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How French research scientists are making use of electronic journals: a case study conducted at Pierre et Marie Curie University and Denis Diderot University

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Abstract.

There have been few studies to date on how French research scientists are using electronic journals in their work. Under a national programme for document digitisation in higher education and research, a qualitative study was conducted at the Jussieu Campus in Paris among 25 researchers and doctoral students and nine documentalists. The main disciplines covered were physics, chemistry and biology, with some representatives from mathematics, computer science and earth sciences. A user typology was built up, and several of the findings agree substantially with those in the (mainly Anglo-Saxon) literature, which demonstrate the importance of factors such as the discipline concerned and the immediate working environment of researchers, including equipment, local practice, and the resources that are promoted or made available. Other more subjective factors also need to be taken into account.

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1. Scientific documentation in France: background

Scientific documentation in the public sector in France involves a number of institutions that are managed by the Ministry of Education, Research and Technology. These public science and technology institutions are collectively known as ESPT (*établissements publics à caractère scientifique et technologique*) and include the CNRS (National Centre for Scientific Research) and higher education and research institutions – primarily 84 universities, fourteen other major institutions and four *écoles normales supérieures* (higher education institutions for teacher training). At present, the central government department with responsibility for coordinating government policy in the field is divided into two sub-directorates: one for libraries and documentation (*Sous-Direction des bibliothèques et de la documentation*), which is attached to the Higher Education Directorate, and one for culture, scientific and technical information and museums (*Mission de la culture et de l'information scientifique et technique et des musées*), attached to the Research Directorate. This division of authority is not very conducive to project development at the national level and, up to now, French policies for electronic documentation have not been particularly affirmative or ambitious [1]. Furthermore, with the implementation of contract-based arrangements between the State and the institutions, the underlying administrative logic has tended to reduce State involvement while promoting contract-based projects, including those focusing on documentation. The national policies on scientific databases of the 1980s have thus been

replaced by policies encouraging subsidised contract-based initiatives at local level.

However, the legal and economic negotiations involved in supplying electronic journals (licence negotiations), as well as the technical arrangements required, are so complex that a clear demand has emerged for coordination at the national level, which the logic described above does not seem to provide for.

Those concerned are nevertheless well aware that negotiating powers can also depend on number and, in fact, some projects have succeeded in getting organised and sharing resources. Examples of such projects are: (i) the French mathematics libraries network (RNBM – *Réseau National des Bibliothèques de Mathématiques*), with its long-standing reputation for cooperation, (ii) a University of Strasbourg initiative which, in 1999, succeeded in negotiating access arrangements with Elsevier for a consortium of four French universities [2] and (iii) still more recently, an agreement between Elsevier, again, and the *Institut de l'Information Scientifique et Technique* (INIST/CNRS) concerning a one-year pilot programme for access to journals in chemistry for CNRS laboratories [3]. Other consortia are currently being set up, which shows that, in spite of the divided administrative structure, efforts towards coordination are possible when they are driven by the institutions concerned.

This state of affairs is the reason for there being virtually no French studies at present on the overall situation of electronic journals and their use. A 1998 survey conducted by the Paris Inter-university Library of Medicine to define the needs for electronic access of all university medical libraries, and a recent article summarising the findings of a survey on the use of the Internet, showed that, while network use in general has undoubtedly taken off and is steadily growing, the use of electronic journals is still low [4]. A number of surveys have been carried out at local level to produce internal working documents, but they were never published.

2. Context of this study

During 1999, a 'Digitization programme for higher education and research' [5], coordinated by the *Maison des Sciences de l'Homme*, was launched by the Ministry of Culture and the Ministry of Education, Research and Technology to promote the use of digitised documentation in education and science. Two research groups, GRESI – *Groupe de Recherche sur les Services d'Information* (Information Service Research Group) at the School of Librarianship and Information Science (ENSSIB – *Ecole Nationale Supérieure des*

Sciences de l'Information et des Bibliothèques) and ERSICO – *Equipe de Recherche sur les Systèmes d'Information et de Communication des Organisations*, a research group on corporate information and communication systems at the Lyon 3 Jean Moulin University, were jointly responsible for the study focusing on use and needs for digitised documentation in higher education and research [6]. The study described here is one of the four field studies conducted from May to September 1999 as part of the programme, and included a total of 36 interviews.

