An exploration into the information seeking behaviours of engineers and scientists

Susan Wellings[+] & Biddy Casselden[++]
[+]Former MSc student, Northumbria University, NE2 1XE, UK; email: sue.wellings@yahoo.co.uk
[++]Senior Lecturer, i-School, Northumbria University, NE2 1XE, UK; email: b.casselden@northumbria.ac.uk

Abstract

This article considers findings from master's research that investigated the information seeking behaviours of engineers and scientists in the workplace. The objectives of this research were to establish where engineers and scientists look for information, consider their search preferences and determine the understanding they have of online search engine operation. There is limited current research in these areas looking at engineers and scientists in the workplace.

The research was undertaken using a mixed methods research methodology. A survey was conducted with engineers and scientists working in the UK, using an online questionnaire and interviews to obtain quantitative and qualitative data. Due to the small sample size (115: 58 engineers, 57 scientists) this research does not make generalisations about the wider population.

The research showed both similarities and differences between engineers' and scientists' information seeking behaviours. The most popular resources used by both engineers and scientists were online search engines, specialist databases and scholar search engines; and the most used sources were from within their own organisation (colleagues and documents). Electronic versions of sources were preferred over print because of their searchability, however when an item was found it was often printed out to read.

Although the main focus of this research was not information literacy it is suggested that there are significant gaps in the understanding of search engine functionality by both engineers and scientists, even though it is the most heavily used resource for information seeking.

Whilst this research does not make generalisations about the wider engineer and scientist populations, potential implications for information professionals working with these groups are considered.

Keywords: information seeking behaviour, engineers, scientists, workplace, search engine understanding

Introduction

In the fields of engineering and science, information is often used to make critical decisions, therefore it is vital engineers and scientists find information that is relevant, accurate and trustworthy (Leckie et al., 1996: 165). There is, and has been for many years, limited current research looking at engineers or scientists in the workplace, in particular in research organisations (Leckie et al., 1996).

Engineers and scientists have sometimes been considered the same user group even though, "engineer and scientist are not synonymous" (Pinelli, 1991: 5). As seen in Pinelli's (1991) review they were found to display different information seeking behaviours. Engineers and scientists therefore, were treated as separate groups in this research.

The purpose of this research was to provide an up-to-date, broad study into the information seeking behaviour of engineers and scientists in the workplace. Their information preferences and their understanding of online search engines were explored. Due to the small sample size (115) this research does not make generalisations about the wider population.

Aim and Objectives

The aim of this research was to investigate the information seeking behaviour of engineers and scientists in a workplace setting. The objectives were to:

- Establish and compare where engineers and scientists look for information and their preferences.
- Establish and compare if engineers and scientists have a basic understanding of how search engines select and order results.
- Provide a better understanding of the information seeking behaviour of these groups, in what is currently an under-researched area.
- Distinguish the key traits of engineer and scientists searching behaviour for the benefit of information professionals working with them.

This research focussed on engineers in a research and development organisation and scientists in pharmaceutical research who worked, or were recently retired (within 12 months), in the UK and who were not based in an academic setting. These groups were selected due to their accessibility to the researcher, i.e. convenience sampling (Lavrakas, 2011).

Literature review

Information seeking behaviour is defined by Feather and Sturges (2003: 300) as being the, "complex patterns of actions and interactions that people engage in when seeking information". There have been a significant number of studies in this field over the years and, "from the 1940s through the 1970s, investigations of scientists (and to some extent, engineers) dominated all others" (Case, 2012: 287). Examples include King et al. (1994); Leckie et al. (1996); and Gerstberger and Allen (1968).

Some information seeking behaviour studies have focussed on engineering and scientific workplaces, including Anderson, et al. (2001), Cool and Xie (2000), Ellis and Haugan (1997), and Fidel and Green (2004). However, there is limited recently published research on engineers' and scientists' information seeking behaviours and, "the investigation of scientists' use of sources is less common today than it was in past decades" (Case, 2012: 287) with even fewer exploring behaviours of engineers or scientists in the workplace.

Pinelli (2001) examined the similarities and differences between engineers and scientists, and observed both groups needed, "large quantities of information to perform their work" (2001: 136). Pinelli summarised the key differences of information use by both groups as being that, "scientists use information to produce information…engineers consume information, transform it, and produce a product that is information-bearing" (2001: 136). In an earlier work Pinelli also identified past research that detailed differences between engineers and scientists, including Krulee and Nadler (1960), Ritti (1971) and Allen (1988) (all cited in Pinelli, 1991). Therefore in this research engineers and scientists were treated as separate groups.

Information seeking behaviours of engineers

Several studies have shown engineers prefer to use resources and sources within their own organisation, including internal documents and colleagues. Leckie et al. (1996: 165) found, “libraries are little used and, instead, engineers rely on personal files, personal knowledge, and personal experience”.

More recent studies show the internet was also used extensively. Chaudhry and Al-Mahmud (2015) found engineers preferred websites, personal documents and colleagues. Kwasitsu (2003) discovered engineers mostly used internal information sources (colleagues, documents and memories) followed by the internet and a corporate library. Library use in Kwasitsu’s (2003) study was more prominent than most other studies, with such usage being more likely as education level increased.

The preference for using other people as an information resource is reported in many studies, however this is frequently considered in conjunction with the use of non-human resources and sources. Leckie et al. (1996: 165) found, “oral communication is predominant”. Contrastingly Robinson (2010: 654) found engineers were likely to spend more of their time using non-human sources to locate an information source and information within a source, than using another person for these tasks. Therefore source and resource preferences were examined in this research.

However, the most important factor for engineers when seeking information is commonly given as accessibility (Fidel and Green, 2004: 564), and Anderson, et al. (2001) explain accessibility is important as engineers commonly follow the path of least resistance. Key barriers to seeking information include cost and time (Hertzum and Pejtersen, 2000).

Information seeking behaviours of scientists

Some similarities can be found in the literature for preferred sources and resources when scientists are compared with engineers, but there are also some differences. The key sources and resources seen in studies are very similar, however the order of preference is different.

