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Adoption and Use of Web 2.0 in Scholarly Communications

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Abstract

Sharing research resources of different kinds, in new ways, and on an increasing scale, is a central element of the unfolding e-Research vision. Web 2.0 is seen as providing the technical platform to enable these new forms of scholarly communications. We report findings from a study of the use of Web 2.0 services by UK researchers and their use in novel forms of scholarly communication. We document the contours of adoption, the barriers and enablers and the dynamics of innovation in Web services and scholarly practices. We conclude by considering the steps different stakeholders might take to encourage greater experimentation and uptake.

Keywords: Web 2.0, scholarly communications, collaboration, Open Science.

1. Introduction

Over the past 15 years, the Web has transformed the ways in which we search for and use information. The past 5 years have seen the emergence of a new array of innovations that go collectively under the name of 'Web 2.0', in which the information user – by creating content or by helping to organise and evaluate information resources provided by others – is also increasingly an information producer. Web 2.0 brings the promise of enabling researchers to create, annotate, review, reuse and represent information in new ways, promoting innovations in scholarly communication practices – e.g. publishing 'work in progress' and openly sharing research resources – that will help realise the e-Research vision of improved productivity and reduced 'time to discovery' (Arms ~~and~~ & Larsen 2007; Hey, Tansley ~~and~~ & Tolle 2009; Hannay, 2009).

However, despite this increasing interest in Web 2.0 as a platform and enabler for e-Research, understanding of the factors influencing adoption, how it is being used, its implications for research practices and policy remains limited.

In this paper, we report findings from a study (funded by the Research Information Network[1]) of the adoption of Web 2.0 by UK researchers, of innovation in Web 2.0 services and their use in scholarly communication practices. We begin by summarising the extent of adoption and the demographic characteristics of users and non-users. We then go on to examine factors that seem to influence researchers' adoption decisions and the evidence for change in scholarly communication practices. We conclude by considering the implications of our findings for the policies and practices of researchers, higher education institutions and funders.

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[1] http://www.rin.ac.uk

2. Web 2.0 and Scholarly Communications

Scholarly communication is often considered to refer primarily to the process of publication of peer-reviewed research. We take a broader view, however, that scholarly communications is constitutive of researchers' everyday activities. Building on Thorin (2003), we define scholarly communications as:

- Conducting research, developing ideas and informal communications.
- Preparing, shaping and communicating what will become formal research outputs.
- The dissemination of formal products.
- Managing personal careers, and research teams and research programmes.
- Communicating scholarly ideas to broader communities.

Each of these aspects draws on a rich set of organisational and cultural practices and histories, involving an evolving set of information resources, communication methods and technologies.

The scholarly communications literature reveals there are huge variations in practices between broad domains, such as 'science' or 'humanities' and the traditional disciplines into which they are divided. Moreover, particular sub-disciplines and schools of analysis, and emerging interdisciplinary areas, can have very different cultures to their 'parent' fields (Knorr Cetina, 1999; Hine, 2008). These disciplinary and local cultures have a strong influence on how new information and communications technologies (ICTs) are adopted (Star et al., 1995; Cronin, 2003; Harley et al., 2008; Fry, 2004; Fry 2006; Sparks, 2005; Arms and & Larsen, 2007; Borgman, 2007). While new ICTs have led to the emergence of new forms of publishing, the central position of traditional forms in scientific debates and their role in career and reputation building means they are still a core currency (Arms and & Larsen, 2007; Harley et al., 2008).

The past decade has seen the emergence of new ideas about the practice of scholarly communications with talk of a 'crisis in publishing' and weaknesses in the peer-review system. One outcome is the notion of 'Open Science'[2] (Neylon and & Wu, 2009) with its advocacy of more open scientific knowledge production and publishing processes (Hull, Pettifer and & Kell 2008; Murray-Rust 2008), inspired by discourses developed in 'Free/Open Source Software' and 'Creative Commons' movements (Lessig, 2004; Benkler and & Nissenbaum, 2006; Elliott and & Scacchi, 2008). Web 2.0 is widely seen as providing the technical platform essential to this 're-evolution' of Science (Waldrop, 2008; De Roure, 2008).

The term Web 2.0 was coined to point to the emergence and rapid uptake (initially in a business context) of a group of new information tools and services – such as social networking sites – that are easy to adopt and use, and which enable their users to be

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[2] See for example the Preface to the *Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities* (22 Oct 2003, Berlin). This stated "The Internet has fundamentally changed the practical and economic realities of distributing scientific knowledge and cultural heritage. For the first time ever, the Internet now offers the chance to constitute a global and interactive representation of human knowledge, including cultural heritage and the guarantee of worldwide access". Available online though the Max-Planck Portal Preface to *Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities*, 22 Oct 2003, Berlin, Max-Planck-Portal at http://oa.mpg.de/openaccess-berlin/berlindeclaration.html (sampled 31 January 2010).

producers and publishers rather than just consumers of information (O'Reilly, 2005; Anderson, 2007). Web 2.0 is often identified with particular technical forms but, as Anderson (2007) emphasises, it may more accurately be characterised as the coupling of particular technologies and social practices:

> *"Web 2.0 encompasses a variety of different meanings that include an increased emphasis on user-generated content, data and content sharing and collaborative effort, together with the use of various kinds of social software, new ways of interacting with web-based applications, and the use of the web as a platform for generating, re-purposing and consuming content.' (Anderson, 2007)*

This definition thus does not just refer to particular the configurations of technologies, but also to changing practices of communication and production of information by individuals and groups.