3. Objectives and methodology

The Jussieu campus in Paris comprises two universities: Paris 6 (Pierre et Marie Curie University) and Paris 7 (Denis Diderot University). In 1998, the Joint Documentation Centre (SCD – *Service Commun de Documentation*) at Jussieu set up an online journal service which, at the time of our survey, provided access to a total of 208 journals in various disciplines, in addition to those available through the RNBM mathematics library network. The aims of the study were to gain better knowledge and understanding of the way this service had been received and used by researchers on the Jussieu campus. The study focused mainly on the disciplines covered by the largest number of electronic journals, i.e. biology, physics and chemistry. The objective was to define a preliminary area of study among French academic scientists whose practice would be compared with the findings described in existing – mainly Anglo-Saxon – literature on the use of electronic journals. Because the survey could only be carried out in the summer, over a short period (June and July for the interviews), and because the interviews were conducted in a large number of laboratories, it is felt that this study should be considered as preliminary.

On the basis of a qualitative survey method, a total of 25 people (thirteen researchers and twelve PhD students) were interviewed, who were working in fourteen different research laboratories (four in physics, three in chemistry and biochemistry, four in biology, one in mathematics, one in earth sciences and one in computer science). Each interview lasted one hour on average and they were all conducted in the workplace of the people involved. Nine other people were interviewed: six head librarians of research libraries specialising in the relevant disciplines, the Head of the SCD and the people in charge of computerisation and electronic publishing.

The choice of a qualitative method was considered to be appropriate for such a study, as individual

discussions in the usual environment of the researchers enabled us to get a more in-depth understanding of individual practice and representations than could have been possible with the use of more distant and anonymous questionnaires.

4. Results

To begin with, a rather significant discrepancy between the researchers' statements as to the use they made of electronic journals in general and their awareness of the journals available through the university's website was observed (see Table 1). While the majority of researchers and PhD students stated that they used electronic journals, half of the researchers and two-thirds of the PhD students were not aware of the online journal service at Jussieu, the latter's demand for electronic access being greater. It is interesting to note that 20 persons said that they used electronic journals, whereas only eleven knew about the online journal service of their university. The reasons for this will be detailed further (see Section 6.2).

For a more detailed understanding of use patterns, a chart was plotted along two axes to bring out the different user categories (see Figure 1): the horizontal axis indicates individual practice among researchers as regards their use of electronic or paper documents, while the vertical axis defines the overall working environment in which these practices take place. For each axis, criteria were defined so that a score could be given according to a predefined scale. The total score for each person provides the result plotted on the chart. On the basis of our interviews, we had determined that criteria

Table 1
Statistics on electronic journal use, based on interviews

	Yes	No	Total
<i>Use of electronic journals in general</i>			
Researchers	10	3	13
PhD students	10	2	12
Total	20	5	25
<i>Awareness of the electronic journal service at Jussieu</i>			
Researchers	7	6	13
PhD students	4	8	12
Total	11	14	25
<i>Demand for electronic journals</i>			
Researchers	7	6	13
PhD students	9	3	12
Total	16	9	25

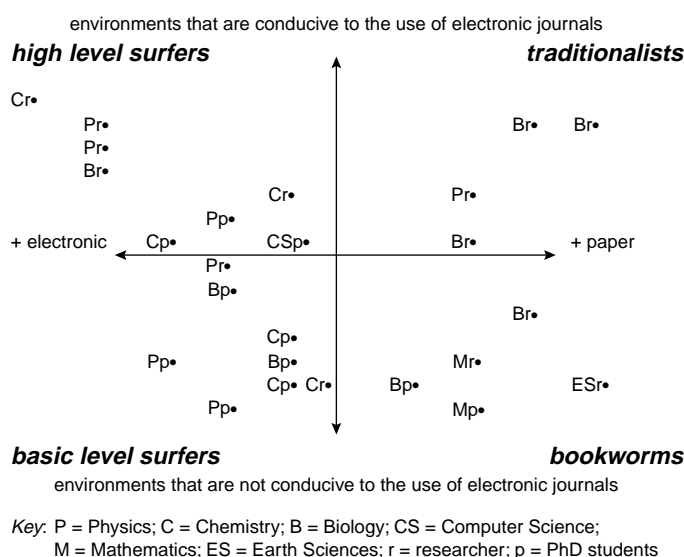


Fig. 1. User typology.

such as career status and the number of years of scientific activity belonged to the vertical axis as decisive in the ability or disability to get direct information on the resources available and access to adequate material. It is therefore quite natural that the majority of senior researchers are to be found in the top two quadrants of the chart, whereas most of the PhD students will find a place in the bottom quadrants. The differences between *high level surfers/basic level surfers* and *traditionalists/bookworms* are more related to the researchers' exterior environment and means available, whereas *high level surfers/traditionalists* and *basic level surfers/bookworms* distinguish themselves by personal attitudes and preferences. This is by no means a definitive way of defining the types of electronic journals users and non-users but simply a method chosen in order to gain a better vision of the sample along axes that were predominant in the analysis of the interviews, i.e. environmental and personal characteristics.