Previous research found scientific journal articles are the most important source of information for scientists (including Grefsheim and Rankin, 2007; Research Information Network, 2006; Hoggan, 2002). Internal colleagues were not as important, but were considered a valued resource for scientists (Haines, et al., 2010; and Research Information Network, 2006). Grefsheim and Rankin (2007: 429) found after scientific journals the next most used resources/sources by biomedical research scientists were databases, books and conference proceedings.

Increasingly the library service was not found to be very important to scientists. Palmer (1991: 106) suggests the, "use of library materials and services was not considered important unless the scientists happened to see the library as part of their 'information world' ". Scientists tend to, "ignore institutional boundaries when searching for information and do not necessarily view the library as the primary source of scholarly information" (Haines, et al. 2010). Palmer (1991: 125) also noted scientists display a, "surprising lack of knowledge" about services and information products available through the library, even by those who use it frequently.

Accessibility appears to be the predominant factor that is important to scientists. Hoggan (2002) suggests, "in an era of instant gratification, researchers are tempted to read only the information that is available online because it is the easiest to obtain". Grefsheim and Rankin (2007: 430) found accuracy and, ease of access and use were the most important factors for research scientists. They also reported the largest barrier to finding information was lack of time.

Use of online search engines

Today the internet is heavily integrated into peoples' everyday lives in the UK through smartphones, tablets, computers, etc. When seeking information internet search engines have become people's first point of call in place of libraries (Baase, 2013: 330). This is partially due to accessibility and people (including engineers and scientists) choosing the path of least effort (Anderson et al., 2001: 132).

Search engines have dramatically evolved as internet use has increased (Ruthven and Kelly, 2013: 201). Google, the most popular search engine (Krawczyk, 2014), has evolved and uses a multitude of systems to feed into its overall search algorithm to rank search results including artificial intelligence, commercial bias and page structure (Sullivan, 2015; Baase, 2013: 330). These developments are intended to return the most relevant results for the user (Yu, 2016). For specialist scientific research this tailoring combined with using automated recommendations offered in some electronic databases could be narrowing research design and deciding which areas to investigate as only "popular" research is reviewed and cited (Evans, 2008).

Therefore given the apparent extensive use of online search engines by engineers and scientists to seek information, it was important to discover if they have an understanding of search engine operations (even though information literacy was not the primary focus of this research). An identifiable lack of understanding raises the issue of whether such use narrows the field of research, and may help to offer some direction for information professionals wishing to assist their clients further.

Research methodology

This research followed the pragmatism paradigm as outlined by Cresswell (2014: 6, 10-11), and the study attempted to gain insight into the information seeking behaviours of engineers and scientists using a mixed methods approach. Cameron (2011: 96) explains mixed methods research (MMR) is an evolving area in research methodology with a variety of definitions. This research adopted Cresswell's (2014: 4) definition of MMR as, "an approach to inquiry involving collecting both quantitative and qualitative data, integrating the two forms of data". The intentions of this research were to gather objective data to outline a picture of information seeking behaviours, and to explore the identified behaviours to gain understanding so as to add detail to the picture, therefore MMR approach was followed (Johnson and Onwuegbuzie, 2004).

Research methods and techniques

Research was undertaken using the survey method. Surveys are used to, “gather and analyse information by questioning individuals…using a standardized questioning procedure applied equally and consistently to all research participants” (Pickard, 2013: 111). Two sequential techniques were used to gather data: questionnaire and interview. Engineers and scientists participated in the questionnaire and engineers participated in interviews (as no scientists volunteered to be interviewed).

Purposive sampling was undertaken with the aim of gathering information rich data (Pickard, 2013: 64) from an accessible group of participants. The snowball approach to purposive sampling was used, where key participants were approached using existing contacts who were then encouraged to share the questionnaire web link further (Foster and Ford, 2003). Whilst this allowed for wider, yet targeted, sampling it was not possible to determine an exact return rate.

Ethics are an important part of good research practice (Pickard, 2013: 87), as such this research was carried out in accordance with Northumbria University’s research ethics and governance policies and procedures (Northumbria University, 2016). One aspect of this involved obtaining informed consent prior to participation in the research.

Questionnaire

Questionnaires are one of the most popular techniques for collecting data and can be used to profile and identify patterns in a sample group (Rowley, 2014: 308-310). Online questionnaires are an increasingly popular technique to gather data and they allow easy access for participants (Pew Research Center, 2016). The aim of this research was to maximise the number of completed questionnaires by offering a convenient and accessible route. To achieve a random and broad spectrum of participants the survey was promoted in three ways: direct email to known contacts, electronic noticeboard at work and by asking contacts to pass the survey on to their contacts (i.e. snowballing).

The questionnaire was viewed as a, “valuable tool in understanding a situation” (Rowley, 2014: 328) and therefore was designed to collect both quantitative and qualitative information. Quantitative information was collected using closed questions, including forced choice Likert type scale (using four ratings to force a view) and multiple-choice questions. Qualitative questions were used to allow participants to expand on responses to the quantitative questions.

One drawback to using a questionnaire is the inability to be certain questions have been understood as there is no help available whereby respondents can query or clarify questions (Jamali and Nicolas, 2008). To check questionnaire suitability and usability a draft was piloted (one scientist, one engineer and one information professional), feedback sought and amendments made (Pickard, 2013: 208). The final version was live for approximately three weeks in March 2016.

Questionnaires typically receive very low return rates (Pickard, 2013: 208). The questionnaire was therefore designed to give the participant control over the length of time taken to complete because time constraints can be a factor for non-completion (Rowley, 2014: 314). It was essential to complete the quick closed quantitative questions but the more time consuming open qualitative questions were optional. This meant that participants with limited time were able to complete the questionnaire in 5-10 minutes by only completing the quantitative questions.

Key themes covered in the questionnaire included:

- Demographic information
- Resources used
- Important factors when searching for information
- Library use (including resources and staff)
- Basic understanding of online search engines

Interview

One limitation of a questionnaire is that it does not allow the researcher to interact directly to the participant so if interesting data comes to light the researcher cannot investigate this further (Jamali and Nicholas, 2008). Interviews can be used for, “gaining insights into or understanding of opinions, attitudes, experiences, processes, behaviours or predictions” (Rowley, 2012: 261). Therefore interviews following the questionnaire were used to gain more insight and understanding of behaviours and perceptions of behaviours.

