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UNIVERSITY OF CALIFORNIA

Los Angeles

The Transition to the Virtual World in Formal Scholarly Communication: A Comparative Study of the Natural Sciences and the Social Sciences

A Dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Library and Information Science

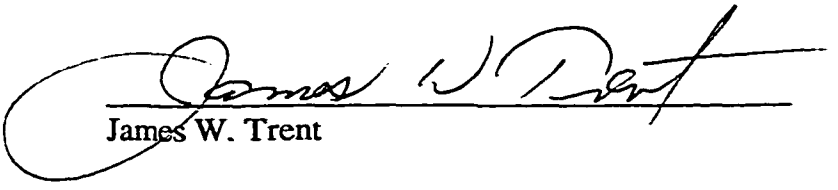
By

Shaojun Lu

1999

The Dissertation of Shaojun Lu is approved.

Clara C. Chu



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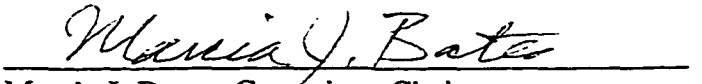

Marcia J. Bates, Committee Chair

University of California, Los Angeles

1999

DEDICATION

In recognition of their constant encouragement and support in this and all the endeavors of my life:

To my mother and father

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VITA

November 2, 1962	Born, Boye County, Hebei, the People's Republic of China
1984	B.A., Library and Information Science Northeast Normal University Changchun, Jilin, the People's Republic of China
1987	M.A., Library and Information Science Wuhan University Wuhan, Hubei, the People's Republic of China
1986 – 1988	Assistant Researcher Research Institute of Library and Information Science Wuhan University Wuhan, Hubei, the People's Republic of China
1988 – 1993	Lecturer Research Institute of Library and Information Science Wuhan University Wuhan, Hubei, the People's Republic of China
1993 – 1994	Associate Professor (on leave) School of Library and Information Science Wuhan University Wuhan, Hubei, the People's Republic of China
1993 – 1998	Ph. D. Student Department of Information Studies University of California, Los Angeles Los Angeles, California, U.S.A.
1993 – 1995	Graduate Student Researcher Department of Information Studies University of California, Los Angeles Los Angeles, California, U.S.A.

1993 – 1998	University Fellowship University of California, Los Angeles Los Angeles, California, U.S.A.
1994 – 1995	Student Assistant Physics Library University of California, Los Angeles Los Angeles, California, U.S.A.
1994 – 1995	Library Assistant Louise M. Darling Biomedical Library University of California, Los Angeles Los Angeles, California, U.S.A.
1994	Who's Who in Social Sciences in China Liaoning University Press Shengyang, Laoning, the People's Republic of China
1995 – 1998	Teaching Fellow Department of East Asian Languages and Cultures University of California, Los Angeles Los Angeles, California, U.S.A.
1996	The Best National Research Award of Scientific and Technological Information System Jointly granted by the National Committee of Science and Technology and other four government departments The People's Republic of China
1997	Hubei Government Award Hubei Provincial Government Wuhan, Hubei, the People's Republic of China
1998 - 1999	Visiting Assistant Professor School of Library and Information Science The University of Iowa Iowa City, Iowa, U.S.A.

PUBLICATIONS

Lu, S. (1998). A cross sectional study of the impact of the Internet on formal scholarly communication. *Proceedings of the 61st American Society for Information Science Annual Meeting*, October 26 – 29, 1998, Pittsburgh. Medford, NJ: Information Today.

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ABSTRACT OF THE DISSERTATION

The Transition to the Virtual World in Formal Scholarly Communication:

A Comparative Study of the Natural Sciences and the Social Sciences

by

Shaojun Lu

Doctor of Philosophy in Library and Information Science

University of California, Los Angeles, 1999

Professor Marcia J. Bates, Chair

This study explored the transition to the virtual world from the traditional paper world in formal scholarly communication in the mid-1990s. It investigated the transition in classic natural and social science fields: economics, political science, sociology, physics, biology, and geology. The purpose of this research was to explore the degree of the transition from paper to electronic formal scholarly communication that has occurred in these selected fields, and to determine if there are significant differences between the two science domains in the stage or character of this transition.

This study drew two samples of high impact research oriented journals in fields from both the natural sciences and the social sciences, and examined the changes associated with the Internet in these typical journals. For exploration of these changes, a set of unobtrusive indicators was developed to describe the transition in formal scholarly

communication, including activities such as publicity, manuscript submission, citation, and information access. Descriptive statistics were used to profile the changes towards the global computer networks in formal scholarly communication. Inferential statistics were employed to test the hypotheses of differences between the two science domains and the difference between 1994 and 1997 in electronic publicity of journals and scientists, acceptance of electronic submission, electronic accessibility of information, and utilization of electronic information resources in these selected fields.

The research generated a cross-sectional picture of the degree to which formal scholarly communication in several classic science fields has converted to electronic formats in place of paper forms. On most measures, it was found that the transition had started during the three-year period between 1994 and 1997. On other hand, the degree to which the transition has been completed by 1997 varied substantially from one indicator to another.

It was also found that the two science areas shared a similar pattern in the electronic publicizing of journals, electronic accessibility of information, and utilization of electronic information resources, with a few exceptions. The significant differences between the two science areas, however, were found in the acceptance of electronic submission and the electronic publicity of scientists, with the exception of releasing a scientist's Web site address. The findings suggest that electronic formal scholarly communication, as a new paradigm, have not been completely accepted. Further study should focus on cognitive aspects of the transition and explore underlying reasons for the transition.

CHAPTER ONE INTRODUCTION

1.1 STATEMENT OF THE RESEARCH PROBLEM

When the United States Department of Defense commissioned the ARPAnet project to investigate problems in communication networking that could survive partial outages in the event of an enemy attack (Krol, 1995), it gave no hint that the Internet, the successor of the ARPAnet, would develop into the world's largest publicly accessible computer network (Gilster, 1995). The global computer network community includes at least 159 countries, of which 81 are part of the worldwide IP (Internet Protocol) Internet (Lin, et al, 1994). Based on the Internet Domain Survey, there were 29,670,000 host computers connected with the Internet by January 1998 (http://www.nw.com/zone/www/report.html, 1998). The rate of the Web's growth has been exponential; the doubling period of web sites is less than 6 months (Gray, 1996).

Since the computer network is speedier, less costly, and in many ways more convenient and flexible than a traditional paper-based communication system, it has the potential to influence scholarly communication among researchers of all disciplines. There has been a call since the late 1970s for a transition or revolution in scholarly communication from among all the participants in scholarly communication, including librarians, publishers, and those in academia. For example, Lancaster (1979) proposed a paperless model for the future library in scholarly communication. The Primary Communication Research Centre in the United Kingdom organized a workshop in the

early 1980s to discuss the prospects for new technologies in light of their ability to replace print on paper (Meadows, 1984). Okerson (1992) concluded that traditional roles in the publishing process would undergo transformation. Roca (1995) believed that "new forms of academic communication have developed" (p. 2). Jacob (1996) predicted "the future is electronic"(p. 204). Reichel (1996) stated "scholarly communication is in a major state of flux due to the impact of computers and the enormous expansion of information" (p. 1). Odlyzko (1995) expected all journals to go electronic eventually. Quinn (1994) predicted that by 2010 the bulk of scholarly communication would be electronic. Entering the 1990s, it is generally accepted that the whole process and structure of scholarly communication is in transit (Brakel, 1995). As Pool (1990) emphasized, "a revolution in communication technology is taking place today, a revolution as profound as the invention of printing. Communication is becoming electronic"(p. 7).

There is no doubt that world-wide computer networks are making global electronic communication a reality today for scientists. As Bailey (1994) said, "global computer networks, such as the Internet, have created a complex electronic communication system that has significantly changed the way scholars informally exchange information and has started to change formal scholarly publication activities" (p. 7). With the advance of the Internet and its support technologies, more and more scientists and scholars are in transition to a virtual world in scholarly communication, while continuing to use traditional communication media. In the virtual world, everything is computer-generated and interactive; scientists and/or scholars from all fields

can communicate directly with each other (Bryson, 1996). Undoubtedly, the virtual world is creating a new convenient environment that can have substantial impacts on the behavior of scientists and/or scholars in scholarly communication. However, no studies have been found that documented how well formal scholarly communication has been transferred into the virtual world. Nor have possible differences between the natural sciences and the social sciences in transition to the virtual world in formal scholarly communication been studied although much has been published regarding general trends to electronic communication.

Communication processes are basic to the nature and practice of science (Meadows, 1974). Scholarly communication studies have been quite popular in the natural sciences and the social sciences (Pandit, 1992). But the definition of the phrase "scholarly communication", is still comparable to Garvey's definition of scientific communication: "By scientific communication I mean those information-exchange activities which take place mainly among scientists actively involved on the research front. It covers scientific communication from the most informal discussion between two scientists to the formal aspects of scientific communication such as journals, reviews, books, etc."(Garvey, 1979, p. ix). The term "scholarly communication" has been substituted for "scientific communication" because it can apply to all fields of knowledge (Reichel, 1996). But Garvey's (1979) definitions and explanations of scientific communication are still applicable. Scholarly communication includes "the full spectrum of activities associated with the production, dissemination, and use of information from the time the scientist gets the idea for his research until information about the results of

this research is accepted as a constituent of scientific knowledge"(Garvey, 1979, p. ix). Shaughenessy (1989) defined scholarly communication as "the social phenomenon whereby intellectual and creative activity is transmitted from one scholar to another" (p.69). Reichel (1995) thought, "scholarly communication is the system by which researchers share their research, ideas, and analysis with each other. The system runs the full range from informal sources, such as contact with colleagues, to formal sources, such as computer files, books, and journals" (p. 68). Graham (1994) recently noted that "The Gutenbergian knowledge chain is roughly hexagonal: from author to publisher to printer to vendor to librarian to the reader, the ultimate consumer, who closes the loop with feedback to the author" (p. 145)

The study of scholarly communication has been focusing on how scholars in any field use and disseminate information through formal and informal channels (Borgman, 1990). It includes the growth of scholarly information, the relationships among research areas and disciplines, the information needs and uses of individual user groups, and the relationships among formal and informal methods of communication (Compton, 1973; Crane, 1972; Garvey, 1979; Meadows, 1974).

Artifacts of scholarly communication is one of the theoretical variables in the study of scholarly communication (Borgman, 1990). Communication artifacts are the formal product, or output, of a sequence of informal communication activities – reading other documents, translating their ideas into their own terms, talking with others (Bazerman, 1988; Callon, Law, & Rip, 1986; Latour & Woolgar, 1979; Small, 1988) – as well as the input to the scholarly communication of others. Artifacts may be studied at

the level of the individual article, conference paper, or book, as well as at aggregate levels such as journals or conferences. Among the scholarly artifacts, journals are universally agreed to be the most important channel of the formal scholarly communication process in the sciences, because the information published in journals is validated by peer review. Since the first scholarly journal, *Journal des Scanvans*, was published as a new medium of communication in 1665, the journal has played a pivotal role for more than three centuries in the creation and transmission of knowledge by serving as a primary medium of scholarly communication (Harter, 1996). If formal scholarly communication is affected by the computer networks or the Internet, scholarly journals would be a crucial locus for these changes to occur. Thus, scholarly journals would be a good place to find the changes in formal scholarly communication that are related to the global computer networks or the Internet.

While it is widely accepted that informal scholarly communication, or the "invisible college," is shifting from traditional print environment to new electronic networks, the academic community and the publishing industry have been slow to replace print journals with electronic publications as a medium of formal scholarly communication (Gresham, 1994). At the same time, a strong opposition has been voiced against this transition in formal scholarly communication. For example, Altbach (1989) argued that "much has been said about the electronic takeover of scholarly communication. In my view, at least for social sciences and humanities, the traditional forms of communication are alive and well – and unlikely to be replaced by any kind of electronic innovations in the near future" (p. 72). Unfortunately, the pro-transition

publications have not provided enough evidence to convince audiences that there is such a transition in formal scholarly communication, nor have the anti-transition publication given enough explanation regarding why formal scholarly communication will not be transferred from the paper-based communication to the electronic-based communication. The key to this phenomenon is that most of these publications are not research-based but the opinions or perceptions of some authors on the future of scholarly communication. They are hardly reliable nor can they be generalized in terms of research design. This situation leaves us with an important mission to further explore what is really happening to formal scholarly communication under the impact of global computer networks, specifically, to study the changes related to the electronic virtual world in formal scholarly communication.

Therefore, a well-designed study, in which both reliability and validity are considered, is highly desirable in order to know the status of the transition to the electronic virtual world in formal scholarly communication, and to determine if there are any differences between the natural sciences and the social sciences in shifting from traditional print to the new virtual world. Understanding this social transformation will eventually help to improve library and information services, human-computer interfaces, as well as the effectiveness and efficiency of scholarly communication.

This study will measure the transition of formal scholarly communication to the virtual world from the mid-1990s, using a variety of unobtrusive indicators. The research will give both cross-sectional and longitudinal pictures of the degree to which formal scholarly communication in several basic natural science and social science fields has

moved to being electronic rather than paper in form. This study will contribute to the basic knowledge of any differences between the natural sciences and the social sciences in their transition to the virtual world in formal scholarly communication. It will also serve as the basis to judge the potential differences between natural scientists and social scientists in using electronic vehicles to deliver information, and their demands for electronic information. It will also serve as the basis for the improvement of existing information services and the implementation of new scholarly communication policy to foster scholarly communication activities.