Each user category is represented by a set of characteristics. This does not mean that every individual in a given category has all the relevant characteristics, but rather that the whole set of characteristics represents an 'ideal' type that the individuals in the sample resemble to a greater or lesser degree. This 'ideal types' method is similar to the approach developed by Weber [7, pp. 172–173] to reconstruct a real situation. In real life, individuals belonging to the same category do not all have the same characteristics, and the categories are by no means homogeneous. The individuals in the sample are distributed over the entire graph, which

shows seven 'high level surfers', eight 'basic level surfers', four 'traditionalists' and five 'bookworms'.

4.1. The high level surfer

In relation to the vertical axis, a *high level surfer* may be defined as a person whose working environment is conducive to the use of electronic journals: such individuals have high-standard computer equipment, have few libraries nearby and their positions allow them easy access to the resources and information they need for their research work. In relation to the horizontal axis, these individuals are totally at ease with computers in general and the Internet in particular. They have been using electronic journals for at least one year, use libraries less frequently and prefer surfing on the Internet. There were two types of *high level surfers* in our sample. The first type were veteran researchers with 20 to 30 years of experience in physics (nuclear energy or solids), theoretical chemistry or cell microbiology and who used the Internet and pre-prints extensively. Two of them had been using electronic journals for more than three years, i.e. since well before the launch of the Jussieu online service with which they were all well acquainted. They were very up to date on network communication and deplored the fact that, when it comes to the resources made available to researchers, France is lagging far behind the USA. The second type of *high level surfers* concerns younger researchers in organic chemistry, solid physics and computer science (formal computing), who began using the Jussieu online service more recently (with the exception of the one in computer science, who was not aware of the service at all but knew of the JSTOR Project) and they were very enthusiastic about such means of access to science journals. They are, in fact, an intermediate category between the first category of *high level surfers* and the *basic level surfers* category below. However interested in the electronic medium, the great majority of *high level surfers* nevertheless recognised that the print medium had its value for archiving or browsing purposes and for a more comprehensive coverage.

4.2. The basic level surfer

On the horizontal axis, *basic level surfers* show roughly the same profile as *high level surfers*. They are at ease with computers and the Internet and appreciate the value of electronic journals. However, the situation is less positive on the vertical axis. Compared to the *high level surfers*, *basic level surfers* often have a lower status

and less access to adequate computer equipment and nearby libraries, which creates an overall less conducive environment to the use of electronic journals. The *basic level surfers* in our sample were all young researchers in physics (mechanics, quantum physics and particle physics), chemistry (molecular electrochemistry and theoretical chemistry) and biology (cell and molecular physiology of plants and biochemistry of protein ageing/alteration). Seven out of eight were unaware of the electronic journal service at Jussieu (whereas only one of the *high level surfers* did not know about it). Despite this adverse environment, they were all frequent, if recent, Internet and Web users and used other access points for electronic journals, usually laboratory subscriptions, Medline or pre-print servers. They valued the speed, the access to specialised journals and the highly targeted or general search facilities. Again, one of the major limitations they gave was that the electronic journal supply was less exhaustive, which made library use still essential. Another disadvantage they mentioned was low resolution in print-outs. Finally, the lack of available equipment often restricted use. Some were fortunate in having well-stocked libraries nearby, so that print still had several advantages in their view, e.g. for archiving, browsing and serendipitous findings and even for ways of relating to information that was described as specific to the library environment.

4.3. The traditionalist

The *traditionalists* in our sample were three researchers in biology (developmental biology of cells and molecules, cell and molecular physiology of plants, biochemistry of protein ageing/alteration) and one in physics (gravitation and relativist cosmology). On the vertical axis, *traditionalist* users, like *high level surfers*, have virtually all the characteristics of potentially frequent users of electronic journals: their computer equipment is more than adequate, their professional status and experience means they are up to date in their research field, and the three biologists of our sample have few library resources nearby. They could therefore be interested in what the networks have to offer. However, despite this profile, the position of the *traditionalists* on the horizontal axis shows that they are still very much attached to paper and libraries. They are often recent users of electronic resources, but make very little use of such resources. They have little online experience and are unwilling to take the time to learn, especially when they are nearing the end of their career, which is the case for three of them. They are very

attached to paper conservation and archiving. Two biologists knew of the online journal service available, but clearly did not wish to use it. Reaching the end of his career, the physicist admitted to having no incentive to learn new ways of accessing information; relying only on paper sources, he made no use of the electronic pre-print services which he knew was a common practice among his colleagues and he did not know about the electronic journal service of the university. The third biologist, the youngest researcher among them, made very little use of electronic journals and declared a strong preference for print resources.

