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Use and Users of Electronic Library Resources: An Overview and Analysis of Recent Research Studies

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August 2003

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Executive Summary

In the last several years, many research studies have focused on how people use electronic resources or on their feelings about electronic and print resources in the library. These usage studies draw many conclusions about the behavior and preferences of library users, although sometimes the conclusions are contradictory or unclear. This report for the Council on Library and Information Resources (CLIR) summarizes and analyzes more than 200 recent research publications that focus on the use of electronic library resources and were published between 1995 and 2003. Eight major ongoing studies (each with multiple publications) are identified as Tier 1 studies and are analyzed in detail, while about 100 smaller-scale studies are classified as Tier 2 studies and are examined together.

The studies use a variety of research methods, including observation, surveys, interviews, experiments, and transaction log analysis. Some surveys or interviews ask questions about preference, including how users feel about the library or about specific media; others ask questions that provide information on user behavior. Observations, experiments, and logs also show what users do, but do not always reveal preferences or motivations. Each of these methods allows different types of conclusions and it is only when they are taken together that we can get a full picture of what users actually do, why they do it, what they would prefer, and what they are likely to do in the future.

The Tier 1 and Tier 2 studies make several valid conclusions that shed light on user behavior with electronic resources. They include the following:

- Both faculty and students use and like electronic resources and most readily adopt them if the sources are perceived as convenient, relevant, and time saving to their natural workflow.
- Experts in different subject disciplines (work fields) have different usage patterns and preferences for print or electronic. There is no one right solution for services or system design for every subject discipline.

- Print is still used for some reading and is part of research in almost every discipline. It is considered important in certain disciplines, especially in the humanities.
- Print remains the most popular medium for books; e-book use is still in the very early stages.
- Most e-journal users still print out articles that are judged useful—so a printing format such as PDF is popular.
- Subject experts use hyperlinks to view related articles; students' use of hyperlinks is less clear.
- Browsing a small number of core journals is important (in print or electronic forms), especially for subject experts and for current awareness searching.
- Searching by topic in an article database is important for all other purposes.
- Users will read articles from a wide variety of journal titles and sources if available to them, although most of the readings come from relatively few journals.
- Personal subscriptions to journals continue to decrease, so users rely more on electronic subscriptions subsidized by the library and on the Internet.
- Most journal article readings are of articles within their first year of publication, but a sizeable minority of readings come from materials that are older than one year.
- College and high school students use the Internet more than the library for research, and many believe they are more expert at searching than their teachers.
- Students exercise some quality judgments about materials they retrieve from the Internet, but those quality judgments may not exactly match faculty members' criteria for quality.

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1. Overview

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1.1 Introduction

Libraries of all sizes and types are embracing digital collections, although most libraries will continue to offer both print and digital collections for many years to come. New purchases and purchases of journals, magazines, and abstracting and indexing services are heavily weighted toward digital, while digital books (e-books) are only beginning to become a presence in library collections.

Libraries prefer digital collections for many reasons, including, but not limited to, the following: digital journals can be linked from and to indexing and abstracting databases; access can be from the user's home, office, or dormitory whether or not the physical library is open; the library can get usage statistics that are not available for print collections; and digital collections save space and are relatively easy to maintain. When total processing and space costs are taken into account, electronic collections may also result in some overall reductions in library costs (Montgomery and King 2002).

Such a dramatic switch from print collections to digital collections has an impact on library users and users' perceptions of the library. Many researchers have attempted to predict or measure that impact through surveys, transaction log analysis, and other research techniques. Librarians would like to be able to use the information and conclusions generated by the many research studies, especially because it is time consuming to conduct good research on their own and because the best measures of impact come after decisions are already made and collections are converted. Unfortunately, the conclusions of various studies sometimes seem contradictory, and it may be difficult to judge which research studies offer valid and reliable findings. The opinion literature outnumbers the research literature, and it may be a challenge to distinguish fact from opinion.

The purpose of this report for the Council on Library and Information Resources is to help librarians identify reliable research studies, to provide a synopsis of the good studies, and to present an analysis of conclusions. A subtitle of the report might well be the same as the CLIR symposium held March 28, 2003, "What Are Users Telling Us?" Or, "What do user studies tell us about how and why library constituents of all types use digital library resources and are likely to use them in the future?" The goal of this report is to provide information that librarians can use to make important decisions about collections, services, and product design. Also relevant to this topic is CLIR's January 2002 report "Usage and Usability Assessment: Library Practices and Concerns" by Denise Troll Covey.

Although this introduction refers to the resources as *digital resources* or *digital libraries*, the less precise, but more commonly used terms *electronic resources* or *electronic libraries* will be used throughout as synonyms.

1.2 Report Outline

Hundreds of recent publications focus on how users interact with or how they feel about electronic library resources. It is important, therefore, to state clear parameters of what is included (and what has been excluded) in this report. Only publications or reports of studies that meet the following parameters are included and analyzed:

- Studies must focus on the use of both electronic resources and libraries (electronic resources through the library, in addition to the library, or in

comparison with the library). Studies that are mostly about the Internet, but include a substantive section on libraries (the Pew studies, for example) or those that are mostly about libraries in general, but include a substantive section on digital libraries (the LibQUAL+[TM] studies, for example) are also included. Internet use studies that do not focus on libraries are excluded.

- Studies or surveys that focus solely on librarians, library staff, library Web sites, or publishers are excluded; only those that study library patrons are included.
- Studies that are limited to the behavior of authors rather than readers are excluded.
- Only research studies are included. Opinion pieces or descriptions of how a library converted their print collections to digital collections are excluded.
- A wide variety of research methods are covered (including surveys, transaction log analysis, experimental). Because different kinds of research methods allow different types of conclusions to be drawn, this report describes the research method used in studies and what types of conclusions made by the researchers are valid in accordance with the method.
- Studies are restricted to those conducted since 1995, or a post-Web world. Some studies compare recent findings with past studies (for example, the Tenopir and King studies), so they may address how usage patterns have changed with the advent of electronic resources, but the main focus remains user behavior in an increasingly digital age.
- Poorly conducted research from which valid conclusions cannot be drawn is excluded.

Applying the foregoing parameters resulted in a pool of more than 200 individual research publications. Some publications describe different phases or parts of large, and often ongoing, research projects. A further distinction was made to separate these large or ongoing studies from the more limited studies and to describe each major study as a whole, rather than as separate publication parts. This led to a distinction between "Tier 1" and "Tier 2" studies.

Tier 1 studies are those major studies that have many publications, sometimes by many different authors. The studies involve hundreds or thousands of subjects over multiple workplaces, work roles, or subject disciplines. Many important conclusions can be drawn from each of these studies and they are typically widely reported and discussed in the library community. Each Tier 1 study is actually a group of studies conducted by a research team. Tier 1 studies are discussed in the greatest detail since they may use multiple methods and provide, at times, complex findings.

The designation as a Tier 1 study was intentionally highly selective. Only eight user studies (actually, groups of studies) were designated as Tier 1 studies, but they represent nearly 100 individual articles or reports. Additionally, nearly that many other publications are designated Tier 2 studies. Tier 2 studies are not of lesser quality than Tier 1 studies; they are just typically smaller in scale or are one-time projects. Tier 2 studies may involve only dozens or hundreds of subjects. They may focus on a single workplace (for example, a single college campus). They provide valuable insights into library user behavior, but are best taken together as a whole to reach general conclusions.

In addition to Tier 1 and Tier 2 studies, selected related materials are briefly described and are included in the bibliography. These include bibliographies of writings about users of digital library materials and several important methods papers.

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2. Tier 1 Studies

2.1 Overview

Eight groups of studies were identified as "Tier 1" or major recent research studies on how people use electronic library resources. Tier 1 studies are (in no particular order):

1. SuperJournal
2. Digital Library Federation/Council on Library and Information Resources/Outsell (DLF/CLIR/Outsell)
3. HighWire/eJUSt
4. Pew Internet and American Life (with comparison to OCLC/Harris and Urban Libraries Council)
5. OhioLINK
6. Tenopir and King studies
7. LibQUAL+^{TM}
8. JSTOR studies

A synopsis of each is given first, followed by an analysis of the methods used, participants included, levels of conclusions, and findings for each group. In the bibliography, all of the publications that report on each study are listed together by the study group name.

2.1.1 SuperJournal

The SuperJournal project is a group of studies of e-journal use that began in 1995 in the United Kingdom in response to the information explosion and limited budgets. The researchers use a variety of research methods, including log file analysis, surveys, interviews, and focus groups, to study how academic users interact with e-journals and what features they value. Academic scientists and social scientists were studied, including both faculty and students in British universities.

2.1.2 Digital Library Federation/Council on Library and Information Resources/Outsell (DLF/CLIR/Outsell)

Outsell, Inc., conducted a survey of information use for the Digital Library Federation and Council on Library and Information Resources in the fall of 2001 and early winter of 2002. Some 3,234 faculty, graduate students, and undergraduate students across seven subject disciplines at private and public doctoral research universities and leading liberal arts colleges were interviewed over the telephone. They were asked about their use and preferences for both print and electronic resources from the library.

2.1.3 HighWire/eJUSt

The Stanford E-Journal Users Study (e-JUSt), published by HighWire Press, used a variety of methods to gain insights into the use of electronic journals, including qualitative user surveys, transaction log analysis, and an ethnographic study of scholarly e-journal usage. The qualitative user surveys were done online with participants taken from subscribers to HighWire's medical and scientific journal Table of Contents service. The participants included graduate students, faculty members, and clinicians from universities, hospitals, and government and academic research institutes from 99 countries. The studies were conducted between November 2000 and August 2002.

2.1.4 Pew Internet and American Life (also OCLC/Harris, and Urban Libraries Council)

The Pew Internet and American Life Project conducted two studies about

how students use the Internet. In the "Internet Goes to College," 2,054 college students at two- and four-year public and private colleges completed surveys. In addition, graduate student researchers observed the behavior of college students at Chicago area colleges and universities. In the other Pew Internet and American Life Project, "The Digital Disconnect: The Widening Gap between Internet Savvy Students and their Schools," middle and high school students were studied between November 2001 and March 2002. About 200 students wrote essays in which they expressed how they and their friends used the Internet for school and how they might use it in the future. Both these studies included how the students view the library. OCLC/Harris and the Urban Libraries Council conducted similar surveys comparing library and Internet use by students and the public respectively. In the OCLC/Harris study, 1,050 participants were surveyed between December 11, 2001, and January 1, 2002. In the Urban Libraries Council study, 3,097 participants were surveyed by telephone between March and April 2000.

2.1.5 OhioLINK

The Ohio Library and Information Network is a consortium of Ohio's college and university libraries and the State Library of Ohio. The consortium serves in excess of 500,000 students, faculty, and staff at more than 80 institutions of higher learning. OhioLINK's Electronic Journal Center makes electronic articles and journals available to OhioLINK members. Transaction log analysis is used to measure the number of articles users download from the Electronic Journal Center. This program, begun in April 1998, is ongoing.

2.1.6 Tenopir and King Studies

The Tenopir and King research studies are a series of surveys of more than 16,000 scientists, engineers, medical professionals, and social scientists in university and non-university research settings. The surveys measure reading and authorship patterns of these subject experts through critical incident, demographic, and usage questions. Information-seeking behaviors, amount of reading, purposes of reading, and source of readings are all measured. Recent studies have focused on how reading patterns have changed over time with the adoption of e-journals and what role library-provided journals play in overall reading patterns. These ongoing experiments began in 1977.

2.1.7 LibQUAL+^{TM}

LibQUAL+^{TM}, conducted by the Association of Research Libraries (ARL) in conjunction with Texas A & M University, surveyed students, faculty, and staff at various community colleges, four-year colleges, and health science schools in the United States as well as the New York Public Library and Smithsonian Institution during the spring of 2002. More than 70,000 faculty, staff, and students related how often they used the physical and electronic libraries. Furthermore, they answered questions about their library's level of service that they found minimally acceptable, the level they perceived, and the level they desired. The results are presented by status of respondent and type of institution. Only those few questions that focus on desired levels for print and electronic collections and services are relevant and reported here.

2.1.8 JSTOR

The JSTOR system provides electronic archives of back issues of scholarly journals. JSTOR uses log analysis of both viewed and printed articles to characterize use of its materials. In addition, some JSTOR subscribing libraries have analyzed their use of the JSTOR journals within their specific library environment. In the fall of 2000, JSTOR surveyed more than 4,000 academic users of the collection in humanities, social sciences, and economics to discover usage patterns and preferences of university faculty.

