User Interaction and Uptake Challenges to Successfully Deploying Semantic Web Technologies

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Abstract. The Semantic Web community could benefit greatly from 'eating its own dog food' in order to better understand the challenges and opportunities of a Semantic Web from the user perspective. In this paper we describe the deployment of Semantic Web applications and services at the 3rd European Semantic Web Conference (ESWC2006), before presenting results of an evaluation into how these technologies were experienced by delegates. Based on themes identified in the evaluation we highlight seven user interaction and uptake challenges raised by the conference experience, and discuss how these may generalize to the widespread deployment of Semantic Web technologies.

1 Introduction

As development of Semantic Web applications continues there is an increasing need to understand how they are received by users. Which factors determine their uptake? Are there unique interaction challenges presented by Semantic Web applications that do not manifest themselves elsewhere? Evaluation and user testing is required if these questions are to be answered. In this paper we describe the deployment of Semantic Web technologies at the 3rd European Semantic Web Conference (ESWC2006), in Budva, Montenegro, and report on an evaluation of how these were experienced by delegates. From this evaluation we identify seven challenges that affected user interaction with, and uptake of, the Semantic Web technologies at the conference. Whilst the evaluation was carried out in a specific context, we argue that the findings have broader applicability.

1.1 Why Deploy Semantic Web Technologies at a Semantic Web Conference?

In software development, the phrase 'eating one's own dog food' describes the imperative to use one's own products, thereby gaining first hand experience of their fitness for purpose [1]. The Semantic Web community could benefit greatly from following similar principles if it is to better understand the challenges and

opportunities of a Semantic Web from the user perspective. Doing so also provides a means to identify technical and human interaction issues before formal user testing is undertaken in the wider community.

Key opportunities for 'eating our own dog food' exist at conferences in the Semantic Web field. Conferences are vitally important events for research and development communities; they are a primary and timely means of dissemination of research and development findings, a meeting place for researchers and users of research, a crucial place for debate of critical issues. With the advent of wireless Internet access during events, the electronic environment associated with conferences has evolved beyond the simple provision of a web site giving details of venues, speakers and abstracts. There are multiple channels used before, during and after an event, allowing delegates and the wider community to communicate more effectively both within and beyond an event. In principle, and as projects such as IUGO[1] are investigating, Semantic Web technologies can add yet more value by enabling the integration of various types of communication, potentially allowing the outputs to be explored and navigated as a well integrated whole, rather than in distinct silos. Therefore deploying Semantic Web technologies at conferences can provide an opportunity to 'road-test' their utility and usability at an early stage of development.

Furthermore, we would argue that the community must make a demonstrable public commitment to deploying and using Semantic Web technologies if the wider web community is to see the long-term vision (outlined in [2]) as feasible, realistic, and compelling [3]. A failure to do so has implications for the adoption of Semantic Web technologies and approaches in general, not least because others may perceive the Semantic Web as a research 'pipe dream' that even those involved cannot deliver. As a very public showcase of Semantic Web research, conferences provide an ideal opportunity to highlight the state of the art in implementation as well as research. In fact, rather than simply an opportunity, use of Semantic Web technologies at conferences in the field should be seen as a requirement; a failure to do so suggests we are reluctant to 'eat our own dog food', or unconvinced of its benefit.

1.2 Related Work

Despite these arguments, the use of Semantic Web technologies at conferences in the field has only recently gained momentum. For example, whilst semantic markup (e.g. in the form of RDF/XML) is one cornerstone of the Semantic Web, it has traditionally not been available on conference sites, or only to a limited extent.

Exceptions to this trend are efforts at the World Wide Web conferences in 2004 and 2006 (where a photo annotation service [4], and an RDF/XML version of the conference program[2] were provided, respectively), and at the International Semantic Web Conference in 2005 (where the Piggy Bank semantic browser extension [5] was available to delegates). Whilst these efforts are notable for attempting to reverse the

[1] http://www.jisc.ac.uk/index.cfm?name=vre_iugo
[2] http://www2006.org/programme/dynamic/

trend, they were focused on one type of media (e.g. photos), or did not constitute a comprehensive offering covering many aspects of the conference.