1.2 THE TRANSITION TO THE VIRTUAL WORLD

In order to conduct this study, we need to understand clearly what is meant by the phrase "transition to the virtual world". The confusion about the transition in scholarly communication has been caused in part by the various understandings of the term "transition". As used in this study, it refers to the change process by which formal scholarly communication is moving from the paper-based, physical medium to the electronic-based, virtual medium in academic writing, publishing, and dissemination of information, the basic activities in formal scholarly communication. Traditionally, these activities are paper-based. Researchers (such as scientists and scholars) write out their ideas and innovations on paper, publishers publish journals or other paper-based products that carry these ideas and innovations, and librarians collect these paper-based products and disseminate these paper-based products to other scientists or scholars. Everything is based on paper in the traditional scholarly communication system. By contrast, in the

electronic age, academic writing, publishing, and information dissemination are based on electronic or computer networks.

The "transition" does not mean that this process has already finished but instead implies that this process is ongoing or happening. It refers to a shift from the paper world to the virtual world in one or more aspects of the scholarly communication process, including academic writing, publishing and delivering. In academic writing, scholars are taking part in this transition to the virtual world in many ways. They reach out by releasing their Web page addresses, and email addresses; they express their ideas via computerized word processors, they provide supplemental materials to their research by using the Internet. For example, physicists who published papers in the journal *Physics Letters* provide the supplemental materials to their research results on the Internet since the print journal does not have enough space to publish these supplemental materials. They also support their ideas by citing electronic resources. Academic publications are also in transition to being electronically published. Some journals have electronic versions while publishing paper versions too, such as the *Bulletin of the American Mathematical Society*; other journals (such as the *Journal of Personal Computing and Technology*, and the *Electronic Journal of Communication)* appear solely in electronic forms. In academic delivery, distribution of a journal or other information products, submission of papers, and subscription to the journal are also in transition to electronic world. For example, some journals have started accepting manuscripts on disk or by email; others can be accessed by the FTP (File Transfer Protocol) or the WWW (World

Wide Web) on the Internet. Electronic subscription is also acceptable for many journals which established their email addresses.

The transition to the virtual world can be traced back to a long time ago. It originated from a mixture of the impacts of the information explosion, of computers, and of telecommunication advances in scholarly communication. In the 1940s, when the computer was applied to the management of scientific literature, this transformation had already started in part. According to W. B. Frakes (1992), automated information retrieval systems were originally developed to help manage the huge scientific literature that has been developed since 1940s. At that time, the computer was a new tool for libraries to manage their collections and for users to access the collections. Some bibliographic information was transformed then into electronic information that served as an inter-medium between scientists and paper-based scholarly artifacts such as journals and books. There was no network-based electronic writing or delivering of information.

However, the situation has changed rapidly since the 1980s. Buckland (1989) observed that libraries are in a phase where most of the collection is in print, including microform, while library operations and access tools are in electronic form. He predicted that at some point the collection would also be in electronic form. But even the present state of automation in libraries is creating strains since the scientific literature is growing at an exponential rate. As Reichel (1996) cited in her dissertation, "what a scientist did not know existed two years ago must now be delivered in a few hours. As the 'visible universe' of literature and data has expanded, important information is coming from unexpected and previously unknown sources" (p. 4). Lanham (1989) has written an

assessment of the fundamental shifts to the electronic world necessary in literary studies and urged scholars to change before they are put out of business. Jacob (1996) also contends that electronic dissemination will rapidly become the usual medium for esoteric publications.

In summary, transition to the virtual world is operationally defined in this study as a movement from the use of paper to the use of electronic vehicles in formal scholarly communication. It is an ongoing process involving the adoption of electronic vehicles such as the Internet (or global computer networks) and computing technologies, like email, online search, Web site, FTP, Gopher, CD-ROM, electronic journal, disk, and others. Therefore, the transition to the virtual world refers to any of these electronic vehicles being used in any aspects of the scholarly communication process.

1.3 CONCEPTUAL FRAMEWORK

Scholarly communication is an information exchange system by which researchers exchange their research and ideas in various informal or formal ways. There are two basic channels for scientists to communicate with each other (Meadows, 1998, Garvey, 1979). One is the informal channel in which new knowledge is disseminated through personal contacts like personal letters, email messages, conversations, and conferences. A typical model of informal channels is the "invisible college" which refers to "an elite of mutually interacting and productive scientists within a research areas"(Crane, 1972, p.34). This kind of communication among scientists is referred to as informal scholarly communication. The other one is the formal channel by which scientists exchange

information and ideas through formal scholarly publication. A scientist creates an idea or research project, writes a manuscript, and submits it to a journal or publisher; then the journal sends the manuscript to a panel for peer review. After the panel validates the manuscript, the publisher publishes it in the form of a journal article or monograph. Other scientists read the publication in libraries or at home. This process is also called formal scholarly communication because it "disseminates information after having evaluated and validated it for scientific community" (Crane, 1972, p. 115).

Usually the informal channel is a step prior to formal scholarly communication. At the preliminary stage of research, scientists communicate the ideas with their colleagues via informal contacts. After the ideas are matured, scientists write formal reports and then submit them to journals. Their ideas or innovations will then appear in the form of publications and enter the library system for circulation in a wider scope. Both informal and formal scholarly communications have to deal with the delivery of ideas and information to others. In formal channels, ideas and information are communicated in publications (including journals, scholarly monographs, conference proceedings) and formal presentation of conferences; and in informal channels, ideas and information are delivered to others through conversations, conferences, letters, email messages. Global computer networks or the Internet provides a medium for scientists to communicate with each other and thus has impact on both formal and informal scholarly communications. In this study, only the impact of the Internet on formal scholarly communication is studied since much has been done regarding the impact of the Internet on informal scholarly communication.

Formal scholarly communication involves at least four aspects: (1) the scientist who is the creator, producer and user of information or new knowledge, although the term scientist is used interchangeably with the term "researcher" or "faculty" in some studies such as Reichel's (1996) study; (2) the scholarly artifact which is the product of information or new knowledge, such as journal, book, computer file; (3) the publisher who is the producer of the information product or scholarly artifact; and (4) the communication process by which scientists exchange research, ideas, and share information with each other, such as reading articles or books written by others. Among these four aspects, the scientist is integral to scholarly communication since s/he plays multiple roles as creator, producer, and user of information. The producer plays a pivotal role in scholarly communication to convert information or new knowledge into a physical form such as journal articles, books, or computer files. The communication process involves the procedures by which the new knowledge is delivered from one scientist to another. The scholarly artifact is the product of science research that not only records new knowledge created by the scientists but also reflects the history of the field and relationships with other scientists' work via citation. It provides a key link between different scientists to communicate to each other. In this sense, formal scholarly communication would be impossible without scholarly artifacts. Thus any changes in the scholarly artifact are very important to the organization of science.

A scholarly artifact is associated with the information, its creator, a validation of the information, and a carrier of the information. With regard to journal publication, the information is the main body of a journal article, the creator is a scientist who publishes

the article, the validation of information is the reference or the citation to the article (and peer review process in some refereed journals), and the carrier of information is the journal in which the article is published. Scholarly artifacts provide not only a public forum for scientists to express their ideas and discoveries, but also an archive for scientists to find these ideas and discoveries. Scientists communicate to each other via scholarly artifacts. Thus the study of scholarly artifacts will not only uncover new knowledge in a specific field but also reveal the impacts of other crucial elements in scientific communication including the Internet or the global computer networks on this field.

Previous studies have revealed that the use of different types of information depends on the type of research and the discipline (Pandit, 1992). Use of information and information-seeking behavior is a central activity in any formal scholarly communication. Formal scholarly communication in the natural sciences may also have different features from the social sciences since each of the science areas has a different history, research objects, research methodology and tradition. The natural sciences, at the simplest level, encompass the knowledge of the world of nature, so that the objects of study of natural sciences are the phenomena in the natural world. The social sciences deal with human behavior in its social and cultural aspects. The objects of the social sciences are social phenomena in society. Generally speaking, technology plays a more important role in the natural sciences than in the social sciences because much research in the natural sciences has taken place in laboratories equipped with modern technologies, while the tools of social science research are less frequently technology-based. Thus the influences of the

electronic medium on formal scholarly communication may be different in the natural sciences and the social sciences. The differences between the natural sciences and the social sciences will very probably influence natural scientists to adapt new technologies differently from social scientists in their scholarly communication.

However, there are also some similarities between the natural sciences and the social sciences. The carriers of information in both are the same, and the formal scholarly communication processes in the two areas are very much alike. Scholarly journals and monographs have the same function in both areas. The similarities between them may also lead social scientists to adopt electronic vehicles in the ways similar to that taken by natural scientists. Therefore, any generalizations without solid research but just based on the basic analysis of the natures of two science areas may have some exceptions. For example, nowadays many social science disciplines depend on advanced computer equipment. For this reason, several disciplines in the natural sciences and the social sciences will be selected and examined to improve the external validity of this study.

Formal scholarly communication involves a series of activities such as submission, editing, publishing, subscribing, publicity, access to and use of information. Transition to the virtual world in formal scholarly communication includes applications of electronic vehicles in all these activities. As a result, a series of new activities with electronic features have been created in formal scholarly communication. These new activities include electronic submission, electronic publicity of journals (including electronic publishing and subscription), electronic publicity of scientists, electronic access to information, and utilization of electronic information.

Submission is a scholarly activity after scientists have finished their research and before their research and ideas are circulated formally. Nowadays, most scholarly works are written in electronic form and most publications are produced with the aid of computers. Therefore, electronic vehicles such as disk, email and FTP (File Transfer Protocol) have been also adopted by scientists in the submission of manuscripts. Electronic submission is defined as submitting electronic manuscripts to journals either via traditional postal services or the global computer networks.

Publicity, in its broadest sense, is providing information about a person, product, organization, or any other entity (Brough, 1986). The term refers to an activity, not a method. And there are many places and opportunities – many media – in which or from which to publicize. Web technology and computer-mediated communication (email) are widely used to publicize journals, publishers, and scientists in current scholarly communication through the release of Web site addresses, email addresses, permitting electronic subscription, and electronic publishing. Journals, publishers, and scientists are being made known to the public through these activities and thus the products of formal scholarly communication are circulated. Electronic publicity of journals is thus defined as publicizing journals by means of electronic vehicles. It includes releasing a journal's or publisher's Web site address, releasing a journal's email address, electronic publishing via the Internet, and permitting electronic subscription. Correspondingly, electronic publicity of scientist is defined as publicizing scientists by electronic vehicles. For this study, it is operationally defined as releasing a scientist's Web site address and/or email address.

Access to information and use of information are related to each other. In order to use information, the information must first be accessible. Electronic access to information is defined as access to information electronically through computer networks, commercial database services, and so on. There are basically two kinds of information that scientists need to access. One is bibliographic information and abstract; and the other is full-text information.

Use of information is also a very important activity in formal scholarly communication. Use of electronic information as a citation source suggests that scientists have accepted information in electronic form as a formal scholarly work. Utilization of electronic information is thus defined as the citation in journal articles of digitized graphical and textual materials. Electronic information includes Web site documents, FTP file documents, Gopher file documents, electronic journal documents, and private email messages, database files, software and so on, so long as it is cited in a journal. Utilization of electronic information in this study is operationally defined as citation of electronic information resources by scientists in their published journal research articles. Electronic sources used but not cited by scientists will of course not be counted.

Because each activity of formal scholarly communication has its own features and history of application of computer technology, the transition in each of these activities may be different from one to another. For example, computer technologies have been applied to information access for a long time. Online information services have been available to the public since 1960 (Bourne, 1980). However, Web technology came out publicly in 1993. The history of application of technology is related to the maturation of

electronic vehicles in some areas. Usually the longer the period of use, the more mature the technology is in the applied fields. The easier the application of technology is, the sooner the technology will be applied in the field.

The different features of different activities in formal scholarly communication, histories of different information technologies, and the nature of the social sciences and the natural sciences, all will contribute to differences between the two science areas in the transition to the virtual world in formal scholarly communication. All the indicators studied in this dissertation relate to one aspect or another of the complex scholarly publishing and communication process. Thus, collectively, these indicators should provide a rich profile of the transition in the two science areas.

1.4 RATIONALE FOR THE STUDY

Scholarly communication has been a very hot topic since the 1960s in the field of library and information science. Much research has been done on scholarly communication among scientists, social scientists, and humanities scholars. However, these studies have focused on the scholarly communication model and behavior among scientists in the traditional paper-based environment. Little has been done regarding the new changes in formal scholarly communication in the new environment of mixed paper and electronic media. The latter is a relatively unstudied area of scholarly communication, which this study is intended to contribute to remedying. The aim of scientific study is not only to reveal what has already happened in the past but also to explore what is happening right now and what will happen in the future. For example,

scientists have been communicating in the traditional paper-based system for a long time, so the results from studying such behavior in traditional paper-based systems will definitely be meaningful in directing information services in the paper-based environment. However, these results may or may not be relevant to information services in new electronic-based communication systems. Studying the transition from paper-based communication system to electronic-based communication will not only help us learn what is happening in current formal scholarly communication but also help us contemplate what will happen in future formal scholarly communication.

Scholarly communication has played a key role in the development of science as a number of scholars have emphasized in their studies. For example, Meadows said, "communication lies at the heart of research. It is as vital for research as the actual investigation itself, for research cannot properly claim that name until it has been scrutinized and accepted by colleagues. This necessarily requires that it be communicated" (Meadows, 1998, p. ix). Compton thought, "communication of scientific and technical information is an integral part of the process of research and development" (Compton, 1973, p. 755). Griffith believed that communication is the only general scientific behavior; other behaviors are specific and technical (Griffith, 1989). Scholarly communication "is also one of our greatest national assets and one of our most challenging national problem" (Compton, 1973, p. 755). A scientist's primary goal is to produce knowledge, and he is aware of the premium placed on originality and priority. He must communicate his findings to establish himself and to add to the cumulative

structure of science. Scholarly communication represents both major input to and an ultimate objective of scientific productivity (Compton, 1973).