2.2 Participants

Each of the eight Tier 1 studies examined a variety of participants, with college and university students and faculty members the most often studied, followed by practitioners and other subject experts in science, engineering, health, and social sciences. Table 2.1 summarizes the main participants included in each study.

Study	Participants
SuperJournal	Students and faculty

DLF/CLIR/Outsell	Students and faculty
HighWire/eJUSt	Scholars and clinicians
Pew/OCLC-Harris/Urban Libraries Council	Middle, high, and college students/general public
OhioLINK	OhioLINK users
Tenopir and King	Scientists and social scientists (academic and non-academic)
LibQUAL+^{TM}	Library users at institutions of higher education (students and faculty)
JSTOR	JSTOR users (mostly faculty)

Table 2.1. Tier 1: Participants

2.3 Methods

The method or methods used in a research study determine what types of conclusions can be drawn about the sampled participants and what findings can be generalized to the population as a whole. Wang (1999) provides an overview of methods for user behavioral research. An extension of her categorization of methods is used here to describe Tier 1 studies. Tier 1 studies use one or more of the following methods:

- surveying users
- interviewing users (including focus groups)
- observing users through experiments
- observing users in natural settings (including keeping journals)
- transaction log analysis (included under "observing users" in Wang 1999)

Covey (2002) also categorizes usage studies to help librarians design the most appropriate studies for the type of information they hope to gather. Covey's categories of research studies are similar to Wang's and include the following:

- surveys (questionnaires)
- focus groups
- user protocols (experiments and observations are both included here)
- other (heuristic evaluations, paper prototypes and scenarios, and card-sorting tests)
- transaction log analysis

Table 2.2 summarizes the methods used by the Tier 1 studies. Several use multiple methods for different phases of their projects; others rely on a single method.

Study	Methods
SuperJournal	Logs/surveys/focus groups/ interviews
DLF/CLIR/Outsell	Interviews
HighWire/eJUSt	Surveys/interviews/logs
Pew/OCLC-Harris/Urban Libraries Council	Surveys/observation/focus groups/journal keeping
OhioLINK	Logs
Tenopir and King	Surveys/critical incident
LibQUAL+^{TM}	Surveys
JSTOR	Logs

Table 2.2. Tier 1: Methods Used

Surveys of users are typically done by sending a questionnaire by e-mail, the Web, or paper mail to a randomly selected percentage of the population under study. Tenopir and King, for example, survey samples of university faculty, members of professional organizations such as the American Astronomical Society, and scientists in companies and government laboratories. LibQUAL+^{TM} libraries survey students and faculty within their own university community for comparison with other LibQUAL+^{TM} libraries. Conclusions based on the responses are generalized to the whole using appropriate statistical tests. Care in selecting samples and a reasonable return rate are necessary to draw valid conclusions.

Almost all of the studies reported here that use surveys follow these basic precepts of sampling and analysis, but the types of conclusions that can be

drawn vary by the types of questions that are asked. Among the Tier 1 studies that use surveys, the main distinctions in types of questions asked can be characterized as follows: 1. preference (focusing on what people want or think about a particular service; e.g., LibQUAL+[TM], Pew) 2. reported behavior (focusing on what people say they do in general; e.g., DLF/CLIR/Outsell, HighWire/eJUSt) 3. critical incident questions (focusing on what people say they do in regard to a specific instance or reading; e.g., Tenopir and King).[1]

Table 2.3 shows methods in more depth by looking at what types of questions were asked.

Study	Type of Questions
SuperJournal	Preference and reported behavior
DLF/CLIR/Outsell	Preference and reported behavior
HighWire/eJUSt	Preference and reported behavior
Pew/OCLC-Harris/Urban Libraries Council	Preference and behavior-reported and observed
OhioLINK	Log analysis
Tenopir and King	Critical incident, preference and reported behavior
LibQUAL+[TM]	Preference and reported behavior
JSTOR	Preference and reported behavior and log analysis

Table 2.3. Tier 1: Types of Questions

Together, the categories of participants and the methods used (as outlined in Tables 2.2 and 2.3) determine at which of three levels valid conclusions can be drawn:

- the "user level," that is, what do individuals or groups of individuals such as social science faculty say they do or prefer;
- the "group level," that is, what do groups of users at an institution do, without demographic differentiation; or
- the "readings or incident level," that is, what do specific users or groups of users do or prefer about a specific type of information or reading (see Table 2.4).

Study	Conclusions
SuperJournal	User level
DLF/CLIR/Outsell	User level
HighWire/eJUSt	User level
Pew/OCLC-Harris/Urban Libraries Council	User level
OhioLINK	Group level
Tenopir and King	User and reading levels
LibQUAL+[TM]	User level
JSTOR	User and group level

Table 2.4. Tier 1: Conclusion Level

SuperJournal, for example, uses transaction logs, surveys with questions about preferences and behavior, focus groups, and interviews to study faculty and graduate students. Demographic information is known for each user. These multiple methods allow conclusions to be drawn at the user level for both behavior and preferences (what specific types of users do and what they prefer). JSTOR uses transaction logs separate from survey questions. DLF/CLIR/Outsell used interviews to gather information on what users say they prefer and say they do in general. Demographic information is known about each user. This allows conclusions to be drawn at the user level as well. Tenopir and King use critical incident questions in their surveys, which ask users to focus on the last article read. Together with demographic data, this allows conclusions to be made at the readings level (characteristics of the total amount of readings done by individuals and groups of individuals).

Each of these methods has advantages and disadvantages. According to Covey (2002), problems or concerns with surveys include the following:

- General surveys are time-consuming and expensive to prepare, conduct, and interpret.

- Unless follow-ups are sent so longitudinal analysis can track changing patterns of use, surveys provide no baseline data.
- People receive many surveys, and it is difficult to motivate them to complete and return surveys.
- The usage information gathered in general surveys might better be gathered by transactional logs.
- Specific surveys are more beneficial, but must be repeated over time.
- User satisfaction surveys may not provide enough information to solve the problem, and service "gap" surveys are more difficult to administer and analyze.
- A survey is only as good as the wording of the questions and the response rate.

Problems or concerns with focus groups, according to Covey, include the following:

- A skilled moderator needs to direct the groups to keep discussions on track.
- An unskilled observer may fail to take adequate notes.
- The qualitative data gathered in focus groups can be time consuming and difficult to interpret.

Problems or concerns with experiments or observations (called user protocols by Covey), include the following:

- Librarians, if observing, have a difficult time not assisting the subjects.
- Librarians may not be trained to interpret and analyze the data from user protocols.
- Recruiting subjects, in particular subjects who are comfortable with the process of thinking aloud, is difficult.

Problems with transaction log analysis, according to Covey, include the following:

- deciding on the right and most useful usage statistics
- collecting the right usage statistics
- getting the right and consistent usage statistics from vendors
- analyzing and interpreting data (it can be time consuming and difficult)
- presenting the data in a meaningful way

In summary, the conclusions that can be drawn from each of the Tier 1 and Tier 2 studies depends on the methods used, including the overall method(s), types of questions asked, level of questions, and participants studied. It may be tempting for a researcher to draw broader conclusions than his or her methods justify—a failing that was found in more than one study examined. Only those findings that are justified by each study's methods are reported here. In general, the following types of conclusions can be drawn from each technique:

Transaction logs: what groups do in general; for example, what the college or university libraries in the OhioLINK system do in general. Transaction logs do not show preferences; rather, they show action from which preferences are often inferred. Demographic data from individuals are usually not gathered because of privacy concerns. Instead usage is identified by IP address, location, or library, so conclusions about differences in work fields or status of user cannot be drawn. Transaction logs that result from an experimental design allow more finely tuned conclusions (see Observation: experimental, below).

Interviews or surveys: preference questions. Preference questions, or questions about what people want, show what people say they prefer or value. Demographic information is almost always asked, allowing conclusions to be made about groups. (For example, in HighWire/eJUSt, most science faculty members say their favorite e-journal feature is linking.) Preferences may or may not predict actual or future behavior.

Interviews or surveys: behavioral questions. Questions about behavior in general (for example, "Do you use the library's electronic journals?") show what people do at least some of the time. Demographic information is almost always gathered as well, allowing conclusions to be drawn about individuals or groups of individuals. (For example, the DLF/CLIR/Outsell study shows that most humanities faculty members use the print collection for at least part of their work.)

Interviews or surveys: critical incident questions. Respondents are asked to focus on a specific incident; for example, the last article they read or the last article they authored. Specific questions about that incident are then asked. Demographic information is also collected. This allows conclusions to be made about the total amount of reading or for specific characteristics of users or readings. (For example, Tenopir et al. [2003] report that 80% of the articles astronomers read in a year are from electronic sources.)

Focus groups. Focus group participants are not randomly selected; instead, individuals who can express opinions about a service or issue are invited to participate. Therefore, preferences and behaviors observed in focus groups must not be overly generalized to the population as a whole, nor interpreted as the only possibilities. (For example, from SuperJournal, faculty members report a variety of uses for electronic journals, including keeping current in their areas of research, gathering background information, and preparing for a specific event.) Focus groups are helpful as a first step or in conjunction with other research methods.

Observation: experimental. Controlled experiments gather both quantitative and qualitative data on how users behave in a controlled environment, such as searching on a specific online system, and why they behave in a certain way. Demographic data are gathered, along with other data about individual differences, such as from controlled tests. Conclusions depend on the experimental treatment. (For example, log analysis in conjunction with experimental observation in the SuperJournal study shows that social scientists browse differently than scientists.)

Observation in natural setting: journal keeping. Participants are asked to record their interactions with information systems or their research process. Conclusions can be drawn about types of behavior, and models of behavior can be derived. (For example, in the Pew Studies, students recorded using electronic resources more than print resources and felt they knew more about the Internet than do their teachers.)

2.4 Tier 1: Analysis
2.4.1 SuperJournal

The SuperJournal studies use a rich variety of methods—including observations, interviews, focus groups, transaction logs, etc.—within the controlled environment of a test database of journals and journal articles. It is one of the best-designed controlled studies of how faculty, undergraduate, and graduate students interact with and use electronic journals. Conclusions are made within the boundaries of subjects, test settings, and resources under scrutiny.

SuperJournal found that users vary in their patterns of use, depending on their subject discipline and status (faculty, graduate students, or undergraduate students). It identified seven categories of e-journal users:

- enthused (one or two sessions per month, wide use of journals and articles, mostly social scientists and graduate students)
- journal-focused (many sessions but concentrated on 4 or 5 specific journal titles and 50% full text, mostly scientists and graduate -students)
- topic-focused (searched less often and by subject rather than -specific journals, used many articles, mostly social scientists)
- article-focused (searched less often, only on one journal, mostly scientists)
- bingers (mostly social science students)
- explorers (students across all disciplines, used tables of contents in multiple journals)
- window-shoppers (students who viewed the journal system just once and did not use the full-text database)

A system must accommodate all of these variations in use by including features that enable browsing through the table of contents or journals, searching for topics or articles, creating topical subsets of journals or articles, and searching across the entire database.

Social scientists tend to retrieve recent articles of interest through vertical chaining (going from table of contents, to abstract, to full-text). Scientists often browse journal titles, retrieve known articles, and do vertical leaping (table of contents to full-text.) Social science students viewed multiple journal tables of contents while using e-journals to fulfill a specific class assignment. Both browsing through tables of contents of known journals

and searching in full-text databases are important, but the relative importance of each varies by work field and status. Once a relevant article is identified, most users print it out.

Focus groups in the SuperJournal project were used as baseline studies. They identified a variety of reported behavior and uses of electronic journals, including the following:

- keeping current with articles in the user's area of research
- keeping up to date with what is being published more broadly in related areas
- gathering background information on a new area on which the user might be embarking, such as a new experiment
- preparing for a specific event such as writing an essay or grant proposal
- performing tasks associated with teaching, such as writing and updating lectures and reading lists

Differences between disciplines were evident in the focus groups, leading the SuperJournal researchers to conclude the following:

- Social scientists seemed to be more task-driven than scientists.
- Social scientists visited the library less often than scientists when new journals appeared (the former are more likely to visit quarterly). Social scientists used databases in the library without mentioning any particular database.
- Social scientists expressed less anxiety about keeping up to date, while scientists expressed a feeling that there was not enough time to keep up to date.
- Scientists didn't think they were finding all the articles that they needed to find.
- Scientists seek articles on a more regular basis.
- Scientists combine online database searching and browsing.
- Both scientists and social scientists value the library as the institution that provides them with journals.