2 Semantic Web Technologies at ESWC2006

To attempt to address these issues, the ESWC2006 Semantic Web Technologies project[3] was conceived. The project was coordinated by the first author of this paper (Tom Heath) in the role of Semantic Web Technologies Coordinator, with input from the second author (John Domingue) who acted as General Chair of the conference, and from the ESWC2006 Organizing Committee. In the following section we will describe the aims of the project and the technologies deployed. Section 3 presents the results of an evaluation into usage and perceptions of these technologies among delegates. Section 4 discusses user uptake and interaction challenges raised by the evaluation data. Section 5 concludes the paper.

2.1 Aims of the Project

The project sought to deploy semantic and next generation web technologies to enhance the conference experience for delegates, whilst also stimulating future research by providing a showcase of the state of the art. Gathering evaluation evidence regarding people's usage and experience of the technologies was intended to explore any user interaction and uptake challenges presented by the deployment of these technologies, inform future research and development, and guide the use of technologies at future conferences.

2.2 Planning and Deploying Semantic Web Technologies at ESWC2006

A 'wishlist' was created by the project team describing the functionality to be made available at the conference. This was clustered into three groups: pre-generated semantic markup, tools for creating additional annotations, and tools that would provide specific functionality using available markup and annotations.

Semantic markup describing various aspects of the conference (such as the program, and a list of delegates) was produced by the project team. 'State of the art' technologies were identified from across the Semantic Web community to provide the second and third groups of functionality.

The ability for delegates to create additional annotations about aspects of the conference (such as papers and photos) was provided through deployment of a *Semantic Mediawiki* wiki [6], the *PhotoStuff* photo annotation application [7], and through publicizing a 'shared tag' (*eswc2006*) for use with existing 'tagging' services such *del.icio.us*[4] and *Flickr*[5]. One common use of the wiki was for creating '*I'll be*

[3] http://www.eswc2006.org/technologies
[4] http://del.icio.us/

there' pages, where delegates briefly introduced themselves and provided links to related resources, such as their homepage or papers they were presenting at the conference.

It is interesting to note that before the conference the shared *eswc2006* tag had not been used on either Flickr or del.icio.us. However, shortly after the tag was used to tag photos on Flickr from the 3rd European Semantic Web Conference, it was also used to annotate photos from another event that also uses the abbreviation ESWC2006 and therefore used the same tag. This example of a collision in 'tag space' highlights the shortcomings of simple text tags compared to URIs, whereby URIs allow for events to be disambiguated even where they use the same abbreviation.

The final group of technologies was deployed to allow delegates to make use of semantic markup and annotations. *SemSearch*[6], (a semantic search engine) was deployed, as were *DBin* [8] (allowing delegates to browse annotations and create their own), the *PhotoStuff Portal*[7] (for viewing annotations made with PhotoStuff), *OpenAcademia* [9] (for managing lists of publications), *Flink* [10] (for browsing social networks on the Semantic Web), and *FOAFmap* [11] (to visualize where delegates came from). Collectively, these applications and services were intended to provide a variety of means for delegates to access information relating to the conference, beyond simple browsing of the conference web site.

A web-based chat service[8] based on the Jabber protocol and 'AJAX' was also deployed to support discussion and networking between conference delegates. The subjective impression of the project team is that delegates primarily used the chat service not for lengthy discussions, but instead to gain the attention of others they already knew personally, as a means to gain quick responses to questions, or as a precursor to meeting face to face. Whilst the chat service did not make use of formal semantics it was felt that, in addition to the functionality it offered, deploying the service presented an opportunity for delegates to further consider the relationship between so-called 'Web2.0'[9] applications and Semantic Web technologies.

Due to limitations of coverage and expressivity in existing conference ontologies the ESWC2006 Conference Ontology[10] was developed to underpin the applications and services at the conference, allowing for example relationships between artifacts, events, places, roles and people to be described.