There exists a wide variety of internet-based services used by researchers that could be termed Web 2.0.[3] These include widely adopted, generic services arising from the effort of commercial providers, tools adapted for specific worksites or research communities and services provided by actors such as publishers and libraries. Further, Web 2.0 is relevant to a large number of scholarly communication practices aside from in addition to the formal publication of articles, ranging from promoting published papers to the sharing of digital research artefacts and the coordination of collaborative work.

While there are certainly technical issues, most notably around standardisation, many of the factors reported as shaping the adoption of Web 2.0 in scholarly communications are institutional and organisational. Particular factors that are suggested to be shaping Web 2.0 adoption include:

- ownership and control of research outputs by individuals, institutions and publishers;
- institutional, individual and cultural factors shaping collaboration;
- the quality and provenance of information; and
- resolution through the availability of effective technical and institutional solutions too of issues of standardisation, IPR and security.

These can manifest themselves as barriers or as drivers. For example, aA commonly identified barrier is that Web 2.0-based modes of scholarly communication may not be recognised by existing systems for quality control, which revolve around peer-reviewed publication processes, and which are seen as fundamental to scholarship and to academic careers. A potentially key driver is the promise of Web 2.0 facilitating new and more effective forms of research collaboration, resolving pressure from funders seeking to improve research productivity and knowledge transfer between disciplinary communities and with external stakeholders.

3. Methodology

Our study deployed a composite methodology designed not only to capture current attitudes and patterns of adoption but also identify problems, needs and aspirations of researchers.

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[3] Deciding which services conformed to the definition of Web 2.0 was not easy. For example, we included Google Scholar because of its role as an aggregator of research-related content and the support the it provides for publishers and libraries to link their content.

First, we used an on-line survey to gather basic demographic data (age, gender, position and discipline), to document respondents' dissemination practices, measure the extent of their research collaborations, uses of Web 2.0 resources and attitudes towards new technology.

In the survey design, we sought to avoid focusing specifically on the use of Web 2.0, which many might not be able to define – or may have never heard of – and which might have introduced a bias in favour of technically-oriented communities. Instead, the survey asked a series of questions concerning existing scholarly communication practices, before turning to questions about use of and attitudes towards IT, and generic and specific Web 2.0 services. By focussing on both scholarly communication practices and technology/service use, we were able to verify responses and identify inconsistencies in reportage (stemming in part from the amorphous character of Web 2.0).

Statistical tests (Chi-squared for non-ordinal variables, Cochran-Armitage test for trend for combinations of non-ordinal and ordinal variables, and Spearman rank correlation for ordinal variables) were carried out to check for associations within the data.

Second, we conducted in-depth, semi-structured interviews (face to face and by telephone) with a stratified sample of 56 survey respondents in order to explore the uses they were making of Web 2.0, their experiences and their perceptions of barriers and drivers to adoption.

Third, we conducted a series of Web 2.0-based service case studies, using semi-structured interviews with service developers and users to investigate adoption issues in more depth within particular user communities: two case studies of publishers of conventional peer-reviewed research papers experimenting with Web 2.0; a commercial start-up providing advertising-funded hosting of presentations; a website for curating and sharing digital research resources; and a website for the digital Humanities.

In this paper, we focus primarily on reporting results from the survey and researcher interviews.

4. Contours of Adoption

The target population for the survey was a list of 12,000 email addresses of UK academic staff and PhD students generated after harvesting email addresses from Web sites in the ac.uk domain and then cleaning to remove duplicates and irrelevant addresses. 1477 responses were received, representing approximately 0.7% of full time UK academics and postgraduates, giving a confidence interval of +/- 2.5% at a confidence level of 95%. By comparing the profile of respondents against known characteristics of the overall UK academic population as defined by our primary independent variables[4], we were able to determine that our sample of academic staff was representative. PhD students account for 27% of the overall sample and all disciplines are represented, but there is a bias in this subgroup towards Economics and Social Sciences.

Comment [RP1]: Check.

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[4] Data sourced from the Higher Education Statistics Agency. See http://www.hesa.ac.uk

We used responses to specific survey questions to identify membership of three distinct categories (Rogers, 1995), reflecting different degrees of adoption of Web 2.0 in novel forms of scholarly communications (writing a blog; adding comments to others' blogs or to online journal articles; contributing to a wiki; post slides publicly) within our sample:

- *innovating communicators*Frequent Users (1~~3~~%): a small cohort who *frequently* use Web 2.0 in novel forms of scholarly communications;

- *experimenting communicators*Occasional Users (4~~5~~%): a larger cohort who *occasionally* use Web 2.0 in novel forms of scholarly communications;

- *conventional communicators*Non-Users (~~39~~%): another large cohort who *never* use Web 2.0 in novel forms of scholarly communications.

Table 1 summarises the contours of adoption of Web 2.0 as defined by age, position and discipline for all respondents and for the three categories defined above.[5] It shows that *Frequent Users* ~~innovating communicators~~ are a small minority, though *Occasional Users* ~~experimenting communicators~~ make up a large minority of respondents. Overall, while most respondents report using 'generic' and well-known Web 2.0 tools such as Google Scholar and Wikipedia, the results indicate that use by the UK research community of Web 2.0 in novel forms of scholarly communication is low.

The use of Web 2.0 in scholarly communications is often characterised as being of special interest for a younger, 'Facebook' generation, but our results suggest that this is not the case. Our results also suggest there is a gender bias, with men making up two thirds of ~~innovating communicators~~Frequent Users, while women make up a slight majority in ~~conventional communicator~~Non-Users and, finally, a discipline effect. Computer Science researchers are more likely to be ~~innovating communicators~~Frequent Users and those in Medicine and Veterinary Sciences less likely.