Interviews took place after the questionnaire closed so data gathered and analysed from the questionnaires could inform the focus of the interviews. Semi-structured, face-to-face interviews were used to collect qualitative information that added value to the questionnaire data by further exploring identified themes (Rowley, 2012: 262). An interview guide was developed prior to, and used during interviews to ensure open, unbiased and non-leading questions were asked (Jamshed, 2014: 87).

Interviews can be time consuming to conduct and analyse, and it was also assumed participants would have limited availability therefore the interviews were designed with these factors in mind (Rowley, 2012: 263-264). The interviews were 30 minutes in duration, and were conducted with 5 participants (all engineers). Participants wishing to take part in the interviews had expressed an interest at the end of the initial questionnaire, therefore the final sample was not fully representative of all initial respondents.

Interviews were used to expand on selected areas covered in the questionnaire and to gain additional qualitative data. Key themes explored included:

- Interviewees’ information seeking process
- Resource and source preferences
- The most important factor(s) when searching for information
- How library staff were used in the search process
- Online search engine understanding

Overview of survey participants

The total number of questionnaire respondents was 115: 58 engineers (50.4%) and 57 scientists (49.6%). The largest group of engineers by age group was 50-59 years (28%) followed by 30-39 years (26%); for scientists it was 30-39 years (37%) then 40-49 years (33%). See figure 1 for full details.

Figure 1

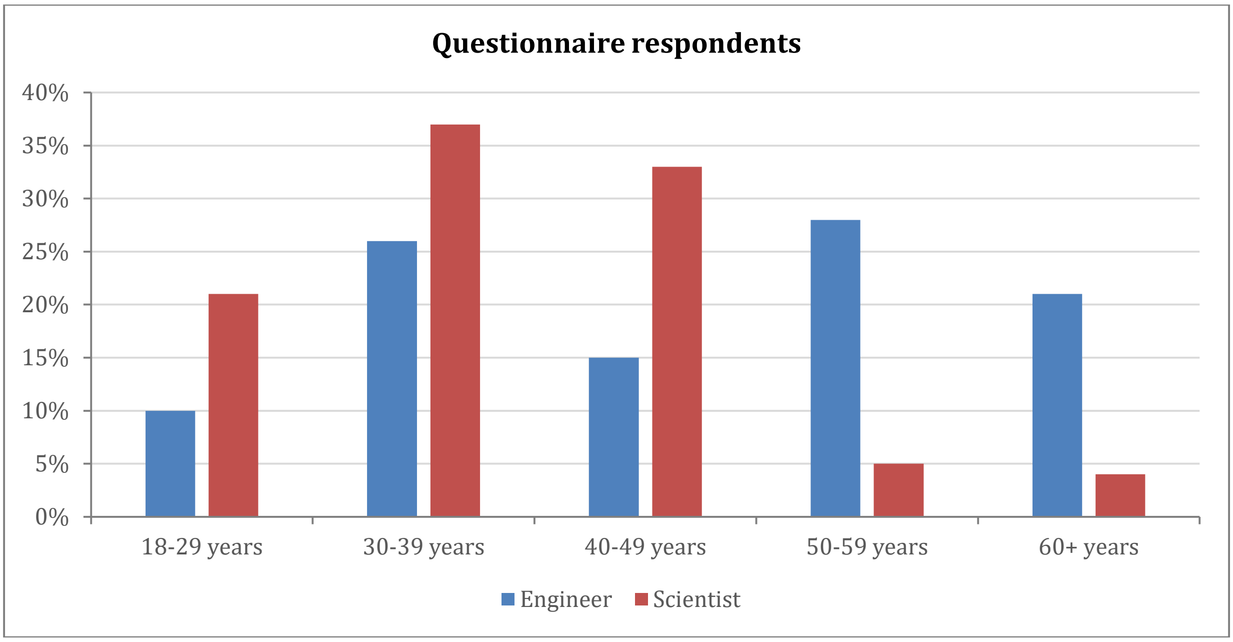

Figure 1: Overview of questionnaire respondents by age and occupation

Five interviews were undertaken with engineers (no scientists volunteered). Engineers were from each age group except 50-59 years.

The majority of engineers worked for a specialist engineering R&D organisation (62%) and the majority of scientists worked for a pharmaceutical research company (86%).

Limitations

The main limitation of this research was its small sample size (115) therefore generalisations about the wider engineering and scientific communities cannot be made. Another limitation worth noting is that the responses of engineers and scientists may not be an entirely accurate reflection of their actual information seeking behaviours. It was seen that some interviewees wanted to change their responses on their questionnaires. This can be explained in Barry's (1995) study into the use of electronic sources by academics in education and theoretical physicists who surmised, "much of their knowledge is implicit…[therefore] information activity is not necessarily easily retrievable to consciousness…they may make guesses or assumptions based on post-rationalization" (Barry, 1995: 112).

Results and discussion

Resources

In this research engineers and scientists have similar resource preferences when seeking in-depth information. A resource is defined as a, "means of doing something"[1], in this study it is interpreted as a means of finding information. The top three resources used are an online search engine, a specialist database and a scholar search engine (see table 1). Almost all engineers (95%) and scientists (98%) use an online search engine either often or always, and very few use social media/networks (9% and 8% respectively).

Table 1

Resource	Engineer		Scientist		Difference between
	Often / Always	Rank	Often / Always	Rank	engineers & scientists
Online search engine	95%	1	98%	1	3%
Specialist database	57%	2	74%	2	17%
Scholar search engine	48%	3	61%	3	13%
Information professional	41%	4	16%	4	25%
Library catalogue	33%	5	12%	5	21%
Social media/ network	9%	6	7%	6	2%

Table 1: Resources used "often" or "always" by engineers and scientists

Qualitative data from the questionnaires and interviews indicate engineers and scientists use search engines because they are convenient, readily available and easy to use. All the engineers interviewed use Google as their search engine of choice. 60% of the engineers said they use Google because they thought it was a good/the best search

[1] Collins, 2016, sv 'resource', 4. Available at: http://www.collinsdictionary.com/dictionary/english/resource

engine available, and one interviewee said they did not know why they used Google, they just did.