Services and applications were customized for the conference by the research groups or individuals that originally developed them. Where a live service was deployed for the conference, this was also hosted by the developers rather than in one central location. Applications and services were provided on a voluntary basis. Despite being hosted in different locations and developed by different groups, services followed a unified ESWC2006 visual brand wherever possible. Applications and services were released as they became available, through links from the main

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[5] http://flickr.com/
[6] http://search.eswc2006.org/
[7] http://photos.eswc2006.org/
[8] http://chat.eswc2006.org/
[9] http://en.wikipedia.org/wiki/Web2.0
[10] http://www.eswc2006.org/technologies/ontology

ESWC2006 web site and from the USB pen drive distributed to all delegates. They were formally introduced at the opening ceremony of the conference.

3 Evaluation of ESWC2006 Technologies

An evaluation was carried out to provide insights into how delegates experienced the technologies at ESWC2006, to assess whether the aims of the project were met, and highlight any barriers to their usage and uptake. Being an exploratory evaluation, the emphasis was on open-ended questions that could provide a richer account of delegates' experiences than would be possible using purely quantitative measures, or through analyzing server log files (although this is also planned for future analysis). It should be noted that this evaluation is not seen as a substitute for formal user testing of applications and services, but merely as an opportunity for formative evaluation during the research and development stage, and as a means to better understand at a general level the challenges of deploying Semantic Web applications and services to end users. The method and results of the evaluation are presented below, whilst conclusions drawn are discussed in Section 4.

3.1 Method

Evaluation data was collected by means of a questionnaire, delivered online using a web-based survey service. Section 1 comprised of questions constructed by the project team (reproduced in the Results section below), covering issues related to the technologies in general. These were a mix of scaled and open-ended free-response questions. Responses to scaled questions were made on 5-point Likert scales. In Section 2 respondents were asked specific questions (provided by the developers) about the Photo Annotation, Semantic Wiki, Semantic Search, Chat, and DBin services/applications. These questions are not considered in this analysis as they relate to specific aspects of applications and services, and consequently any lessons learned are unlikely to generalize to the wider Semantic Web. The final section of the questionnaire comprised a single open-ended question asking for any further comments on the technologies.

Of 299 delegates at the conference, 48 (16%) completed the questionnaire, on a voluntary basis. Whilst this represents a respectable response rate for this form of data collection, the sample should not be seen as representative of all delegates. However, the aim of the evaluation was to explore themes arising from the project using qualitative methods, for which this sample is adequate. Analysis of all responses to open-ended questions was carried out to identify key themes in respondents' answers, following the methodology described in [12]. Two of the authors independently analyzed and categorized the responses, each producing a list of themes present in responses to each question. These were then amalgamated into a master list of themes, with labels for each theme agreed by both. Any discrepancies were resolved through discussion, although there was a high level of agreement for major themes. Differences tended to be concentrated on themes with low numbers of responses.

3.2 Results

Frequencies of responses to scaled questions are presented below in Figures 1, 3, and 6. Themes identified in responses to each question are shown in Figures 2, 4, 5, 7, and 8. Two figures are shown in brackets next to each theme, representing the number of delegate responses assigned to this theme by each coder. The results are discussed in Section 4 below.

Fig 1. Responses to Question 1: **How would you rate your level of usage of the Semantic Web Technologies at ESWC?**

Not At All	Very Low	Low	Moderate	High	Very High
2%	21%	21%	40%	10%	4%

Fig 2. Themes identified in responses to Question 2: **What would have increased your usage of the services?**

- greater awareness (10,10)
- more time (8,9)
- greater usability (7,9)
- clear benefits (7,7)
- critical mass (6,7)
- additional functionality (5,5)
- fewer personal technical issues (4,3)
- earlier availability (3,3)
- internal integration (3,3)
- technical openness (2,2)
- more guidance (2,2)
- more sexiness (2,0)

Fig 3. Responses to Question 3: **Please rate your agreement with the following statement: Availability of the Semantic Web Technologies at ESWC enhanced the conference for me**

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
7%	13%	30%	39%	11%

Fig 4. Themes identified in responses to Question 4: **If applicable, in what ways did the Semantic Web Technologies enhance the conference for you?**