Scholarly communication is a major concern not only of individual scientists and the professional societies and employing institutions to which they adhere but also of both the legislative and executive branches of the federal government. "More effective scholarly communication has been the subject of a number of congressional studies and hearings and of numerous special panel and task-group reports sponsored by the President's Science Advisory Committee and Federal Council for Science and Technology's Committee on Scientific and Technological Information (COSATI)." (Compton, 1973, pp. 755 - 756) The current transition of formal scholarly communication to the virtual world is one of the efforts for improving effectiveness and efficiency of scholarly communication. Thus, studying the transition of formal scholarly communication will not only help understand this social process but also improve the effectiveness and efficiency of scientific research. With effective and efficient scholarly communication, the process of scientific research and development will more fully benefit humanity and the planet.

Support of scientific research is costly. Scientific information is the principal product of research and development, the major return on an annual investment by the U.S. government, and more than half again as much by U.S. industry (Compton, 1973). Such funding is wasted unless the results of the research are presented to their appropriate audiences. As worldwide investment in research and development expanded, both the need for and volume of information increased rapidly. Current pressures to maximize the

return on the substantial investment in research and development and to speed the application of scientific knowledge to the solution of such problems as pollution, transportation, urban renewal, poverty, and global communication are intensifying this need. Efficient and effective communication is not only an essential part of the research process, but also a key factor to help human beings solve these problems they are facing. Thus, studying the transition of formal scholarly communication will also eventually help scientists solve these problems efficiently and effectively.

The most important issue in scholarly communication is how the communication of research can be handled more efficiently. In order to solve this issue, many inventions have been created by human beings. The most powerful invention for communication is the computer. Computers were already being used for information handling a long time ago. Their future development will surely allow the rapid manipulation of large quantities of information and make them increasingly effective tools for the communication of research (Meadows, 1998). Computer network-based, electronic dissemination will rapidly become the usual medium for formal scholarly communication. The electronic medium is frequently compared to the invention of the movable print type; the time we are living in has been compared to being in the midst of a second Gutenberg revolution in the dissemination of information (Jacob, 1996). Current scholarship is most likely to be transformed from relying on paper to the virtual world. As Jacob (1996) emphasized, "electronic publications are likely to become an essential characteristic of the work environment of scholars. Those who adapt will flourish; those who resist are likely to be left behind in the dust" (p. 209). Therefore, at this crucial point

of time, the importance of studying the transition in formal scholarly communication cannot be overstated.

1.5 RESEARCH QUESTIONS

As noted, little has been done with a solid research basis toward understanding the transition to the virtual world in formal scholarly communication in various natural science and social science fields, and nothing has been found that is directed toward understanding the difference of the transition to the virtual world between the natural sciences and social sciences. This situation inspired the current research and aroused the following two basic research questions.

(1) What changes have been taking place in formal scholarly communication toward the electronic-based virtual world? Drawing on data from several natural and social sciences, what is the status of the transition to the electronic world in formal scholarly communication of these sciences?

(2) Are there any significant differences between the natural sciences and the social sciences in the transition to the virtual world in formal scholarly communication? In other words, are the natural sciences different from the social sciences in electronic publicity of journals and authors in formal scholarly communication? Are electronic information sources and electronic submission in the natural sciences more or less acceptable than in the social sciences? And is information in the natural sciences more or less accessible electronically than that in the social sciences?

1.6 OBJECTIVES OF THE STUDY

The present work is intended to study the transition issues in formal scholarly communication in light of the potential of electronic-based virtual communication system to replace the paper-based traditional communication system. There are two basic objectives of this study.

The first objective is to give a descriptive profile of the degree of the transition to the virtual world in formal scholarly communication from the paper world in several selected natural sciences and social sciences. In order to create this profile, a variety of unobtrusive indicators related to electronic formal scholarly communication are developed to describe the possible changes associated with the global computer networks or the Internet.

The other objective is to determine if there are any significant differences between the natural sciences and the social sciences in transition to the virtual world in formal scholarly communication. Specifically, the work of the study examines whether there are any possible differences between the natural sciences and the social sciences in the electronic publicity of journals and authors, acceptance of electronic submission, electronic accessibility of information, and utilization of electronic information sources.

1.7 THE SCOPE OF THE STUDY

Although both informal and formal scholarly communication are affected by the global computer networks since the computer networks themselves are communication

tools, this study solely focuses on the transition to the virtual world in formal scholarly communication.

Formal scholarly communication is a process by which information is created, recorded, disseminated, and used in scholarship and science. Scientists or scholars, publishers, publication distributors, and librarians are all participants in this process. Although all participants of scholarly communication might be influenced by global computer networks, this study does not study the impact of global computer networks on librarians or publishers or other participants. Only scientists are studied because they are not only creators but also end-users or consumers of knowledge or information; scientists tend to dominate formal scholarly communication.

Formal scholarly communication is a basic activity of scientists and scholars in all disciplines. Electronic media affect scientists and scholars in all disciplines, including natural scientists, social scientists, and humanities scholars. However, this study solely focused on the transition to the virtual world in scholarly communication among scientists (including social scientists), since humanities scholars are relatively reluctant to adapt new technologies (Wiberley, 1989; Bates, 1994).

Due to differences in research objects, research methods, and tools between the natural sciences and the social sciences, even among different disciplines within the natural sciences or social sciences, the impact of global computer networks may be various among different disciplines within the natural sciences and the social sciences. The emphasis of this study is not on the possible differences among the disciplines within the natural sciences or the social sciences, although descriptive data for the test fields is

also presented as a part of the contrast between these two science areas. This study emphasizes the possible difference between the two science areas and between different years in the transition to the virtual world.

CHAPTER TWO LITERATURE REVIEW

This study is based on two premises. One is that scientists are fundamental to determining the ways in which scholarly communication operates and what the future direction of scholarly communication should be. Scientists are the producers and the users of the new knowledge that forms the basis of the scholarly communication system. Scientists are integral to scholarly communication. As has been emphasized, "the scholars themselves are of course central figures in our system: the basic reason for the system is to help them carry out their work" (Scholarly Communication: The Report of the National Enquiry, 1979, p. xii).

The other premise is that electronic media are important channels for scholarly communication. Electronic media are "frequently compared to the invention of movable print; we are in the midst of a second Gutenberg revolution in the dissemination of information" (Jacob, 1996, p.204). Therefore, this study will focus on scientists, although the transition to the virtual world is being made by all the participants in the process of formal scholarly communication, including scientists, publishers, vendors, and librarians.

To understand the transition to the virtual world in scholarly communication, this chapter will review the literature in four areas: (1) scope of natural science and social science, (2) pattern of social scientists' and natural scientists' use of electronic media in scholarly communication; (3) use of electronic information in scholarly communication, and (4) the impact of electronic media on scholarly communication. It is very important

to know how scientists move from the paper-based communication system to the electronic based communication system for the research purposes. Unfortunately, there does not appear to be any research on this question. However, the general habits and characteristics of scientists' use of information may be relevant to this study since the pattern and attitude of information use may be reflected in their transition to the virtual world more or less.

2.1 UNDERSTANDING THE SCIENCES

The basic terms to be defined for this study include the "social sciences," the "natural sciences," and the "scholarly communication." These concepts have various explanations in different studies in which these three concepts are involved. There is however, one common feature among these studies, that is, the method of operational definition is used to define the concept of social sciences and natural sciences. Nachmias (1982) defined the operational definition as "a set of procedures that describes the activities one should perform in order to establish empirically the existence or degree of existence of a concept" (p. 34). The operational definition of social science or natural science is usually based on the organizational structure of a university or other institutions or a certain classification schedule as the standard for dividing academic fields. For instance, Bouazza (1986) used operational definitions based on the organization of the university or other institutions they are studying. For the purpose of this study, subject divisions in the Social Sciences Citation Index and the Science Citation Index published

by the Institute for Scientific Information will be used as a standard for dividing academic fields into major categories, namely the social sciences and the natural sciences.

2.1.1 Natural Sciences

Natural science, in contrast to social science, is a set of disciplines which study phenomena and their relationships in the natural world. In western intellectual systems, "nature is viewed as that part of the terrestrial world that is external to human society, containing its own laws, operating according to its own physical, chemical, biological process" (Bynum, ed., 1981, p. 289). In other words, the nature sciences are the disciplines which deal with natural phenomena in the terrestrial world, such as atom, molecular, cell, organism and so on. Bynum (1981) defines "nature sciences" as "a set of separate, specialized disciplines – consisting primarily of physics, chemistry and biology – of relatively recent origin. Defined as consisting in the experimental (or empirical) study of the material or external world from the standpoint of a neutral, methodical observer, they appeared as such only in the mid-19th century, as the product of a particular philosophical tradition" (p. 287). Conventionally, "the natural sciences comprises the physical and biological sciences, the earth sciences, meteorology, and sometimes mathematics" (Cohen, 1993, pp. 6). In Reichel's (1995) dissertation, natural sciences included agriculture, agricultural education, agricultural engineering, entomology, nutrition and food science, plant pathology, plant sciences, soil and water science, veterinary science, biochemistry, microbiology and immunology, molecular and cellular biology, family studies, clothing and textiles, interior design, counseling and guidance,

home economics education, consumer studies, landscape resources, range resources, forest-watershed resources, and wildlife fisheries and recreation resources, aerospace and mechanical engineering, chemical engineering, civil engineering and engineering mechanics, electrical and computer engineering, hydrology and water resources, materials science and engineering, mining and geological engineering, nuclear and energy engineering, and systems and industrial engineering, astronomy, atmospheric science, chemistry, computer science, ecology and evolutionary biology, geosciences, geology, microbiology and immunology, molecular and cellular biology, physics, planetary science, speech and hearing sciences, statistics, and optical sciences. Medicine, nursing, pharmacy, and other health-related professions are not included in the list of natural sciences in her dissertation.

In this study, the concept of the natural sciences is operationally defined as the fields within the scope of the SCI (Science Citation Index) Journal Citation Reports (1995), which include over a hundred fields or disciplines in natural science, technology, medicine. For the purpose of this study, only three classic fields, specifically, physics, biology, and geology are selected to represent the natural sciences.

2.1.2 Social Sciences

The conceptualization of social science is an ambitious undertaking and there is no widely accepted definition of the social sciences so far since "the social sciences differ in their scope from one generation to another. There are also within-generation differences" (Sills, 1968, xxi). Generally, the social sciences is a set of disciplines of

scholarship that study social phenomena and social relationships among individuals as members of groups in human society. Social science is a very broad concept, including many sub-fields ranging from anthropology to statistics. The social sciences are generally understood to include anthropology, archeology, economics, history, political science, psychology, and sociology (Cohen, 1993). In the International Encyclopedia of the Social Sciences (Sills, ed., 1968), social sciences includes anthropology, economics, geography, history, law, political science, psychiatry, psychology, sociology, and statistics. However, Seligman (Sills, 1968) made a distinction among the social sciences (which he defines as politics, economics, law, anthropology, sociology, penology, and social work); the semi-social sciences (ethics, education, philosophy, and psychology); and the sciences with social implications (biology, geography, medicine, linguistics, and art) (Sills, 1968). Roberts (1980) added to this list: criminology, education, environmental planning, ergonomics, futurology, linguistics, management, social policy and social administration. Psychiatry was not part of Roberts's list. Bouazza (1986) in his definition of social sciences wrote that the social sciences "encompass such disciplines as industrial administration, history, psychology, social sciences, statistics, urban and public affairs"(p. 9). However, sometimes "history" was excluded from the social sciences and counted as humanities (Cohen, 1993). In her 1989 study of social science researchers and information use at the University of Wisconsin-Madison, Folster included only four social science disciplines, "industrial relations, anthropology, sociology, and economics" (p. 8). The Research Libraries Group (1989) study on social sciences included

economics, political science, sociology, psychology, and anthropology. The precedent for including education was set by the INFROSS (Line, 1971) studies.

Reichel (1995) defined the social sciences in her dissertation by using the college divisions at the University of Arizona. So far, her list of social science is the most comprehensive. The social sciences in her dissertation included anthropology, communication, geography and regional development, history, journalism, linguistics, oriental studies, philosophy, political science, psychology, and sociology, library science, American Indian Studies, Russian and Soviet Studies, Women's Studies, Black Studies, Latin American Studies, Mexican American Studies, and Southwest Studies, Business and Public Administration, Public Administration and Policy, and Education.

From these studies, it is easy to see that anthropology, economics, political science, psychology, and sociology are widely recognized as social sciences. These fields are also within the scope of social sciences set by the SSCI (Social Science Citation Index) Journal Citation Reports (1995). For the purpose of this research, only economics, political science, and sociology are selected to represent the social sciences because they are well-established, and present no debate on whether they belong to the natural sciences or the social.

2.2 STUDIES ON FORMAL SCHOLARLY COMMUNICATION

2.2.1 Natural Sciences

Studies on scientific communication and information use started in the late 1940s and grew in scope and importance in the1960s. The review articles on information needs

and use since the 1960s in the Annual Review of Information Science and Technology provide summaries of the direction of these studies. As Skelton (1973) and others have noted, there was substantial fragmentation in the early information use studies.

Most of the major work with scientists involved mail questionnaires using large samples. For instance, Menzel (1966) reported on a 1965 study by Pauline Atherton with the Physics Documentation Research Project of the American Institute of Physics. In the study, questionnaires were sent to 2,000 research physicists. Garvey, Tomita and Woolf (1974) analyzed the data in regard to the way scientists use information. They found that "local colleagues and students, non-local colleagues, meeting presentation, preprints, technical reports, journals, and books" are the major types of information sources that had been successfully used by scientists (Garvey, et al, 1974, p. 265). The researchers found that the two most heavily used sources of information were local colleagues and journals.

Lancaster, in the book Toward Paperless Information Systems (1978), discussed the communication system in science and summarized earlier studies. He distinguished, as others had done, between the formal and informal communication systems. He discussed major problems in the formal communication system that he identified as the "increasing fragmentation and specialization in science which tends to cause greater dispersion of the literature" (p. 65), and the increasing costs and delays in publishing.