The influence of accessibility and ease is supported by Anderson et al.'s (2001) and Pinelli's (1991) reviews of past research which identified that engineers usually follow the path of least effort. In today's internet enabled world this appears to be online search engines as they are available to all at their desks and on mobile devices, and are easy to use (Anderson and Rainie, 2014). Haines, et al. (2010: 77) suggest scientists begin with the, "whole world of information available to them from their desktops". However, Grefsheim and Rankin (2007: 432) consider that research scientists are more likely to start their search from the, "library's website than other methods including Google".

It is worth noting some respondents said they used online search engines as a starting point to gain an overview of the research topic, before progressing to using a more specialised resource.

The data in table 1 also shows engineers are less likely than scientists to use a specialist database (57% compared with 74%), and engineers are more likely to use an information professional (41% compared with 16%). Qualitative data from the questionnaire show some scientists use specialist databases (in particular PubMed) because they are easy to use and contain relevant information. Studies of engineering staff in academic settings discovered a heavy reliance on search engines and scholar search engines (including Zhang, 2015; Engel et al., 2011; and Tucci, 2011). Similarly Jamali and Asadi (2010: 291) argue that there is an, "increasing use of Google by scientists for finding scholarly articles". Zhang (2015: 276) suggests Google Scholar is replacing specialist database use because engineers, "do not completely recognize the usefulness of library resources". This could explain in part the low usage of libraries seen in this research.

Engineers in this study are more likely than scientists to use a library or information service. From the questionnaire results the top reason given by engineers responding to "why", is they feel library staff have expert knowledge in finding information. Haines, et al. (2010: 77) argues that scientists would only consider using the library when a, "document was not readily available to them online or was too expensive", however they would often try colleagues (internal or external) with more access to resources before the library.

The top reason given by five out of eight scientists on the questionnaire for not using library staff was speed. Cool and Xie (2000: 467) found even though library staff were not used frequently, engineers scored them highly for satisfaction. One explanation offered by Cool and Xie (2000: 468-469) for engineers not using the library was they kept their own personal library but they did value the library, even if it was used as a, "resource of last resort". On the questionnaire almost a quarter of engineers (23%) and a third of scientists (33%) responded they never use a library even though they have access to one.

In the questionnaire a small number of engineers said whilst they do have access to a specialist library, they do not use it because they are unaware of the services available to them. This result matches findings from Grefsheim and Rankin (2007: 430) who discovered a quarter of non-library users in their study of research scientists had a, "lack of awareness of library offerings". An interesting point to note is that 10% of respondents (engineers and scientists) have no access to any library at all.

As previously stated the majority of scientists in this study work for the same pharmaceutical company (86%) and have free unlimited access to the PubMed database at their desks. The majority of engineers work for the same engineering R&D organisation (62%) and have limited access to specialist databases from which access to full text papers may have cost and/or time implications. These factors could influence the results seen in this study.

Sources

The questionnaire data shows that whilst there are differences between the sources used by engineers and scientists, there are also similarities. Source material is defined as, "publications from which information is obtained"[2]. Both groups extensively use colleagues within their own organisation (93% each) and to a lesser extent, internal documents (78% engineers and 65% scientists). See table 2 for a summary of results.

Qualitative data from the questionnaire shows some engineers and scientists use colleagues and internal documents because they are easily accessible, "credible sources" and they can get very relevant information from them. These findings are in line with Hertzum and Pejtersen who argue that, "engineers get most of their information from colleagues and internal reports" (2000: 761).

Table 2

Source	**Engineer**		**Scientist**		**Difference between engineers & scientists**
	Often / Always	**Rank**	**Often / Always**	**Rank**	
Colleagues (within organisation)	93%	1	93%	1	0%
Conference proceedings	45%	6	44%	7	1%
Specific websites	62%	4	56%	4	6%
Enewsletters	10%	11	16%	10	6%
Scientific journals	59%	5	65%	2	6%
Internal documents	78%	2	65%	2	13%
Colleagues (outside organisation)	43%	7	28%	8	15%
Books/eBooks	40%	8	13%	11	27%
Email alerts	19%	9	47%	5	28%
Patents	14%	10	47%	5	33%
Standards or similar	73%	3	18%	9	55%

Table 2: Sources used "often" or "always" by engineers and scientists

The largest differences seen in source use between engineers and scientists are for standards (55%), patents (33%) and email alerts (28%). Engineers in this study use

[2] Collins, 2016, sv 'source materials'. Available at: http://www.collinsdictionary.com/dictionary/english/source-materials

standards more than scientists (73% compared with 18%), and some engineers view standards as very reliable sources of relevant information that are, “instantly accessible”. Scientists use patents (47% compared with 14%) and email alerts (47% compared with 19%) more than engineers. Although there is no qualitative data from this study to offer an explanation for the use of patents and email alerts by scientists, Ellis and Haugen (1997: 401) suggest that the latter “tend to look outwards for most of their information”.

Scientific journals are used more by scientists (65%) than engineers (59%) in this study, which is in line with Ellis and Haguen’s (1997) findings. One scientist stated on their questionnaire they “always” use a specialist database because it has, “peer reviewed journal articles”. Literature suggests that scientists make more use of conference proceedings than engineers (Ellis and Haguen, 1997), but in this study use was almost the same (45% engineers and 44% scientists).

Electronic Vs print preferences

Participants were asked about their preferences with regards to reading material format (print or electronic) and their use of print and electronic sources and resources.

Engineers and scientists both preferred a mixture of reading print and electronic materials, with 34% of engineers and 42% of scientists selecting the 50:50 (print:electronic) option (see figure 2). Engineers in this study lean more towards electronic reading materials and scientists towards print.