4.4. The bookworm

The vertical axis shows that the *bookworm's* environment, like the *basic level surfer's*, is not conducive to the use of electronic journals and, like the *traditionalists*, *bookworms* are rather attached to print journals and libraries. In our sample, they were PhD students or researchers in biology (cell microbiology, developmental biology of cells and molecules), mathematics (theory of numbers) and earth sciences (sedimentary geology). None of them knew that an electronic journal service was available and only one, a PhD student in biology (cells and molecules), declared some use of electronic resources. All of them declared having print resources in their immediate environment (research, laboratory or personal library), which means that they could have quick and easy access to documentation on the spot, which in turn reduced the need for online resources. Three of them were young researchers or PhD students with little status and inadequate or inappropriate computer facilities. They all agreed on the fact that the world of print is a familiar environment in which they knew their way round and they often saw libraries as quiet, pleasant places where information could be located quickly and easily. They considered that electronic documents do not offer the same guarantees as print documents: the paper document is reassuring, it has been validated and is easier to handle than the electronic document.

These findings provide a static picture reflecting statements made at a given point. Individuals may change in different ways, depending on their present situation. *Traditionalists* may not change at all, especially if they are close to retirement, but this does not mean that they would not be interested in an appropriate training programme, which could move them over to the *high level surfer* side of the chart. In fact, two researchers who were nearing the end of their careers had just begun to use online resources, but the

idea of going through a solitary learning process had little appeal for them. Similarly, a *bookworm* could easily become a *traditionalist* if he or she gained in status and means but remained attached to paper. Alternatively, with more incentive to use electronic resources, *bookworms* could move into the *basic level surfer* category. *High level surfers*, on the other hand, will probably remain in that category, since they have no reason to change once they have adopted the new technology. *Basic level surfers* will tend to move up into the *high level surfer* category once they gain status and as their access to resources improves.

5. Results by discipline

5.1. Physicists

The physicists in our sample seem to be unanimously in favour of electronic resources: all of them but one are on the left-hand-side of the chart, thus indicating strong personal preferences and favourable attitudes towards electronic resources. The only one located on the 'paper' side of the chart belonged to the *traditionalists*: he was nearing the end of his career and the fact that he did not make any use of the electronic pre-print services, although he knew they were heavily used by his colleagues, made him sound like an exception in an otherwise quite homogeneous community. These are probably the researchers who have the best computer facilities in the sample. Furthermore, they have succeeded in organising exchanges of scientific information very effectively, whether at national or international level. A large number of pre-print servers are operating, the best known and most widely used being the one in Los Alamos, and the French physics libraries have set up a union catalogue. Information circulates very effectively between laboratory colleagues and during seminars and symposia. The physicists in the sample made heavy use of the Internet, the Web, e-mail and especially pre-print servers, even when they are newcomers to such technology. All but one stated that they used electronic journals. However, only four of them were aware of the electronic journals available through the Jussieu service (among which were three *high level surfers*). The others presumably had access to electronic journals through laboratory subscriptions or there may have been some confusion with pre-prints, as the definition of 'electronic journals' is not always clear and can lead to misunderstandings [8, 9]. Technical problems sometimes prevent them from accessing electronic resources. One laboratory was not recognised by

publishers as being part of the Jussieu campus; another had no Web connection for security reasons and relied on file transfers. Finally, the majority were not yet prepared to give up the print media. They appreciated the well-stocked libraries available to them and still needed to consult older articles and books that are not available through the electronic networks. They felt that print archives were also essential for the same reason. Experiments in physics can extend over long periods of time and so researchers need to be able to locate early articles easily. Thus, the physicists in our survey were unconditionally in favour of electronic resources, but without giving up print resources.