In 1991 the Research Libraries Group published Information Needs in the Sciences: An Assessment which looked to the future of scientific information needs (Gould & Karla, 1991). One hundred and thirty-one individuals were interviewed and consulted from eight disciplines including physics, chemistry, biology, geosciences,

astronomy, engineering, geology, and computer science. The purpose of this study was to assess information access in the different disciplines, to determine future trends, and to project information needs based on the future trends. The report concluded that "for those concerned with ensuring access to the information required for research, the most difficult task will be to keep pace with the staggering growth in research information of all types" (p. 74). Three areas are cited as needing particular attention: journal literature, unpublished research, and primary data.

In addition, the report found that enhanced bibliographic information about unpublished research and primary data sets is needed. The report also suggested the development of "integrated information environments" that will "offer access to resources such as national and international computer networks for communication among researchers, bibliographic access to information on the latest published and unpublished research, information about primary data, and gateways to remote databases" (p. 75). The impact of computers on research in scientific disciplines was also discussed in this report. For example, it discussed chemists' and biologists' concern about electronic journals because "online journals do not include diagrams and illustrations and some of the most important information is therefore lost" (p. 15). For engineers there was a major concern that information be available in their offices and there was increasing emphasis for engineers on research from other countries. For computer scientists the importance of contact with colleagues as a primary information source was noted. The importance of electronic mail was noted as it was in other fields. It is obvious that their concerns are behind the development of electronic information technology.

Today's electronic journals based on the Internet can not only provide diagrams and illustration, but also provide three dimensional graphs and moving pictures. And accessing information from their own offices has already become a practice for most scientists.

With the rapid development of publishing technology based on the Internet, perceptions of electronic journals have changed to some extent. In Reichel's (1995) study, some scientists projected the total elimination of the journal in print format while others foresaw the continued use of paper in some combination with electronic formats as they said the "scholarly communication system will be much as it is today" (Reichel, 1995, p. 224). Scientists also expressed concerns about the availability of journals in electronic format that included quality of images, high cost, obsolescence of technology, and preservation issues. She concluded that in 2001 "electronic access will be to one large database which will have published and unpublished material, sophisticated searching capabilities, and will be accessible from any computer. Scientists will find information through electronic access, and everything will be at their fingertips" (p. 224). Scientists also perceived that an electronic mail system will be pervasive and will be used extensively for informal scholarly communication. The importance of the journal literature as the major source of previous research studies for scientists was also supported by her study. International and interdisciplinary research will be facilitated by the ease of access to other scholars through electronic mail systems.

2.2.2 Social Sciences

The work on information use by social scientists started in the late 1940s and continued to grow (Reichel, 1995). Brittain (1982) provides a historical summary of this work. In Great Britain in 1967 researchers at the University of Bath undertook an investigation into information use by social scientists. Line (1971), Brittain, and their associates set out to gather similar information about social scientists and their work continues to be a benchmark in the field. In their study (INFROSS for Investigation into Information Requirements of the Social Sciences), the scientists in the fields of anthropology, economics, education, political science, psychology, and sociology were studied.

In the INFROSS study, a questionnaire was sent to 2,602 social science researchers, interviews were held with 75 researchers and 50 practitioners, and a few researchers were observed daily. In the report, Line (1971) found that "the social scientist as an information user is at a point along a continuum, from 'hard' to 'soft' social science. The 'hard' social scientist exhibits a number of characteristics that have been found in science user studies, and is distinguishable in a number of ways from the 'softer' social scientists" (p. 430). That there are variations in information use among social scientists is echoed in Skelton's 1973 comparison of the INFROSS results with results of studies of scientific information use. She compared the results of 13 user studies done with scientists to the results of the INFROSS research. These 13 studies used similar methodology, conceptual bases, and obtained data in similar areas. In use of information sources, scientists find that the "most useful sources are journals, plus trade literature and

handbooks. Informal, personal contact is valuable" (p. 147). For the social scientist, monographs and journals are used to a large extent and informal personal contact is also valuable.

In methods for locating references, both scientists and social scientists use similar approaches: personal recommendation, chance, and abstracts/indexes. Scientists ranked personal recommendation as the most frequently used, followed by chance encounter with the information, and then abstracts and indexes. Social scientists ranked citations first, then abstracts and indexes, and then personal recommendation. Neither group found library use to be important, although abstracts and indexes are frequently used in libraries. Social contacts were important to both groups, but social scientists also gained from papers presented. Both groups experienced late detection of information to a similar extent, and both groups received ideas from written material, their own work, and personal contact. Skelton (1973) agreed with Line (1971) that scientists and social scientists for the most part "use similar information sources, similar methods to retrieve information and both experience similar problems in dealing with information. However, the extent of use of different methods and the degrees of problem created do vary and account for the difference in the information seeking behavior of scientists and social scientists" (p. 138). Hogeweg-De Haart in his 1984 summary of social science use studies reached the same conclusion as Line and Skelton.

Slater (1988) reported on a preliminary, qualitative update of the INFROSS studies in which librarians, social science practitioners, and social science academics were given in-depth interviews. In her preliminary report which was written before all

the interviews were conducted, she found some of the same characteristics as had been found in earlier studies, including concern about language barriers among social scientists.

In 1989 Folster reported on a study of social science researchers at the University of Wisconsin-Madison. She did not find major differences in the use of information among the faculty, graduate students who had passed their preliminary examinations, and graduate students who had not passed their preliminary examinations. She did find that "journals are the most important source of information in the research process and tracking citations is also an essential factor in the acquisition of information" (p. 10). She also found that "for both faculty and students, computerized literature searching ranked as one of the least important sources of information" (p. 10). This finding echoed a similar conclusion reported by Skelton (1973) that "information is found by chance as often as it is by formal use of bibliographical tools" (p. 144).

There are differences reported in the social science disciplines studied by the Research Libraries Group (Gould & Mark, 1989). This study covers five social science fields, including economics, political science, psychology, sociology, and anthropology. In economics the importance of working papers and current information on social science data was emphasized. Political science is characterized by a large variety of types of sources. Political scientists have been leaders in sharing machine-readable data files. The success of the Inter-university Consortium for Political and Social Research is emphasized throughout the report. The report found that sociologists use informal approaches rather than indexes and abstracts while psychologists "have been converted to

the virtues of on-line indexes; some even claim that print indexes, because they do not allow Boolean searches, are 'useless'" (p. 34). A possible explanation for the differences in the formal bibliographical searching between sociologists and psychologists might be the differences in quality of their major indexing tools. Anthropology, it was found, is not a literature-based field, but anthropologists need information on photographs and films and other artifacts.

In 1995 Reichel used focus groups to study 15 social scientists' perceptions of scholarly communication and information needs in 2001. She found that "electronic access and format will be available more widely, but other types of sources will be used as well" (p. 221). She also found that "Electronic access will be pervasive for finding information. Electronic databases will provide abstracts for documents, enhanced indexing systems, and keyword searching" (p. 222). As for electronic mail, she emphasized the importance of electronic mail in facilitating informal communication including international communication. But in her study, social scientists believed that "communication through electronic mail systems will not be part of the formal scholarly communication systems" (p. 222). They also projected that "there will be a slow rate of change in the scholarly communication system, and it will have many of the same elements as today" (p. 221). Based on the results of her study, she concludes that "at this time, the communications which take place through electronic mail are not projected to become part of the formal products of the scholarly communication system" (Reichel, 1996, p. 232).

2.2.3 Comparison between the Social Sciences and the Natural Sciences

Although there are common assumption and perceptions that scholars in the three broad areas of natural science, social science, and humanities use information sources and communicate with each other differently, there are only a few research-based studies found in the literature comparing information use and/or scholarly communication in different areas. Skelton (1973) compared the INFROSS data with the data from science use studies and she found the extent of use of different methods and the degrees of problems created vary and account for the differences in the information seeking behavior of scientists and social scientists. Garvey, Tomita and Woolf (1974) also studied the difference between physical and social scientists on information needs in relation to a variety of reasons for gathering information. They found social scientists needed more information at the stages of designing data collection techniques and choosing a data-analysis method than physical scientists did.

In another study, Garvey, Lin, Nelson, and Tomita (1972) reported that 70 studies were conducted between 1966 and 1971 "on the information-exchange activities of over 12,000 scientists and engineers in a sample of nine physical, social and engineering sciences" (p. 165). The study's purpose was comprehensive in looking at active researchers and how they contributed to and used the scientific communication system. Factors examined included such areas as the informal network, the formal network, how information moves from one to the other, and the use of communication media. Much of the major work of this study dealt with the scientist as a contributor to the communication

system. In a 1974 paper by Garvey, Tomita, and Woolf, they found some differences among scientists and social scientists. For example, it was determined that for social scientists local colleagues and books were more useful than they were for the physical scientists, and for physical scientists meeting presentations and technical reports were more useful than they were for the social scientists. Bebout, Davis, and Oehlerts (1975) synthesized the previous studies and predicted that unlike scientists who used journals more than books, social scientists used both journals and books equally.

Bouazza (1986) conducted his dissertation research on Use of Information Sources by Physical Scientists, Social Scientists, and Humanities Scholars at Carnegie-Mellon University. In his study, Bouazza looked at information use in the sense of frequency of use generally and in relation to research and teaching. He sent a questionnaire to 390 faculty at Carnegie-Mellon University and received 240 completed questionnaires. He found that no objective study had been completed "which examines and compares simultaneously the differences among the information seeking behavior of physical scientists, social scientists, and humanities" (p.2). He looked at informal and formal sources and at use of sources at various stages of a research project: proposal, data collection, and data analysis. He found that in general faculty of all disciplines do not differ in their use of formal sources, but they do differ in their use of informal sources when they are collecting data, and when they are starting a new course. There was also a difference in the use of informal sources in the data collection phase. No difference was found at either the proposal stage or the interpretation stage for formal or informal

sources. When initiating a new study faculty do not differ in use of sources, but they do differ when developing a new course in their use of informal sources.

Reichel (1995) conducted a qualitative study on the future of scholarly communication as projected by faculty at the University of Arizona. Five groups including scientists, social scientists, humanists, librarians, and computer specialists were interviewed by the author. Although her study does not focus on comparing the different groups, her study does reveal some differences between scientists and social scientists on perceptions of information needs and scholarly communication in the future. She found that scholars in an university environment do not foresee a totally electronic environment for scholarly communication. Even though the general thrust is that computers and electronic access will be dominant, the participants of her study projected that the present products of the scholarly communication system still will be important in 2001.

While these studies revealed differences between the natural sciences and the social sciences in information seeking behavior and information use, there are also some studies that reveal similarities between the natural sciences and the social sciences. For example, Ellis, Cox, and Hall (1993) conducted a comparative study of information seeking patterns of researchers in the physical and social sciences by means of interview. They concluded that "the comparison of the information seeking patterns of the physicists and the social scientists shows no overriding differences between the two groups," "Although the extent of usage of a source and the stage at which a particular characteristic may be employed may differ, the characteristics of the information seeking patterns of the physicists and the social scientists are fundamentally the same" (p. 365).

Their findings confirm the broad conclusions of other studies by Garvey, Lin, and Wilson (1970, 1971, 1979) and Skelton (1973) that there are no major differences in the information seeking activities of social scientists and natural scientists although there are differences of emphasis.

Almost all the studies used obtrusive study methods such as interviews and questionnaire. None of research has used unobtrusive methods. The research angles of most these studies have solely focused on the subjects, what scientists wanted and used, where they found important sources, and how they used them, and what their perception of information was. This research will provide different focus by examining scholarly artifacts – journal articles in order to ascertain the stage of transformation to the virtual world achieved by natural and social scientists.

2.3 USE OF ELECTRONIC INFORMATION

Electronic information is the information existing in networked environment in the forms of computer files, including text files, graphic files, and program files. The history of the use of electronic information by the academic community goes back to as early as the time when the computerized information retrieval system was available. But use of full-text networked information began in the 1980s. Parallel publication of both the electronic and print versions of the same journal appeared with the American Chemical Society (ACS) in 1983 when it offered the full-text of its journal through BRS, a commercial online information services company (Tonta, 1995). The fifth edition of the Directory of Electronic Journals, Newsletters and Academic Discussion Lists,

contains entries for "nearly 2500 scholarly lists and 675 electronic journals, newsletters, and related titles such as newsletter-digests – an increase in size of over 40% since the 4th edition of April 1994 and 4.5 times since its first edition of July 1991" (Okerson, 1995, p. ii). Although the number of electronic journals and newsletters available through the network increased tremendously over the last couple years, Tonta (1995) thinks that the use of electronic networks as a means of publishing scholarly articles has not been accepted readily by the academic community.

Schauder (1994) conducted a survey in 1992 by means of questionnaire on the perceptions of scholars using electronic mail as well as using the network as a medium of publication, information distribution, and as a retrieval tool. He found that scientists used networks mainly for sending and receiving electronic mail. Only a small proportion (7%) of the scientists used networks to obtain information or publish articles therein, and a majority of them (75%) would prefer to read the printed copies of articles received in electronic form. Most scholars tend to be skeptical about the virtues of electronic publishing as the medium is "still widely perceived as unfit for serious scholarship, more like a global graffiti bound for trivial pursuit" (Harnad, 1993, ftp file). Stoller (1992) shared similar views in his comparison of electronic journals and print journals. He thought that:

> "The electronic journal is a hybrid. It springs form an effort to merge the informality, speed, and relative cheapness of network communication with the durable scholarship of the print world. In some degree, it is a hopeless endeavor, because the two components are so very different and indeed

contradictory. How does one inject durability into an electronic medium that is by nature transient or bring speed and cheapness to a print format that has become incurably cumbersome and expensive? But, if the electronic journals fail to achieve some form of formality of their print cousins, they will also fail to make a lasting contribution to scholarship" (p. 666).

