Engineers: What do they Read and Write, and Why? – A Survey of Information and Publishing Behavior of Academic Engineers

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ENGINEERS: WHAT DO THEY READ AND WRITE, AND WHY? – A SURVEY OF INFORMATION AND PUBLISHING BEHAVIOR OF ACADEMIC ENGINEERS

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Abstract
Serving our academic community expects us to understand the researchers, their professional lives, motivation, needs, workloads, work organization, partnerships, etc. – maximum information that stand behind their work. A lot is identified just by serving the academic community, however in order to understand the reasons behind their information and publishing behavior, a deep interview survey was conducted at our university.

This paper describes particular detailed findings in the area of information and publishing behavior of engineers in academic environment and their attitude towards traditional and current aspects of scholarly communication incl. Open Access and social networking.

The work was conducted for a dissertation at the Institute of Information Studies and Librarianship, Faculty of Arts, Charles University in Prague, defended in 2016.

Keywords
Information behavior, publishing behavior, engineering, information literacy, research skills

1. The scope of engineering

Engineering is an applied science aiming at finding solutions to particular technical issues. Engineers are continually seeking new, innovative, less expensive, effective and optimal solutions to the use of natural resources and materials to make everyday life easier [McGraw-Hill encyclopedia of science & technology, 2012; Engineering, 2016].

Academic and industrial environments are very different in their scope and aims, though they closely cooperate in many issues. Academic community is focused on education, research and publishing research results, whereas industrial environment is aimed at development, innovation, and industrial production, providing customers with high quality, safe and reliable products. Their activities are driven by market demands or by end users’ requests. Research activities in industrial area are given by the companies’ business strategies and by the return of investments. Research activities are not profitable for many companies [Tenopir and King, 2004; Navrátil, 2008].

The majority of engineering work in academia is focused on applied research, although researchers are most likely to conduct a combination of basic and applied research (in some areas it is not easy to clearly distinguish between basic and applied research). Field wise, most research is conducted partly or completely as an interdisciplinary research in the means that engineering is aimed at applying scientific findings to a particular technical solution.
2. Research methodology

In order to provide effective and efficient information support, it is essential to understand the researchers’ work. A lot of information and publishing behavior is identified by knowing and serving the academic community and by research described in literature. In order to step ahead to identify future development in research support, a deep interview survey was conducted among researchers at the university. Due to the fact that academic researchers cooperate with industry on a high extent (which can lead to the influence in their information behavior), a brief insight into industrial environment was also taken.

The research was conducted through a semi-structured interviews with some aspects of narrative interviews. The primarily aim was to find explanations, opinions, and approaches that stand behind individual aspects of information and publishing behavior of engineers. It was not meant to find statistically significant results. However, the explanations were in its core very similar across all respondents and have shown some possible patterns that are described in the paper.

Respondents were selected to represent various research fields within engineering, various academic degrees (levels of professional experience), and age groups. Only researchers with Ph.D. and higher degrees were recruited, since Ph.D. students still possess many characteristics of students’ information/publishing behavior especially in terms of research and publishing activities. One pilot respondent was selected to test the scenario, and 16 further respondents were interviewed. After that the research was terminated for saturation. Responses were kept and analyzed anonymously under a general ID, separate list of names and IDs was kept aside.

3. Engineering activities & work motivation

Activities that engineers conduct in their work include design, innovation, development, production, and managerial work, and above all experimental research in laboratories, and/or field work incl. measurements, experiments, testing, modeling, diagnostics, data processing and analysis, software development, prototyping, instruments/equipment development, etc.

Engineers’ work in academia is very much influenced by the funding and administrative environment – by criteria issued by R&D assessment bodies, grant agencies, and other funders and stakeholders. Researchers show strong tendency to adjust their outputs to the funders’ requirements even if it does not correspond to the specifics of their research area (e.g. types of activities and outputs). The changing funders’ requirements strongly influence their work and above all outputs that they produce. From their own perspective, engineers know what to do in their research. The task is to match the research goals with the funders’ requirements and find the gap on the market.

Grant projects and cooperation with industry is frequent in their work. Grant funding is an essential part of their budget both, in terms of equipment and personal resources, it is crucial to keep projects running continuously as much as possible. Although it is very time-consuming.