At the end of the entire SuperJournal project, concluding focus groups revealed that as a result of their exposure to electronic journals:

- They visit the library less because of desktop access.
- They accomplish tasks more efficiently.
- They felt more up to date.
- Users do what works best for them. There appears to be no change through the project in individual preferences for searching and browsing.

2.4.2 DLF/CLIR/Outsell

Interviews in the DLF/CLIR/Outsell study also found that the use of electronic journals varies with the subject discipline, the use (teaching or research), and the status of the individual. According to the survey results, the percentage of faculty who use e-journals for research varies between a low of 62.1% (law) and a high of 83.3 % (biological sciences). The percentage of faculty who use e-journals for teaching ranges between a low of 27.7% (law) and a high of 55.5% (biological sciences). The percentage of students who use e-journals varies between a low of 35% (law) to a high of 61.7% (biological -sciences).

Although 80% of the respondents across all disciplines say that the Internet has changed the way they look for information, only about one quarter of the faculty and 38.3% of the students said they needed more online journals. More graduate students desire additional e-journals than do faculty or undergraduates.

About 80% of faculty and graduate students access e-journals online, and 75% prefer this mode of access. About 23% use e-journals in the library, but only 13.9% prefer to access them this way. Almost three-quarters of the faculty access electronic information from their office or home. About three-quarters of students access the journals online, and most prefer to do this but only 68.5% of arts and humanities students reported online use.

Respondents report a difference in how they trust information that comes from the library versus that from the Internet. Almost two-thirds of the faculty (62%) and graduate students (66%) say they use the library's Web site. When information comes from the library almost all (98.2%) believe it is from a credible source. Less than half (45.9 %) reported using

information from the Internet without verifying it.

DLF/CLIR/Outsell made some other interesting discoveries as follows: Respondents differ in their level of comfort with electronic information depending on discipline and status. Respondents in the arts and humanities do not feel as comfortable with electronic information as respondents in social sciences, engineering, and business.

Most people (72% of respondents) print out the information they find online. DLF/CLIR/Outsell found some differences between men's and women's reported use of online resources. More women than men say they use e-journals in their research (80.4% and 72%, respectively). In teaching, men report significantly more use of a search engine to access e-journals than women who access e-journals (23.8% and 5.9%, respectively). Women report that they use their institution's Web site more often than did men (26.5% and 11.6%, respectively) to access e-journals for teaching. More women than men in research use electronic sources most of the time (37.4% and 31.7%, respectively) or all of the time (7.4% and 4.2%, respectively).

Not only did respondents differ in their use of e-journals based on status, discipline, and gender, they also differ in how they find information about e-journals. More than 90% of the faculty and graduate students who use e-journals for research in biological sciences, physical sciences/math, social sciences, and business find information about them online. More faculty members than graduate students (92.5% and 75.5% respectively) use online sources to discover information about e-journals. When it comes to course work, students learn about e-journals in a variety of ways. Most use online sources, but the percentage of the respondents varies according to discipline, with 88.4% of the biological sciences students using online sources compared with only 69.8% of the engineering students. More undergraduates said they preferred to use a search engine than did graduate students.

The DLF/CLIR/Outsell survey cuts across all sizes of colleges and universities and includes faculty members, graduate students, and undergraduates in all subject disciplines. The findings show reported behavior and preferences and how these respondents use resources at least some of the time.

2.4.3 HighWire eJUSt

The Stanford E-Journal User Study, published by HighWire Press, surveyed members of professional societies in life sciences that are affiliated with HighWire Press to find preferences and reported behavior. Although 92% of respondents reported they like online retrieval because it is convenient, they still prefer printed copies or paper journals for reading. Two-thirds of the respondents report that they print out selected e-articles for reading and for their own archives, and they do not like HTML for printing.

Like many other studies, eJUSt found differences in preferences and behavior between work fields and work roles. Biologists are more likely to read e-journals than are other life scientists, but the reason is unknown. Clinicians and biology researchers use e-journals differently: clinicians search online material (often abstracts) for educational and clinical purposes, while biology researchers use online material for research. Health professionals with an M.D. degree use abstracts rather than full-text articles to access treatment protocols and say they would go without an article rather than pay for online access. Those without the M.D. degree use e-journals even more often. Both life scientists and medical practitioners appear to have increased their e-journal usage somewhat from the first to the third eJUSt survey (May 22ÐJune 20, 2001, and MayÐAugust 2002). In addition, more than half (52%) of the respondents said that e-journals make them aware of the literature on the periphery of their discipline, and some said e-journals increase their ability to communicate with their peers.

Scientists say they like e-journals for retrieving full-text articles and for ease of browsing and searching. While searching, 77% of the scholars are more likely to begin their search at a multi-journal Web site with links to full text, such as PubMed, Ovid, Science Direct, HighWire, or Medline, than at a specific journal. The journal title as a known entity is less likely to be sought than a specific article found through a database or subject search.

By analyzing transaction logs, eJUSt found that readers of electronic journals often search journal tables of contents, then go to the full-text article to read it briefly online in HTML, and then request a PDF file for archiving or printing. Medical searchers often come to the journal article from a PubMed search, then view articles in HTML and print them out in PDF. Multi-journal databases such as PubMed create major traffic for journal Web sites (30-60% of the searches by life scientists and M.D.s are in PubMed).

Unlike some of the other studies, the eJUSt studies found differences in journal use by the age of readers. Younger scholars report they are more likely to be frequent e-journal users than are older readers, and older scholars believe e-journals decrease the quality and rigor of research literature searches. The older the respondent, the more likely he was to report that unfriendly interfaces waste users' time and older scholars report more trouble with interfaces. Older scholars are less likely to think e-journal usage increases scholarly productivity, but they are more willing to pay for online access than to go without an article.

Online access may actually motivate personal subscriptions and society memberships. Scholars with very few or very many subscriptions used e-journals more frequently than those with an average number (found to be four per scholar in this study).

The eJUSt participants also commented on what they like about paper journals. Just over half reported that portability is an advantage of printed journals since 80% print out a copy to read or file, or both. They like the better readability of paper, including the ability to make notes on the paper and maneuver easily between articles. Finally, they say that paper journals help users move within and between documents while reading intensely. When they are scanning articles on the computer screen, they like hyperlinking.

Participants rated the value-added features of e-journals, with hyperlinking rated as the most useful value added feature (63% like linking to scientific databases; 61% like linking to an author's e-mail address; 52% like linking to an author's Web sites; and 45% like linking to video-animated graphics).

Participants made suggestions for improving e-journals by listing what they desired in e-journals, including deep archives, greater clarity from libraries and publishers about what they offer, and e-journal design that addresses the more comprehensive needs and practices of the user. Furthermore, users report they need tools and services that support seamless navigation across different landscapes; they need help knowing what is linked, and they need more choices in subscription and membership packages.

The bottom line for journal use by these subject experts is convenience and versatility. Scholars integrate paper and electronic journals in a way that makes the most sense to them. They develop multiple ways of using e-journals to support a range of information practices. They monitor and review content regularly to keep current. Because they report that they read less intensively than in the past, they search using abstracts and metadata to help them evaluate material. The eJUSt reports conclude that scholars' research habits have not changed—they read to extract knowledge and prefer to do it on paper. They circulate and exchange content to build peer networks, organize content by context and relevance into mini-libraries, and document original content to establish ownership of ideas.

2.4.4 Pew Studies/OCLC-Harris/Urban Libraries Council

The Pew Internet and American Life Studies used focus groups, observation, and journal-keeping to study the use of the Internet by middle, high school, and college students. The comparison of Internet and library use is the focus of this report. In the focus groups held between November 2001 and March 2002, the middle and high school students explained why they used the Internet for library and reference resources. They reported that the Internet is easier and more convenient to access from home and it is closer to home than the physical library, plus it is open 24 hours per day, seven days a week. Although the quality of Internet materials may be dubious, users say Internet materials are more current than library resources. Respondents believe that the Internet material covers a large variety of topics. It can be cut and pasted virtually rather than physically. They can print out the material at home. Furthermore, they can do all these things while baby-sitting, and do them more comfortably than in the

physical library.

Participants in the Pew studies realize there are problems with the Internet. They know the information is not always true or understandable. They retrieve too much irrelevant information because they don't know how to conduct good searches. Sometimes, specific online material is unavailable or must be purchased. The respondents complained about too many advertisements at some Web sites and the lack of foreign-language material online. In general, the more Internet-savvy students believed that they were better than their teachers at using it.

Almost three-quarters of college students (73%) said they used the Internet more than the library. On the other hand, only 9% use the library more than the Internet. Most students doing research use commercial search engines because it is easier to find resources; few used the library or university-based Web sites. Most students were observed using electronic resources rather than print resources and reported that they use the computer because it is convenient.

The Pew studies were preceded by two major studies that compared Internet use with library use. OCLC commissioned Harris Interactive to survey 1,050 college students between December 11, 2001, and January 1, 2002. The Urban Libraries Council, in conjunction with the State University of New York at Buffalo, conducted a telephone survey of 3,079 adults in March and April 2000. The OCLC/Harris survey included 11% graduate students and 89% undergraduate students in a variety of majors. Students are self-confident in their use of the Web for course-related research and in their ability to judge the quality of the Web sites.

According to the OCLC/Harris survey, three-quarters of the students feel that that they are successful at finding the information they need for courses and assignments, but unless professors or teaching assistants direct them to specific course-related Web sites, they make their own decisions about which Web sites to use (OCLC 2002).

More than two-thirds strongly feel they know best what information to accept from the Web and only 4% think the quality of the information is not good enough on the Web. Respondents rated the importance of various Web attributes and how they believed the Web measures up. The most important attributes were as follows:

1. Accuracy of information was rated as the most important (9.0 on a 10-point scale), but they don't believe the Web delivers accurate information (6.2 on a 10 point scale).
2. Web doesn't cost too much (8.9), and they rate it as (8.0).
3. Information is up to date (8.8), and they rate it as (6.8).
4. Web is easy to use (8.3), and they rate it as (8.5).

About 80% of the students sometimes use the library for Web access, but only 20% prefer to do so. More than 90% of the students access the Web outside the library, from their home computer, and 78% prefer this type of access. When it comes to needing help, however, 80% of the students prefer face-to-face rather than online help. Nearly half say they are more likely to get help online or by telephone, but 62% say they would use online help from a librarian if there were no charge. When students do use librarians for help, they rate that help 7.8 on a scale of 10—which is similar to the ratings for help from friends (7.8) and faculty or teaching assistants (7.9).

The students use a variety of Web resources for assignments, including search engines, Web portals, course-specific Web sites, and the campus library Web site. They learn about the library Web site from the following sources: professors and teaching assistants (49%), look it up themselves (45%), classes about using the library (34%), and librarians (27%). Only 21% say they ask a librarian for help, while 61% ask their friends, and 36% ask their professors or teaching assistants for help.

Eighty-nine percent of the students use print resources from the campus library at least part of the time, including books (75%), journals and periodicals (70%), journal articles (64%), and encyclopedias (34%). When they locate information they need, two-thirds of the respondents prefer to print out a copy for reading, rather than read from the screen.

Based on their experiences, students say they would like the campus

library to do the following to help them with their assignments:

- make it easier to use and access library information
- make both print and electronic journals available
- offer interactive maps, study guides, and resource guides
- provide links to other library and research sites—over half want some way to search other libraries

The students report the following as barriers to online use:

- inability to access databases remotely because of password requirements or license restrictions, or both
- difficulty searching and navigating within a library Web site
- costs of printing and copying at the library
- shortage of knowledgeable librarians
- lack of customer orientation

The Urban Libraries Council report used focus groups to decide what questions to ask to find out about the interaction between library and Internet use. The focus groups included both users and non-users of the library, as well as those who did and did not use the Internet. The final questionnaire was administered over the telephone to 3,097 participants between March and April 2000.

The study found that three-quarters of Internet users say they are library users and 60% of library users are Internet users. Use of the library and of the Internet are both inversely related to age, with library users and Internet users both significantly younger than non-users. Both use of the library and use of the Internet are also positively related to educational attainment and annual household income. There is no relationship with race, but females used the library and the Internet more than males.

The study concluded that there is no evidence that "use of the Internet is changing the reasons why people use the library," nor "that length, frequency or recency of use of the Internet is affecting the frequency with which people use the library" (D'Elia et al. 2002).

