (2007), Ontology maturing: a collaborative web 2.0 approach to ontology engineering, in N. Noy, H. Alani, G. Stumme, P. Mika, Y. Sure & D. Vrandečić, eds, 'Proceedings of the Workshop on Social and Collaborative Construction of Structured Knowledge (CKC 2007) at the 16th International World Wide Web Conference (WWW2007) Banff, Canada, May 8, 2007', Vol. 273 of *CEUR Workshop Proceedings*.
- Braun, S., Schora, C. & Zacharias, V. (2009), Semantics to the bookmarks: A review of social semantic bookmarking systems, in A. Paschke, H. Weigand, W. Behrendt, K. Tochtermann & T. Pellegrini, eds, '5th International Conference on Semantic Systems (I-SEMANTICS 2009), Proceedings of I-KNOW 09 and I-SEMANTICS 09', Verlag der Technischen Universität Graz, Graz, Austria, pp. 445–454.
- Braun, S., Zacharias, V. & Happel, H.-J. (2008), Social semantic bookmarking, in T. Yamaguchi, ed., '7th International Conference on Practical Aspects of Knowledge Management (PAKM 2008)', Vol. 5345 of *Lecture Notes In Artificial Intelligence*, Springer, pp. 62–73.
- Breslin, J. G., Bojars, U., Aleman-meza, B., Boley, H., Nixon, L. J., Polleres, A. & Zhdanova, A. V. (2007), Finding experts using internet-based discussions in online communities and associated social networks, in 'First International ExpertFinder Workshop'.
- Crowder, R., Hughes, G. V. & Hall, W. (2002), 'Approaches to locating expertise using corporate knowledge.', *Int. Syst. in Accounting, Finance and Management* **11**(4), 185–200.
- Farrell, S. & Lau, T. (2006), Fringe contacts: People-tagging for the enterprise, in F. Smadja, A. Tomkins & S. Golder, eds, 'Proc. of the Collaborative Web Tagging Workshop at WWW2006'.
- Farrell, S., Lau, T. & Nusser, S. (2007a), Building communities with people-tags., in M. C. C. Baranauskas, P. A. Palanque, J. Abascal & S. D. J. Barbosa, eds, 'INTERACT (2)', Vol. 4663 of *Lecture Notes in Computer Science*, Springer, pp. 357–360.

- Farrell, S., Lau, T., Nusser, S., Wilcox, E. & Muller, M. (2007b), Socially augmenting employee profiles with people-tagging, in 'UIST '07: Proceedings of the 20th annual ACM symposium on User interface software and technology', ACM, New York, NY, USA, pp. 91–100.
- Golder, S. & Huberman, B. A. (2006), 'The structure of collaborative tagging systems', *Journal of Information Sciences* **32**(2), 198–208.
- Harzallah, M., Berio, G. & Vernadat, F. (2006), 'Analysis and modeling of individual competencies: Toward better management of human resources', *IEEE Transactions on Systems, Man, and Cybernetics ? Part A: Systems and Humans* **36**(1), 187–207.
- Heckner, M., Mhlbacher, S. & Wolff, C. (2008), 'Tagging tagging. analysing user keywords in scientific bibliography management systems', *JODI: Journal of Digital Information*.
- Iverson, L., Razavi, M. N. & Mirzaee, V. (2008), Personal and social information management with opntag., in J. Cordeiro & J. Filipe, eds, 'ICEIS 2008 - Proceedings of the Tenth International Conference on Enterprise Information Systems', pp. 195–203.
- John, A. & Seligmann, D. (2006), Collaborative tagging and expertise in the enterprise, in 'Proceedings of the Workshop on Collaborative Web Tagging at WWW2006'.
- Kaschig, A., Maier, R., Sandow, A., Lazoi, M., Barnes, S.-A., Bimrose, J., Bradley, C., Brown, A., Kunzmann, C., Mazarakis, A. & Schmidt, A. (2010), Knowledge maturing activities and practices fostering organisational learning: Results of an empirical study, in 'Sustaining TEL: From Innovation to Learning and Practice 5th European Conference on Technology Enhanced Learning, EC-TEL 2010, Barcelona, Spain, September 28 - October 1, 2010. Proceedings', Vol. 6383 of *Lecture Notes in Computer Science*, Springer, pp. 151–166.