4. Information and publishing behavior of engineers

The most significant factor that stands behind information behavior of engineers is the environment in which they work – whether industry or academia [Yitzhaki and Hammerslag, 2004]. There are significantly different patterns in information behavior between purely academic researchers and researchers who cooperate with industry. Academia is much more focused on academic outputs, i.e. publishing activities and gaining citation feedback. Information behavior is very much driven by the particular activity that researchers conduct [Tenopir and King, 2004]. On a personal level, information behavior is rather an individual characteristic mostly influenced by the academic position of the researcher, and by the scope of information support available, and is not much influenced by the particular discipline [Niu and Hemminger, 2011].

Our research revealed that engineers use different information for different purposes, and they search for information different ways. Engineers use different resources for teaching and for research, and different resources for basic and applied research. Due to their cooperation with
industry, academic engineers tend to follow partly patterns significant for researchers in academia and partly patterns significant for industrial researchers.

4.1. Information behavior and the use of resources of academic engineers

Academic publications

There is different information behavior in basic and applied research [Pinelli, 1991]. Academic researchers in applied disciplines use much more conference publications, scholarly journals, as well as personal contacts, informal communication, and other document types, e.g. reports, internal materials, standards, and patents [also by Vilar et al., 2012; Yitzhaki and Hammershlag, 2004]. They use less monographs than researchers in science. Journal articles and conference proceedings are the core resources for academic engineers [Yitzhaki and Hammershlag, 2004]. Reading monographs is less important for engineers out of all subject areas [Tenopir et al., 2013].

Our research results reveal that since researchers work in academic environment, they tend to use academic publications – monographs, journal articles, conference proceedings. For applied research and cooperation with industry, they use mostly applied resources. Information resources that they use are tight with the types of outputs that they publish. The core are journal articles, mostly journals with impact factor, and mostly available electronically. Monographs usually describe basic theories. It takes long time to publish them therefore they contain rather steady information and theories useful rather for teaching. They are not used as sources of up-to-date information for research. Conference proceedings are usually of such events that researchers attend themselves. These are sources of information about other peoples’ research.

Grey literature and other types of resources

Engineers are specific for using grey literature in a higher extent than researchers in other disciplines – standards, technical reports, company materials, trade magazines, product catalogues, etc. Vilar states that engineers use standards and patent literature in a high extent, and do not use raw research data very much [Vilar et al., 2012].

Our research revealed that standards are key information resources containing core information for research in many areas. Standards are expensive, however researchers usually have their own ways of obtaining it – either through cooperation with the standardization institute, or through cooperation with industry. They usually buy the required standards themselves.

Patents are not very important literature, since researchers do not apply for patents very much. The same with dissertations, they usually catch information about patents and/or dissertations in journal articles.

Research reports and company literature are used mostly together with cooperation with industry. There are two types of both of the outputs - non-public materials, available only from the industrial partners that are gained from the companies based on personal connections or cooperation. In some fields however, technical reports are available, and some types of company literature is available too, and are a significant source of information – documentation, product catalogues, newsletters, etc.

Informal information – information from colleagues – is very common. Personal contacts are the most important means of communicating and sharing experience and know-how. Personal contacts are often more important than literature.

4.1.1. Information seeking patterns

Engineers continuously follow key journals in their field and get most information there. Valuable information about information resources are also obtained from their colleagues or people in their community. Once they have learned about the article, they use library collections, delivery services, ask their colleagues, e-mail the authors, or search in Open Access resources to obtain full text. Journal articles are acquired through subscribed electronic information resources or through document delivery services through the library [Tenopir and King, 2004]. Researchers also use Google to search for information, though it does not mean that Google is the only
resource [Vilar et al., 2012]. The most important is to get the information quickly and in electronic version [Niu and Hemminger, 2011].

Our research revealed that the most important is to get the information/document as soon as possible, within 24 hours. Researchers have their own methods and channels to get information and they do not have much time to learn new methods and communication techniques. They are saturated in terms of information tools and channels available, and through their own social network, they do not feel the necessity to look for other information channels. They feel overloaded by information and information systems. They say, one can easily become a slave of the technology.

Researchers know what information and documents they need and they look straight for them. They do not conduct information retrieval for research purposes very much. For that purpose they follow key journal titles, and search for particular articles specifically. They conduct retrieval mainly for teaching purposes to find literature for their students.

Other means to find out about literature is from their colleagues, through references of interesting articles, and at conferences. Also from articles that they review, and from their students. Looking at references has shown to be a common way to find out interesting articles.