Library users who do not have Internet access at home or at work use the library more than others to attend literacy classes and for children's schoolwork. Significantly more people who have access to both the Internet and the library use the Internet for the following:

- to do research for school
- to obtain information for children's schoolwork
- to obtain local history or genealogy information
- to browse Web with children for fun
- to participate in and communicate through chat rooms or listservs
- to obtain ethnic heritage information

Library service ratings were significantly greater than the Internet's service ratings for ease of use, low cost, availability of paper copy (versus digital copy), accuracy of information, helpfulness of librarian (versus net help lines), and privacy. The Internet's service ratings were significantly greater than the library's service ratings, however, for ease of getting there, time to get there, hours of access, range of resources, expectation of finding what is sought, ability to act immediately on the information obtained, currency of the information, fun, enjoyment of browsing, and the ability to work alone (versus being among people at the library).

The Urban Libraries Council concludes there is no evidence that use of the Internet is a reason people do not use their library. People who use neither the library nor the Internet get their information through newspapers and television.

2.4.5 OhioLINK

OhioLINK is a consortium of 84 college and university libraries in Ohio. The academic institutions represented by these libraries range from Ohio State, with almost 50,000 students, to two- and four-year colleges with 360 students (Mount Carmel School of Nursing). OhioLINK mounts electronic journals on its own system, providing it with consistent transaction log information. The Electronic Journal Center uses log analysis to study usage levels and usage patterns across all OhioLINK libraries.

Perhaps the most dramatic finding from several years of log analysis is that

e-journal users are reading from a wider array of journal titles than anticipated—much wider than the titles to which libraries previously subscribed. From April 1999 to March 2000, 40% of the journal titles accounted for 85% of the downloads; 45% of the least-used titles accounted for just 10% of the downloads, and 1% of the titles accounted for 8 to 10% of the downloads for each publisher. Between April 2000 and March 2001, of the 1,306,000 articles downloaded, 58% were from journals not held in print at the downloading patron's library. For small colleges, 90-95% of articles downloaded were from newly accessible electronic journals in 2000. For two-year schools (both technical and community colleges), 95% to 100% of the articles downloaded were from newly accessible journals. Furthermore, each title has at least one download somewhere in the consortium. This leads to the seemingly obvious conclusion that adding new journal titles increases use.

OhioLINK analysis found that all member libraries have experienced growth in the annual number of downloads. The total number of annual downloads from April 1998 to March 2001 increased from 280,000 articles to 1,306,000 articles. More than half (51%) of the articles downloaded were from titles not held in print except by the large universities of Ohio State University, Case Western Reserve University, and the University of Cincinnati. Furthermore, when the licensing agreements are analyzed with the OhioLINK downloads for 1999, Dierdrichs (2001) reports that 120,000 articles were downloaded from titles not previously held at the patron's library. Eighty-six thousand nine hundred ten of the 120,000 would have been over the fair use limit of five. In addition, online access to new titles increased the use of journals at all schools. For instance, small colleges in Ohio owned between 3 and 54 print journals, but they downloaded between 126 and 6,284 articles from 45 to 410 titles during the first year. Thus, Dierdrichs (2001) concludes that the OhioLINK consortium both saves money and provides faculty and students with a much larger array of journals that help them keep current.

Providing electronic access to journals increases use in a way that would likely not be matched by merely increasing the size of the print journal collection. OhioLINK's director, Thomas Sanville, concludes that "only through immediate desktop delivery will users make use of journals at these expanded levels." Sanville (2001a) believes that the "use of information is highly elastic as access is improved with the rapidly evolving advances in electronic technology." This means that librarians' attitudes should change from "I know what my users need" to "Let's find out what my users need."

Recently, the OhioLINK results have been challenged (or, at least questioned). Davis (2002) compared usage statistics of articles downloaded from a collection of more than 200 titles in the sciences and social sciences (Academic IDEAL e-journal package) at all the institutions in the NorthEast Research Libraries Consortium (NERL). He found that each institution within the consortium has a unique pattern of use; larger institutions used a wider range of journals, except for medical schools, which used a smaller number of titles than universities. He found that no institution uses every title and some titles are used very infrequently by all institutions. Furthermore, some of the small liberal arts colleges and technical institutes used only about 30% of the collection. Based on cluster analysis of journal usage, he suggests that institutions should form a consortium with like institutions (same size and type) to purchase journals. For instance, he suggests that medical schools may want to subscribe to a group of core journals and get the rest through interlibrary loan because they do not use all the journals that a research institution such as MIT uses. Davis believes that consortiums should be formed based on institutional characteristics rather than on geographic area.

2.4.6 Tenopir and King

From 1977 to the present, Tenopir and King have surveyed more than 16,000 scientists, engineers, and social scientists in both university and non-university settings. They found consistently over time that the amount of reading varies by work field and workplace. They also found that scientists, on average, read more journal articles than do engineers, and that medical faculty read the most. Chemists and physicists read between these extremes. Faculty members read more than professionals in non-university settings and write many more articles. Still, the amount of

reading remains strong or is increasing in all work fields, and both scientists and engineers are reported to value journal articles highly. Most groups readily switch to electronic journals when they are convenient and are provided at no direct cost to them, but some of their readings still come from print sources.

Since the number of personal subscriptions is declining, scientists rely more on library-provided copies. Now they also rely more on reading articles from a variety of sources, including e-print servers, author or university Web sites, journal article databases, and personal e-mails.

Scientists, engineers, and medical faculty read primarily for research (34% of all readings in a survey of national laboratories; 29.9% in surveys of medical scientists), current awareness or continuing education (22% in both groups), and communications-related presentations or consulting (16% of the national laboratory scientists; 16.9% of the medical scientists). For non-university scientists, an important purpose of reading is for background research (24%). Additional purposes reported for the university medical scientists included clinical practice (7.8%) and teaching (16.9%). Most of the readings are articles that are less than two years old, but readings of older articles are reported to be very valuable. Currency is most important to the medical faculty. In the latest survey of medical faculty, more than 87% of the readings were from the past 14 months and 94% from the past two years. In a survey of astronomers, two-thirds of the total readings were from the last year and nearly three-quarters from the last two years. The oldest article read was more than 60 years old.

The average time spent reading has fluctuated and does not appear to be increasing as much as the number of readings. Scientists, on average, are doing quite a bit more reading without spending a great deal more time. The time spent reading per article also varies among disciplines, with engineers averaging 72 readings per year (but 80 minutes per article) and medical faculty averaging 322 readings per year (but only 20 minutes per reading). Although the average amount of reading and time spent reading vary somewhat, scientists continue to show the value they place on journal articles by the time they spend reading.

Recent counts of percentages of reading that come from electronic journals varies in the studies, from a high of about 80% of all readings by astronomers to a low of 35% from science and social science faculty at one university. Habits are changing and most students and faculty prefer e-journals when they make access easier, save the reader's time, and are known within the specific scholarly discipline.

2.4.7 LibQUAL+^{TM}

LibQUAL+^{TM} is an electronic survey administered by college, university, and health science libraries (both ARL and non-ARL institutions) that began in the spring of 2000. To date, more than 70,000 students, faculty members, and staff have responded. The percentage of respondents who use the electronic library at least weekly ranges from a low of 30% at community colleges to a high of 66% at health sciences institutions. The percentage of the same respondents who use the physical library at least weekly ranges from a low of 36% at community colleges to a high of 55% at four-year colleges (both ARL and non-ARL institutions). At ARL four-year colleges, 75% of both faculty members and graduate students use the electronic library at least weekly, while only 47% of the faculty members and 64% of the graduate students visit the physical library. On the other hand, a greater percentage of undergraduates use the physical library (53%) than the electronic library (44%) at least weekly. At ARL health science institutions, 80% of the faculty members use the electronic library at least weekly, while only 37% use the physical library. More graduate students use the electronic library (75%) than the physical library (63%) weekly, while the undergraduates use both about equally (59% and 61%). At OhioLINK community colleges, 31% of the faculty members use the electronic library at least weekly, while 69% of the faculty members at four-year OhioLINK institutions do so.

The percentage of respondents who never use the physical or the electronic library varies. The smallest percentage of respondents who never use the physical library are undergraduates at ARL health science institutions (0.6%), while 7.2% of the same undergraduates say they never use the electronic library. On the other hand, the smallest percentage of

respondents who never use the electronic library are faculty at four-year ARL institutions (3.4%), while 1.9% of them say they never use the physical library. About 20% of respondents from community colleges never use the electronic library, while only 4% never use the physical library.

LibQUAL+ respondents were also asked to rate their desired level of service, their minimum acceptable level of service, and the level of service they perceive that their institution provides. The resulting gap is the perceived level of service minus the minimally acceptable level of service. Again, the results depend on the status of the respondent and the institution where respondents worked. Graduate students and faculty members at four-year ARL institutions, and faculty at ARL health sciences institutions did not believe that their libraries have the complete run of journals they deem minimally acceptable. Faculty members at OhioLINK community colleges, four-year OhioLINK institutions, four-year ARL institutions, and health science institutions all believed that the print collection was not minimally acceptable. Faculty members at four-year ARL institutions, and undergraduates and faculty members at ARL health science institutions do not believe that they can access electronic resources from their home or office at the level they find minimally acceptable.

In identifying the minimally acceptable level of service, all respondents at all institutions (except health sciences) ranked as the most important feature a library Web site that enables respondents to locate information on their own. Respondents in the health sciences ranked the library Web site and the ability to access electronic resources from home or office almost equally as the most important features at a minimum level of service.

Making electronic resources accessible from the home or office either tied with the library Web site or was second to it for faculty members and students in ARL institutions. The most desired attribute for community college respondents was having modern equipment that affords easy access to the needed information. Undergraduates at four-year ARL institutions believe that, at a minimally acceptable level of service, modern equipment and easy-to-use access tools are more important than making electronic resources accessible from home or office.

The attributes rated as least important are the complete run of journal titles and the print collection, but those ratings are based on the status of the respondent. Faculty members and graduate students at ARL institutions (both four-year and health sciences) believe the complete run of journal titles is more important than the print collection. Undergraduates in the health sciences institutions would accept an equally minimal level of service for both the print collection and electronic journals, but the electronic journals appeared to be slightly more important to them than the print collection (8.0 and 7.90, respectively). However, for the community college respondents, both the minimum (6.56) and desired (7.24) level of the print collection was more important than the complete run of journal titles (6.19 minimum level and 7.24 desired level).

The bottom line is that respondents, especially graduate students, faculty, and staff, believe that making information easily accessible, either through the library Web site or through tools that allow people to find things independently, is very important.

When OhioLINK members administered the LibQUAL+^{TM} questionnaire to their constituents, they added questions about electronic resources. Faculty members and graduate students from OhioLINK institutions, including four-year institutions and community colleges, indicated that the availability of online help when using their library's electronic resources did not meet their minimum expectations. The comprehensive collection of full-text articles online did not meet the minimum acceptable level for either students or faculty at OhioLINK's four-year institutions, or for faculty at the community colleges.

At the minimum level of service, OhioLINK students ranked the importance of various service attributes as follows:

1. ease of using library's online article indexes
2. comprehensiveness of collection of full-text articles online, and convenience of borrowing books from other colleges (tie)
3. availability of online help when using their library's electronic resources

4. informing them about useful library services

Faculty, by contrast, ranked the convenience of borrowing books from other colleges as most important, followed by the ease of using the library's online article indexes. The comprehensive collections of full-text articles online and the availability of online help tied at the minimum level of service. At the desired level of service, the students most wanted a comprehensive collection of full-text articles online, while faculty thought that the convenience of borrowing books from other colleges and the ease of using the library's online article indexes were more important, in terms of desired service, than the comprehensive collection of online journals, the availability of online help, or information about useful library services.

2.4.8 JSTOR

The JSTOR retrospective journal collection began as a project sponsored by The Andrew W. Mellon Foundation at the University of Michigan to help researchers determine whether the digitized versions of older research journals might serve as a substitute for the paper version. In 1999, JSTOR conducted a survey of print journals in which librarians counted the volumes not on the shelf to compare print journal use with the use of the electronic JSTOR journals. By comparing paper usage with JSTOR data logs at the same libraries, it was found that electronic access increased the usage of older material because it increased convenience.

Use of JSTOR in subscribing libraries (and the number of titles in JSTOR) grows each year. When logs were analyzed for a one-week period, over 90% of the searches included more than one journal title and about 85% of the searches were in pre-defined discipline-specific collection clusters. Of the cluster searches, 69% were for more than one cluster.