Schaffner (1994) reached similar conclusions and pointed out that in order for electronic journals to be accepted as the medium of choice for publishing articles they must "meet the basic needs that print journals do, that they will initially maintain many of the features of traditional print journals, that their transformation may be driven by external forces, and that they will be slow in reaching their full potential" (p. 242).

In 1995 Budd and Connaway (1997) also conducted a survey on the habits and attitudes of university faculty towards the use of networked information. They sent a questionnaire to all faculties in six different departments including chemistry, physics, sociology, psychology, English, and history at eight universities across the United States. The six disciplines chosen covered broad academic areas (natural sciences, social sciences, and humanities), and the universities selected reflected both private and public governance structures and were dispersed geographically across the country. They found that many faculties used networked information for some kinds of communication and information-seeking activities. However, there appeared to be a substantial difference of opinion on pressure to publish and the place of electronic journals in the tenure and promotion process by rank and tenure status of the faculty. Among other conclusions,

they concluded that there was a lack of trust in electronic journals (or at least a lack of confidence that electronic journals allowed authors to reach their intended audiences and junior faculty to earn tenure) and that the future of this particular aspect of networking may be in question.

The study made by Tonta on the use of electronic information is also worthwhile to mention here. In 1995, Tonta conducted a survey on the use of networked information sources by checking the footnotes and bibliographies of 97 scholarly articles published in twenty-seven print journals that represent a wide range of subjects including chemistry, engineering, sociology, social science, library and information science, and business. The networked information sources were operationalized as electronic journals, electronic mail and ftp archives, messages to electronic discussion lists, personal communication and unpublished manuscripts. He found that networked information sources received very few citations in the top-ranked print journals during the period of 1993 – 1994. He explained the reasons as to why networked information is cited so infrequently. He thinks that lasting contributions to scientific inquiry through the articles published in electronic journals have yet to be made. And he also points out that articles published in electronic journals are not adequately indexed and abstracted in standard reference tools. However, his sample is very small, only four articles are chosen from each journal and his method of selection of sample is not very clear. Thus, he realized, "the results cannot be generalized to the overall scholarly communication activities" (Tonta, 1995, p. 5). Even if his results well represent the situation in use of networked information sources in the footnotes and bibliographies of scholarly articles, his results cannot be generalized to the

use of electronic information in scholarly communication since the use of electronic information does not necessarily mean that they are reflected in footnotes and bibliographies of scholarly articles. Some scientists may not note the electronic sources in the references of their article even if they used these electronic sources while doing research.

With support provided by a grant from the Council on Library Resources, the SUNY University Center Libraries conducted a four-campus survey of faculty use of electronic information technologies and resources in the fall of 1992 (Adam & Bonk, 1995). They tried to determine the availability to faculty of equipment and network connections necessary for access to electronic information resources, to measure use and frequency of use ,of these resources. This study includes all academic disciplines and a broad range of faculty at several institutions joined in a consortia relationship. Because the questionnaires were distributed by mail, it measured non-use as well. They found that there were inequities in access to electronic technologies among disciplines, and in general, the most common obstacle to the use of electronic information resources by faculty is a lack of knowledge about what is available, and that user training is considered by faculty to be a high-priority need.

Abels, Liebscher and Denman (1996) conducted a study in Fall 1993 and Spring 1994 to explore factors that influence the adoption and use of electronic networks by science and engineering faculty in six small universities and colleges. They used both mail survey and interview methods to collect data and used the dichotomous variable of use and non-use of the network and for five individual services to measure the adoption

of the networks. They found that, in general, factors influencing the adoption of the networks are different from those that influence the intensity of use and the number of services used. The results also indicate that physical access to a networked station seems to be the biggest determinant of network adoption. For optimum adoption levels, faculty needs access to the network from their primary workstation. They concluded that various actions such as expanding training programs to include a broader audience and a broader scope and increasing accessibility to a networked workstation, are necessary to enhance adoption and increase use. Also, expanding training programs to include a broader audience and broader scope will increase use. They also studied the different use of five types of the Internet services, including email, electronic discussion groups, accessing remote databases, accessing remote computer facilities, and file transfer. They found that in terms of services used, electronic mail was predominant and that electronic discussion groups were not a major resource for faculty at these institutions (Liebscher, 1997).

Lin, et al. (1994) conducted a study on the diffusion of the Internet among various academics by using data from the databases of the SCI and SSCI. They categorized the articles related to the Internet in sciences and social sciences into different disciplines to study the diffusion of the Internet among them. They found computer sciences and library and information science are the top fields which published the Internet-related articles in science and social science respectively. They also found that those academic communities that need international collaboration utilize the Internet as an effective tool for swift coordination.

Bane and Milheim (1995) conducted a survey of Internet use by "academics" (a term which they did not define) who subscribed to 231 randomly chosen discussion groups from a list of Scholarly Electronic Conferences. While they reported results regarding use of a number of Internet services in 17 countries, they did not collect or publish data on use by discipline, just sector (e.g., commercial, education, and government). Among other findings they state that "many academics are still not aware of its resources and possibilities, and not all foreign countries have access" (Bane & Milheim, 1995, p. 35). Another 1995 study of Internet use in academia is a Ph.D. dissertation which examined network information retrieval (NIR) among 888 faculty members at the University of Arizona with Internet-accessible computer accounts. Ashley reports that respondents from various colleges at the university use between 20 and 39% of available NIR technologies, suggesting that NIR is in an early stage of diffusion in all colleges. Another Ph.D. dissertation (White, 1995) examined a specific segment of faculty members, but included non-users as well, distributing the survey by mail to faculty members in professional organizations related to the study of mass communication, consumer behavior, and advertising and public relations. Unlike the previous studies, this study found that the majority (73%) of faculty in the sample used "computer mediated communication," with young faculty members and female faculty members showing significantly higher use than the general population. Alexander (1995) examining the use of the Internet listservs as post-teleconference support to faculty at community colleges and two-year institutions in her dissertation, found that 475

(nationally) of community colleges teleconference participants had access to the Internet and 30% knew how to use email.

Chu (1994) reported that an email survey administered to faculty at two U.S. universities showed that there were positive relationships between email use and such variables as specialty and experience with computers. Negative correlation, however, existed between age and the use of email. The majority of the faculty members (92%) included in the study used it in scientific communication. An Australian study (Bruce, 1995) analyzed the data of two samples of academics from a wide range of disciplines in 13 Australian universities. In this study, the use of the Internet to enhance their teaching was analyzed. The data revealed that the Internet, for Australian academics, represents "a mechanism for overcoming the disadvantages to academic teaching which may arise from institutional amalgamation, geographic remoteness or the under-representation of certain teaching disciplines in Australian universities" (Bruce, 1995, p. 191).

In her dissertation, Covi (1996) conducted a study on digital library perceptions and use by faculty and doctoral student researchers in diverse universities and in diverse fields to discover how resource arrangements influence researchers' abilities to effectively use digital libraries (including technologies such as the World Wide Web, shared databases, and bibliographic systems). She interviewed three faculty researchers in each of four fields (molecular biology, computer science, sociology, literary theory) at eight major Carnegie I research universities (four public and four private universities). When doctoral students were available in each field, they were also interviewed for her study. In total, she interviewed 96 faculty and 28 doctoral student researchers. She found

that knowledge workers' material use practices are shaped by the requirement to master bodies of knowledge for production of work. The principle of mastery was very apparent in molecular biology. Molecular biologists relied primarily upon print materials since they did not share common formats for exchanging electronic documents. Sociologists tended to rely on retrieving to focus the selection of materials for their work. The norms for work production in computer science often induced use and provision of the body of knowledge in electronic form, even if most of the work was published in print form. Literary theorists were usually bibliophiles and used retrieving to collect books and articles. Thus the utilization of digital libraries depends not only upon having electronic materials available, but also upon making relevant collections available in ways that support the development and maintenance of mastery ability in research subspecialties.

Lazinger, Bar-Ilan and Peritz (1997) investigated 462 faculty members in various disciplines on Internet use at the Hebrew University of Jerusalem in 1995. They distributed a questionnaire that consisted of 26 questions, primarily in multiple choice format by campus mail instead of through the Internet because they wanted to get both the responses of users and non-users among the faculty. The primary focus of their study was on the differences in usage, training, and the perceived importance of the Internet among two groups of faculty members – those in the sciences or agriculture and those in the humanities, social sciences or law. They found that faculty in the sciences and agriculture tended to use the Internet more intensively than faculty members in the humanities and social science.

Kling (1997) did an empirical study of the ways that faculty and graduate students in several fields in eight major US research universities used digital library (DL) services in the course of their routine work in 1995 by means of interview and field study. The DL services were characterized broadly in this study, including resources that are anchored in the traditions of library automation (i.e., Online Public Access Catalogs, digital abstracts, full text databases) and digital materials that are available through the Internet (i.e., certain electronic journals, conference proceedings, technical reports). Four disciplines were selected in this study including molecular biology, computer science, social science and literary theory. He found that there is a substantial variation in the use of digital libraries across disciplines. Literary theorists, sociologists, and molecular biologists made significant use of indexes and abstracting services that were mediated by publishers and provided by their campus libraries. In contrast, computer scientists do not use these indexing and abstracting services; they were the primary researchers who extracted electronic texts from Internet-mediated sources. He also found that too few scholars perceive electronic journals to be a legitimate means of communication for them to become major media soon. The Internet might become great of interest to scholars if electronic journals become a major medium of scholarly communication.

In February 1998, Ciolek (1998, "The Scholarly uses of the Internet: 1998 online survey", http://www.ciolek.com/PAPERS/InternetSurvey-98.html) sent an impromptu questionnaire surveying professional uses of the Internet to 1767 subscribers of seven English language electronic mailing lists specializing in Asian and Pacific studies via email. The method he used was self-selection, namely, the subscribers responded the

questionnaire voluntarily. It simplified the sample selection process but decreased the ability to generalize the results to the entire population since a set of members in the sample may decide not to participate. However, at this moment, most Internet-based surveys adopt this kind of method since there is no centralized registry of all users of the Internet and users are spread out all over the world. A total of 280 valid responses were received from 38 countries. He found that the three most popular professional uses of the Internet revolved around sending and receiving electronic mail (individual an list-mediated), and reading online news. The three most popular Internet construction activities were those which involved development of personal web pages, investigation of the Internet, and maintenance of various electronic mailing lists. He also found that during 1997, scholars who participated in the online survey spent approximately 43% of their office hours working on the Net, and 57% on paper-based and face-to-face activities.

2.4 IMPACTS OF ELECTRONIC COMMUNICATION

2.4.1 Social Impacts of Electronic Communication

Electronic communication has captured the attention of policy and propaganda media. Major newspapers run at least one story per week about electronic mail, the Internet, videomail, and other forms of computer-mediated communication (CMC). Electronic communication operates on a computer network that supports social networks. It combines location flexibility, rapid transmission to multiple others across time and space, and the ability to store and process information. These features make it an attractive tool for organizations that are geographically dispersed, work collaboratively,

and are information intensive. Thus, electronic communication has affected modern life in many aspects.

It is difficult to keep up with the proliferation of research on the social impacts of electronic communication, because relevant studies are published in many disciplines, and often only in poorly circulated reports and conference proceedings. Most articles on the impacts of electronic communication have focused on the electronic mail system. Garton and Wellman (1995) made a comprehensive review of the research on the social impacts of electronic mail in organizations. They summarized the methods used by those studies, including experiments, ethnographic observation, closed-ended surveys, open-ended interviews, and electronic data collection. They found that the discussions of media choice within organizations have largely treated it as an individual, voluntary act of matching tasks to media, and less attention has been paid to the influence of organizational power, group perceptions, and social network relations. The nature of interpersonal relationships, social networks, social influence, and organizational power structures all affect how groups and individuals use electronic mail.

Steinfield (1986) found that people with more email access to others in a large decentralized corporation used email more than did people who had less such access. Another study of a small office showed that those who were more involved in the existing communication network were more likely to follow group norms about whether or not to use email (Rice et al., 1990). Finholt, Sproull and Kiesler (1990) found that those groups that used email heavily spent less time in face-to-face meetings, on the telephone, and exchanging paper memos. Garton and Wellman (1995) also predicted that the effects of

computer mediated communication may spread well beyond today's narrow focus on organizational tasks, productivity, and structure; computer mediated communication may increase the dispersal of work, from offices to homes. Electronic mail increases access to new people, weakens spatial, temporal, and status barriers; and provides access to information that would otherwise be unavailable. Hess, Sproull, Kiesler and Walsh (1993) argue that networked discussion lists help improve the visibility and influence of scholars who are outside an inner circle within a field—i.e. those who are in lower status institutions, institutions with weaker programs in a particular specialty, and those who are lower ranked such as assistant professors, lecturers and so on.

There are a few studies focusing on the impacts of electronic media or computer mediated communication on academia. In his dissertation, Cohen (1995) investigated the relationship between the use of computer mediated communication (which includes email, electronic discussion list, Gopher, the World Wide Web, and electronic journal) and scholarly productivity as measured by publications and prestige factors. The population of this study covered full-time chemistry, philosophy, political science, and sociology faculty in U.S. research universities. He found that there is a positive relationship between the frequency of use of CMC and publications, including co-authored publication. Faculty who used computer mediated communication also had a higher incidence of prestige factors, including receipt of awards, service on a regional or national committee of a professional organization, service on an editorial board of a refereed journal, and service as a principal investigator. White (1995) conducted a mail survey of faculty members in professional organizations related to mass communication

and related fields on the use and impacts of computer mediated communication. He found that productive scholars in fields were likely to use computer mediated communication to communicate with scholars on different, geographically scattered campuses and to use computer networks in an instrumental way to send paper drafts for editing and review. He also found that the use of inter-campus email, discussion groups, and the use of computer networks for entertainment was less important to productivity. Crum (1989) surveyed 354 people by questionnaire to investigate factors influencing electronic mail use. She determined that sending and receiving one's own electronic mail messages, colleagues' pressure, organizational position, program area of responsibility, and type of equipment used to perform electronic mail are the significant factors influencing electronic mail use. Golden, Beauclair, and Sussman (1992) conducted a survey at an urban Midwest university to test several assumptions about the circumstances under which an individual will elect to use an electronic mail system. They found that user perceptions of the medium's usefulness will affect use, and formal and informal pressure can be used effectively to help induce nonusers to adopt.