	All respondents	~~Innovating communicators~~Frequent Users	Occasional Users~~Experimenting communicators~~	~~Conventional communicators~~Non-Users
All respondents	100%	14%	44%	40%
Age Under 25	4%	2%	3%	5%
25-34	27%	27%	25%	28%
35-44	26%	34%	25%	23%
45-54	22%	19%	26%	22%
55-64	16%	16%	17%	17%
65 and over	4%	3%	4%	5%
Position Professor	18%	20%	21%	19%
Reader	7%	6%	9%	5%

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[5] Figures are given as percentages for each independent variable. Missing values of some variables mean that percentages do not necessarily add up to 100%.

	Senior Lecturer	14%	15%	18%	11%
	Lecturer	11%	13%	9%	12%
	Research Fellow	16%	18%	15%	15%
	PhD Student	28%	20%	22%	31%
Gender	Female	46%	34%	41%	52%
	Male	54%	66%	59%	48%
Discipline	Medicine and Veterinary Sciences	15%	7%	17%	17%
	Biological Sciences	5%	5%	5%	5%
	Physical Sciences	16%	14%	16%	15%
	Computer Science and Mathematics	13%	25%	15%	7%
	Engineering	4%	5%	4%	4%
	Economics and Social Sciences	29%	25%	27%	32%
	Arts and Humanities	18%	19%	16%	20%

Table 1: Adoption by age, position, gender, institution and discipline.

Statistical tests on the results reveal several significant correlations at the p<0.1 level. In particular:

Statistical tests on the data reveal several significant associations (at the p>0.1 level) between degree of adoption, and age, position and gender. In particular:

- Degree of adoption is positively associated with older age groups (rho=0.05, p=0.048), more senior positions (rho=0.14, p<0.001) and males (Z=5.52, p<0.001).

Being an innovating communicator is correlated with more senior positions, gender and discipline.

Being an experimenting communicator is correlated with older age groups, more senior positions and gender.

Being a conventional communicator is correlated with younger age groups, more junior positions, gender, and discipline.

Looking more closely at experimenting communicatorsOccasional Users' Web 2.0 tools usage patterns by discipline, we find wide use of generic resources (Google Scholar, Facebook, etc) in Humanities and Social Sciences, and Natural Sciences. In the latter we also find wide use of more specific resources that have gained salience with particular fields. Most notable is PubMed, which is used frequently by 59% of respondents in Biological Sciences and 61% in Medicine and Veterinary Sciences. In addition, 65% of respondents working in this field use *Public Library of Science* (PLoS)[6] either occasionally or frequently. However, these respondents have evidently not yet made use of these resources routine or begun to explore their more innovative features.

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[6] http://www.plos.org

5. Factors Shaping Web 2.0 Adoption

In this section, drawing on a combination of survey results and interviews, we examine some of the factors influencing adoption decisions.

5.1 Collaboration

Table 2 suggests that adoption of Web 2.0 is strongly influenced by the extent to which researchers are engaged in collaborative research activities. Those who work in collaboration with different institutions are significantly more likely to be ~~innovating or experimenting communicators~~Frequent or Occasional Users of Web 2.0. Those not involved in collaborative research activities are much less likely to adopt; they may have a lower incentive to adopt. Statistical analysis reveals a significant association between degree of adoption and extent of collaboration (rho=0.26, p<0.001). ~~Statistical tests on the results reveal significant correlations between adoption and collaboration at the p<0.1 level.~~

		All respondents	~~Innovating communicators~~Frequent Users	~~Experimenting communicators~~Occasional Users	~~Conventional communicators~~Non-Users
Collaboration	Work with collaborators in different institutions	65%	76%	69%	58%
	Participate in informal, local research networks	40%	55%	42%	35%
	Participate in wider, discipline-based research networks	45%	60%	51%	36%
	Do not do collaborative research	17%	9%	14%	20%

Table 2: Percentages of respondents collaborating in research by form of collaboration and subgroup.

5.2 Local Support

Survey responses confirm earlier research highlighting the importance of local formal and informal support for adoption. One of the principal differences between the subgroups is the perceived level of encouragement respondents report that they receive from local research groups and department (see Table 3). ~~Conventional communicators~~Non-Users, in particular, report virtually no local encouragement.

	All respondents	~~Innovating communicators~~Frequent Users	~~Experimenting communicators~~Occasional Users	~~Conventional communicators~~Non-Users
Local research group	19%	46%	23%	6%
Department	21%	41%	24%	9%
Institution	27%	44%	29%	17%
Library and Information Services	30%	40%	35%	19%
Computer support services	20%	30%	23%	14%

Research Funders	18%	26%	21%	12%
Conference Organisers	22%	45%	26%	11%

Table 3: Percentage of respondents reporting support for adoption of Web 2.0 by source of support and subgroup.