- Lau, T. & Sure, Y. (2002), Introducing ontology-based skills management at a large insurance company, in 'Modellierung 2002, Modellierung in der Praxis - Modellierung für die Praxis, Tutzing, Deutschland, 25.-27. März 2002', pp. 123–134.
- Ley, T., Kump, B. & Albert, D. (2010), 'A methodology for eliciting, modelling, and evaluating expert knowledge for an adaptive work-integrated learning system', *Int. J. Hum.-Comput. Stud.* **68**, 185–208.
- Marlow, C., Naaman, M., Boyd, D. & Davis, M. (2006), Position Paper, Tagging, Taxonomy, Flickr, Article, ToRead, in 'Collaborative Web Tagging Workshop at WWW2006'.
- Mcdonald, D. W. & Ackerman, M. S. (2000), Expertise recommender: a flexible recommendation system and architecture, in 'Proceedings of the 2000 ACM conference on Computer supported cooperative work', ACM Press, pp. 231–240.
- Raban, D. R., Ronen, I. & Guy, I. (2011), 'Acting or reacting? preferential attachment in a people-tagging system', *Journal of the American Society for Information Science and Technology* **62**(4), 738–747.
- Razavi, M. N. & Iverson, L. (2009), Improving personal privacy in social systems with people-tagging, in 'Proceedings of the ACM 2009 international conference on Supporting group work (Group'09)', ACM, New York, NY, USA, pp. 11–20.
- Reichling, T., Veith, M. & Wulf, V. (2007), 'Expert recommender: Designing for a network organization', *Computer Supported Cooperative Work* **16**(4-5), 431–465.
- Schmidt, A. & Kunzmann, C. (2007), Sustainable competency-oriented human resource development with ontology-based competency catalogs, in M. Cunningham & P. Cunningham, eds, 'Expanding the Knowledge Economy: Issues, Applications, Case Studies. Proceedings of E-Challenges 2007', IOS Press, Amsterdam.

- Schumacher, M., Diviné, M., Cardinal, J. S.-L. & Bocquet, J.-C. (2010), Aided virtual team building system: Zooming in on web 2.0 tools and competence management, *in* ‘Collaborative Networks for a Sustainable World - 11th IFIP WG 5.5 Working Conference on Virtual Enterprises, PRO-VE 2010’, pp. 346–355.
- Sen, S., Lam, S. K., Rashid, A. M., Cosley, D., Frankowski, D., Osterhouse, J., Harper, F. M. & Riedl, J. (2006), tagging, communities, vocabulary, evolution, *in* ‘CSCW ’06: Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work’, ACM Press, New York, NY, USA, pp. 181–190.
- Sicilia, M. (2005), ‘Ontology-based competency management: infrastructures for the knowledge-intensive learning organization’, *Intelligent Learning Infrastructures in Knowledge Intensive Organizations: A Semantic Web perspective* pp. 302–324.
- Thielen, P. I. (2010), Social tagging systems – shall we use the collaborative and collective approach to gather competency related information?, *in* S. Strohmeier & A. Diederichsen, eds, ‘Proceedings of the 3rd European Academic Workshop on Electronic Human Resource Management’, Vol. 570, CEUR-WS, pp. 186–205.
- Trant, J. (2009), ‘Studying social tagging and folksonomy: A review and framework’, *Journal of Digital Information*.
- von Ahn, L. (2006), ‘Games with a Purpose’, *Computer* **39**(6), 92–94.
- Wal, T. V. (2005), ‘Explaining and showing broad and narrow folksonomies’.
- Wang, Q. & Jin, H. (2009), Selective message distribution with people-tagging in user-collaborative environments, *in* ‘Proceedings of the 27th international conference extended abstracts on Human factors in computing systems (CHI’09)’, ACM, New York, NY, USA, pp. 4549–4554.