5.2. Chemists

All the chemists taking part in the survey were also in favour of electronic resources: they are all located on the 'electronic' side of the chart. Virtually all of them knew and used the Jussieu electronic journal service. They had excellent computer facilities and exchanges of information seemed to be fairly well organised. However, with the exception of one researcher who had been instrumental in persuading the chemistry library to provide an electronic journal service, and one PhD student who was unconditionally in favour of electronic media, the chemists were not quite ready to give up print journals. While appreciating the advantages of electronic resources, they at the same time continued to be attached to the advantages of print resources; all the more so as the Jussieu libraries meet their needs admirably and are close at hand, with basic reference material in the research library and specialised material in laboratory collections. The two types of resource seem to be complementary: what cannot be found through the electronic networks is available in print, and vice versa. In addition, it appears that the chemists' working environment is such that they sometimes prefer the quiet, studious library environment to the hustle and bustle of relatively noisy offices that they often have to share with others.

5.3. Biologists

There were no such clearly discernible trends among the biologists. The eight persons who took part in the survey were divided among all four categories: five of them on the 'paper' side and only three on the 'electronic' side of the chart, two PhD students and one very enthusiastic researcher. Neither was there any discernible pattern for the different laboratories, as their results are also distributed over the entire graph. This spread of practice patterns in biology has already

been mentioned in one study by Rolinson *et al.* [10]. The students are all on the negative side of the 'working environment' axis and all but one of the researchers (a *high level surfer*) are on the 'paper' side. The scientists interviewed in this discipline were rather ambivalent towards information technology. The *high level surfer* had been using electronic journals for four years, but the student working in the same laboratory (cell microbiology) did not use them at all and did not know about the Jussieu service. She was not familiar with computers and preferred the tranquillity of the library environment. The use of electronic resources for the three other researchers appeared to be both recent and a more or less direct and inevitable result of changing practice in their field. Medline was said to be unavoidable, but although the biologists used it for bibliographic searches, they always went to a library to find the article in print and would not easily change their habits. We did not find among biologists the willingness and ability to use electronic resources displayed by chemists and physicists. Two of the PhD students were far happier using a library than a computer. The other two, though they were motivated, either did not have adequate facilities or felt that image resolution was poor and they often had no idea of means available for accessing electronic resources.

5.4 Others

In mathematics, earth sciences and computer science, the number of interviews conducted was too small to warrant any conclusions by discipline. Those representing the first two fell into the *bookworm* category. Both mathematicians strongly rejected electronic media and were equally strongly attached to print. Working habits relying on print still seemed to be thoroughly ingrained among the earth scientists. Furthermore, because of the limitations of today's technology, the person we interviewed considered that his colleagues could not yet access the material they needed, which did not encourage them to make greater use of electronic resources. The one computer scientist we interviewed was an enthusiastic *high level surfer*; he would have liked the possibility of institutional access to the American JSTOR Project but was not aware of the online journal service at his university.

5.5. Advantages and disadvantages of electronic journals

The advantages were considered much the same, regardless of discipline and of the extent to which the researchers used electronic resources. Time-saving was

the advantage most frequently mentioned: with direct access to the full text of an article, there is no need to go over to a library and make photocopies (a chore that scientists particularly dislike); articles can be accessed at any time, regardless of library opening times and with no risk of articles being out on loan or in the bindery; finally, computerised searching is fast, targeted and the presence of the full text makes it possible to select the most relevant articles.

Electronic journals can also be received in advance of the printed version; they allow researchers to keep abreast of new developments, consult the most recent articles and use current awareness services to be regularly informed. The possibility of printing the text directly, apart from doing away with the tedious task of obtaining photocopies (as mentioned earlier), is also simpler, cheaper and gives better results. The advantages of navigation and its flexibility are mentioned only by the chemists, which again shows that they feel particularly at ease with this type of resource. They also mentioned access to additional material. In fact, the chemists, along with the physicists, were the most eloquent with regard to the advantages of electronic resources, most probably because they used them the most.

The disadvantages often mentioned were of two types. Some mentioned the real problems actually inherent to the electronic medium, while others stressed the advantages of print and libraries resources as opposed to electronic resources. The latter were the most numerous by far, which may lead one to conclude that previous habits relying on print are in fact the greatest obstacle to the use of electronic journals among scientists. The advantages of print included personal habit and the fact that paper means 'real work'. Paper is reassuring, it corresponds to articles published in journals, which automatically means that they have been validated and guaranteed by the scientific community. Furthermore, print journals encourage browsing, which can lead to finding other interesting articles and information. Less frequent visits to libraries mean less reading of more general literature, because online searches are conducted in response to a specific need and therefore tend to be more targeted and specialised. Also, paper is presently the only medium that guarantees the conservation of archived information. In addition to the many advantages of printed documents, the libraries associated with them were seen either as meeting places or as pleasant, quiet places that are near at hand, easily accessible and have exhaustive resources. Some researchers saw the new type of electronic resource as an invasion of computer technology at every level of their activity that should be curtailed. Working