- gave social benefits (6,13)
- improved access to conference info (4,6)
- enhancement through specific features of services (3,6)
- created dataset for future use (3,6)
- provided a showcase/overview (4,5)
- opportunity to eat own dog food (2,4)
- provided first hand experience (3,0)

Fig 5. Themes identified in responses to Question 5: **If applicable, what general changes would have enhanced your experience of the Semantic Web Technologies at ESWC? (please comment on general issues)**

- greater awareness of the technologies (5,3)
- greater usability (4,4)
- technical openness/different technical approach (3,4)
- additional functionality (3,4)
- more participation by others (critical mass) (2,4)
- sustainability/reuse of data (3,3)
- clear benefits (3,2)
- integration with other "stuff" (0,4)
- more guidance (0,2)
- technologies working as intended (0,2)

Fig 6. Responses to Question 6: **Please rate your agreement with the following statement: Availability of the Semantic Web Technologies at ESWC caused me to reflect on challenges or issues facing the Semantic Web community**

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
7%	9%	22%	42%	20%

Fig 7. Themes identified in responses to Question 7: **If applicable, what challenges or issues facing the Semantic Web community were most apparent to you?**

- usability (10:11)
- need for clear benefits (5:4)
- having sufficient data (4:5)
- integration (data and technologies) (3:4)
- specific technical issues (2:4)
- need for critical mass (4:1)
- meeting user needs/approachability (3:2)
- delivering on promises (2:2)
- search for a killer app (2:2)
- specific technical opportunities (2:2)
- annotation issues (2:1)
- lack of user tools (2:0)
- demonstrating effective use of semantics (0:1)

Fig 8. Themes identified in responses to Question 8: **Please add any other general comments about the ESWC2006 Semantic Web Technologies here**

- encouragement for the project (12:12)
- publicity/awareness comments (5:7)
- suggestions for future projects (4:4)
- clear benefits (3:2)
- usability (2:3)
- lack of time (2:2)
- social/uptake issues (2:2)
- offers of help (2:2)

Responses to Question 1 ("*How would you rate your level of usage of the Semantic Web Technologies at ESWC?*") show a reasonable degree of variation in respondents' usage of the technologies. A variety of factors are cited in Figure 2 that may have increased usage. The responses to Question 3 ("*Please rate your agreement with the following statement: Availability of the Semantic Web Technologies at ESWC enhanced the conference for me*") suggest that the project was relatively successful in its aim of enhancing the conference experience for delegates, with 50% of

respondents *Agreeing* or *Strongly Agreeing* with the statement. Fig 4 shows themes indicating how the conference was enhanced for respondents.

In response to Question 6 ("*Please rate your agreement with the following statement: Availability of the Semantic Web Technologies at ESWC caused me to reflect on challenges or issues facing the Semantic Web community*"), 62% of respondents *Agreed* or *Strongly Agreed* with the statement. This suggests a high degree of success for the project in its aim of stimulating future research activities.

4 Discussion: User Interaction and Uptake Challenges

The results above highlight a number of recurring themes in how delegates experienced the technologies at ESWC2006. Such a recurrence of themes in the evaluation suggests some critical underlying issues. Through a synthesis of the most user-oriented themes, we have identified seven user interaction and uptake challenges that impacted on the success of the ESWC2006 Technologies project. These challenges are presented below, following a sequence that reflects their interdependencies. We argue that these challenges must be addressed if Semantic Web technologies are to enter into widespread usage. In the following sections we discuss how each challenge may generalize beyond the conference domain to the Semantic Web as a whole.

We acknowledge that members of the Semantic Web research community, being well-versed in the technologies and motivated to use them, cannot be considered representative of those users who may take up future Semantic Web applications and services. On this basis one may question the validity of any conclusions drawn. However, the aim of the evaluation reported here is not to be representative of a broader population, but simply to provide insights into the experience of this sample of delegates. Despite this caveat, we would argue that the challenges discussed below are worthy of careful consideration and reflection by the Semantic Web community in developing future applications. As the challenges represent issues identified by the Semantic Web community itself, it may be reasonable to conclude that they will also be present among 'regular' users who do not share the same background knowledge and motivations, and possibly at even greater levels.