Of all the articles in JSTOR, more than half (51.8%) have been viewed, and 29.9% have been printed. JSTOR research shows that older literature remains important in many fields, but its importance varies among fields. For the most highly used articles in economics and mathematics, there is essentially no correlation between the age of the article and usage. However, for history, the newer articles are more apt to be printed.

The percentage of viewings represented by the top ten views for a given cluster varies between clusters. For instance, the top ten articles viewed account for 22% of the articles viewed in economics, but the top ten articles viewed account for only 1% in Asian studies. Guthrie (2002) suggests that the articles used the most might be the classic articles used in large classes.

In the fall of 2000, JSTOR surveyed faculty members at institutions of higher education in the United States and received more than 4,000 responses from humanists, social scientists, and economists. Most of the respondents (more than 60%) greatly value electronic journals. They reported they are comfortable using electronic resources, believe a variety of electronic resources are important to their research, and consider electronic databases invaluable. Faculty members report that they use online catalogs, full-text electronic journal databases, and abstracting and indexing databases the most, and they expect they will use them more extensively in the future.

When faculty members were asked about their dependence on the library, 48% said they are very dependent now but only 38% expect to be very dependent in five years. The following statement sums up how 44% of the respondents feel: "Before long, computers, the Internet, and electronic computer-based archives and databases will allow academics to conduct much of their research without setting foot in the library." This attitude varied by field; 52% of the economists shared this view, but only 22% of the humanists did (Guthrie 2002).

Faculty members considered the following functions of the library very important, although their responses vary according to discipline:

- a gateway or starting point for their researchÐ65% (80% of humanists and 48% of economists)
- a trusted repository or archive of resourcesÐ77%
- a buyer of resourcesÐ80%

Almost half of the respondents (48%) agreed with the following statement "Regardless of what happens with electronic archives of journals, it will

always be crucial for libraries to maintain hard-copy archives." The agreement with this statement varied according to discipline, with about one quarter of the economists but 63% of the humanists agreeing.

Fifty-six percent of the respondents did not agree with the following statement: "Assuming that electronic archives of journals are proven to work well and are readily accessible, I would be happy to see hard-copy archives discarded and replaced entirely by electronic archives." Again, the degree of disagreement with the previous statement depended on the discipline of the respondent. Thirty-five percent of economists disagreed with the statement, and nearly three-quarters of the humanists reacted very negatively to the statement.

Guthrie (2002) interprets this to mean "that faculty do not believe that a reliable solution for electronic preservation is in place and that the hard copy is needed for backup. Furthermore, many are worried about electronic archives." Three-quarters (76%) of faculty members, regardless of discipline, said the following statement described their point of view: "With more and more journals becoming available electronically, it is crucial that libraries, publishers, or electronic databases archive, catalog, and protect these electronic journals."

In another study, Seeds (2002) surveyed JSTOR use at Penn State and found that as JSTOR use increased, paper journal use decreased. More important, the use of the electronic journals increased for the four journals evaluated. He concludes that it appears as if electronic access is a viable substitute for print when the print titles are remotely stored.

FOOTNOTE

[1] See Urquhart et al. (2003) for a description of the critical incident technique in information research.

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3. Tier 2 Analysis

Contents

How people use electronic resources or their preferences for print and electronic library services have been the focus of dozens of individual research studies in the last few years. (In this report, these studies are designated as Tier 2 studies to differentiate them from the major, ongoing studies reported as Tier 1.) Surveys are by far the most popular method, with academic faculty and students the most popular participants. Although participants include a variety of subject experts, scientists of various sorts have been studied most frequently. Not every study will be discussed in detail in this analysis, but both common threads and unique findings of the studies will be highlighted. Summary analyses of the methods used and groups studied are shown in Figures 3.1, 3.2, and 3.3.

Fig. 3.1. Methods Used in Tier 2 Studies

Fig. 3.2. Participants Studied in Tier 2 Studies

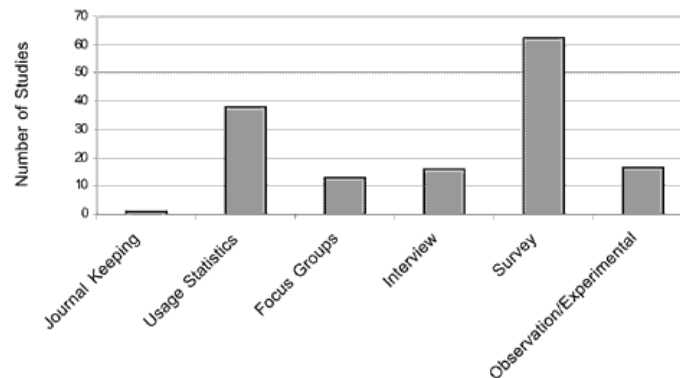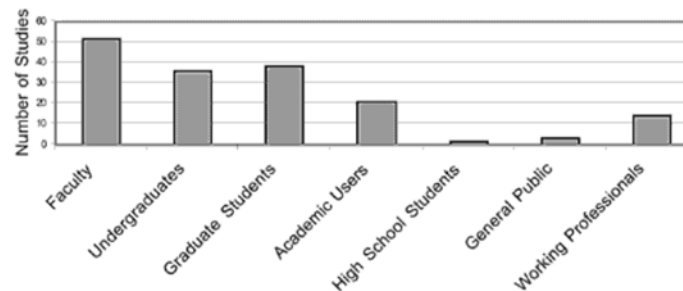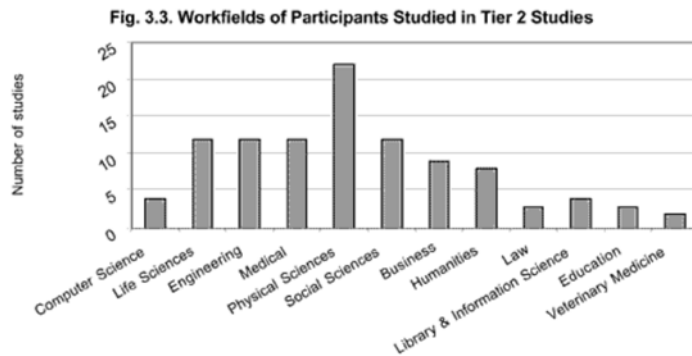Fig. 3.3. Workfields of Participants Studied in Tier 2 Studies

The Tier 2 studies echo many of the findings of the larger Tier 1 studies, allowing some consistent conclusions to be drawn about user behavior. This section is arranged by general themes that are found in many studies, and then further organized by specific themes, some of which emerge in only some of the studies, others that emerge consistently, but with contradictory results. The general themes and specific sub-themes are as follows:

1. Differences in behavior or preferences that can be explained by differences among users. Differences include:
   - differences by subject discipline
   - differences by user status or workplace
   - differences by task
   - differences by age or gender

2. Information-seeking behavior and preferences, including differences between print and electronic resources:
   - browsing versus searching
   - preferences for print or electronic resources
   - awareness of electronic resources
   - search strategies
   - reasons for using the resources
   - sources of information about resources
   - self-evaluation of system navigation

3. Perceived advantages of electronic resources and preferences, including:
   - how electronic resources improve workflow or save time
   - preferred features of electronic information systems
   - currency and timeliness of sources

4. Perceived disadvantages or concerns about electronic resources, including:
   - technological or service problems
   - archiving
   - problems or confusion with information systems
   - preferred formats for reading
   - electronic versus print resources

5. Library policy and financial issues:
   - willingness to pay for electronic information
   - willingness to cancel print journals in favor of electronic
   - other library budgetary issues that affect users

3.1 Differences in Behavior or Preferences that can be Explained by Differences Among Users

The concept of a single typical "user" of information systems is clearly a fallacy. Scientists seek and use information differently than do social scientists or humanists; undergraduate students behave differently than do graduate students or faculty; searching for information for personal use is different from searching for work-related tasks. Numerous studies have reached these conclusions.

Faculty members and other professionals in the sciences, math, and medicine fields were early adopters of electronic journals and other digital library resources and remain the heaviest and most enthusiastic users (Kidd 2002; Tenner and Yang 1999; Voorbij 1999; Hiller 2002; Rowley 2001; Dillon and Hahn 2002). Lenares (1999) found as early as the late 1990s that 90% of the physical science faculty used electronic journals at least part of the time, compared with 61% of all faculty users in ARL universities. The percentage of faculty using electronic journals for at least some of their readings increased from 1998 to 1999 and has continued to increase each year since (Lenares 1999). By 2002 at the University of Maryland, more faculty members used electronic journals daily or weekly than they did print journals (Dillon and Hahn 2002). This corresponds to the decrease in physical visits to the library by graduate students and faculty, especially in health sciences, science, and engineering (Hiller 2002). (This is discussed in more detail in section 3.5).

Enthusiasm for electronic journals and patterns of use vary even among fields of science. Chemists and physicists use them frequently, while earth scientists and mathematicians see fewer advantages (Mahe, Andrys, and Chartron 2000). Medical school users rely on fewer electronic journal titles for their downloads and readings than do other library users (Davis 2002). These variations are also reported by Tenopir and King, who found physicists and astronomers to be among the most enthusiastic users of electronic articles, partly because the digital e-print archives (arXiv.org), the Astrophysics Data System (ADS), and e-journals of the American Astronomical Society were designed specifically to facilitate their natural work patterns.

Business school faculty members were also early adopters (Tomney and Burton 1998). Business school faculty reported the highest use, while Palmer and Sandler (2003) found economics faculty to be the most enthusiastic users of electronic journals. Speier et al. (1999) and Hahn et al. (1999) found that among business faculty, finance and management information systems faculty were more aware of electronic journals than those in other fields. Faculty members in history, education, and the arts have been slower to adopt electronic journals (Tomney and Burton 1998). Among corporate users, investment and banking companies or departments spend a higher percent of their budgets on electronic products than do other types of businesses such as pharmaceutical firms, legal services, food services, or telecommunications (Carrick 2002).

Although high percentages of faculty members use electronic journals, they still use a variety of sources, including print, for their readings (Tenopir and King; Brown 1999). In 1999, Lenares found that although 90% of physical sciences faculty respondents at ARL libraries used electronic journals, half reported that they read articles from electronic journals infrequently.

Undergraduates in the life science disciplines were found by Whitmire (2002) to engage in more information-seeking activities than were students in other disciplines, including using the online catalog, asking librarians for help, using indexes, and browsing the stacks. Engineers engaged in the fewest information-seeking behaviors.

Variations in information-seeking behavior by individual groups make the task of designing an e-journal, user interface, or electronic library a challenge. One attempt to meet this challenge is to provide a "MyLibrary" feature on a library's home page. This allows users to customize their view of the electronic library and highlight the resources they use most often (Ghaphery 2002).

Another solution is to maintain a balance between print and electronic collections, depending on the preferences of the main user groups. (This will be discussed in more detail in sections 3.2 and 3.5). Librarians must gauge their systems, collection development decisions, and instruction with user differences firmly in mind. No single solution will be best for everyone and the totally digital library is a long way in the future in many subject disciplines. Publishers also must design electronic resources that facilitate the work patterns of their target audiences.

Differences in motivation or task also cause variations in information seeking and use. Nelson (2001), in a study of faculty and students at the University of West England, found that the greatest predictor of electronic use was whether or not the person was engaged in research. Researchers

and academic staff were more likely to use electronic journals than were administrative staff. King and Montgomery (2002) found that more than half of the readings by faculty and doctoral students are done while conducting primary research. Faculty who publish more and those who had served on promotion and tenure committees were found to be more likely to be aware of electronic journals, and faculty with tenure are more likely to submit articles to electronic journals (Hahn et al. 1999, Speier et al. 1999). Scientists who win awards read more on average (Tenopir and King).

Graduate students, particularly Ph.D. students, are often found to be heavy users of electronic journals (Rudner, Miller-Whitehead, and Gellman 2002; King and Montgomery 2002), most likely in their role as researchers. As found in the SuperJournal projects, graduate students may be "binge" users, consulting electronic journals extensively for a short period when they are writing a thesis or dissertation. There are some exceptions —undergraduates were the most frequent users in an experimental study conducted by the American Chemical Society (Entlich et al. 1996).

Different workplaces or types of institutions have varying use patterns as well. Davis (2002), as mentioned in Tier 1, examined electronic journal user logs in libraries of the NorthEast Research Library Consortium and found that each institution has a unique pattern of use—medical institution users had higher use of a smaller number of journals, while users at large universities and smaller colleges downloaded articles from a greater variety of journal titles.