One way in which local support manifested itself was in raising awareness and peer encouragement ~~influence~~. The absence of this contributes to people's reluctance to experiment:

> *"I don't think my immediate colleagues in the (…) department are using Web 2, not to any great extent, not that I know of."* And: *"But I do need people to recommend why I need to change to use something."*

When interviewed, several respondents remarked how they felt handicapped by inadequate institutional IT support for research:

> *"HEIs put [a] lot of effort into supporting innovations in teaching but little effort into supporting innovations in research."*

Some also doubted whether institutional IT support services had the competence to meet their needs:

> *"The blog system is being run by people who we see as not technically competent enough to do it reliably."*

5.3 Skills

Many respondents remarked that they felt they lacked the skills necessary to make use of new services:

> *"I'm enthusiastic in that I think there's a lot of potential there, but pragmatically I think there are problems still because people don't have the knowledge (…) to make use of it."*

> *"I don't understand how to get the most out of it (…) I don't find it that easy to use but I haven't really invested the time."*

Many expressed a willingness to learn, but some felt they didn't have the time, especially for more complex applications:

> *"I can see other people using it and I'd like to be able [to] use it better. I really could do with having a tutorial or something, but I really don't have time to do all these things (…)"*

Web 2.0-based services have a reputation for being intuitive to use. These comments suggest that irrespective of whether this reputation is justified, understanding what to use them for and what the value might be, is more challenging,

5.4 Information Discovery

Services that make research information easier to find and access are universally welcomed and used. Google Scholar was seen as "*particularly useful for looking up some papers that are online but not published yet*" and to find out "*what is new*".

The use of personal networks figures prominently in researchers' strategies for information discovery:

> *"Certainly a lot of the articles that I pick up in journals are through verbal face to face recommendations (…) if someone in my area (…) would say that this article is important to our area, then I would take that on board and look at it."*

~~Innovating communicators~~Frequent Users highlight the usefulness of new sources at early stages of research, when scholars are attempting to survey wide areas of literature and learn about research communities beyond their personal networks. One ~~innovating communicator~~Frequent User commented on the value of Web 2.0 as a tool~~s~~ for extending personal networks and for 'social filtering' as a coping mechanism for the deluge of information:

> *"One of the key social skills for the 21st century is building and maintaining your network (…) It is also about filtering the information coming in."*

Perceptions about the quality, scholarly merit and sustainability of content are key factors in respondents' assessment of 'unconventional' knowledge sources such as Wikipedia or Blogs. ~~Conventional communicators~~Non-Users, in particular, are dismissive of these as a waste of time and unreliable.

> *"[I] wouldn't use Wikipedia or anything like that, anything that isn't peer reviewed like that is worthless".*

Even syndicated blogs and blogs associated with established publishers were described by some as 'entertainment' and regarded as more suited for discussion of policy and administration, rather than 'science' itself. This suggests assessment of these formats is a very much a question of framing – those who use these resources do not see them as comparable to formally reviewed sources, but as having their own distinctive role; for example, using Wikipedia to find out basic information on a topic outside of one's core discipline.

5.5 Attitudes towards Novel Scholarly Communications

A number of ~~conventional communicators~~Non-Users expressed the view that novel forms of scholarly communications brought no benefits and were even a "*waste of time*." This was especially true in relation to social networking:

> *"I'd rather spend the time thinking about what I'm going to do next rather than spend it telling others what I'm doing (…) I think it's definitely a younger person's thing."*

In some cases, this view was shaped by failure in experiments and consequent disappointment that benefits had "*never really materialised*."

> *"The institute had a blog for two years but we actually gave it up, because it wasn't the interactive service we thought it should be (…) nobody really commented."*

~~Experimenting communicators and innovating communicators~~Occasional and Frequent Users see Web 2.0 as enabling novel forms for content creation, and new ways of reaching industry, policy makers and the public. ~~Innovating communicators~~Frequent Users also see opportunities for raising their profile within their communities and laying foundations for future collaborations:

> *"If it increases your profile and more people were aware of the work you did that would be a benefit."*

> *"There are career benefits too. Those working in the media field who are actively*

using these materials and are perceived to be on the 'cutting edge' are often very successful."

"To exchange ideas and to get ideas but, most of all, to disseminate ideas. (..) It is of big value to be able to communicate with academics from all over the world."

"It almost offers you a half way house in that you can be less formal, you don't have to have completed your research project, you can talk about your research findings as it were and it's kind of put out there in the public space and people can comment or interact without having to wait until your final output is a journal article that will appear in print".

"People are very keen to have unconventional dissemination practices, but I think it all boils down to whether they will be valued (...)"

When asked to rate routes to dissemination, respondents emphasised the dominant role of conventional, peer-reviewed outputs. Print journals were rated as very important by 70% of respondents, in contrast to 56% for online-only journals, suggesting that new, and less formal dissemination outlets are unlikely to be favoured while widely used peer-reviewed online-only outlets continue to be relatively poorly rated.

These findings illustrate how scholarly communications has at least two forms of value for the researcher: the value of raising awareness of one's work among one's peers, and the value for formal assessment and career development. Though researchers are conservative in their choice of publishing outlets for outputs of significance for formal assessments (e.g. appointment and promotion decisions), they also understand the benefits in securing relatively unconstrained early dissemination and discussion of findings through a means that does not prejudice their subsequent ability to secure formal recognition through peer reviewed publication.

5.6 Changes in Practices of Peer Review

Peer review is seen as fundamental to the research process, even though many find the process problematic in practice:

"I think peer-review is essential (...) I think a lot of publications that I can use somehow are less useful because of suspicion that they were not peer-reviewed. It might not be common for areas where people put their materials online."

It is generally acknowledged that increases in the volume of publications might eventually put the peer review system under severe pressure:

"I think the current system is unsustainable because of the demands of work load and the peer review process."

Nearly half (47%) of respondents expect that, in future, peer review will be complemented by reader ratings, citation rates, etc. Unsurprisingly, opinions are divided on whether these would be useful and trustworthy:

"Things like citation rates that come out of a formal process can be tracked (...) but reader comments and ratings would be so open to abuse it's hard to imagine that people would interpret it as valid of the paper's worth."