Whilst potentially of significant interest, technical themes (e.g. "technical openness"), meta themes (e.g. "eating own dog food"), and those that are more circumstantial (e.g. "personal technical issues"), are beyond the scope of this paper and will need to be discussed elsewhere.

4.1 Challenge 1: Increased Awareness

A consistent theme throughout the evaluation data (occurring in three of five open-ended questions) was the need for increased publicity, to generate greater awareness of the technologies among conference delegates. Intuitively, greater awareness among delegates would have led to greater uptake and usage of the technologies. However, it could be argued that more publicity may encourage delegates to 'take a look' at the services but would not fundamentally change the proportion of people wishing to use

them, unless the benefits they provide are clear and compelling, and functionality is appropriate to user needs. These issues are addressed in more detail below.

Regarding the relevance of this issue outside the conference domain, the need to ensure awareness could be seen as a generic issue affecting the uptake of any new technology. This issue may manifest itself for Semantic Web applications and services as it has for previous internet-based technologies, growing out from an initial technical user base to widespread adoption by the general public. However, we would argue that any Semantic Web technologies reaching the mainstream are unlikely to use the label 'Semantic Web'. To do so would require users to understand the meaning of the phrase and subscribe to the technical 'vision', rather than adopting technologies for the benefits they confer.

4.2 Challenge 2: Clearer Benefits

In response to Question 4 ("*If applicable, in what ways did the Semantic Web Technologies enhance the conference for you?*") respondents described the technologies as providing social benefits and improved access to conference information. However, the need for clearer perceived benefits to using the technologies was a consistent theme in the analysis, occurring in response to four of the five open-ended questions. This emphasizes the need for the benefits of using a technology to be clear to potential users. Functionality should be described to users in terms of the benefits it can deliver, rather than what it performs technically.

This finding is especially noteworthy given the nature of the audience. It might be expected that members of the Semantic Web research community would seek to use technologies out of curiosity, with benefits being conveyed through greater awareness of developments in their field of research, rather than purely through the functionality of the application. However, the results presented here suggest that is not the case, and that clear benefits are highly important even to this audience.

One factor contributing to this finding may be the times at which technologies were made available. It may transpire through further analysis that some technologies are of greater benefit before or after a conference. Consequently delegates may have perceived less clear benefits in using them during the event itself. An additional theme relevant to this discussion is a lack of 'spare' time for using the technologies, occurring in responses to two evaluation questions. It may be that with more time available delegates would be sufficiently motivated to try the technologies, but did not perceive them as something which was able to save them time or effort at the event. This calls into question the extent to which the conference was itself enhanced by the deployment of the technologies, once the aims of providing a showcase and 'eating one's own dog food' are discounted.

From the business perspective, Alani et al [13] discuss the costs and benefits of adopting new technologies in the enterprise and relate this discussion to potential uptake of Semantic Web technologies. The results of this evaluation suggest similar principles may apply to uptake by individuals. Whereas the costs may be less easily quantifiable in financial terms when considering individual users, a lack of clear benefits is enough to discourage usage of the technology even for those who (by

virtue of their membership of the Semantic Web community) could be considered highly motivated.

Where Semantic Web applications and services are designed for mainstream adoption, clear communication of the benefits the technology provides is likely of even greater importance than when deploying to a technical audience who may have pre-existing motivations in using the technologies. Exactly how these benefits may be conveyed without requiring users to understand the novel technical characteristics of the Semantic Web remains an open question of critical importance.

4.3 Challenge 3: Appropriate Functionality

The evaluation of ESWC2006 Technologies highlights a consistent desire among delegates for certain functionality that was not provided, despite related services being available. For example, respondents reported a perception of a general shortage of 'approachable' end-user tools for utilizing RDF metadata related to the conference. In addition, multi-user chat or IRC-style channels related to each conference session were consistently requested. These had not been provided, as existing IRC channels were presumed to be adequate and sufficiently embedded in regular usage by the community.