In 1992, Kovacs, Robinson and Dixon (1995) conducted a qualitative study of the impact that Internet-distributed e-conferences have begun to have on the information-seeking and sharing behavior of library and information science professionals and scholars. They sent open-end questionnaire to 57 library and information sciences related e-conferences in existence in the spring of 1992. The purpose was to test the idea that e-conferences replace or enhance traditional sources of professional information for librarians and to learn how the e-conferences were being used and how much time was

spent by them. Along with other findings, they found that scholars in the field of library and information are using e-conferences as a source of professional and research information for their personal use. They are also using e-conferences as a source of information in providing direct or indirect service to library patrons.

2.4.2 Impacts of Electronic Journals

Electronic journals have various names such as electronic publications, online journals, digital journals, Web journals, as well as networked-based journals. They are a new vehicle to deliver scholarly information through a computer network. Although electronic journals have been under development since 1976 (Turoff and Hiltz, 1982), electronic journals in their non-experimental phase did not begin until the 1990s, with few exceptions (Harter and Kim, 1996). The first peer reviewed electronic, full-text electronic journal including graphics was the Online Journal of Current Clinical Trials (Keyhani, 1993). Many commentators such as Lanham (1993, 1994), Odlyzko (1995) and Okerson (1991) have conjectured about the nature and promise of future scholarly electronic journals, and even predicted the eventual demise of the journal in its print form. However, there are only a few research-based articles dealing with the impact of electronic journals on scholarly communication. Harnad (1991) described the scholarship activities based on electronic journal publication as "the fourth cognitive revolution," which is just about to take place.

Hitchock, Carr and Hall (1996) made a survey of full-text, peer reviewed electronic journals in the areas of science, technology and medicine (STM) and

discovered over 100 online titles towards the end of 1995. They found that hundreds more online journals were promised by publishers in 1996. Aimed at publishers, content producers, editors, authors, and archivists, the publication data presented were analyzed to indicate the nature and form of these electronic journals as well as something of their history, to discover trends and to highlight features that may project the shape and publication processes of future electronic journals beyond the immediate prospect of paper-dominated electronic editions. The paper also surveys journal awareness lists, from which many of the journals included were discovered, comparing the numerous lists now available and briefly assessing their reliability for discovering electronic journals. They found that some major publishers, those that have resolved what they expect to be an acceptable way of charging for electronic editions of existing paper journals, are about to move surprisingly quickly to make these journals available online. The survey also found some of the state-of-the-art online journals were produced by smaller, independent groups. Some electronic-only journals are beginning to demonstrate and exploit the potential of the new medium. They predicted that the next stage should see real examples of multimedia enhancements involving sound, video, and simulations, particularly in the fields of biology and medicine. They concluded that the emergence of electronic journals on a large scale will depend on whether electronic editions can evolve to become electronic-only journals, or on the commitment of the scholarly community to demand these features through the development of new journals, producers, and publishing structures.

Harter (1996) conducted a citation analysis of 39 scholarly electronic journals to study the impact of electronic journals on scholarly communication. He assessed the extent to which scholars and researchers are aware of, are influenced by, and build their own work upon research published in electronic journals. Based on the citation data that only eight of the 39 electronic journals had been cited ten or more times over their life times, he concluded that the great majority of scholarly, peer-reviewed electronic journals have had essentially no impact on scholarly communication in their respective fields. He suggested the possible reasons for this were that electronic journals were publishing far few articles in a given year than most other journals in their respective fields and that not enough authors view electronic journals as legitimate publication vehicles. In another article, Harter and Kim (1996) applied citation analysis to measure the impact of the electronic journal on formal scholarly communication. They also examined the forms in which scholars cited electronic journals, the accuracy and completeness of citations to electronic journals, and practical difficulties faced by scholars and researchers who wish to retrieve electronic journals through the network.

Collin and Berge (1994) conducted a case study on an electronic journal – Interpersonal Computing and Technology Journal: An Electronic Journal for the 21st Century. They maintained that for the electronic journal to be successful it should at least conform to some requirements, including credibility, accessibility, technical ability, and permanence. They concluded that even if electronic journals are less expensive, easier to access, or save time, this is not going to allow electronic journals to compete with print journals if the content of the electronic journal is not perceived to be of high quality.

Bailey (1994) pointed out that "global computer networks, such as the Internet, have created a complex electronic communication system that has significantly changed the way scholars informally exchange information and has started to change formal scholarly publication activities" (p. 7). He examined how scholarly electronic publishing could be conducted on the Internet, the National Research and Education Network, and the National Information Infrastructure. Six types of models for network-based electronic publications were discussed in his paper, including benchmark print-based, acquisition-on-demand, national site license, discipline-specific literature base, augmented print, and distributed information models. He envisioned network-based electronic publishing as initially augmenting conventional publishing efforts and then gradually displacing them.

In the report prepared for the Andrew W. Mellon Foundation, Cummings et al. (1992) addressed two main issues: (1) the explosion in the quantity of desirable published material, and the rapid rise in unit price of those items, jeopardizes the traditional research library mission and (2) new technology makes it possible to envision radically different ways of organizing collections and services. Based on research at 24 research libraries, they discussed the virtues of electronic publication, including that a reader can instantly locate a passage in the commentary of particular interest using a search-engine and that electronic media may be a more appropriate channel for distribution with respect to economic cost-effectiveness, in very specialized fields where monographs can, at best, be expected to sell just a few copies. They observed that electronic publication has the virtue that it is the only existing medium appropriate for publishing material of certain types. They concluded that electronic texts can remove the limitations of print on paper.

They can be dynamic, mutable, and are potentially eminently interactive. They may allow the producer and the user to uncouple the material object from the intellectual content. Yavarkovsky (1990) also came to the same conclusion, "In some instances, research results are not published by conventional, printed means because the results can't be printed and still be meaningful. This is true, for example, when the results are three dimensional, graphic, moving simulations, or animations, or when the outputs are dynamic visual representations of variable processes or theoretical constructs" (p. 14).

Based on a pilot study, Olsen (1994) examined the interaction between the scholar and journal literature with a focus on the scholars' requirements for an electronic journal system. To conduct the study, he selected one discipline from the physical sciences (chemistry), one from the social sciences (sociology), and one from the humanities (English). In each discipline sixteen scholars at two major research universities (Cornell University and the University of Pennsylvania) were randomly selected and interviewed on their interactions with journal literature. He explored the ways academics use journal literature in printed form and speculated on its use in electronic form. He found that the scholars interviewed for this study generally did not indicate reluctance to accept the concept of electronic journal. All scholars readily identified the advantages it would have over print and did not seem concerned that it would disrupt their work habits. However, he did find some basic requirements of design for the publication of electronic journals by these scholars. These requirements include improvement of access to the literature, searching, reduced log time in access to recent literature, and creation of their own electronic file of articles.

Quinn (1994) stated that theoretical physics is further along in the development of electronic scholarly communication than other disciplines. He predicted the collapse of the traditional paper journal in theoretical physics and expressed concerns about the consequences of hypertext citation (http://publish.asp.org/EPRIINT/quinn.html). He further predicted the collapse of traditional journals and discussed the difficulties of using electronic journal citations for tenure and promotion decisions. He concluded that papers not in computer databases will be cited less frequently. Langston (1996) looked at the issue of how scholarly publishing in an electronic forum affects the academic tenure process. He argued that print technology will be with us for a long time while network technology and electronic authorship is changing what we think of as text, what is a work, and who is an author.

In October 1993, two organizations – the Council on Library Resources (Washington, DC) and the Professional/Scholarly Publishing Division of the Association of American Publishers (New York and Washington, DC) agreed to co-sponsor a Joint Working Group on Professional and Scholarly Information in the Electronic Age (Scovill, 1995). The Joint Working Group, consisting of equal numbers of professional and scholarly publishers and academic librarians, was asked to address the common issues of value-added contributions in the emerging electronic environment and to identify the issues that need to be addressed for successful collaboration. Although this effort has concentrated on primary publishers and academic librarians, the Group has considered the entire chain, from researcher to end user, with all intermediate links including subscription agents, secondary publishers, on-line vendors, and listserves.

The focus of the group was on scholarly journals. They discussed the roles and functions of publishers and librarians in both print and electronic environments. They concluded that electronic publications sometimes replace, sometimes supplement, and sometimes parallel traditional print publication. It may shorten the distance, smooth the path, or offer alternate routes between researcher and end user, but it will not eliminate the need for the functions now performed by publishers and librarians which add value to the scholarly communication process. Nonetheless, the electronic environment will change financial, technological and intellectual functions, and value added activities. Their study suggests that although the electronic age may change the methods by which the functions of publishers and academic librarians are performed, and in some cases who performs them, the scholarly community's need for these functions will still remain.

Kling and Covi (1995) examined how moving from paper to electronic distribution alters the legitimacy and perceived quality of journals. They tried to locate electronic publication within a larger social system of scholarly communication and concluded that the rapid demise of paper-based publications seems less likely. They argued that electronic publication might also give people who are outside an inner circle within a field greater visibility, if their electronic journal articles are read by scholars in more prestigious positions or more central locations.

2.4.3 Transformation of Scholarly Communication

Since computer mediated communication is speedier, less costly, and in many ways more convenient than the traditional paper-based communication system, it affects

both informal and formal scholarly communication processes. As a result, scholarly publishing in electronic form based on the Internet has profound impacts on scholarly communication including research, the academic tenure process as well as other aspects. An optimistic view claims that new technology (as epitomized by graphical, easy-to-use browsers for the world wide web, coupled with sophisticated software that can perform citation anlysis and intelligently search through vast amounts of information) will transform scholarly publication for the better by allowing people to quickly seek out information, respond to others, publish electronically at a low cost, and ultimately speed up the typically long cycle of publishing a peer reviewed article (Harnad, 1995a, Harnad, 1995b, Lanham, 1993, Odlyzko, 1995, Schwier, 1994, Stodolsky, 1995, Taubes, 1996a, and Taubes, 1996b). The transformation process happens in both informal and formal scholarly communication. Gresham (1994) did a case study on informal scholarly communication through a computer network among the scholars of religious studies. He observed their behavior and also did a survey about how they use the Internet, especially electronic conferences to facilitate research and instruction. He concluded that "the kind of informal scholarly communications that characterized those social networks known as invisible colleges are now increasingly taking place across computer networks" (p. 38). Informal scholarly networking is moving from physical locations in conference and research centers into "cyberspace," the virtual space created by electronic networks. He believed that the transformation of informal scholarly communications has already begun and that academia is in the initial stages of a shift from the invisible college to the cyberspace college as a new form of the informal research network.

While Gresham (1994) and other scholars focused on the impacts of electronic networks on informal scholarly communications, much has been published regarding the changes in the formal scholarly communications network that will follow the shift from print to electronic journals (Robison, 1993). Although the visions of the shift are different, there is a common opinion, that is, that electronic scholarship based on the network will dominate the future of formal scholarly communication. For example, some researchers focused on new forms of electronic communication, such as electronic discussion list as representing the transition (Kovacs, 1994), others concentrated more on electronic scholarly journals (Langschied, 1994) and computer models and simulations, real-time presentation, and multimedia creations (Brett, 1993). Kappe, Pani and Schnabel (1993) argued that Gopher and World Wide Web are new ways of sharing information with constituencies. Smith and Johnson (1993) discussed the pressures on scholarly communication caused by the exponential growth in the volume and complexity of scholarly information and see an emerging long-term solution "as the research/higher education community takes advantage of the new information technology, transforming scholarly communication from a print-based to an electronic-based system" (p. 394).

In his paper, Lynch (1993) describes the transformation of scholarly communication in the age of networked information as "the use of new technology to change process in a fundamental way" (p. 8). He defines the transformation as "a shift from a scholarly communication system that fixes results into print publications to one that relies on quality-controlled distributed hypertext databases that are updated continuously, accessed and distributed through computer communications networks, and

perhaps controlled by intelligent agent programs operating on behalf of end users, describes a potential transformation" (Lynch, 1993, p. 8). He also thinks, "the ability to publish relatively raw experimental data and programs that model and manipulate, not merely summarize and analyze it, represents a potential transformation in scholarly communication. The possibilities of developing distributed network-based multimedia that combine images, sounds, text, computer programs, and other objects is transformational in nature. Shared virtual reality environments, operating across the network as a 'place' to perform scientific collaboration, point the way towards yet another transformation in the scholarly communications process" (p. 8-9). In 1989 Rogers and Hurt described a new scholarly communication system for the 21st century as "an electronic network" on which scholars in all disciplines could "publish" their articles and they could also read other publications. This system could provide three new capabilities: a "notes and comments" section, citation tracking, and a usage log (p. 5).

In November 1996 the Association of Universities and Colleges of Canada (AUCC) and the Canadian Association of Research Libraries (CARL) published a final report of the AUCC-CARL Task Force on Academic Libraries and Scholarly Communication. Many observers, preparing the final report, believe that the concept of the "virtual library" which harnesses the power of the personal computer to create an open system accessible to anyone, anywhere, at any time, represents the future for scholarly communication. The final report – The Changing World of Scholarly Communication Challenges and Choices for Canada, considers the changing nature of scholarly communication, explores major options for actions, and makes recommendations for

follow up. It was reported that "we are in the midst of an enormous and exciting revolution in academic communication."