on screen was seen as a solitary occupation that prevents interaction with colleagues. There were also fairly numerous references to problems to do with viewing quality and readability on screen, navigation difficulties, etc. Regarding content, complaints included the lack of older material and exhaustivity. The Internet was considered to have serious limitations, since there are no guarantees that information is reliable, supply is fluctuating, and electronic resources are more restricted compared to print. Other grievances included inadequate training, learning and maintenance, compounded by slow response time of networks, incompatibility between formats, inadequate facilities for viewing or printing out high-quality documents and sometimes the lack of available facilities. Looking at these aspects by discipline, it appears that biologists emphasise viewing and print quality problems, while the lack of older material and exhaustivity is the major problem for chemists and physicists. For the former, there are real, material limitations to the use of electronic material, while the latter would like to have more possibilities for using the facilities available. However, the disadvantages mentioned by the biologists were usually 'perceived' rather than actually experienced, as many of them never used electronic journals at all.

6. Discussion

Through our analysis of the interviews and corresponding disciplines, it was possible to define the factors that seem to play an important part in the way research practices integrate the use of electronic journals. It is not always easy or even possible to separate these factors, as they frequently interact. Successive studies have demonstrated the importance of these different factors, as well as the need to delve deeper into the particularities of use patterns through qualitative studies [11].

6.1. Research discipline

The discipline is obviously crucially important in determining whether electronic journals are used or not. This has been already largely demonstrated in several studies in the UK and the USA, and the French context here certainly does not contradict this point. A comparative study carried out in the UK has amply demonstrated it [12] and it has been further confirmed by the SUPERJOURNAL project [13] and in an article by Kling and McKim [14]. Another study made in 1997 on documentation practice among PhD students at the University of Jussieu has also pointed out various

differences between disciplines [15]. Gomes and Meadows [16] have suggested that while acceptance of electronic journals is an individual matter, it is also highly influenced by peer pressure. Each discipline has its own background, activity patterns and underlying information needs. Some disciplines will use books, conference proceedings or patents rather than journals. These particulars are described for a number of disciplines in an article by Kling and McKim [14]. The scope of documentary research also varies. In long-established disciplines such as physics, chemistry or mathematics, there is a greater need for older information, while emerging or fast-changing disciplines (biology or computer science) need to keep up with the latest developments as closely as possible and do not have the same needs in terms of older material. Some scientists will need only a small selection of titles to keep up to date in their field, while for others, the information they require is scattered among a large number of journals. Science is evolving rapidly and these patterns are by no means stable. Physicists, for example, are increasingly working in several different research teams, while researchers in some fields of biology increasingly have to collaborate and share information. The discipline also influences the use of information technology and electronic resources in general. We have seen that it has become standard for physicists and chemists, but more of an obligation for biologists. Whatever the case, access to information is of crucial importance to all scientists.

6.2. The social and material environment

The environment in which scientists work sometimes has even more impact than their discipline. Researchers are dependent on the facilities made available to them, as well as on local working habits. Pullinger, who carried out the analysis for the SUPER-JOURNAL project, noted that the extent to which electronic journal use becomes part of normal research practice depends not only on the discipline concerned but also on the role and status of the researcher, on the resources that are available locally (print and electronic), on awareness of the existence of these resources and on specific information needs. In addition, network access possibilities are obviously a determining factor in the use of electronic resources, although 'perceived' possibilities are in fact more important than material possibilities and ease of use has also to be taken into account [17]. In our study, 'working environment' includes equipment, local habits, available resources and whether or not they are being promoted.

6.2.1. Equipment

Scientists are by no means equal in this respect. Some are provided with state-of-the-art equipment, while others have to make do with a few elderly machines that they have to share. The physicists in our sample all had their own personal computer (PC), as well as several types of printers. The biologists and earth scientists were less fortunate. It is easy to see that a computer that is busily processing and churning out experimental results is unlikely to be available for documentary searches. In the earth sciences, the technology is not yet advanced enough for electronic journals to offer genuine advantages (other than access to contents pages). In general, students have the least adequate equipment. Austin's experience [18] as a 'typical frustrated user' clearly shows how important technical problems can be, hence his praise for the virtues and practicality of print.