Other differences are more controversial or less conclusive. Some studies (Speier et al. 1999; Tomney and Burton 1998; Antoir 2001; Monopoli et al. 2002; Palmer and Sandler 2003; Hahn et al. 1999) found differences in preferences or behavior based on the age of the user. In the late 1990s, Speier et al. (1999) and Hahn et al. (1999) found that younger ARL university business faculty members reported that they read from electronic journals more often and were more aware of electronic journals than were older faculty. In a study done in 1996 and 1997, more than half of the faculty members under the age of 40 reported using electronic journals, as compared with only 14% of those over 40, although more than 80% of the total respondents indicated they would consider using electronic journals in the future (Tomney and Burton 1998). Antoir (2001) found that older people preferred print articles; Monopoli et al. (2002) found that users between 21 and 34 used electronic journals most frequently. Older University of Michigan social sciences faculty members tended to prefer print more often than did younger faculty (Palmer and Sandler 2003). Age made a difference in how faculty members, staff, and students at Colorado State University rated their computer skills, with more respondents under 30 rating their skills as good (Cochenour and Moothart 2003).

Differences in electronic journal use may be attributed to age, status, or rank (Sathe, Grady, and Giuse 2002; Tenner and Yang 1999). Tenner and Yang (1999) found that assistant professors are most likely to have used electronic journals (44.7%), followed by full professors (34.5%), and associate professors (34.2%). Sathe, Grady, and Giuse (2002) found that undergraduates, medical students, and residents prefer electronic journals, while clinical and research faculty members prefer print. Researchers in other studies found no relationship between age and searching skills, although the researchers observed that younger users are more likely to browse on the computer, while older users prefer print journals for browsing (Brockman et al. 2001). Tenopir and King found no relationship between age and reading patterns among astronomers.

Age differences should be studied more, at least for the next generation, since most college students now are computer literate and report that they use the Web frequently (Tenopir 2003; Waldman 2003). This does not necessarily correlate with effective use, however. An experimental study by Cockrell and Jayne (2002) found that faculty performed tasks requiring retrieval and use of journal and newspaper articles significantly better than undergraduates. Tenopir (2003) found that students had more confidence in their searching skills than did their faculty. Although lower division undergraduate students used the Web and Web search engines frequently, students are mostly unaware of the distinctions between material on the Web and peer-reviewed journals. Freshman psychology students with higher self-efficacy scores are more motivated to learn about electronic journals and find electronic journals easier to use, but they also visit the

library more often (Waldman 2003).

Gender differences are even more inconclusive. Only a few studies have examined gender as a factor in information use, beyond studies of recreational Internet use. Majid and Abazova (1999) found that male academic staff at the International Islamic University, Malaysia, reported they possessed better computing skills than did their female counterparts; Finholt and Brooks (1999) found males to be slightly more frequent users of JSTOR; and Monopoli et al. (2002) found that male staff at the University of Patras, Greece, reported more frequent use of electronic journals than did female staff (although a very small percent of students or faculty used electronic journals at all since the electronic journals are in English rather than Greek). These reported differences by gender are too minor, outdated, or idiosyncratic to form conclusive findings.

DLF/CLIR/Outsell (Tier 1) did, however, find differences between men's and women's reported use of online resources. More women than men say they use e-journals in their research; they reported using their institution's Web site more often than men, and using electronic sources more than men most or all of the time. In teaching, men report significantly more use of a search engine to access e-journals than do women who access e-journals.

Some individual differences may be a factor only in early adoption and, as electronic resources become familiar and ubiquitous through the library, these differences may cease to be important. Other factors, such as the way different disciplines do their work, may be more pervasive. Mahe, Andrys, and Chartron (2000), for example, found that biologists rely on print because of deeply ingrained work habits, and earth scientists fail to see work advantages of electronic journals. Part of the hesitancy of some may be a discomfort with technology, unavailability of technology, or insufficient knowledge of electronic journals, all of which are already changing (Mahe, Andrys, and Chartron 2000; Curtis, Weller, and Hurd 1997). Physicists embrace preprints and have adopted e-print servers enthusiastically in part because their research tends to be highly collaborative and is conducted in large research institutions that have internal peer review.

3.2 Information-Seeking Behavior and Preferences

Students, faculty, and non-university professionals now use a variety of sources for articles, including electronic journals, print journals, Web sites of professional organizations, author's Web sites, e-mail from colleagues, and e-print servers (Dillon and Hahn 2002; Tenopir and King; Cochenour and Moothart 2003). Print remains important for at least some information for all subject disciplines and as part of the research process for undergraduates (Dilevko and Gottlieb 2002). Even as early as 1996, academic users expressed dissatisfaction with library collections of printed journals, books, and conference proceedings (Bancroft et al. 1998).

Both current and older materials remain important, as many of the Tier 1 studies found. At the University of California, Berkeley, 93% of faculty members and 87% of graduate students across academic disciplines reported that they use materials older than five years "sometimes" or "often." Most preferred electronic resources and often use the library from their desktops (Maughan 1999). Faculty and other subject experts make a distinction between core journal titles and non-core journals. At the University of Maryland, 70% of the faculty want core journals in both print and electronic form, but the same number wanted non-core journals only in electronic form (Dillon and Hahn 2002).

Although both browsing and searching remain important information-seeking strategies, electronic journals (in particular, full-text databases) are causing a decrease in browsing titles, while searching by topic has increased (Sathe, Grady, and Giuse 2002; Tenopir and King). Browsing of core journals by tables of contents remains important, but searching by topic for additional journals and articles is increasingly popular, particularly in large, mixed-journal title databases. Most libraries offer a combination of these large full-text databases, which facilitate searching, and journal systems from publishers, which facilitate browsing.

In systems restricted to journals from a single publisher, browsing through tables of contents remains important. Use of the John Wiley & Sons online journals in a biotechnology company was heavily weighted toward finding articles through browsing (1.42 average per session) as opposed to searching (.02 articles per session.) There was a dramatic increase in the

number of articles viewed or downloaded between 1999 and 2001, but PDF remained a more popular format than HTML (Crawford 2002).

Worlock (2002) found that articles recommended by colleagues were more often in print than in electronic format. Contradictory results were obtained by Tenopir and King, who discovered that e-mail and listservs make it easier to share recommended articles with colleagues. University faculty members reported the ability to send articles to their colleagues instantly as being one of the major advantages of electronic journals (Palmer and Sandler 2003).

Use of online indexes and abstracts seems to have increased, particularly when there are links to full texts. More than 80% of veterinary medicine students at Iowa State University used online indexes in 1997, compared with only 16% a decade earlier (Pelzer, Wiese, and Leysen 1998), indicating a major shift to electronic resources during that decade. More than half of the medical faculty, residents, and students at a regional site of the University of Illinois report that they search MEDLINE at least weekly and much of their identification of journals comes from MEDLINE. Awareness and use of other abstracting and indexing services or full text databases is low, however (De Groote and Dorsch 2003).

The Pew studies (see Tier 1 analysis) and Graham (2003) clearly show that high school students, in particular, and undergraduate students prefer to search the Internet first for school-related tasks. When given a specific research task, only 2% of undergraduates at Wellesley College's "Computers and the Internet" class included non-Internet resources in their answers. The students have extraordinary faith in their favorite search engine, even though they are unclear how it works.

A nationwide survey of students and academics in the Netherlands found that 60% of respondents in the humanities, 78% of respondents in the social sciences, and 82% of respondents in the sciences used the Internet for study or work and nearly all believed they had Internet skills (Voorbij 1999). Still, when rating the importance of different means of searching, more than 88% believed that subject searching of tables of contents databases was important or very important, followed by searching the OPAC, citations, and asking colleagues (asking a librarian came in last). Nearly two-thirds believed searching the Internet or the Web were important or very important, and most perceived that their Web searches yielded enough or more than enough information (Voorbij 1999). A vast majority reported they were self-taught Internet searchers, who rely on trial and error. Assistance from colleagues was the second most frequently cited means of acquiring searching skills; gaining the skills through library courses was far less commonly cited.

Ninety-seven percent of freshmen psychology students reported that they access the Internet at least weekly, about 44% of the time for educational information. More than three-quarters say they begin their research through the Internet, and two-thirds say they find most of their information through the Internet. Still, two-thirds also report that they visit the physical library at least weekly, most often for studying. The role of the library as a place to study and socialize (and sleep!) was more important than as a place to get information. Half of the students access the library's electronic resources from home, and only a quarter said that use of the electronic resources was a reason to visit the library (Waldman 2003).

Dilevko and Gottlieb (2002) report efforts to attract undergraduates to the physical library. Since most undergraduates report that they turn first to online sources, and since turnstile counts were going down at the University of Toronto library, they surveyed students to find what role print materials still play for undergraduates. About 47% of undergraduates reported that they began their assignments with online sources 90% of the time, but printed journals and, especially, print books remain important in their research, particularly for humanities students. The authors conclude that print books are still vital and are associated with high-quality work. They recommend that librarians stress the value of printed materials in addition to online materials for the successful completion of assignments.

A teacher's or librarian's recommendation of specific sources, such as a library full-text database or a specific Web site, is reported to influence a student's choice of sources (Waldman 2003; Tenopir 2003). At the University of California, Berkeley, the groups of faculty and graduate

students that report the heaviest use of electronic resources also recommend the need for more library reference and instructional services (Maughan 1999). Use of electronic books is also clearly course driven —books with the highest usage are those required in a class, and most users come to an electronic book collection to use a single title (Summerfield and Mandel 1999).

MacDonald and Dunkelberger (2000) also found that most undergraduates in a composition class were always or almost always likely to use a recommended full-text database provided by the library as a first stop for information; the next largest group went first to the Web, and the smallest group went first to print. When searching on a mixed full-text/bibliographic database, many said they always restricted their search to full text. Most students did not limit their research to a single source of information, but of those who did, the Web was the most popular single source for information, followed by a full-text database (MacDonald and Dunkelberger 2000).

Faculty members and librarians can influence students' choices of electronic resources, although faculty may not always be familiar with the range of sources available to them through the library. Library instruction, with time for practice, increases college students' efficacy in online searching. Ren (2000) found that students who had a more positive attitude toward learning electronic information search skills had fewer negative emotions about electronic searching and performed better in assignments. Librarians should stress the importance of all library materials, including print and electronic resources, since undergraduate students value recommendations (Dilevko and Gottlieb 2002). The most effective way for students to learn about important resources in academic libraries seems to be for librarians to work directly with faculty to bring relevant electronic resources into the classroom (Tenopir 2003).

Students bring Web searching habits to their use of electronic scholarly materials and seem to have difficulty adapting to different types of information resources, interfaces, or search systems (Cockrell and Jayne 2002; Tenopir 2003). In a controlled study of 49 undergraduates, graduates, and faculty members, Cockrell and Jayne (2002) found that few undergraduates took time to read explanations or help screens, and that they give up easily and are not selective—they tend to choose the first item on the list, rather than scrolling down to see information displayed lower on the screen. These findings are similar to the many Web use studies beyond the scope of this report that show Web users in general tend to enter only a single search term and seldom look beyond the first screen (see, for example, Spink et al. 2001).

Students claim to use evaluation methods for Web sites (e.g., "If it's pink with flowers it probably isn't any good") (Tenopir 2003). However, Graham (2003) found that students were susceptible to advertising claims on Web sites, government misinformation, and propaganda and could not consistently differentiate between advertising and fact. Only a few students in this experiment double-checked the information they found on the Web.

There is some evidence also that college students have a low tolerance for system features that don't work or are too difficult. Bishop (1999) conducted user tests at the University of Illinois and found that if an abstract was missing when a student clicked on the abstract button, the student never again clicked on the button for abstracts. She concluded that one small system failure might have a long-term impact on student searching behavior.

Some college students report that they receive at least some training in evaluating library sources (57.6% in a study by Burton and Chadwick 2000), but a sizable minority do not. Those with no training show a slight preference for the Internet over the library for research. More than half of the undergraduate and graduate students from 97 different majors in a medium-sized Western university reported they use both the library and the Internet for research, while 21% use the library exclusively, 21% use the Internet exclusively, and 6% use neither (Burton and Chadwick 2000).

Although this report does not attempt to cover the many studies of Internet-only use and Internet searching behavior, these studies can provide some insights into the Web search patterns of children and adults who use the Web for both recreational and work-related purposes. To locate many of these studies, see Wang (1999), Yahoo's directory under

"Internet," and Molyneux and Williams (1999).