> "The quantum leap in electronic and communications technologies has altered the behavior and activities of scholars in ways that could not have been foreseen a mere two decades ago. The use of personal computers has swept across academia, redrawing communication patterns. Many researchers and students of the 90's rely extensively on the Internet and its graphics-rich component, the World Wide Web, to find and exchange information" (1996, http://homer.aucc.ca/english/sites/aucccarl.htm# Introduction).

It also concludes, "computer-based communication has changed the behavior of many scholars and scientists. More rapid and frequent exchanges of information between scholars are occurring in a less formalized way, making the communication of scholarly and scientific information less a product than a process." It predicts that electronic publishing will become more prevalent and will "ultimately achieve widespread recognition as a legitimate form of scholarly communication" (1996, http://homer.aucc.ca/english/sites/aucccarl.htm#conclusion).

The transformation of scholarly journals from a paper to an electronic format is one possible impact of the growth of the Internet and has drawn a good deal of attention within the sciences. Giles (1996) coined this kind of new scholarly communication based on electronic format as a "cyberspace model" of scholarly communication. Within the cyberspace model, scholarly communication, is done electronically via the Internet. The central element of this model is the server. The server is a site on the Web where papers

can be posted and from which they can be retrieved. He describes two types of servers that operate in the cyberspace model: unrefereed and refereed. Unrefereed servers simply provide a place for scholars to make their ideas and research available to the scholarly community. A scholar can still send a manuscript to selected individuals and do so more conveniently, but through the use of the server Web site, the scholar provides his or her ideas and research for the general use and scrutiny of the scholarly community. Anyone interested can access and make use of the paper. In turn the author will receive comments and can produce revised versions. The refereed server, on the other hand, functions in much the same way as current print journals. Manuscripts are submitted and reviewed by a panel of experts in the substantive field. On the basis of these reviews, the editor/owner of the server either accepts or rejects the manuscript for placement on the server. Manuscripts placed on refereed servers are said to be "archived" indicating that this work has been judged of sufficient merit that it should be maintained as part of the discipline's accumulated knowledge base.

2.4.4 Arguments on the Transition

While most literature expressed optimistic opinions on the impacts of electronic computer networks on scholarly communication, there are some studies that reached the opposite conclusion. Ellis, Cox and Hall (1993) made a comparison study of the information seeking patterns of researchers in the physical sciences and social sciences. They found "the relatively minor impact which developments in information technology have had on the information seeking and communication activities of the three groups"

(p. 336), these three groups include physicists, chemists, and social scientists. "In relation to the communication of research, the employment of electronic communication as a complement to or substitute for the traditional forms is, as far as can be discerned, virtually non-existent" (Ellis, et al, 1993, p. 336). Their findings confirm an earlier observation by Meadow and Buckle (1991) that although the potential for electronic communication of research, in the form of electronic conferences and journals, has been widely discussed, and despite the technical feasibility of this form of communication as demonstrated in many projects, the impact on the scientific communication of academic research, at least in the UK, has remained negligible. Based on the findings, Ellis and his colleagues concluded,

> "There does appear to be increasing interest in the USA in electronic communication of research results in the form of electronic conferences and journals but it seems unlikely that this form of communication will displace traditional conference and journal publication – at least in the near future – partly because of the role of conference in creating and maintaining personal contact but also because of the lack of formal recognition of electronic media as representing legitimate outlets for publication" (p. 336).

In a recent study done by Reichel (1996), she also concludes that "at this time, the communications which take place through electronic mail are not projected to become part of the formal products of the scholarly communication system" (p. 232).

2.5 Gaps of the Literature

The literature above reveals that (1) there are some differences between the natural sciences and the social sciences; (2) there are some differences in the information seeking and scholarly communication of the natural sciences and the social sciences in some aspects, such as usage of information sources, but that they all share similar paradigms of scholarship and they have some similar fundamental characteristic; (3) global computer networks have impacts on both the natural sciences and the social sciences, and also have impacts on both formal and informal scholarly communication.

Overall, the literature has set up a foundation for us to further study the transition to the virtual world in formal scholarly communication. This will arouse scientists, librarians, and publishers to work cooperatively towards this transition in their scholarly activities, and further promote formal scholarly communication. However, there has been insufficient work done to reveal the transition to electronic form in formal scholarly communication in terms of research content, research approach, methods, and timeliness. The basic shortcomings of these studies are as follows.

First of all, as reviewed above, studies on scholarly communication have focused on information use and need by scientists in the traditional paper-based communication environment since the 1960s. Dervin and Nilan (1986) summarized these studies as demographic because most of the studies focused on what, what type of, when, how information was used, and by whom. Questionnaire and interview approaches were widely used in these studies. However, the scholarly communication environment has changed dramatically since then, especially the global computer networks and the Internet

which have been widely adopted and become a useful tool in scholarly communication, and information becomes more and more available electronically worldwide. Unfortunately there is little research on formal scholarly communication in this new environment. As a matter of fact, even the studies of the traditional paper based environment have validity problems in original research design. Many information use and need studies have exclusively measured bibliographic information which has narrower meaning than the concept information. But it seems that this kind of validity problem has been ignored in library and information science.

The perspective of the research-based articles regarding the transition in formal scholarly communication is from the point of view of the publishing process. Most studies were done by observing the changes of publishing means, whether paper-based or electronic-based, to measure the transition. For example, articles listed by Robison (1990) are almost all about the electronic publishing process. Studies done by Stoller (1994), Harnad (1991), Harter and Kim (1996), are also publishing process oriented. However, publishing is only one step in formal scholarly communication that produces scholarly artifacts to carry the information created by scientists or scholars. The whole process of formal scholarly communication includes academic writing, submitting, editing, publishing, delivering as well as absorbing or using. It involves at least scientists, publishers, and librarians. The publishing is definitely not the essential part in formal scholarly communication but a bridge between information creator and user. There are many other ways to build the bridge between information creator and user. The essential part in formal scholarly communication is the scholarly behavior of scientists,

namely, how they seek and use information, and how they communicate with each other in a formal scholarly fashion. Scientists are dynamic characters in formal scholarly communication. Therefore, the research perspective should be shifted from focusing on the publishing process to emphasizing the behavior of scientists.

The transition in formal scholarly communication is not only a subjective social event but also an objective social phenomenon. Thus it should be studied both unobtrusively and obtrusively in order to judge the extent of the transition fairly. However, almost all studies were done by means of obtrusive methods such as interviews, questionnaires, and focus groups. These methods are good at collecting people's opinions or perceptions on formal scholarly communication but do not reveal all aspects of scientists' behavior in formal scholarly communication. In obtrusive interviewing, a researcher may not be able to avoid reactivity and consequent distortion of results. The experience of the subjects, their attitudes toward new technologies, and their scholarship styles will heavily influence their perceptions on the changes in formal scholarly communication. These perceptions may not always agree with their actual behavior, as revealed in obtrusive studies. This may be why there has been a conflict in understanding the transition in scholarly communication.

Furthermore, the transition is a chronological process so the extent to which the transition take place at different times should vary in many aspects. Time period is a key factor to studying the transition in formal scholarly communication since technological progress and innovations are time-related. For example, before Gutenburg's invention of movable print type, no one was able to predict its impact on scholarly communication

since it did exist then at all. However, if there is a reliable and valid methodology to study the transition, we would not only get research results that can be generalized, but that would also useful for prediction. Unfortunately, no efforts of this sort have been found in the literature.

In order to avoid these shortcomings, the research perspective should be shifted from focusing on the publishing process to scientists' behavior in formal scholarly communication, and unobtrusive methods should be adopted in addition to the obtrusive study methods, and a good study should be well designed in terms of validity and reliability. The present study is designed to draw on the merits of previous studies while trying to avoid their shortcomings and enhance the validity and reliability of the research.

CHAPTER THREE RESEARCH METHODOLOGY

3. 1 RESEARCH DESIGN

This study explores the transition from the traditional paper world to the virtual world in formal scholarly communication in the mid-90s when global computer networks are playing an increasingly important role in modern scholarly communication. The present study has two basic objectives. The first objective is to describe the degree of transition in formal scholarly communication from paper to electronic formats in selected natural sciences and social sciences. The second objective is, by comparing the status of adoption of electronic vehicles in the chosen fields in the natural sciences and the social sciences, to determine if there are any significant differences between the natural sciences and the social sciences in the stage or character of the transition. In order to achieve these two objectives, a variety of unobtrusive methods are adopted for data collection and analysis in this study.

For the first objective, this study drew two groups of high impact research-oriented journals published in two different years from classic fields in both the natural sciences and the social sciences, and investigated changes from paper to electronic form at the two publication times of 1994 and 1997. To accomplish this objective, a set of unobtrusive indicators was developed to describe the transition in formal scholarly communication. These indicators include activities such as publicity, manuscript

submission, citation, and information access. Descriptive statistical methods were used to describe the changes towards electronic formal scholarly communication.

For the second objective, this study views global computer networks as an experimental treatment and the transition is viewed as the effect caused by the global computer networks. This study examines whether there are any changes in adopting electronic vehicles between the two years and if there are any differences in the transition to the virtual world between the natural sciences and the social sciences under the impact of global computer networks. To determine if there are any differences between the natural sciences and the social sciences in the stage or character of the transition, this study measures the electronic publicity of journals, acceptance of electronic submission, and electronic accessibility of information, utilization of electronic information sources, and electronic publicity of scientists among these selected natural science fields and social science fields. For the purpose of this study, the following null hypotheses about the differences in the transition between the natural sciences and the social sciences in those aspects were postulated. Statistical inference is employed to analyze the data from the research, and especially, the Chi square test will be used to test the null hypotheses.

> ***Hypothesis I***: The electronic publicity of journals is not related to the type of science in formal scholarly communication. (Here the term "type of science" refers to whether a discipline falls into the category of the natural sciences or the social sciences in this hypothesis and the following hypotheses.) In other words, there is no significant difference in the electronic publicity of journals between the

natural sciences and the social sciences. Electronic publicity could be realized through releasing the journal's Web site address, its publisher's Web site address, its email address; permitting electronic submission; or electronic publishing. Thus this hypothesis may imply the following sub-hypotheses in formal scholarly communication:

Hypothesis I_1: There is no significance difference between the two science areas in releasing journal's Web site address.

Hypothesis I_2: There is no significant difference between the two science areas in releasing publisher's Web site address.

Hypothesis I_3: There is no significant difference between the two science areas in releasing journal's email address.

Hypothesis I_4: There is no significant difference between the two science areas in permitting electronic subscription.

Hypothesis I_5: There is no significant difference between the two science areas in electronic publishing.

Hypothesis II: The acceptance of electronic submission is not related to the type of science in formal scholarly communication. In other words, there is no significant difference in the acceptance of electronic submission between the natural sciences and the social sciences. There are three types of electronic submission: disk submission, plain email message submission, and formatted FTP

file submission. Therefore, this hypothesis may imply the following sub-hypotheses:

Hypothesis II_1: There is no significant difference between the two science areas in the acceptance of electronic submission on disk.

Hypothesis II_2: There is no significant difference between the two science areas in the acceptance of electronic submission via plain email message.

Hypothesis II_3: There is no significant difference between the two science areas in the acceptance of electronic submission via formatted FTP file.

Hypothesis III: The electronic accessibility of information is not related to the type of science in formal scholarly communication. In other words, there is no significant difference in electronic access to information between the natural sciences and the social sciences in formal scholarly communication. Information in formal scholarly communication can be published in two forms: full-text information and non-full-text information (bibliographic information and abstract). This hypothesis may imply the following two sub-hypotheses:

Hypothesis III_1: There is no significant difference between the two science areas in accessibility to bibliographic information and abstracts electronically.

Hypothesis III_2: There is no significant difference between the two science areas in accessibility to full-text information electronically.

Hypothesis IV: The electronic publicity of scientists is not related to the type of science in formal scholarly communication. In other words, there is no significant difference in the electronic publicity of scientists between the natural sciences and the social sciences in formal scholarly communication. Publication of email addresses and Web site addresses of authors are the two ways by which scientists publicize themselves electronically. This hypothesis thus may imply the following two sub-hypotheses:

Hypothesis IV_1: There is no significant difference between the two science areas in releasing a scientist's email address in journals.

Hypothesis IV_2: There is no significant difference between the two science areas in releasing a scientist's Web site address in journals.

Hypothesis V: Utilization of electronic information sources is not related to the type of science in terms of the frequency of electronic citations appearing in journals. In other words, there is no significant difference in utilizing electronic information sources between the natural sciences and the social sciences in terms of citations. In this study, electronic citations include Web site documents, FTP file documents, Gopher file documents, electronic journals, and other electronic documents. This hypothesis thus may imply the following sub-hypotheses:

Hypothesis V_1: There is no significant difference between the two science areas in citing Web site documents.

Hypothesis V_2: There is no significant difference between the two science areas in citing FTP file documents.

Hypothesis V_3: There is no significant different between the two science areas in citing Gopher file documents.

Hypothesis V_4: There is no significant difference between the two science areas in citing electronic journal documents.

Hypothesis V_5: There is no significant difference between the two science areas in citing other electronic file documents.

Hypothesis VI: There is no significant difference between 1994 and 1997 in the electronic publicity of journals in formal scholarly communication. This hypothesis may imply the following sub-hypotheses:

Hypothesis VI_1: There is no significant difference between 1994 and 1997 in releasing a journal's Web site address.

Hypothesis VI_2: There is no significant difference between 1994 and 1997 in releasing a publisher's Web site address.

Hypothesis VI_3: There is no significant difference between 1994 and 1997 in releasing a journal's email address.

Hypothesis VI_4: There is no significant difference between 1994 and 1997 in permitting electronic subscription.

Hypothesis VI_5: There is no significant difference between 1994 and 1997 in electronic publishing.