Subscribed electronic information resources and library document delivery services are the most used means of obtaining literature. Also Google searching is common – note that Google is rather used as a central interface/discovery tool to access subscribed information. To request article from the authors is also a common method, e.g. nuclear physics community is so small and compact that they usually send out their preprints to the whole community. On the contrary there are research fields that would never give their articles out this way, since they tend to save their know-how. The communities that are user to using repositories for their publications, e.g. ArXive.org, also use these repositories to search for literature.

4.2. Information behavior in industry

Engineers in industry work more under time pressure and therefore rely more on their own information, knowledge, experience, and on their colleagues. The information they need are usually quick and accurate answers to particular questions.

The most important issue in all activities in industry incl. seeking information and purchasing information resources is the return of investments (financial and time-wise). Industry does not conduct much research, this is done at universities, industries rather produce the outputs.

There is an information need in industry, however the information is needed at the very moment and there is not much time to search for information in the academic way.

4.2.1. Information seeking patterns in industry

Engineers seek information when they need it to solve a particular issue. They follow the Zipf’s principle of least effort to minimize time and effort necessary to reach the information [Pinelli, 1991].

The main criterion for resource selection is its availability and accessibility. They prefer accessibility to the quality and comprehensiveness of the document. Therefore they prefer resources that they know, that take the least effort to access, and resources that are the closest. This means experienced colleagues, distributors, known documents, and internal technical and other reports. They prefer using their own social networks to search for the document to search engines [Hertzum and Peitersen, 2000]. Personal communication and personal networks is the key factor for searching for information. The work of engineers in industry depends on mutual communication and cooperation. Studies state that engineers spend most of their time communicating. Therefore keeping their own informal social network within and outside the company is crucial for engineers [Navrátil, 2008].

Engineers in industry tend to use unpublished internal technical reports and documentation, handbooks, standards, patents, governmental reports, company reports (product and technical
information, reports, catalogues, trade magazines), and information straight from their colleagues, and possibly their own collection of documents. A lot is further learned through cooperation with universities and students – e.g. literature review compiled by students is a valuable information resource.

Libraries are the last place in terms of looking for information. Libraries are considered information providers, whereas engineers like to find the primary information themselves, without the need of a provider. Taken from the literature reviewed, these information sources were considered the most useful for industry engineers:

- Personal communication – people in their own team
- Personal communication – other people in the company, supervisors
- Own collection of documents
- Handbooks, reports, patents, internal documentation.

[Yitzhaki and Hammerschlag, 2004; Kwasitsu, 2003]

According to our research, the most important information resources in industrial area are technical documentation, technical drawings, standards, and material characteristics. Patents are followed mainly by companies that conduct research and produce their own innovative products. Then these companies have large patent departments to follow patents in their area. For other companies that do not conduct research it is rather a competitive information issue.

Standards and safety regulations are some of the most important document types that industrial companies follow. The use of standards is given by customers. The products must correspond to the standardization and regulations used in the specific customer’s country, so each product must correspond to a specific set of standards. Only official standards might be purchased and they shall be stored with the particular product’s documentation. Industrial companies usually have standards departments that take care of purchasing the required documents and monitoring standards in the particular area. Engineers are also responsible for knowing and following the particular standards and regulations.

Second important literature types are internal technical documentations, standards, and directives/regulations according to ISO 9000 series:

- Technical documentation
- System and processing documentation
- Safety regulations.

Third document type is project documentation that is archived in an internal collection (and a copy of which is given to the customer).

Use of the rest of documents is individual, everyone has their own set of connections and resources to follow – their own partners, contacts from exhibitions and trade fairs, testing, or from companies that they cooperate with, and they follow annual reports, monographs or journals.

Libraries are the first departments to get reduced or transferred for economic reasons. Wherever there is a library in a company, monographs of well-known publishers in the particular area are kept (e.g. Wiley, Elsevier, Janes, etc.). Academic electronic information resources are a matter of return of investments and usually are not purchased for financial reasons. There is not much demand for them either. Academic types of information are rarely requested. Engineers rely on their own knowledge and experience and if they need they get information their own way. Some industries might have access to factual databases like, e.g. material characteristics, etc. If this is the core matter of their business.

5. Publishing behavior in academia

5.1. Publishing patterns of academic engineers

Puuska states that publishing behavior of engineers in academia in Finland is influenced by the pressure from the National R&D council, by other funding bodies, and by the end community that
the author wishes to address, and also by the research type, scope and financing models. Publishing activities also depend on the authors’ motivation in self-promotion as well as on their experience, knowledge of the research area, scientific writing skills and experience, and on their experience with publishing activities. This influences the type of output (article, conference, etc.; applied output), and the level of internationality.