The point is that while personal recommendations are trusted (see section 5.4), perhaps even if they came through a Web 2.0 service, aggregate, 'crowd-sourcing' style recommendations would perhaps not be.

Publishers such as PLoS, as they look to innovate their publishing services, are attempting to promote a model where Web 2.0 services (fora, blogs, ratings, etc.). integrated ~~into~~ with conventional dissemination outlets (online journals; conferences). 'add value' to peer review-based publication (by surrounding it with an aura of information) rather than displace peer review. However, rating published articles and leaving comments is generally unpopular. Publishers have found readers are reluctant to leave 'throw away' assessments or comments on papers that may be critically assessed by other readers or promotion boards at a later date.

5.7 Open Science

For ~~experimenting communicators and innovating communicators~~Occasional and Frequent Users, enabling collaboration was a significant driver. Most ~~experimenting communicators~~Occasional Users agreed on the importance of collaboration and networking and reported using a range of Web 2.0 resources (blogs, wikis, bookmarking services, bibliography systems):

> "(…) you can have a 'conversation' of more than just two-way. Other people can be watching the conversation. That's quite useful. They can contribute if they want and you can always make it private."

> "The more material is available and the more people can connect and collaborate, the better."

> "I think this whole idea of using social networking tools in science is intriguing and we've really only begun to scrape the surface because, at heart, a lot of science is a social networking exercise. It's quite a good model for science when we finally get our head around it and I'm only beginning to start to understand that, I think."

One ~~innovating communicator~~Frequent User stated, "*ultimately it will change how people do research*" and

> "it is about accelerating the research cycle for small pieces of research that are easily distributed" while acknowledging that, so far, it is bringing "mostly relatively small benefits."

The extent of Open Science practices such as sharing data or publishing work in progress varies between disciplines, but is very modest overall and tends to be restricted to small groups of collaborators. Though a committed cohort evidently finds it useful to put early research ideas into the public arena, others consider such publication practices a waste of time, 'unscientific' and even dangerous:

> "I do not support Open Science and I do not see any benefits for me. I have a negative attitude to use blogs and videos in research. Once it's finished it should be published otherwise it will be anarchy in science."

Others were not entirely sure of what the term meant, but were broadly supportive:

> "I presume it's concerned with the production of papers and research materials that [are] placed in some publicly accessible place. I support it, yes."

We found evidence that institutional IPR policies relating to the use of Web 2.0 in scholarly communications are beginning emerge and ~~which~~ may act as a barrier to Open Science:

> "In our university we have a certain guideline what may or not may be put onto the blog. I have to agree that something needs to be saved and I don't want people to

say: we just discovered X."

There is considerable uncertainty about what Open Science means and scepticism about its viability. Even the subgroup we identified as *open scientists*, who practice data sharing and are more open with work in progress, tend to think that new tools are not sufficient to achieve radical institutional and cultural change.

6. Analysis: the Dynamics of Adoption and Use

Our findings suggest that Web 2.0 services that are generic, intuitive and easy to use, build incrementally upon existing practices, available free or funded by advertising revenue, offering near zero adoption costs and clear advantages to users, are experiencing rapid uptake. More specialised services, arising, for example, from the efforts of publishers and other knowledge intermediaries, and which offer more scope for exploring novel forms of scholarly communication, have made more uneven progress.

In some cases where the benefits of adoption have been sufficiently high (and costs sufficiently low) to motivate community adoption (or where resources have received significant investment – e.g. PubMed – or have spun-off from established resources – e.g. Nature) resources have achieved the 'critical mass' of users needed for them to become viable, generating 'network externalities' that lead to them being pervasively adopted by particular communities or across the board.[7] However, whether there is sufficient added value for network externalities to stimulate widespread adoption has been questioned (Bradley, 2009). It appears from our study that many researchers are discouraged from making use of new forms of scholarly communications because they are unable to put their trust in resources that have not been subject to traditional peer review. These findings are consistent with other studies (e.g. Ware ~~and~~ & Monkman 2008) that suggest researchers do not see the 'wisdom of the crowds' mode of citation counts, usage statistics or reader ratings as substituting for peer review.

Our findings concerning the contours of adoption confirm some stereotypical expectations while challenging others. Confounding expectations that use of Web 2.0 is for the younger 'social network' generation, our survey confirmed Newman's (2009) finding that relatively few researchers in the 21-27 age group use Web 2.0 tools for research or collaborative working. We did find a gender bias: fewer women are engaging, and this is reinforced by lower awareness and less enthusiasm for using Web 2.0 in scholarly communications. However, Web 2.0 was by no means a male preserve and the moderate gender bias may be exaggerated by disciplinary factors, notably the lower participation of women in Computer Science and Mathematics, where adoption is higher.

Web 2.0 is characterised by rapid technological innovation, with an array of new services being launched by an emergent supply sector as well as through the activities of various knowledge intermediaries. This proliferation of resources and the constant churn of new and enhanced offerings pose problems for potential adopters. It is hard to keep track of these developments, let alone assess benefits for particular kinds of

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[7] Services that exhibit what economists describe as 'network externalities', whereby their benefits for each user increase with the number of users, may not be viable until a critical mass is achieved (or at least until there is expectation that a critical mass will be obtained). See, for example, Arthur, W. B. (1989). Competing technologies, increasing returns, and lock-in by historical events. *Economic Journal* 99: 116-131.

activity. Contrary to some expectations, adoption costs are not necessarily trivial – and, given the returns to sunk investment in exploring the use and utility of a product, people tend to stick to tools they already use and trust. The plurality of resources and the continuation of diversity over time result in fragmentation of the potential user base. This ~~and~~ poses particular problems where benefits are closely related to size of the user base. Users may well defer adoption until patterns of wider usage become established (in this context, as well as first-mover advantages, there may be last-mover or late-mover advantages).