Figure 2

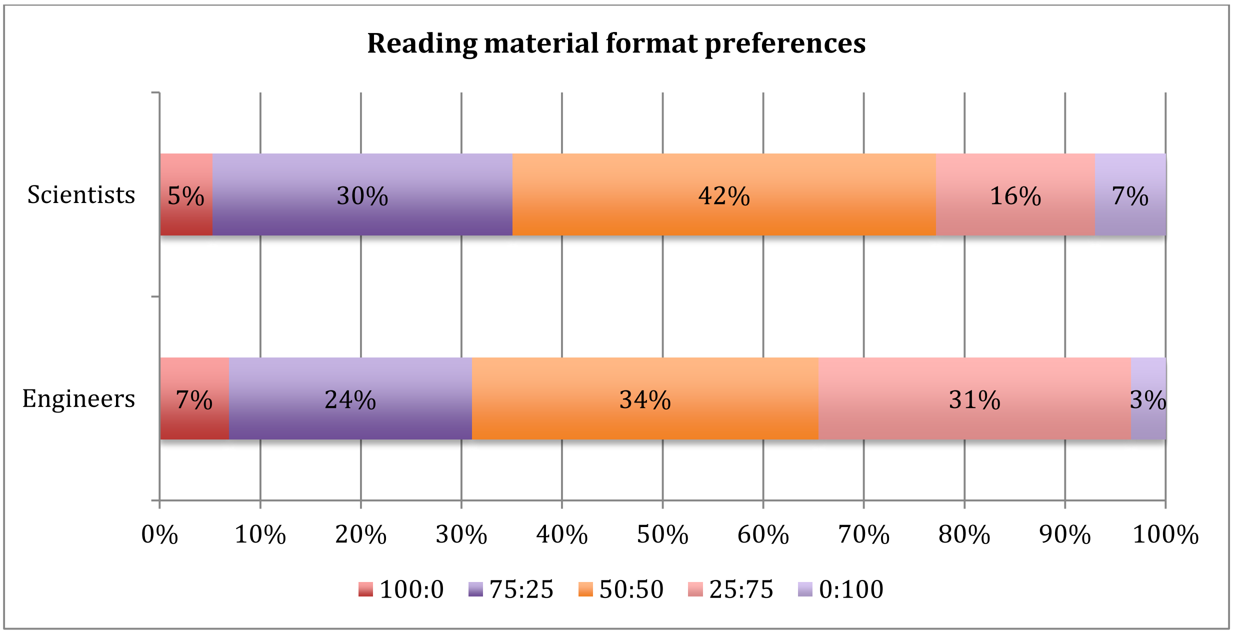

Figure 2: Reading material format preferences (print:electronic) for engineers and scientists

The reasons for this discrepancy are varied. Of all the participants, 31 engineers and 30 scientists responded to "why" in the questionnaire about their preference for reading print or electronic material. The main reasons given for reading print were comfort (less tiring) and readability (34%), being able to make notes (26%) and when reading in-depth material or a large amount (15%). For reading electronic material the main reasons were skim reading (15%), accessibility and convenience (11%), and ease of storage and transportation (11%). These comments are supported by data gained from the interviews with engineers

These findings mirror Niu and Hemminger's (2012: 343) study that discovered academic scientists preferred a mixture of print and electronic reading materials, "depending on the situation". However, Liu (2006) identified a preference for reading print over electronic material, and a high frequency (78.3-81.8%) of, "printing out electronic documents" for graduate students.

Additionally the preferred format for searching resources and sources was examined. Engineers and scientists in this study preferred to search electronic resources and sources to print. The top three resources used by both groups were all electronic: online search engines, specialist databases and scholar search engines (see table 1). The same was seen for sources where the electronic version of a source is preferred to its print version, with the exception of books and eBooks for engineers (see table 3). This is supported by Niu and Hemminger's (2012: 343) study.

Table 3

Source	**Engineer (often / always)**			**Scientist (often / always)**		
	Electronic	**Print**	**Difference**	**Electronic**	**Print**	**Difference**
Scientific journals	66%	52%	14%	93%	32%	61%
Internal documents	88%	67%	21%	86%	42%	44%
Books/eBooks	31%	49%	18%	13%	12%	1%
Standards or similar	83%	62%	21%	26%	9%	17%

Table 3: Source material format preferences of engineers and scientists

The largest difference between the use of electronic and print sources is for scientists and their use of scientific journals (93% electronic compared with 32% print). One reason for this can be seen in the questionnaire responses where some engineers and scientists like to search and skim read electronic materials, but prefer to print information out to read it in-depth because it is more comfortable and they can make notes more easily. This supports the views of Grefsheim and Rankin (2007, p.429) who suggest the majority of scientists in their study preferred online journals to print.

Online search engines

Table 1 illustrates that online search engines are the preferred resource when looking for in-depth information for almost all engineers and scientists in this study. As outlined in the literature review the majority of search engines (in particular Google) are not impartial and tailor results using complex algorithms as they try and 'understand' a search (Yu, 2016). Due to the vast number of signals (including user specific signals such as location, web history, etc) used to ‘decide’ which results to be shown (Google, 2016) it is unlikely a search carried out on two different computers will return exactly the same results (McEvoy, 2015). Given the significant use of search engines by both groups, a brief exploration into engineers’ and scientists’ understanding of how search engines operate was undertaken.

There were similarities in the questionnaire responses of engineers and scientists with regards to their understanding of online search engines. Two thirds of scientists (61%) and just over half of engineers (53%) thought search engines were not impartial (see figure 3). One engineer responded to “why” stating, “search engine results are biased by commercial sponsors. You always have to consider the effect of any such bias”. Bradley (2016) simply states, “Google is there to make money folks, not make your life easier”.