Some research areas publish on national level, some at international level, and that is given by the end user community. Publications meant for the enhancement of national industry are published at the national level, publications in some other areas are mostly international [Puuska et al., 2013; Puuska, 2014].

According to our research, the motivation to publish is based on the same principles as the motivation to the entire work process. Publish or perish principle – to spread the ideas and results to the community is the core followed by gaining credit and financial reward from the R&D assessment system. Researchers also feel responsible to the home institution to publish.

The main factor that influences the research activities, is the national R&D assessment. This pressure to increase the quantity of publications is considered as a negative aspect and leads to balancing at the edge of publishing ethics. It also makes researchers publish different outputs that are not always primary for their research area. They try to sell all they can and adjust to the system even if it does not comply with the research area characteristics. A typical example is software (SW). After 2013, SW outputs were no longer financed by the R&D assessment system and immediately the number of SW outputs decreased.

This has negative impact also on the production of educational materials and course books, since these are not supported by the R&D assessment and funding.

Not only the national R&D assessment influences the work of the researchers, also the global system of measuring impact of research outputs – the publication and citation rate according to Web of Science, h-index, journal impact factor, etc.

Some researchers are more tolerant to this issue. This is given by the extent into which one is existentially dependent on the funding, and on the pressure that individual teams / departments are under regarding the funding requirements.

5.2. Types of output published

In academia, the majority of outputs are conference and journal publications. Other types of outputs are rather rare – chapters, monographs, reports, etc. Unpublished materials play an important role, especially when the cooperating with industry [Puuska et al., 2013; Puuska, 2014].

Conference materials are core outputs in engineering since the areas evolve rapidly. These are usually first-stage-outputs that are usually further developed into journal articles. Conferences are good to discuss ongoing partial research outputs. Proceedings are not easily available for non-attendees, so papers are less likely to be highly cited [Godin, 1998].

Our research revealed that publication outputs are rather published as a result of academic research, whereas cooperation with industry generates applied outputs or unpublished internal documents and reports.

Journal articles are the core materials in terms of scholarly communication. They are still considered as the most prestigious channel and are highly followed by the community. Outputs in prestigious journals bring credit to the authors, research teams and institutions. Conference proceedings are core in some research areas, however the publications themselves are considered lower quality compared to the journal outputs. Conference materials also rarely comply with the funding requirements. Chapters and monographs are overview materials usually composed by those who have had the knowledge and experience. Reports are usually composed as outputs from a cooperation with industry and as project reports. Those are usually non-public materials for funders. Patents are usually registered when a product is invented based on a cooperation with industry, it does not make much sense to publish them otherwise. However, they are quite richly funded by the national R&D assessment, so sometimes even commercially less useful outputs are subject to a patent.
Other types of outputs are not very common, it includes standards, SW, and utilities (the latter two were formerly funded by the R&D assessment system as mentioned above).

5.3. Motivation for choosing an output:

The journal/publisher prestige is the main principle and is connected to the journal impact factor and to the research community that follows these outputs. Impact factor is the main metrics that is followed because of financial reasons as well as because of the global prestige of the journal.

An important issue is the speed of peer review process, mainly because of meeting the requirements by grant agencies/funders. Researchers consider this as a critical issue that influences the publishing process.

Secondary issues are meeting publishing standards and website quality, since these criteria are met if the journal is of a high prestige.

The experience with the particular journal title is an interesting aspect, for many respondents it is important to have positive experience with the title, to know a member of the editorial board from whom one can find out the information about the editorial process and habits, or to have an experience with the journal as a peer-reviewer.

Above all, electronic publishing is the main principle as well as indexing of the publication in some global database of research literature that can be reached by the worldwide research community.

6. Publishing behavior in industry

As mentioned above, industry (besides the product itself) publishes mostly technical documentation to the products that are provided only to customers and kept in internal archives. Out of external outputs, the most common are standards and other industrial property documents. Companies are often members of standardization committees and thus co-authors or reviewers of national standards, or more likely of translations of international standards that are being incorporated into a national standardization system.

Patents are carefully considered. Patents are registered only in case of a large invention, else it is rather strategical to keep the know-how internal and unpublished.

Technical reports are internal materials, for internal archive and use only.