6.2.2. Local habits

A laboratory is a working environment which crystallises ways of doing things, as well as ways of managing work, equipment and communication, and passes them on to successive researchers. In this survey of the Jussieu campus population, there were marked differences from one site to another. First of all, they differed in terms of spatial arrangements: some laboratories were made up of individual offices in which researchers could work on their own, while in others, several people were sharing the same office with others coming and going, telephones ringing, etc. Spatial arrangements can have specific repercussions on the way people communicate or share information. In open-plan offices, people are constantly in contact, which tends to encourage them to communicate more than through closed doors. One researcher mentioned that the library in his laboratory was at an intersection between two corridors and it had therefore become a meeting place in which there were constant comings and goings. In such cases, it is difficult to concentrate on an article and people will tend to prefer the quiet atmosphere of a research library. Each laboratory is a microsystem that organises its resources in its own way. The task of collecting information, using photocopies or a computer system, is often allocated to several people at once. One laboratory had dedicated each PC not to a person but to a specific task (results analysis, word processing, Internet access, etc). The chemists seemed to communicate a great deal, but the biologists much less. Awareness or not of the existence

of the Jussieu electronic journal service can be related to the way in which information is communicated. This seems to be the case for biologists, three of the four researchers knowing about the service, but none of the four PhD students. Moreover, the practice of using a resource can spread rapidly within a given laboratory, but not necessarily from one laboratory to another. One student mentioned the deeply ingrained reliance on print in her laboratory (cell microbiology – actually the same laboratory that the one *high level surfer* biologist we interviewed was working in) and said that the biochemistry laboratory next door used electronic journals a great deal. McKnight [19], looking into the way electronic journals are perceived by their users, noted that a deeply ingrained reliance on print went hand in hand with a rather negative perception of electronic journals, despite the potential advantages being considered (including easier access to documents). According to this author, electronic journals are not well suited to reader needs.

6.2.3. Available resources and promotion

The researchers were mostly very satisfied with the services offered by the university libraries on the Jussieu campus and were generally aware of their good fortune compared to researchers in other institutions. They liked the library environment, with which they were totally familiar and which needed no advertising. The same was far from true of the electronic journals available. The Jussieu service had been set up only very recently and, of the 25 people interviewed, eleven – seven researchers and only four PhD students – said they knew about it, nine of them being on the ‘electronic’ side of the chart. This, however, left nine other people who were accessing electronic journals without knowing what was available to them from their university. Some physicists cannot access through the university service because of technical reasons, but electronic accesses offered by the university service being on the basis of Internet protocol (IP) addresses, it is then highly possible for a researcher to go directly to a publisher’s website and be allowed to view and print the articles in full text without knowing this is made possible by his or her university documentation service. This is apparently the case among six *basic level surfers* who read and printed online science journals without knowing such a service was being provided by the university. This shows the diversity of ways researchers can access electronic journals, the role of the library or documentation service being sometimes far from visible.

This also indicates that promotion of the service was far from adequate. On the results of our study, the librarians decided to address this issue. They had previously sent e-mails to the relevant heads of laboratories and posted up announcements in their libraries. However, if information does not circulate properly (as in the case of the biologists and mathematicians we interviewed) or if the people who receive it are not particularly motivated by it, the message will not spread. Also, merely indicating that a service such as this is available is not enough. For those who are not particularly ‘computer literate’, appropriate training courses would seem to be an effective way of learning to use such a service. It is also easy to understand that researchers cannot afford to ‘waste’ time on testing a new type of resource if they do not know in advance whether they will derive any substantial benefit from it. Researchers need to be sure that a new tool is going to prove useful and this is one reason for their tendency to often find out about a new resource from their colleagues. Thus, one or two people in a laboratory who have received appropriate training can help others to use the facilities in question. A recent article by Voorbij explains this in terms of the ‘*law of least effort*’, highlighted in several studies, which shows that scientists are generally reluctant to spend time on taking training courses in documentary resources [20]. This is why most studies stress the need to implement adequate means for promoting electronic journals as well as individualised training schemes. Finally, they usually emphasise the vital role of librarians in managing and selecting electronic resources and training people to use them.

More subjective factors should also be considered, such as status, motivation and personal experience. While a person’s age does not seem to be a certain factor in whether or not they adopt electronic journals, the reverse is true of their status. It was observed that the higher a researcher’s status, the easier it was for the researcher to access the information and resources needed for his or her work. Researchers have much more direct access to information than PhD students; even more so when they are accustomed to sharing information within their local working environment. Availability of computer facilities is also very diverse and it was found that PhD students are generally the worst off in this respect, since most of those in our sample did not have a dedicated PC (except for the majority of physicists and chemists), which means that they had fewer possibilities for access to electronic resources (library computers were reserved for CD-ROM searches). The most blatant evidence of unequal access to resources was the lack of awareness

of the Jussieu electronic journal service. Among the fourteen people unaware of its availability, eleven are situated on the lower part of the chart, corresponding to an environment not conducive to the use of electronic resources, seven of these eleven persons being PhD students.