Figure 3

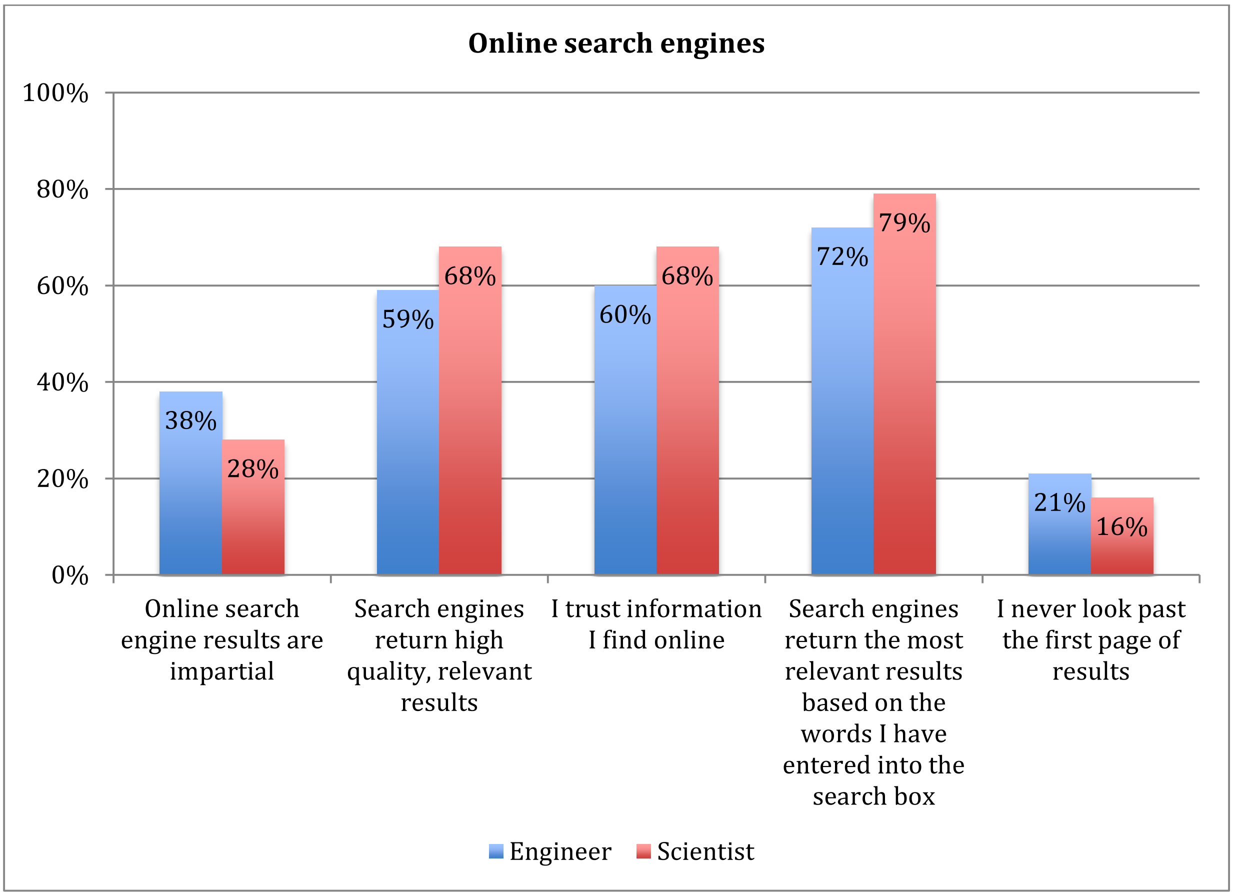

Figure 3: Online search engine understanding “agree” or “strongly agree” for engineers and scientists

The majority of engineers and scientists trust the information they find online (60% and 68% respectively) and will look past the first page of results (79% and 84% respectively). However, qualitative data from the questionnaire indicates these figures need to be expanded upon: engineers and scientists do not necessarily trust online information, they tend to trust online information from credible sources and some will also corroborate information by using multiple sources before accepting it as true.

Almost a third of engineers (31%) and a quarter of scientists (26%) thought they would get exactly the same results if they conducted the same search on different computers, e.g. home and work (see figure 4). Approximately a quarter of engineers (24%) and scientists (28%) responded they do not know. This equates to just over half of the engineers (55%) and scientists (54%) not having a good understanding of how online search engines function, yet the vast majority of each group use them a significant amount (see table 1).

Figure 4

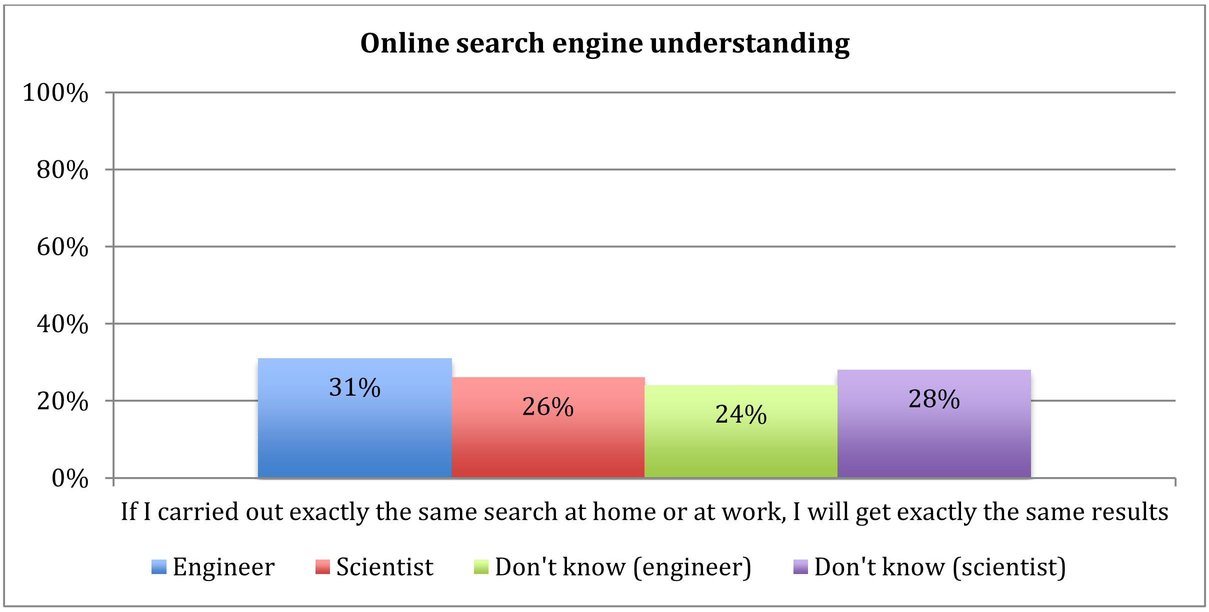

Figure 4: Online search engine understanding "agree" or "strongly agree" and "Don't know" for engineers and scientists

During their interview two engineers were asked if they were told Google tailors results so they are not seeing a true reflection of all the information available online, would this change their willingness to use it. One said, “kind of. In a way that’s a good thing though because hopefully it would tailor the results to the way you actually want. But…you might miss out on some”, the other said, “it would to some extent…I’ve always known that there was some commercial bias in the results but it’s not something I always think about when I’m doing a search”. As briefly touched on in the literature review there is literature inferring this tailoring, whilst helpful, could also have the side effect of narrowing R&D (Evans, 2008).