One key factor that correlates with being ~~an innovating communicator~~a Frequent User seems to be a context in which collective communication requirements had proved favourable to adoption and, in particular, the exigencies of running collaborative research projects and networks and associated dissemination activities. These contingencies provided an incentive to explore aids to communication across institutional boundaries within extended research groupings, and with broader stakeholder arrays and publics. In addition, encouragement by the research group was a key factor.

Not all attempts at innovation proved successful. Our interview data threw up many instances where researchers had experimented with new practices, but had reverted to more established knowledge exchange methods. Web 2.0 services offering immediate saving in effort or improvements in effectiveness get rapidly taken up. Where they do not offer compelling advantages for a community over existing tools and practices they will not be adopted. Further, it is not easy for researchers to figure out what the advantages might be and to weigh them up against the costs and risks.

The likelihood of major changes in patterns of adoption in the future is unclear. A relatively small group have embraced the potential, making frequent and innovating use of Web 2.0 in communicating their research. The majority of researchers have either not adopted these tools or use them sporadically and in more limited ways. ~~Yet,~~However, few ~~conventional communicators~~Non-Users expressed scepticism or hostility to using new technologies in scholarly communications, suggesting that they might respond to encouragement and support; among ~~experimenting communicators~~Occasional Users, there is considerable enthusiasm that has not yet been translated into routine use. Our evidence suggests that possession of more sophisticated skills is perceived by many to be an enabling factor in this transition. It might therefore be expected that this issue might resolve itself as the 'digital natives' (Prensky, 2001) replace older generations of researchers, but Crotty (2009) has cast doubt on this assumption.

In the process of adoption of innovations, local support and encouragement is usually crucial in shaping of attitudes, learning processes, and in creating a critical mass of users (Rogers, 1995; Stewart, 2007): local support and encouragement (informal as well as formal) within departments, research groups and networks seem to be crucial in identifying relevant tools, demonstrating their utility, reducing learning and~~,~~ start-up costs and other adoption barriers, and in creating a critical mass of users. It seems likely, therefore, that the extremely uneven process of adoption of Web 2.0 we have found may be due, in large measure, to the differences in the level of local support reported by our three subgroups. ~~Conventional communicators~~Non-Users, in particular, report virtually no local encouragement. Given that the barriers cited by both ~~experimenting communicators~~Occasional Users and ~~conventional communicators~~Non-Users – lack of time, lack of skills to investigate, experiment and

evaluate alternatives – are those that are best tackled through local support measures, this may also explain why these subgroups do not anticipate significant changes.

Certain knowledge intermediaries (exemplified in our study by innovative publishers and conference organisers) have emerged as key nexuses of service innovation and uptake. However, we see here Web 2.0 services supplementing established media rather than displacing them as the 'Web 2.0 revolutionaries' had proposed. For many researchers, existing mechanisms for information exchange work more-or-less adequately and, importantly, are entrenched within long-established institutional and professional assessment and reward systems.

Overall, there is little evidence to suggest that Web 2.0 will prompt the kinds of radical changes in scholarly communications advocated by the Open Science community in the short or medium term: a wholesale 'Web 2.0 revolution' is not imminent. We are, instead, in the initial stage of a process of 'social learning' surrounding the development and use of Web 2.0 in research. The concept of social learning[8] (Sørensen, 1996; Williams, Stewart ~~and~~ & Slack, 2005) criticises notions that technology design can somehow fully anticipate novel user/societal needs; instead the emergence, adoption and use of new technologies, and the development of new uses involves often protracted negotiation and discovery processes:

- as potential users struggle to uncover, explore and exploit new technological capacities (affordances) and adapt them to their purposes and contexts; and
- as designers/developers seek to identify ~~capture~~ and better understand emerging users and usages.

In this process, technologies and conceptions of use are typically reworked. Given that we are still at an early stage in the innovation of Web 2.0 services and associated scholarly communication practices, the priority must be to encourage relatively open-ended processes of experimentation around both the development of tools and service offerings, and around information exchange practices – together with support to disseminate and build upon beneficial developments thrown up in this highly dispersed, indeed chaotic, innovation system. Attempts to impose particular systems or concepts of how they will be used could unhelpfully stifle innovation and use.

7. Conclusions and Implications for Policy

A range of service and creative industries have been created through processes of informatisation over the past 30 years that have involved significant restructuring and re-evaluation of activities and practices. The most effective way to facilitate this change, however, is not through the introduction of technology as a driver of change or the mechanistic pursuit of particular models of use. Instead, evidence of local innovative use of Web 2.0 can reveal potential opportunities for major beneficial change in the practice of scholarly communication. However, local innovation generates a very uneven pattern of uptake and is unlikely to be the driver for widespread change – this will come from harnessing technological capabilities to further broader policy and scientific goals.