Other types of outputs are individual by individual people, e.g. articles, presentation at fair trades, conferences, seminars, etc.

7. New trends in scholarly communication

7.1. Open Access

The philosophy of open access to research literature is accepted quite positively. The researchers’ feedback is such that the more open the environment is, the better access to literature and research results. However due to patent and copyright issues it is not always possible to open all publications. There are no plagiarism fears or fears of low-quality outputs. Authors stated that everyone should be able to judge the quality of the outputs themselves.

Openness and timeliness of published information, free communication of information, self-promotion, and better chance to become member of the community are all a large advantage of Open Access.

The negative issues of Open Access were pointed out to be the financial and bureaucratical matters associated with EU funding.

Green Open Access
Many researchers do not have a good understanding of their rights and of copyright issues and are not very much familiar with the green Open Access principle as a whole. Otherwise, the idea of green open access principle is taken positively. On the other hand, the self-archiving procedure itself is taken negatively as another organizational burden. Researchers do not have time to deal with all the respective issues themselves and would prefer to have someone doing it for them. University library helps researchers with this issue which is being taken positively.

**Gold Open Access**

Researchers consider Gold Open Access as a new business model that is related to the overload of research articles. It is considered a way to publish more outputs.

Article processing charges (APCs) need to return. If the journal is of a high quality (high impact factor), the costs will return through R&D funding. In this case authors are more likely to pay APCs. Especially since APCs can be eligible within grant projects. Researchers tend to have an opinion that publishing Open access is faster than publishing in a traditional journal (which often takes up to 1,5 years). So because of the time pressure with publishing, they have the impression that Open Access publishing will save their lives in terms of meeting project deadlines.

In terms of quality, there is a strong opinion that Open Access publishing generates many 2nd category articles repeating existing findings, and is hardly publishing new ideas. They think that Open Access journals are lower quality and there are many threads and deception so still publishing in traditional journals is preferred and considered safer.

7.2. Social media

Koltay states that studies have shown that social media has not been used very much in academia. Researchers are quite reluctant to use them. It is rather the lack of familiarity, reluctance, carefulness, skepticism about these tools. Despite the high dependence on personal contacts, this trend has not been transferred to online environment. Researchers adopt new technologies only if it helps them with the evaluation of their work and their reputation – that is still considered to gain through publications and citations received through traditional resources. They do not consider social media as an alternative to traditional publishing. The main argument is that social media and web 2.0 applications in general lack peer review – which is still considered as the quality control mechanism [Koltay, 2015].

Our research showed no age-pattern in using social media. All age groups were present among people who support as well as those who are opposed to social media. As a contrary, the youngest respondent was fairly against social media whereas the oldest respondent was one of the main supporters.

ResearchGate is the most preferred system. The reasons for using ResearchGate are: watching or searching for other authors’ publications, and following authors who have cited their works.

The opponents say that following social media if the worldwide community has about 10-20 people, has not much added value. People say it is a waste of time, also social media send out many e-mails that are considered spam. Also people said that the use of social media is for self-marketing which is what the established authors do not need anymore. Some people said that there is no community in their research area on ResearchGate.

On the other hand, researchers who found their community there were able to share publications, watch what the community is doing and keep themselves up to date.

8. Summary and conclusion

The presented research showed that information and publishing behavior is an individual characteristic. Researchers rely highly on their own know-how, experience and skills. The aspects that influence information behavior are: basic vs. applied research, the rate of cooperation with industry, and the purpose of seeking the information (research vs. teaching). Further on, information behavior can be said to be dependent on the erudition and esteem of the particular author. There is also a criterion if the researcher is financially dependent on the income from the research activities or not.
The research showed that electronic environment is just a tool to conduct research and communicate and gain research outputs easily. The rest of information behavior has not changed much compared to the literature even of the 1970s. The literature that dates back to this time is still relevant for this topic.

Researchers feel they are saturated in terms of information support. They have their own ways and have no time or capacity to learn new things. They will only do this once they feel it will help them in their research and scholarly communication activities. They feel they are at the edge of information overload. They prefer quality to quantity and speed of obtaining information, and the principle of least effort.

Information support in industry depends on the company's aim, activities and goals. Information support depends on the internal policy and financial situation. Engineers rely mostly on their own know-how and knowledge. Also professional development is a matter of every individual person. The existence of company library is also a matter of economic situation and internal policy. It has shown that if the library and information support exists, it is appreciated.
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