Differences in the logic underlying the activities of researchers and PhD students, as novice researchers, can also explain the reluctance of some younger people to use electronic resources, as well as their need for the reassurance of print. The information they handle is more likely to be material they have come across using the facilities they have, rather than material that has been duly validated by a disciplinary invisible college, hence the legitimate mistrust of some of them towards material found through electronic networks.

A 1998 survey among researchers at INRIA (the French Institute of Computer and Automation Research) has shown that '*access to information appears to form an integral part of the individual learning process in scientific activity*', through the experience each person acquires in the field [21]. Chartron, commenting on the 1997 survey among PhD students on the Jussieu campus, also highlights the importance of '*self-training processes*' in documentary research [22]. Researchers generally prefer to be able to carry out their own information searches: they are best able to decide which results are relevant to their needs and are reluctant to leave this aspect of their work to librarians who, they feel, may not have their scientific expertise. This means that information searching is not systematic and especially that it relies on habits that scientists do not attempt to change, for lack of time or appropriate knowledge. The need for autonomy, coupled with lack of time, also explains why resources that are near at hand are so important to scientists: PhD students on the Jussieu campus tended to use their laboratory collection to consult scientific journals much more than the library [15], while document collections and bibliographic databases at INRIA tended to be set up by researchers either individually or as a team effort [21]. Although researchers do not usually have much time to look into new tools and learn how to use them, this does not mean that they do not need them. The INRIA study clearly shows the researchers' interest in, and capacities for, integrating the use of tools that are designed for them [21]. What is vital to researchers is access to relevant information; this is why they often prefer to stick with a few specific tools even if they are not familiar with these tools and do not really know which is which. Librarians therefore have a role in this area, but they also lack the time and resources they need to become more familiar with user

practice. Electronic resources show up this gap even more clearly. Researchers do not have the time to explore and test what is available, let alone keep up with advances on the technical side, while librarians continue to be unaware of the way researchers work in their laboratories outside the library and cannot, therefore, be aware of the influence of these habits. In an article based on a study at King's College London, Barry underlined some of the factors that are liable to cause researchers to use information technology inappropriately and even to reject it altogether [23].

7. Conclusion and future work

As has already been stated, it is not possible to make generalisations based on this sample. However, it has been possible to highlight a number of points which broadly concur with those made in other studies and which help to pinpoint the factors to be considered in assessing practice. One of these points is that researchers' practice is influenced by a whole range of intertwined factors: communication habits in the discipline, sharing of information, status, working environment and context and various more subjective factors, such as personal or inherited working habits, greater or lesser individual motivation or reluctance, etc. This mix of factors does not allow one to propose an homogeneous integration of electronic journals among the different scientific disciplines [14]. The trends noted among physicists and chemists agree substantially with observations made in other study locations [24, 25]. Of particular interest is the reluctance that is apparent among biologists and mathematicians. Among the biologists of the sample, this seems to be connected not only with deeply ingrained working habits relying on print, but also with technical limitations which prevent them from fully realising the advantages of electronic resources and with the fact that they do not feel at ease with information technology as a tool. In this respect, there are similarities between biology and the earth sciences, where electronic journals do not as yet have advantages that fully justify their use. The reluctance demonstrated by the mathematicians is more surprising, especially in view of the efforts undertaken by the French mathematics community to make electronic resources available.

Whatever the individual level of motivation for, or interest in, electronic media, printed documentation remains important in every case, whether for reasons of conservation, scientific validation or habit. A shift towards electronic journal use is definitely emerging, though rather hesitantly as yet, owing to a largely

insufficient knowledge of this new medium. The French situation differs greatly from the Anglo-Saxon contexts to the extent that, both in the UK and the USA, numerous and large experimental projects have enabled researchers to gain a growing familiarity with the electronic journals. Experiments of this kind are only starting in France and they are likely to yield very interesting results concerning their reception by French researchers and the incentive role institutions and libraries can play. The study related here is also a part of a PhD thesis in which a wider field study is being investigated at the Atomic Energy Commission, a French scientific research organisation that covers a wide range of scientific disciplines. Moreover, a consortium of French research laboratories and publishers is about to launch an experimental investigation in the humanities and social sciences to assess progress in this hitherto largely unresearched field.

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