3.3 Perceived Advantages of Electronic Resources and Preferences

Users perceive electronic resources—in particular electronic journals and, for students, the Internet—to hold many advantages. Faculty members at ARL institutions cited convenience, timeliness, and the ability to search text as the most important factors in choosing electronic journals over print (Lenares 1999). Least important to them was animation of graphics, although others sometimes mention that as an important advantage. In other surveys, graduate students said the top reasons for using electronic journals were the ability to link to additional information, the ability to search, and the currency of materials (Liew, Foo, and Chennupati 2000; Woodward et al. 1997). The ability to search across a wide range of journal articles, search within an article, and interact with multiple levels of information objects were listed as the top three significant features sought in future electronic journals (Liew, Foo, and Chennupati 2000).

Many studies have found that users believe the main advantage of electronic journals is convenience of accessing articles any time from their desktop computer (Palmer and Sandler 2003; Woodward et al. 1997; Rusch-Feja and Siebeky 1999; Maughan 1999; Tenner and Yang 1999; Hiller 2002; Nicolaides 2001; Chu 1998; Bishop 1999). Experienced users also liked the ease of skimming and searching, the possibility of downloading or printing the desired document or segment, the currency of information, the speed of access, and the ability to send articles to their colleagues instantly (Palmer and Sandler 2003; Rusch-Feja and Siebeky 1999; Sathe, Grady, and Giuse 2002; Entlich et al. 1996; Chu 1998). Storing articles electronically, then printing out a portable print copy, appeals to frequent e-journal users (Palmer and Sandler 2003).

Convenience and speed of access are mentioned or implied repeatedly. Students reported the top three ways that access to electronic resources has improved their academic careers: access to a wider range of information, faster access to information, and easier access to information (Ray and Day 1998). In England, Tilburg University faculty members cite timely availability, easy access, full text searching, and access from home as factors that promote the use of electronic journals (Roes 1999). Focus groups of engineering faculty members and students wanted to search electronic journals quickly and easily, but they desired interfaces that could be customized and the ability to create personal collections (Bishop 1995), while economics students and faculty want the addition of data sets (Nicolaides 2001).

The TULIP project, an early electronic journals study (1992-1995), was a cooperative undertaking between several university libraries and Elsevier. It attempted to predict the potential use of electronic journals through log analysis, focus groups, and interviews, while making sample collections available to faculty members and graduate students. The lessons from TULIP are incorporated into later commercial products, and the conclusions agree with later studies. Even in the early 1990s, faculty members and graduate students wanted electronic journal systems that are as intuitive as possible, preferably using a familiar interface, with access to all information from one source. They wanted high processing speed for downloading and printing, timely information, good image quality, many journal titles and sufficient dates covered, and linking. Graduate students used the system more often than faculty members. At this early date, TULIP researchers noticed an emotional tie to paper and the library—something that has diminished fairly rapidly with today's convenience of electronic journals. Still, users liked the convenience of desktop access, but, consistent with almost all studies today, they preferred to print out a hard copy for reading. Promotion and training were both found to be crucial to develop a base of regular users (TULIP 1996). Familiarity, in the case of electronic journals, has bred continued use.

3.4 Problems or Concerns with Electronic Resources

Although the advantages are outweighing the perceived problems or concerns as use increases and more resources are available, users still express some concerns about the disadvantages of electronic library collections. Participants in several studies expressed the desire for more online materials, including additional journal titles, a wider variety of special

or out-of-the mainstream materials, and complete volumes or back files of existing journals (Quigley et al. 2002; Palmer and Sandler 2003; Rusch-Feja and Siebeky 1999; Stewart 1996; Nicolaides 2001). Print is a proven archival format. Even those who prefer electronic access to journals (75% of respondents from the University of Michigan faculty in economics, sociology, and anthropology), prefer that books remain in print format (Palmer and Sandler 2003).

The most common complaint found in many studies is the discomfort of reading from the screen or poor graphic quality (Nelson 2001; Palmer and Sandler 2003; Woodward et al. 1997; Woodward et al. 1998; Sathe, Grady, and Giuse 2002; Costa 2000). Respondents consistently report that they prefer to print out articles for reading and do most of their reading from the paper printout (Stewart 1996; Entlich et al. 1996; Tomney and Burton 1998; Brown 1999; Woodward et al. 1997; King and Montgomery 2002; Cherry and Duff 2002; Duff and Cherry 2000). They prefer PDF format for printing, although the HTML format is better for skimming.

Faculty members from ARL institutions said that the most important characteristics that would lead them to choose print over electronic were ability to browse, portability, physical comfort, and convenience (Lenares 1999). In citing the chief reasons for preferring print over electronic journals, Vanderbilt University medical faculty and students said that print is an easier to read format, of better graphic quality, easier to browse, and easier to access (Sathe, Grady, and Giuse 2002). Access to adequate technology may still be a problem for some (Mahe, Andrys, and Chartron 2000); 22% of science faculty respondents at the University of Michigan requested that procedural or technological barriers to access be removed (Quigley et al. 2002).

When asked to identify problems, only a small percentage of respondents to most interviews or surveys agree to the same ones (or even agree that there are problems). The response rate for any one concern or problem is rarely more than 20% and "top problems" are usually expressed by less than 10% of the respondents. Students at one university were asked how "access to electronic resources has hindered your academic career." Although not nearly as many agreed to hindrances as they did to improvements, the top three hindrances mentioned were that online access is time consuming (16.4%), it detracts from doing work (13.5%), and lack of information technology knowledge hinders effective use (11.1%) (Ray and Day 1998). The top category for disadvantages among faculty members and graduate students at Ohio State University was "don't know" (24% and 33% respectively); an additional 8% of faculty and 6% of graduate students saw no disadvantages (Rogers 2001).

A continuing problem is that users may be unaware of relevant resources in the library collection. In a survey at the University of Maryland, 31% of the faculty members reported never using electronic journals; the reasons cited were unfamiliarity with how to access the journals and a lack of need because of personal subscriptions (Dillon and Hahn 2002). In a study of computer engineering undergraduate students in Nanyang Technological University in Singapore, researchers discovered that more than one-third of the respondents had never accessed computer engineering databases available through the library and of those, half had never heard of them (Majid and Tan 2002). Lower-division undergraduates in focus groups at the University of Tennessee report that they know the Web and major search engines such as Google, but unless a library resource is specifically named (and required) in a class, they are unaware of its usefulness (Tenopir 2003). Although French research scientists are using electronic journals more often, librarians still need to promote the resources because scientists hesitate to use electronic sources when they feel they have insufficient knowledge of them (Mahe, Andrys, and Chartron 2000).

The perception that electronic journals are of lower quality than print is another problem that may be diminishing as a high percentage of peer-reviewed journals are digitized. In the late 1990s, business school faculty members surveyed at ARL institutions reported that they did not perceive electronic journals to be of as high quality as paper counterparts; their responses changed, however, when they were asked to evaluate a well-respected print journal evolving to electronic format (Speier et al. 1999). While more than 70% of the faculty members in a British university believe the quality of articles in electronic journals is the same as in print

journals, this same group of respondents cited the top disadvantage of electronic journals as being the impression that electronic publication is not "real" publication (Tomney and Burton 1998).

On the other hand, faculty members at the University of West England reported that they believed electronic journal content generally to be of good quality, and in some cases, to have added value. They said that they would use more electronic journals as more were made available in their area of interest and would recommend them to students (Nelson 2001). Texas A&M faculty members also reported that they have no objections to students using peer-reviewed electronic journals and that they would recommend electronic journals to students (Tenner and Yang 1999).

The proliferation of sources for articles and the sheer amount of information now available may be confusing to some users. Retrieving too much information is a problem mentioned by some, as is getting lost on a tangent and not knowing when to quit searching (Epic 2001). The distinction between the "article" and the "journal" in full-text databases was unclear to faculty members and undergraduates surveyed in the Decomate study (Nicolaides 2001), although at Columbia University (Epic 2001) researchers found that students clearly understood the difference between electronic databases and Web sites. In focus groups at the University of Tennessee, Tenopir (2003) found that students understand that information found on the Web is different from the resources provided by the library, but many are not fully aware of what resources the library offers.

3.5 Library Policies and Financial Concerns

Decisions that libraries make based on financial concerns, such as pay per use, may have unintended consequences on user behavior. Electronic journal collections in libraries are growing steadily (see, for example, Kidd 2002 and ARL 2003) and some libraries are formulating collection development policies that encourage lease of electronic journals over purchase of print journals (Montgomery and King 2002; King and Montgomery 2002; and Council of Australian University Librarians 2002). Even as early as 1999, 29% of ARL and 33.5% of non-ARL academic libraries reported cancellations of print journals in favor of electronic access, and more said they would cancel print in the future (Shemberg and Grossman 1999).

There has been a steady increase in the percentage of acquisitions dollars spent on electronic resources in ARL libraries. On average, ARL libraries spent 13.2% of their acquisitions budget on electronic resources in 1999Ð2000, and several libraries reported spending more than 20%. By 2000Ð2001 the average had grown to 16% (ARL 2003), and some special libraries spend a far greater percentage. Investment banking and brokerage firms are reported to spend 40-100% of their information budgets on online products, by far the highest of any type of company (Carrick 2002).

Library policies that favor electronic journals over print are having an effect on user behavior. Users are increasingly positive about electronic collections and visits to the physical library by faculty and graduate students are down in many libraries, replaced by visits to the virtual library (Rogers 2001; Hiller 2002). At the University of Washington, between 1998 and 2001 graduate students and faculty in the health sciences, sciences, and engineering reported the most pronounced decline in visits to the physical library. The primary use of the library by undergraduates tends to be as a workplace, although science and engineering students say they visited the library most often to find journals (Hiller 2002).

Libraries that report a decline in visits to the physical library as a decrease in library usage do themselves a disservice. Users enjoy the convenience and other benefits of electronic access and are adjusting their behavior as encouraged by library collection development policies. Total library use—physical plus virtual—is likely actually up in most institutions. Virtual library users are less likely to ask for help or communicate with librarians (Epic 2001), unless the library offers special virtual reference services.

University faculty members report that an increase in their electronic journal usage is accompanied by a decrease in the frequency of their use of print journals (Lenares 1999; Rogers 2001). Surveys of Ohio State University users from 1998 to 2000 found a steady increase in acceptance of electronic journals and their reported use. By 2000, almost two-thirds of

faculty members and graduate students said it was important for OSU libraries to replace their print subscriptions with electronic journal subscriptions when permanent electronic storage is available (Rogers 2001).

Users of the University of Southern California Norris Medical Library viewed approximately 28,000 electronic full-text articles in a six-month period, as compared with 1,800 uses of the corresponding print volumes (Morse and Clintworth 2001). Even considering that users might have read more than one article per print volume, the electronic viewings far outnumbered the print. Part of this may be explained by the availability of new titles in electronic form, but use of both print and electronic titles was concentrated on a small number of the most popular titles—just 20 of the titles accounted for 60% of the total usage and the top 25 titles were common to both print and electronic (Morse and Clintworth 2001). The most requested electronic titles at the Elektronishche Zeitschriftenbibliothek in Germany are major journals whose print editions are also heavily used (Hutzler and Schupfner 2002). Use is also higher for electronic versions of books at Columbia University compared with the same titles available in print (Summerfield and Mandel 1999), although the University of Pittsburgh Health Sciences library found that use of both print journal titles and electronic journal titles covered by the Ovid online system increased at a similar rate (Tannery, Silverman, and Epstein 2002).

This pattern of a small number of titles accounting for a large percentage of use is, of course, not new to electronic resources. The so-called 80/20 rule has been well documented in library collections, where a large percentage of use is concentrated in a small percentage of the collection. Usage logs make the calculations of use much easier with electronic resources, and this 80/20 phenomenon is reported by many studies that use transaction log analysis (Roes 1999; Day 2001; Davis 2002). Interestingly, this rule may also hold true for users—a small percent of total library users is responsible for most electronic journal use (Entlich et al. 1996). This is similar to the phenomenon of "binge" users in the SuperJournal project. Davis and Solla found that a vast majority of users of American Chemical Society journals at Cornell University download few articles and consult few journals. They conclude that a small number of heavy users can have a great effect on the number of total downloads.

Still, as the OhioLINK studies have shown, many of the remaining 80 or so percent of the journals in an electronic collection will get some usage. In addition, Day (2001) found that at least one article was downloaded from 92% of the journals available to users at the University of Manchester Institute of Science and Technology. In his examination of NERL usage logs, however, Davis (2002) found that no institution uses every available title and some journal titles are used infrequently by all institutions. Overall, 90% of the downloads came from 40% of the collection.