This demonstrates the need for technology that meets a well evidenced and clearly defined user need, rather than something that fits a category of technology that is deemed important but may not address a specific requirement. This suggests that the project team's wishlist of technologies may not have been the most effective approach to selecting technologies for the conference. Future conferences may benefit from deploying primarily those technologies that meet well evidenced user needs, while speculatively introducing a small number that are relatively untried. One alternative approach may be to address the 'technical openness' theme identified in the evaluation. By ensuring all deployed technologies are as open as possible to integration with other applications and services, delegates may be able to use existing applications alongside conference technologies, to ensure their needs are more specifically met. Whilst at present it is likely that only more technically aware users may be able to make use of such integration possibilities, it is hoped that as tools evolve such integration will become accessible to a wider range of users.

A related challenge occurs when attempting to identify appropriate and compelling functionality that can be delivered to 'regular' users through Semantic Web technologies. As this evaluation has demonstrated, the wishlist approach may be insufficient in scoping services for widespread usage, as the desired functionality may be influenced by pre-held assumptions about what is useful. Perhaps in this case the project team's focus on markup, annotation, and usage reflected our own researcher-centric view of the Semantic Web, at the expense of a person-centered view of what would provide most value to delegates. Similarly, at present the use of 'motivating scenarios' to justify development of a particular application is common. Whilst they serve an important function in identifying problems that may be addressed by a particular technical approach, the Semantic Web community may benefit from further investigating whether applications stemming from such motivating scenarios offer mainstream appeal, or meet a genuine user need.

4.4 Challenge 4: Guidance to Users

One could argue that software should be sufficiently intuitive to be used without having read a manual or working through a tutorial. However, the ESWC2006 experience suggests that where novel functionality is provided in an application, tours, tutorials, and demos may be useful in highlighting this functionality and demonstrating how to make use of it. This may be particularly important where functionality is not intuitive based on ones previous experience or mental models. For example, whilst photo annotation has generated significant interest within both the Semantic Web and 'Web2.0' communities, we would argue that there are relatively few clear parallels to this form of interaction in previous applications. Whether providing additional guidance is feasible in a conference setting is open to debate. Over time delegates may become familiar with certain types of Semantic Web applications and services, mitigating the need for additional guidance at the conference itself. However, users outside the Semantic Web community may not receive the same degree of exposure through which to adapt to novel functionality provided by Semantic Web applications.

4.5 Challenge 5: Improved Usability

Usability of applications and services was widely cited throughout the evaluation, both as a factor affecting usage and as a challenge facing the Semantic Web research community. The theme manifested itself as both general comments about usability, and observations about specific aspects of applications or services. Without further in depth analysis it is not clear the extent to which these specific issues map to existing issues identified in the web usability literature, or the extent to which existing principles are applicable to this deployment of Semantic Web technologies. Irrespectively, it would be wise to follow existing web usability guidelines where possible, although these may need to be refined in the light of novel interaction paradigms enabled by the Semantic Web.

One potentially significant issue regarding the usability of Semantic Web applications is the extent to which the mechanics of Semantic Web technologies should be exposed to the user. Extrapolating from the principle that users should not need knowledge of HTML to use the web, we argue that no knowledge of RDF or ontologies should be required to use Semantic Web applications. However this does raise the issue of how to harness the power of the Semantic Web in the interface (e.g. rich information modeling, enabling new kinds of queries) in such a way that the complexity of the underlying implementation is hidden. This is an area that would seem to require considerable further research.

4.6 Challenge 6: Coherence

Both practical issues identified by the project team and themes occurring in the evaluation (e.g. 'integration - data and technologies') highlight the challenge of

providing Semantic Web applications and services that are coherent to the user, in how they make use of data, and how navigation across them is provided.

A key feature of the Semantic Web is the ability to use data from one source in another application or service, something that is considerably more challenging on the conventional web. However, this ability to reuse data poses a significant challenge in presenting a coherent picture to the user. Firstly, it must be clear what data is present in a system they are using, and secondly where else data they provide may be used.