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[8] "Social learning can be characterised as a combined act of discovery and analysis, of understanding and giving meaning, and of tinkering and the development of routines. In order to make an artefact work, it has to be placed, spatially, temporally, and conceptually. It has to be fitted into the existing, heterogeneous networks of machines, systems, routines, and culture." (Sørensen, 1996)

Our study shows that the adoption of Web 2.0-based novel forms of scholarly communications has reached only modest levels so far. It reveals a flow of generic Web 2.0 offerings that are proving themselves useful and easy to use across a range of academic disciplines and contexts. These services are being rapidly adopted, but still in a rather fragmentary manner and are unlikely to promote radical changes in scholarly communications. In contrast, more specialised resources geared towards research community practices offer potentially greater benefits – though they may require higher levels of up-front investment in both service development and uptake. Our study has confirmed the important role played by local research groups and knowledge intermediaries in encouraging adoption. We also encountered the (unanticipated) role played by conference organisers in this respect.

Web 2.0 services and tools are developing and evolving rapidly, and this has implications for strategies intended to encourage adoption. Attempts to introduce collaborative tools through top-down initiatives, for example, by promoting particular standards, have not been very effective. A more successful model appears to revolve around more dispersed and dynamic innovation patterns arising from community-based activities and from start-ups. At this stage, it may be better to encourage experimentation and 'social learning' (Williams, Stewart and & Slack, 2005) among developer and adopter communities. It would be premature to expect rapid closure and attempts to align around current tools/practices could inhibit innovation.

Our study suggests that lack of formal skills may be less of a barrier to adoption than awareness of what is services and tools are available and models of how they may productively applied to support research. This is why a key determinant of adoption was a supportive local environment (in terms of research group and institution). Successful practices are spreading through the research community through informal exchange of ideas among particular groups and networks. However, more organised exchange of knowledge and experience may help overcome the consequent unevenness of adoption. Research managers may need to consider how best to create circumstances for such exchange.

Higher Education Institutions (HEIs) can do much to stimulate experimentation and exploitation of new forms of scholarly communication, but they must also engage in a process of learning how to adapt their policies to maximise the benefits and minimise the risks. The adoption of Web 2.0 services has often by-passed central HEI computing and information services. This— perhaps reflectsing the importance of local support to make Web 2.0 available and relevant to scholarly activities – and suggestsing the need to reconsider institutional support structures and approaches. The growing attention to the 'third mission' of HEIs, and to 'impact' of research on non-academic stakeholders proposed under the upcoming Research Excellence Framework ought to encourage HEIs to revise management practices and cultures which incentivise traditional communication modes. However, this will need to be balanced against the equally strong imperative to protect valuable IPR.

There are also broader issues for HEIs about the ways in which researchers' recognition and reward structures are locked in to traditional modes of validation and dissemination (e.g. peer reviewed publication), which act as a disincentive to innovation (this is one reason why Web 2.0 services have mainly arisen as an adjunct to, rather than a substitute for, established dissemination channels). Broadly similar issues also arise around attempts to promote data archiving, re-use and open-access.

Comment [RP2]: More specific?

Policies that are being developed for the latter are likely to be helpful in promoting exploitation of Web 2.0.

If new forms of scholarly communications are to flourish, it is important that funders recognise and incentivise the use of new forms of dissemination and research outputs. Given that dissemination, knowledge transfer and impact have never been higher on funders' agendas, it would seem timely for funders to encourage new practices and for impact measurement programmes such as the RAE (and its successor, the REF) to acknowledge a wide variety of research outputs and scholarly contributions.

Acknowledgements

Bibliography

Anderson, P. (2007). What is Web 2.0? Ideas, technologies and implications for education. JISC Technology and Standards Watch. JISC, Bristol, February. Retrieved April 23, 2010 from http://www.jisc.ac.uk/media/documents/techwatch/tsw0701b.pdf

Arms, W.Y. and & Larsen, R.L. (2007). *The Future of Scholarly Communication: Building the Infrastructure for Cyberscholarship,* Report of a workshop held in Phoenix, Arizona April 17-19. Sponsored by the National Science Foundation (NSF) and the Joint Information Systems Committee (JISC). Retrieved April 23, 2010 from http://www.sis.pitt.edu/~repwkshop/NSF-JISC-report.pdf)

Benkler, Y. and & Nissenbaum, H. (2005). Commons-based Peer Production and Virtue, The Journal of Political Philosophy, Vol. 14, No. 4. (2006), pp. 394-419.

Borgman, C. (2007). Scholarship in the Digital Age: Information, Infrastructure, and the Internet. The MIT Press. Retrieved April 23, 2010 from http://polaris.gseis.ucla.edu/cborgman/PubsDA.html

Bradley, D. (2009). Gen-F Scientists Ignoring Social Networking. Sciencebase. Retrieved April 23, 2010 from http://www.sciencebase.com/science-blog/gen-f-scientists-ignoring-social-networking.html

Crotty, D. (2009). Scientists Still Not Joining Social Networks. The Scholarly Kitchen. Retrieved April 23, 2010 from http://scholarlykitchen.sspnet.org/2009/10/19/scientists-still-not-joining-social-networks/

De Roure, D. (2008). Web 2.0 and the Democratisation of e-Research. International Summer School on Grid ComputingSSGC2008, Hungary, July. Retrieved April 23, 2010 from http://www.semanticgrid.org/presentations/issgcWeb3.ppt

Elliott, M. and & Scacchi, W. (2008). Mobilization of Software Developers: The Free Software Movement, Technology and People, 21(1), 4-33., 2008 Retrieved April 23, 2010 from http://www.ics.uci.edu/~wscacchi/Papers/New/Elliott-Scacchi-Free-Software-Movement.pdf

Fry, Jenny (2004). The Cultural Shaping of ICTs within Academic Fields: Corpus-based Linguistics as a Case Study, Literary and Linguistic Computing 2004 19(3):303-319; doi:10.1093/llc/19.3.303 Retrieved April 23, 2010 from http://llc.oxfordjournals.org/cgi/content/abstract/19/3/303

Fry, Jenny. (20064). Scholarly Research and Information Practices, A Domain Analytic Approach, Information Processing and Management, September. Retrieved April 23, 2010 from http://portal.acm.org/citation.cfm?id=1138816

Hannay, T. (2009). From Web 2.0 to the Global Database. In Hey, T. Tansley, S. and Tolle, K. (Eds.) The Fourth Paradigm: Data-Intensive Scientific Research. Microsoft Research, Washington, USA.