Faculty and graduate students say 24-hour availability is a prime advantage of electronic journals (Rogers 2001), but even with 24/7 availability of the virtual library, most academic use follows the normal rhythms of the workweek and academic calendar. Just as turnstile counts mark the use of physical academic libraries, log data of virtual collections show peak use in March, November, and April (Mackie-Mason et al. 1999) and Monday through Thursday mid-morning to late afternoons, with a huge drop-off on Friday afternoons (Tenopir and Read 2000).

Although a user's institution pays for subscriptions or access to electronic journals, this cost is hidden from the user. Any overt charge or obvious pay per-view has an impact on user behavior. The "Pricing Electronic Access to Knowledge" (PEAK) project in the late 1990s was a major experiment with 12 libraries of varying size and type and the Elsevier journal collection. It measured not only use of electronic journals by journal title and type of library, but also measured use under two different payment models for articles. Users of the subject libraries were provided with both "unmetered" access (in which access comes with subscription) and "metered" access (in which users receive an I.D. and use tokens, generally paid by the library, to get to full texts) to journal articles. Although use increased from the first to the second year in the experiment, 60% of accesses were for "unmetered" content, most of which was more than one year old. The study concluded that the "user cost of access, consisting of both monetary payments and time or effort, has a significant effect on the number of articles that readers

access" (Mackie-Mason et al. 1999).

Pay per-view or pay per-use creates a barrier that affects the frequency of online access and downloads. Nicolas and Huntington (2002) found that users who entered an online journals system from a subscribing institution visited the collection more often than non-subscribers (who could search for free, but had to pay per article selected). Subscribers also spent more time viewing each article, viewed articles from more journals, and used a wider variety of journal titles and subjects than did non-subscribers. Although seven students studied at Central Connecticut State University found the end-user system Questia easy to use, only one of the seven thought "it is worth it to subscribe" on their own (Tomaiuolo 2001).

Some users may be willing to pay for electronic articles, at least part of the time. Worlock (2002) surveyed 252 working scientists and social scientists in the United Kingdom (split between academic and non-academic workplaces) to find out if they ever pay for articles. Nearly two-thirds of the respondents reported that, on average, they pay for between one and five articles per week beyond regular subscriptions. Still, two-thirds said they felt the articles were too expensive (Worlock 2002).

Passwords can be another barrier to use, in particular different passwords for different databases or collections (Roes 1999). Users want free (to them) access, without having to remember multiple passwords or log-on protocols. In eliminating special access requirements, however, libraries may create a problem for themselves. There is evidence that many faculty members and students do not realize that the numerous electronic journals they can reach from their office, dormitory, or home computer through their university user name or identification are actually paid for and provided by the library. If users are not aware what the library provides, they will be less inclined to advocate for the library at budget time.

Users can help libraries set collection and service priorities, with no one best solution for all types of libraries, types of users, or all subject disciplines. They can help make decisions about licensing choices and be made familiar with relative costs and tradeoffs. When asked to make choices about what they were willing to forego to get more electronic access, researchers from the Max Planck Society felt there were certain services or materials they could do without, including binding of journals, journals with low impact factors, and print versions of journals readily available electronically (Rusch-Feja and Siebeky 1999). Science, engineering, and health sciences faculty at the University of Washington favored canceling print journals in favor of electronic only, while humanities and social sciences faculty opposed this idea and responded that maintaining the quality of the print collection is their highest priority (Hiller 2002).

3.6 Summary of Tier 2

Many of the findings in the Tier 2 studies support findings in the larger Tier 1 studies. These consistent findings will help librarians know more about their users, which will help them set policy, make decisions, and design more effective products and services.

First, there is no one typical user and, thus, no satisfactory single information policy. Although all groups of users rely on electronic resources to some degree and will do so more in the future, the enthusiasm with which changes are embraced, the system features valued, and the need for continued print collections varies. These variations occur in different subject disciplines, but also in the way information is used, the task undertaken, and the role of the user. Currently, younger people may be more enthusiastic adopters of technology.

As libraries make more electronic journals and full-text databases available to users, both browsing and searching remain important information-seeking behaviors, but browsing by journal titles is decreasing while searching by topic is increasing. Most subject experts have a core group of journal titles that they browse, read from, and recommend to students, but they read from a wider variety of journals through subject searching. Most users employ a variety of sources to find journal articles, but high school and lower division college students most frequently turn first to the free Web and Web search engines such as Google or Yahoo.

Almost all types of users perceive many advantages of electronic journals,

in particular when electronic journals are convenient for their work. The speed of access, desktop availability, and convenience of downloading and printing are most often mentioned as advantages.

Most users also perceive some disadvantages. Almost everyone prefers to print out articles in PDF format for reading, but to use HTML for viewing. Some novice users, or users where there is poor technological infrastructure, are worried about how well they will be able to use the technology. Some professionals are concerned about longevity and archiving.

Finally, library policies affect users in both anticipated and unanticipated ways. Visits to the physical library by faculty members and graduate students in particular decrease as more digital resources are accessible from their offices or homes. Undergraduates use the library as a place to socialize and study, so their frequency of use is affected less. When many additional journal titles are provided online, users will read from a wider variety of sources and read more, but most reading will still be done from a relatively small proportion of sources. This varies with subject discipline —medical users, for example, seem to read more from a smaller core group of titles. Barriers to use, including fees or passwords, will restrict use by almost all users except the most highly motivated.

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4. Reviews of the Literature and Methods; and 5. Conclusions

Contents

Although this report summarizes conclusions from recent research studies and highlights some conclusions about how people use electronic collections, there are individual and library-specific differences that make it beneficial for many libraries to collect their own data. The last section of the bibliography in this report lists selected resources to help with this process and to identify additional usage studies.

For several years, Charles Bailey at the University of Houston has maintained a comprehensive literature review of all types of articles about scholarly electronic publishing. This monumental piece of work is the first place to look to identify articles on any aspect of the topic, including research and user studies. Since the review is updated regularly, bibliographic information about new studies appears there frequently.

Literature reviews by Kling and Callahan (2003) and Giangrande (2002) supplement Bailey; also, the *Annual Review of Information Science and Technology* occasionally publishes review articles that focus on electronic publishing or research techniques. Several recent relevant chapters from ARIST are listed in the bibliography. ARIST typically is published every autumn, but the topics vary from year to year.

Beyond general textbooks of research methods, several recent publications focus on research methods for library and Web usage studies. The ARIST chapter by Wang (1999) formed the basis for the categorization of research methods in this report. McClure and Lopata (1996); Liu and Cox (2002); Hurd, Blecic, and Robinson (2001); Griffiths, Hartley, and Wilson (2002); and Tenopir (2003) are all recent papers that discuss methods for collecting data and measuring usage of electronic library collections. Macintyre (2001) and Luther (2000) discuss the importance of and use of vendor statistics. Connaway (1996) and Chase and Alvarez (2000) describe how to conduct focus group interviews in information contexts.

Urquhart et al. (2003) describe in detail critical incident technique as it relates to information behavior studies. This method provides a richness in interview or survey data beyond opinions or reports of estimated behavior by asking respondents to focus on details of a specific incident of research or reading. The Tenopir and King studies also use critical incident technique to draw conclusions about readings.

Experimental (or usability) tests are less often used in the library environment, perhaps because they are time-consuming and must use relatively small groups of participants. Veldof, Prasse, and Mills (1999) and Wang (1999) provide some guidelines on running usability tests. Gullikson et al. (1999); Park (2000); Chisman, Diller, and Walbridge 1999; and Battleson, Booth, and Weintrop (2001) are some examples of practical experimental testing. Usability tests allow specific system design features to be compared and measured and are particularly useful for testing library catalog and Web site design. Think-aloud or verbal protocols provide information on why subjects pursue certain courses of action and how they react to systems at the time of use (Morrison 1999).

Probably the most important source for libraries planning to conduct their own user studies is the January 2002 report from the Digital Library Federation and CLIR by Covey (2002). Covey explains in detail when to use and how to design studies that gather data from surveys

(questionnaires), focus groups, user protocols (experiments or observations), transaction log analysis, and other research methods.

In addition to excellent advice on conducting user studies, Covey (2002) presents a selected bibliography covering general research methods and specific articles through 2001 on each of the research methods she describes. The other methodological articles listed in this report were published after Covey's report.

5. Conclusions

Although there are some contradictions in the findings of the many recent research studies on user behavior with electronic library collections, some clear messages emerge. By examining the wide variety of methods, participants, and workplaces in these 200-plus studies we do know some things that library users are telling us about their use of electronic resources in the past, present, and future.

Although there is no one typical user for whom a single system design or collection decisions can be made, users can be segmented into groups that display similar preferences and patterns of use. Behavior differs based on the following:

- *Status*. High school students and undergraduate students, for example, turn first to the Web for research but will change behaviors if they are given a specific assignment or are asked to use a particular resource. Graduate students are heavy and cyclical users of electronic journals, especially for research. Faculty members and professionals will use electronic journals if they are convenient and support their natural work patterns. Peer reviewed journals that are considered to be core to a researcher's work will be sought regardless of convenience.
- *Subject discipline, for subject experts*. Scientists and business faculty members were early adopters of electronic journals and read from a variety of full-text databases and e-journals; some fields of science use many sources to get articles, including e-print servers. Social scientists and humanists use both electronic resources and print and rely more on books than other fields.
- *Task*. Most high school and undergraduate students turn first to the Internet for class assignments and feel they are expert searchers. The heaviest use of electronic resources is for research, followed by preparing for teaching and gaining current awareness.
- *Type of institution or workplace*. Academic faculty and graduate students read the most, and they readily use electronic journals accessible from their office or home, but scientists in government laboratories and companies also rely on electronic and paper journals for research. Students prefer to access electronic resources through the library from home. Users in medical libraries read from fewer journal titles than do general university or college users.
- *Age*. There is some evidence that younger users are more enthusiastic adopters of electronic resources than are older users. Younger users rely on electronic resources more heavily and rate themselves more expert in using them than do older users.
- *Gender*. There is little evidence that gender in most cultures makes a difference in use of electronic resources, although in the DLF/CLIR /Outsell studies, women report more use of electronic journals and men use Web search engines more often to locate journals.

In terms of information seeking, today's researcher seems to be comfortable with using a wide variety of sources for information. Internet search engines, e-print servers, author Web sites, full-text databases, electronic journals, and print resources are all used to some degree by most users. The relative amounts of use and enthusiasm for use vary as described above, but today's users are mostly flexible and adaptable.

Both browsing and searching remain important information- seeking behaviors, but there is some evidence that the amount of searching is going up when users have access to multi-title, full-text databases. Browsing through journal issues is done in print issues or in electronic journals for core journal titles. Articles from non-core journals are most often located through searching.

Students are highly responsive to recommendations of specific resources

by their teachers, friends, or a librarian. Educating both high school and college students in the best resources, how to evaluate Web resources, and search strategies is important. Convenience remains the single most important factor for information use—all types of users prefer electronic journals only if they make their work easier and give them the information they need. Desktop access, speed of access, and the ability to download, print, and send articles are top advantages of electronic journals for all groups.

Almost universally, users report that they print out relevant articles for detailed reading. This means that both viewer-friendly formats, such as HTML, and printer-friendly formats, such as PDF, are important features in electronic journals.

Some concerns remain, such as worries that electronic journal collections may not be complete or long-lived. Concerns over the quality of e-journals seem to be diminishing as most mainstream peer-reviewed journals are digitized. Still, concerns remain over the quality of Web resources, particularly among faculty and librarians who fear students use the Web indiscriminately. There is still confusion over the variety and relative quality of e-resources, in particular among novice users or students. Archiving has been expressed as a concern in some studies.

When high-quality electronic collections are made available, people use them. Use of electronic journals increases every year. Among faculty members, graduate students, and other professionals, higher use of electronic journals is accompanied by a decrease in visits to the physical library. Access to back files and many journal titles is important to many users, although the 80/20 (or thereabouts) rule has been shown to apply to electronic journal titles. Most readings will come from a relatively small percentage of the collection, but users will read from a greater variety of titles when they are made freely and easily accessible to them.

Both Tier 1 and Tier 2 studies show that library policies have intentional and unintentional effects on user behavior. Unfettered access to electronic collections will result in an increasing use and reliance on electronic resources, although a certain percentage of use in many disciplines will continue to come from print resources for some time to come. Virtual reference services are needed to accompany this shift, as are better ways to count and report virtual library use.

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