By way of example, this issue manifested itself in the following way at ESWC2006: delegates registering online before the conference were asked if they wished to opt into the public "Semantic Delegates List", and if so to provide some additional details about themselves such as the URL of their homepage. This list was used to populate the Semantic Wiki with delegates at the conference, as these wiki pages would also be public. In contrast, all delegates who had pre-registered for the conference were pre-registered for use of the Chat service, as this did not make information publicly available. Due to the resources required to manage and update these different data sets, delegates who registered at the conference were not automatically added to the Semantic Delegates List, Semantic Wiki, or Chat service. Whilst this arrangement is in line with expectations from a data protection point of view, verbal reports suggested it presented a confusing picture to users, for whom the chain of dependencies in how data was used was not apparent.

Whereas unified branding of ESWC2006 services may have provided a visually coherent offering, it may have served to weaken the user's mental model of distinct services that may have access to different sets of data. This situation would be compounded if data was generated by inference or aggregated to form composite views. At present there does not appear to be a widely used interface metaphor or convention indicating (visually or otherwise) what data a service has access to, an issue which we argue warrants further investigation.

The model of distributed services followed in the ESWC2006 Technologies project, and the varied use of information across services, also made it difficult to ensure coherent navigation and a meaningful user experience across services and applications. For example, a page in the Semantic Wiki about a particular delegate was not automatically linked to depictions of that person stored in the Photo Annotation service. Whilst the traditional web usability literature may be able to provide guidance on overcoming this issue of coherent navigation, the Semantic Web provides new challenges due to lesser reliance on the notion of a 'web site' as an organizing structure.

This raises the issue of whether a distinct 'semantic' layer separate from a non-Semantic Web site is the most appropriate approach in ensuring a coherent mental model for users. Further questions are raised as to the level at which 'Semantic Web Browsers' such as Magpie [14] or Tabulator[11] should manifest themselves: as a complement to the conventional browser, or as a wholly different application either integrated into or distinct from document display? If the latter is the case then we may need to rethink the reliance on the traditional hypertext interaction paradigm when building Semantic Web applications.

[11] http://dig.csail.mit.edu/2005/ajar/ajaw/tab

4.7 Challenge 7: Critical Mass of Participation

The issue of reaching a critical mass of uptake among delegates was raised in four of the five open-ended evaluation questions. This is particularly significant for services and applications that have a social element, such as the ESWC2006 Chat service. However, even in services that have a less explicit social element, a low level of uptake can be problematic if it results in a shortage of semantic markup that consequently reduces the value of the service.

Given the prominence of socially-oriented technologies in Semantic Web research, and the general assumption that a proportion of annotations will be provided manually, addressing uptake issues is critical. Insights may be available from the discussion in [13] of issues affecting how applications may reach and maintain critical mass. Furthermore, given the generic relevance of these issues to any community focused service, irrespective of the technology used, guidance may be available from literature on the development of virtual communities. Future deployments of Semantic Web technologies may give further insights into whether critical mass can be achieved through attention to the challenges outlined in this paper.

5 Conclusions

In this paper we have presented an evaluation of Semantic Web technologies deployed to delegates at ESWC2006. From these results we have identified seven user interaction and uptake challenges that impacted on the successful deployment of the technologies. Whilst these challenges may usefully inform similar projects at future conferences, we argue that they have broader relevance.

Despite drawing on evaluation data from members of the Semantic Web community, we argue that addressing these challenges will lower user interaction and uptake barriers to widespread adoption of Semantic Web technologies, across a broad spectrum of users. Similarly, whilst the technologies deployed were those seen to be useful in a conference context, we would argue that the challenges identified are sufficiently general and fundamental as to be applicable to a wide range of Semantic Web applications and services.

Encouragingly, responses to Question 7 ("*If applicable, what challenges or issues facing the Semantic Web community were most apparent to you?*") indicate that at least some respondents recognize these challenges exist. However, evaluation of further deployments of Semantic Web technologies is required to demonstrate how feasibly they can be addressed.

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