Harley, D., Earl-Novell, S., Krzys Acord, S., Lawrence, S. and King&, C.J. (2008). Interim Report: Assessing the Future Landscape of Scholarly Communication, (Spring 2008), Center for Studies in Higher Education. Retrieved April 23, 2010 from http://cshe.berkeley.edu/publications/publications.php?id=300

Hey, T. Tansley, S. and & Tolle, K. (Eds.) (2009). The Fourth Paradigm: Data-Intensive Scientific Research. Microsoft Research, Washington, USA.

Hull D., Pettifer S.R. & Kell D.B. (2008). Defrosting the Digital Library: Bibliographic Tools for the Next Generation Web. PLoS Computational Biology 4(10): e1000204 doi:10.1371/journal.pcbi.1000204

Knorr Cetina, K.D. (1999). Epistemic Cultures. How the Sciences Make Knowledge. Cambridge: Harvard University Press.

Lessig, L. (2004). Free culture: how big media uses technology and the law to lock down culture and control creativity. New York:, NY, Penguin Press.

Lin, Y., Poschen, M., Halfpenny, P and Procter, R. (2008). Research 2.0: Social Networking Sites for Scientists. In Proc. Association of Internet Researchers Conference: Internet Research 9.0: Rethinking Community, Rethinking Place. Copenhagen, October.

Murray-Rust, P. (2008). Chemistry for everyone. Nature, 451: 648-651.

O'Reilly, T. (2005). What is Web 2.0? September. Retrieved April 23, 2010 from 2005 http://www.oreilly.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html

Newman, J. (2009). Researchers of Tomorrow. Retrieved April 23, 2010 from http://explorationforchange.net/index.php/current-projects/researchers-of-tomorrow/researchers-of-tomorrow-home.html

Neylon, C. and & Wu, S. (2009). Open Science: tools, approaches, and implications. Pacific Symposium on Biocomputing.

Prenksy, M. (2001). Digital Natives, Digital Immigrants. On the Horizon, 9(5): 1-6. Retrieved April 23, 2010 from http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf

Rogers, E. M. (1995). Diffusion of innovations. New York, Free Press.

Snee, H. (2008). Web 2.0 as a Social Science Research Tool. A report on behalf of Social Sciences Collections and Research, The British Library: ESRC/British Library Student Placement Scheme.

Sørensen, K. H. (1996). Learning technology, constructing culture. Sociotechnical change as social learning' STS working paper no 18/96, University of Trondheim: Centre for technology and society.

Sparks, S. (2005). JISC Disciplinary Differences Report, JISC Scholarly Communications Group 3 August 2005, Sue Sparks, Rightscom Ltd Available at http://www.jisc.ac.uk/media/documents/themes/infoenvironment/disciplinarydifferencesneeds.pdf notes]

Star, S. L. (Ed.) (1995). The Cultures of Computing. Wiley-Blackwell.

Stewart, J. (2007). Local Experts in the Domestication of Information and Communication Technologies. Information, Communication and Society 10(4).

Stewart, J. & Hyysalo, S. (2008). Intermediaries, Users and Social Learning in Technological Innovation. International Journal of Innovation Management, 12(3), 295-325.

Thorin, S.E. (2003). Global Changes in Scholarly Communication Retrieved April 23, 2010 from http://www.springerlink.com/content/w873x131171x2421/

Voss, A., Mascord, M., Fraser, M., Jirotka, M., Procter, R., Halfpenny, P., Fergusson, D., Atkinson, M., Dunn, S., Blanke, T., Hughes, L. & Anderson, S. (2007). e-Research Infrastructure Development and Community Engagement. Proceedings of the UK e-Science All Hands Meeting, Nottingham. Retrieved April 23, 2010 from http://www.allhands.org.uk/2007/proceedings/papers.866.pdf

Voss, A., Asgari-Targhi, M., Procter, R., Halfpenny, P., Dunn, S., Fragkouli, E., Anderson, S., Hughes, L., Mineter, M., Fergusson, D. & Atkinson, M. (2008). Widening Uptake of e-Infrastructure Services. Proceedings of 4th International e-Social Science Conference, Manchester, UK, June. Retrieved April 23, 2010 from http://www.merc.ac.uk/sites/default/files/events/conference/2008/programme/thurs/voss.pdf

Waldrop, M. (2008). Science 2.0: Great New Tool, or Great Risk? Scientific American. Retrieved April 23, 2010 from available on line at http://www.sciam.com/article.cfm?id=science-2-point-0-great-new-tool-or-great-risk (retrieved on 24 November 2008).

Ware, M. & Monkman, M. (2008). Peer review in scholarly journals: Perspective of the scholarly community – an international study. Retrieved April 23, 2010 from http://www.publishingresearch.net/PeerReview.htm

Williams, R., Stewart, J. & Slack, R. (2005). Social Learning in Technological Innovation: Experimenting with Information and Communication Technologies, Edward Elgar: Aldershot.