All five engineers interviewed said the online search engine they use is Google. Two of the engineers said they use Google because they feel it is the best search engine. Other reasons given include it being easy to use, returns relevant results, simply, “I don’t know” and, “I’m not sure what the alternative is”. These remarks demonstrate Google’s significant dominance in the general consciousness (Research Information Network, 2006: 7) and show Google is synonymous with searching for information, hence today’s common phrase “Google it”.

Conclusion

This research did not identify a difference between engineers’ and scientists’ resource preferences. The top three resources used ‘often’ or ‘always’ by both groups were online search engines (95-98%), specialist databases (57-74%) and scholar search engines (48-61%). Reasons given for their use included convenience, availability and ease of use.

However, there did appear to be some slight differences when information source preferences were reviewed. The favoured information sources for both engineers and scientists were sources within their own organisation: colleagues (93%) and documents (65-78%), with accessibility, trust and relevancy being given as reasons for using these sources. The greatest differences between the two sets of respondents were seen for standards (55% difference) and patents (33% difference). Engineers in this study used standards more, and scientists used patents more.

Engineers' and scientists' reading material format preferences were mixed, however engineers leaned more towards an electronic format (34% compared with 23%) and scientists towards a print format (35% compared with 31%). The main reason given for reading electronic material was for skim reading information, and for print material it was comfort and readability.

Engineers and scientists preferred electronic over print resources and sources. The largest difference seen between print and electronic sources was for scientists and scientific journals (32% print compared with 93% electronic). Electronic resources and sources were preferred to print because of their searchability, however when an item of interest was found it was often printed out to read.

There were no significant differences between engineers' and scientists' understanding of online search engines. Both groups demonstrated a mixed level understanding. The dominant search engine, Google, is not impartial and it is unlikely to get exactly the same search results when using two different computers. However, 47% of engineers and 39% of scientists thought search engines were impartial, and 55% of engineers and 54% of scientists either did not know or thought they would get the same results on different computers.

These findings suggest around half the engineers and scientists in this study did not have a good basic understanding of how online search engines function and offer them results, and yet almost all of them heavily use search engines for work purposes.

This research suggests information provision for engineers and scientists must be easy to use, easy to search and accessible (i.e. electronic) if it is to compete with, or be used alongside, Google. Additionally, information services should promote not only their own resources and services but also invest in information literacy strategies, including how best to use available resources and raise awareness of potential issues with using commercial search engines. These steps will educate and enable engineers and scientists to better help themselves in a time pressured world where they feel they do not have time to consult information professionals. This will thereby allow them to access high quality, reliable information that is critical to their role, and for information professionals to continue to add value to their organisations.

Recommendations for further study

This article presents a broad view of current information seeking behaviours of engineers and scientists. One of the intentions of taking a broad view was to highlight areas that could be explored in more depth for engineers and scientists in the workplace. These recommendations are:

- A skills and knowledge gap analysis of online search engines to identify training needs carried out on engineers and scientists to use their favoured information resource.
- The impact of ‘stealth’ search result filtering by online search engines and suggested recommendations seen when using specialist databases, on the breadth of research and development.
- Investigate barriers experienced and perceived by engineers and scientists to using a corporate library, including service awareness.
- A detailed exploration of information professionals’ perceptions of their customer base in scientific communities.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

References

Anderson, CJ, Glassman, M, McAfee, RB and Pinelli, T (2001) An investigation of factors affecting how engineers and scientists seek information. *Journal of Engineering and Technology Management* 18(2): 131-155.

Anderson, J and Rainie, L (2014) Digital life in 2025. Available at: http://www.pewinternet.org/2014/03/11/digital-life-in-2025/ (accessed: 28 Aug 2016).

Baase, S (2013) *A gift of fire: social, legal, and ethical issues for computing technology*. Harlow: Pearson Education Ltd.

Barry, CA (1995) Critical issues in evaluating the impact of IT on information activity in academic research: Developing a qualitative research solution. *Library and Information Science Research* 17(2):107-134.

Bradley, P (2016) Google's 'my activity'. Available at: http://philbradley.typepad.com/phil_bradleys_weblog/2016/07/googles-my-activity.html (accessed: 29 Aug 2016).

Cameron, R (2011) Mixed methods research: the five Ps framework. *The Electronic Journal of Business Research* Methods 9(2): 96-108.

Case, DO (2012) *Looking for information: a survey of research on information seeking, needs, and behavior*. Emerald.

Chaudhry, AS and Al-Mahmud, S (2015) Information literacy at work: a study on information management behaviour of Kuwaiti engineers. *The Electronic Library* 33(4): 760 – 772.

Cool, C and Xie, H (2000) Patterns of information use, avoidance and evaluation in a corporate engineering environment. In: *The 63rd annual meeting of the ASIS*, Chicago, 12-16 November 2000, pp. 462-472. Information Today.

Creswell, JW (2014) *Research design: qualitative, quantitative, and mixed methods approaches.* Sage.

Ellis, D and Haugan, M (1997) Modelling the information seeking patterns of engineers and research scientists in an industrial environment. *Journal of Documentation* 53(4): 384-403.

Engel, D, Robbins, S and Kulp, C (2011) The information-seeking habits of engineering faculty. *College and Research libraries* 72(6): 548-567.

Evans, JA (2008) Electronic publication and the narrowing of science and scholarship. *Science* 321(5887): 395-399.

Feather, J and Sturges, P (2003) *International encyclopedia of information and library science*. Routledge.

Fidel, R and Green, M (2004) The many faces of accessibility: engineers' perception of information sources. *Information Processing and Management* 40(3): 563-581.

Foster, A and Ford, N (2003) Serendipity and information seeking: an empirical study. *Journal of Documentation* 59(3): 321-340.

Gerstberger, PG and Allen, TJ (1968) Criteria used by research and development engineers in the selection of an information source. *Journal of Applied Psychology* 52(4): 272-279.

Google (2016) *How search works: from algorithms to answers*. Available at: https://www.google.co.uk/insidesearch/howsearchworks/thestory/ (accessed: 29 Aug 2016).

Grefsheim, SF and Rankin, JA (2007) Information needs and information seeking in a biomedical research setting: a study of scientists and science administrators. *Journal of the Medical Library Association* 95(4): 426-434.

Haines, LL, Light, J, O'Malley, D and Delwiche, FA (2010) Information-seeking behavior of basic science researchers: implications for library services. *Journal of the Medical Library Association* 98(1): 73-81.

Hertzum, M and Pejtersen, AM (2000) The information-seeking practices of engineers: searching for documents as well as for people. *Information Processing and Management* 36(5): 761-778.

Hoggan, DB (2002) Challenges, strategies, and tools for research scientists: using web-based information resources. *Electronic Journal of Academic and Special Librarianship* 3(3). Available at: http://southernlibrarianship.icaap.org/content/v03n03/Hoggan_d01.htm (accessed: 26 Aug 2016).

Jamali, HR and Asadi, S (2010) Google and the scholar: the role of Google in scientists' information-seeking behaviour. *Online Information Review* 34(2): 282-294.

Jamali, HR and Nicholas, D (2008) Information-seeking behaviour of physicists and astronomers. *Aslib Proceedings* 60(5): 444-462.

Jamshed, S (2014) Qualitative research method-interviewing and observation. *Journal of Basic and Clinical Pharmacy* 5(4): 87-88.

Johnson, RB and Onwuegbuzie, AJ (2004) Mixed methods research: a research paradigm whose time has come. *Educational Researcher* 33(7): 14-26.

King, DW, Casto, J and Jones, H (1994) *Communication by engineers: a literature review of engineers' information needs, seeking processes, and use.* Washington DC: Council on Library Resources.

Krawczyk, K (2014) *Google is easily the most popular search engine, but have you heard who's in second?* Available at: http://www.digitaltrends.com/web/google-baidu-are-the-worlds-most-popular-search-engines/ (accessed: 29 Jan 2016).

Kwasitsu, L (2003) Information-seeking behaviour of design, process, and manufacturing engineers. *Library & Information Science Research* 25(4): 459-476.

Lavrakas, PJ (2011) Convenience sampling. Available at: http://methods.sagepub.com/reference/encyclopedia-of-survey-research-methods/n105.xml (accessed: 04 Sep 2017).

Leckie, GJ, Pettigrew, KE and Sylvain, C (1996) Modeling the information seeking of professionals: a general model derived from research on engineers, health care professionals, and lawyers. *The Library Quarterly* 66(2): 161-193.

Liu, Z (2006) Print vs. electronic resources: a study of user perceptions, preferences, and use. *Information Processing and Management* 42(2): 583-592.

McEvoy, M (2015) *7 reasons Google search results vary dramatically*. Available at: http://www.webpresencesolutions.net/7-reasons-google-search-results-vary-dramatically/ (accessed: 29 Aug 2016).

Niu, X and Hemminger, M (2012) A study of factors that affect the information-seeking behavior of academic scientists. *Journal of the American Society for Information Science and Technology* 63(2): 336-353.

Northumbria University (2016) *Ethics and governance.* Available at: https://www.northumbria.ac.uk/research/ethics-and-governance/ (accessed: 5 Mar 2016).

Palmer, J (1991) Scientists and information: I. Using cluster analysis to identify information style. *Journal of Documentation* 47(2): 105-129.

Pew Research Center (2016) *Collecting survey data*. Available at: http://www.pewresearch.org/methodology/u-s-survey-research/collecting-survey-data/ (accessed: 28 Aug 2016).

Pickard, AJ (2013) *Research methods in information*. London: Facet.

Pinelli, TE (1991) The information-seeking habits and practices of engineers. *Science and Technology Libraries* 11(3): 5-25.

Pinelli, TE (2001) Distinguishing Engineers from Scientists - The Case for an Engineering Knowledge Community. *Science and Technology Libraries* 21(3-4): 131-163.

Research Information Network (2006) *Researchers and discovery services: behaviour, perceptions and needs.* Available at: http://www.rin.ac.uk/system/files/attachments/Researchers-discovery-services-report.pdf (accessed 27 Aug 2016).

Robinson, MA (2010) An empirical analysis of engineers' information behaviors. *Journal of the American Society for Information Science and Technology* 64(4): 640-658.

Rowley, J (2012) Conducting research interviews. *Management Research Review* 35(3/4): 260-271.

Rowley, J (2014) Designing and using research questionnaires. *Management Research Review* 37(3): 308-330.

Ruthven, I and Kelly, D (2013) *Interactive information seeking, behaviour and retrieval*. Facet.

Sullivan, D (2015) *FAQ: All about the new Google RankBrain algorithm*. Available at: http://searchengineland.com/faq-all-about-the-new-google-rankbrain-algorithm-234440 (accessed: 29 Jan 2016).

Tucci, VK (2011) Assessing information-seeking behavior of computer science and engineering faculty. *Issues in Science and Technology Librarianship* 64(winter). Available at: http://www.istl.org/11-winter/refereed5.html (accessed: 26 Aug 2016).

Yu, J (2016) *Search update impact on SEO & content strategies: staying ahead with a focus on quality*. Available at: http://searchengineland.com/search-update-impact-on-seo-content-strategies-240558 (accessed: 29 Jan 2016).

Zhang, L (2015) Use of library services by engineering faculty at Mississippi State University, a large land grant institution. *Science and Technology Libraries* 34(3): 272-286.