Hypothesis VII: There is no significant difference between 1994 and 1997 in the acceptance of electronic submission in formal scholarly communication.

Hypothesis VII_1: There is no significant difference between 1994 and 1997 in the acceptance of electronic submission on disk.

Hypothesis VII_2: There is no significant difference between 1994 and 1997 in the acceptance of electronic submission via plain email message.

Hypothesis VII_3: There is no significant difference between 1994 and 1997 in the acceptance of electronic submission via formatted FTP file.

Hypothesis VIII: There is no significant difference between 1994 and 1997 in the electronic accessibility of information in formal scholarly communication.

Hypothesis $VIII_1$: There is no significant difference between 1994 and 1997 in accessibility to bibliographic information and abstracts electronically.

Hypothesis $VIII_2$: There is no significant difference between 1994 and 1997 in accessibility to full-text information electronically.

Hypothesis IX: There is no significant difference between 1994 and 1997 in the electronic publicity of scientists in formal scholarly communication.

Hypothesis IX_1: There is no significant difference between 1994 and 1997 in releasing a scientist's email address in journals.

Hypothesis IX$_2$: There is no significant difference between 1994 and 1997 in releasing a scientist's Web site address in journals.

Hypothesis X: There is no significant difference between 1994 and 1997 in utilization of electronic information resources in formal scholarly communication.

Hypothesis X_1: There is no significant difference between 1994 and 1997 in citing Web site documents.

Hypothesis X_2: There is no significant difference between 1994 and 1997 in citing FTP file documents.

Hypothesis X_3: There is no significant difference between 1994 and 1997 in citing Gopher file documents.

Hypothesis X_4: There is no significant difference between 1994 and 1997 in citing electronic journal documents.

Hypothesis X_5: There is no significant difference between 1994 and 1997 in citing other electronic file documents.

3. 2 CHOICE OF RESEARCH METHODS

There have generally been two types of methods used in research on scholarly communication so far. One method is obtrusive, in which the research is undertaken with subjects who are known and are cooperative with the researchers, such as interviews, questionnaires, focus groups, and so on. Most information use studies use this kind of method, such as Reichel's (1995) dissertation research, and most information use studies

described in review articles appearing in the Annual Review of Information Science and Technology since the 1960s. The other method is unobtrusive study, in which the research is conducted while the subjects are not aware that they are being studied. For example, citation analysis, studies of computer logs of information activities, measures of productivity based on the number of publications, and all other bibliometric studies are unobtrusive studies.

3. 2. 1 Obtrusive Study Methods

Survey methods are a standard methodology in social science research and have been used extensively in information use and scholarly communication studies. In this research methodology, a researcher frames a number of questions, typically consisting of closed-ended questions, and administers the survey instrument containing these questions to a randomly selected sample from an appropriate population. The survey instrument is designed carefully with tests for validity and reliability. Comprehensive research studies of the natural sciences such as the one done by Garvey (1979), and of the social sciences, the INFROSS study (Line, 1971), were all based on survey methodology. A more recent example of a study using this methodology is the research done by Abels, Liebscher, and Denman (1996) with a population of science and engineering faculty in six small universities and colleges. The major advantage of the survey method is that a large number of subjects can be questioned, and, with an appropriate sample, the behavior of the population as a whole may be inferred. A disadvantage of the survey is that it restricts the kind of answers that can be elicited. And more important, surveys may be more

appropriate for investigating scientists' attitudes toward and perceptions of scholarly communication and behavior in informal scholarly communication. They may not accurately reflect scientists' behavior in formal scholarly communication because of potential bias in self-report.

Interview methodology involves one-on-one interviews with a sample or an entire population to be studied. The interviewer starts with a pre-determined list of questions or topics and poses them to the interviewees. The interview method may involve closed-ended or open-ended questions. Interviews using closed-ended questions may be used in place of survey questionnaires. An interview that uses open-ended questions is more qualitative in nature. The advantage of the interview over survey methodology is that it might elicit more speculative information and bring out strands of ideas that have not been considered by the researcher. One disadvantage of the one-on-one interview method is that the interview takes place in isolation and the interviewee does not have an opportunity to interact with other people and build on the ideas of others. Another disadvantage is the practical consideration of getting a large enough number of scientists to agree to individual interviews.

Focus group methodology is one means of gathering qualitative research data through carefully planned group interviews. Krueger (1988) defined it as "a carefully planned discussion designed to obtain perceptions on a defined area of interest in a permissive, non-threatening environment. It is conducted with approximately seven to ten people by a skilled interviewer. The discussion is relaxed, comfortable, and often enjoyable for the participants as they share their ideas and perceptions. Group members

influence each other by responding to ideas and comments in the discussion" (p. 18). A successful example of using focus groups to study scholarly communication is the research done by Reichel (1996). She selected five groups from the faculty at the University of Arizona to investigate their perceptions on scholarly communication and information needs in the year 2001. One advantage of this methodology is the ability to gather data that might include speculative ideas. One disadvantage is that some participants may not contribute as fully as they would like because they may be uncomfortable in a group situation.

All these studies involve some interactions with the people who are under study: asking them questions in a questionnaire or interview, and giving them tasks to perform in a group. There is a concomitant danger that accompanies such intrusions into the flow of social life: the act of research may influence that which is the subject of study (Babbie, 1995). By asking people about their preferences in using retrieval systems, we may influence those preferences to some degree, perhaps making respondents more definite in their choices by getting them to commit themselves out loud.

3. 2. 2 Unobtrusive Study Methods

Many research techniques can be called unobtrusive in that they have no impact on what is being studied. As Babbie (1995) said, "this method allows researchers to study social life from afar, without influencing it in the process" (p. 306). Content analysis, the analysis of existing statistics, and historical/comparative analysis are all unobtrusive research methods (Babbie, 1995). This methodology has been successfully

used in the evaluation of library and information service, such as in Childers' study (1972), and concerning scholarly communication, as in Bradford's bibliometric study (Bradford, 1934), and in Garfield's citation analysis study (Garfield, 1979). One major advantage of unobtrusive studies over obtrusive ones is the research subjects who are being studied are not aware of being studied so their behavior is not affected at all by the study. The most common unobtrusive approach in scholarly communication is to study scholarly artifacts created by scientists, such as articles, journals, or citations used by them. In the social sciences this method is similar to content analysis but in scholarly communication study this method is called a bibliometric study or citation analysis. Through scholarly artifacts, the roles of scientists, the information use behavior of scientists, the relationships between scientists, and relationships between disciplines can be studied unobtrusively. Because these artifacts have already been historically produced, scientists cannot make any changes to them. This means that the studies based on them will not be affected by the scientists. This will help researchers improve the reliability of the data, since anyone else will get the same data whenever s/he wants to re-collect them.

Based on the above comparison of obtrusive and unobtrusive studies, the researcher therefore decided to adapt unobtrusive methods to collect data and conduct the study. Formal scholarly communication is highly dependent on scholarly artifacts -- scholarly journals, as the scholarly artifacts, carry the information that was created, delivered, and used by scientists in scholarly communication. These scholarly artifacts, in general, reflect scientists' behavior and their interaction in formal scholarly communication, although there are some limitations in citing behavior. Through studying

these artifacts created by scientists, we can learn how scientists in the classic natural science and social science fields are transforming formal scholarly communication from the traditional paper world to the virtual world.

3. 3 SAMPLING DESIGN

3. 3. 1 Two Samples

The universe selected for representation in this study consists of academic journals in the natural sciences and the social sciences, which were listed in the Journal Citation Reports (JCR) published by the Institute for Scientific Information in 1995. The Journal Citation Reports usually comes out one and a half years after source articles are published. The 1995 version of Journal Citation Reports was the latest one published when the researcher started gathering data for this study in June 1997. There are two samples in this study. One sample is composed of the journals from the natural sciences; and the other sample of journals from the social sciences. The two samples were drawn from the SCI (Science Citation Inddex) Journal Citation Reports and the SSCI (Social Sciences Citation) Index Journal Citation Reports, respectively, by using three criteria for finding the "typical" individual journals for this study. The sample size was determined to be thirty for each sample.

Three classic fields from each of the natural sciences and the social sciences were chosen for this study, including biology, physics, and geology, economics, political science, and sociology. Starting with the journal with the highest impact factor, ten research-oriented, refereed academic journals for each of these three fields of the natural

sciences and each of those of the social sciences, were selected from each of these selected fields, respectively, for this study. A total of sixty journals selected in the two samples was used as data sources regarding electronic submission, publicity of journals, and accessibility of academic information in these fields.

The first issues of the years 1994 and 1997 of each of the thirty selected journals from the natural sciences and each of the thirty selected journals from the social sciences were chosen to constitute the research data source in general. One year before 1994, 1993 was the year that the World Wide Web service was first available publicly. Since then, no new major electronic communication service of comparable scope has been implemented. The data from 1994 will provide us with data about the early days of the transition of formal scholarly communication to the virtual world and serve as a basis for longitudinal study. At the same time, 1997's data will give us a picture of the most recent developments in electronic formal scholarly communication. Therefore, the data from two different points in time will help the investigator understand both the early development of electronic vehicles in formal scholarly communication and the most recent status of the transition.

In cases when the first issues of the years were not available at the time of the data collection, the next issues of the same year (namely, 1994 and 1997) were chosen; if the next issues are not available either, the last issues in the prior years (namely, 1993 and 1996) were chosen. These sixty journals provided the data on the electronic publicity of journals, acceptance of electronic submissions and the electronic accessibility of information. The sixty journals and issues selected are listed in Appendix 1 and 2.

However, for the other two kinds of data, the investigator had to turn to articles and references within the journals selected. Every research-oriented article in the issues selected for the two years of the total sixty selected journals constituted the research data source on the utilization of electronic information sources in this study. Scientists who published these research-oriented articles in these issues of the selected journals constituted another layer of data source regarding the electronic publicity of scientists in this study. For studying the utilization of electronic information and electronic publicity of scientists, all research articles from both the natural sciences and the social sciences in the selected issues were selected for each of the two different time slices. An investigation into these journals, articles/scientists, and references was conducted during the spring and summer of 1997.

The data source in this study has a hierarchical structure, which is composed of journals, articles/scientists (authors), and citations. The details are shown below (Figure 3.1).

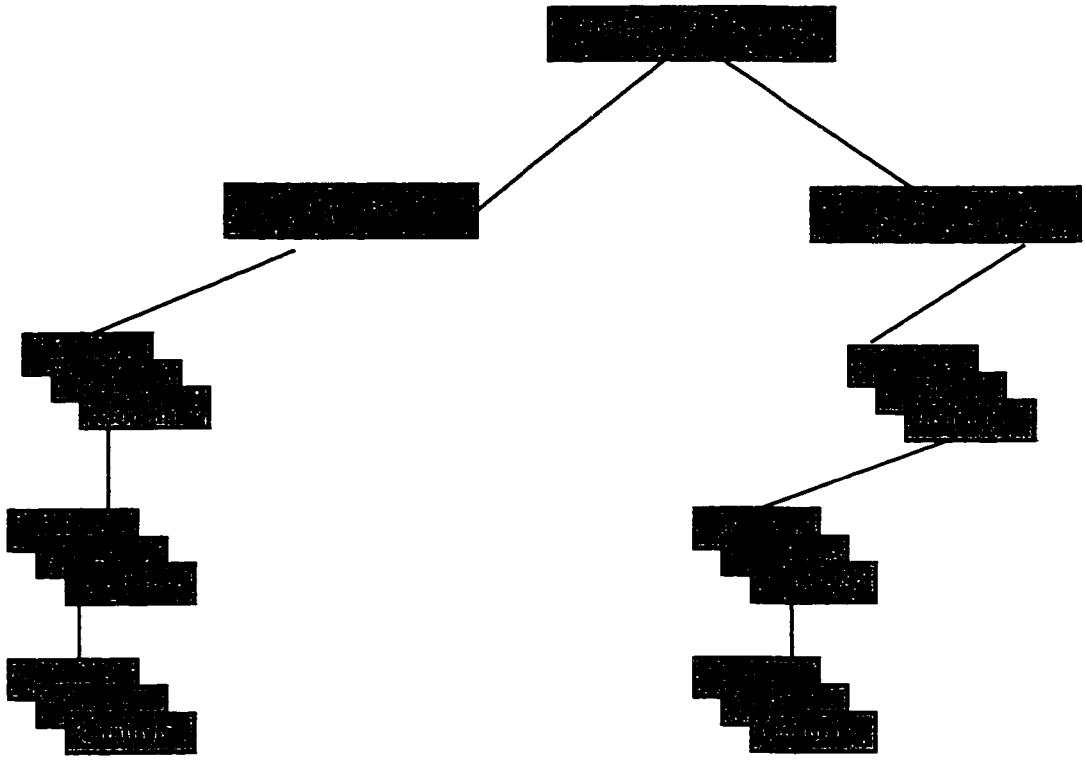


Figure 3.1 Hierarchical structure of data sources

3. 3. 2 Criteria for Selecting Samples

Several criteria were used for selecting the sample in this study in order to improve the external validity of this research. First of all, it is necessary to think what kind of journals should be selected in this study, and then to think what kinds of articles and scientists should be selected. The criteria used for choosing journals, articles and scientists are as follows.

(1) the journals used for this study were be research-oriented academic journals. There are various academic journals used in scholarly communication. These journals can be grouped into the research-oriented and non-research-oriented. Non-research-oriented journals are those that publish primarily information

that is not original or that appeared somewhere else already. Research-oriented journals are those that publish original research results and ideas. Only these research-oriented journals are chosen as a data source in this study, because these journals are the formal forum for scientists to communicate original research results and to exchange their original ideas and information. Scientists who publish articles in these journals are most likely active in formal scholarly communication. The scientists who are not publishing articles in these journals may not be active in current formal scholarly communication, because scientists generally will not publish if they are not actively involved in research activities. Therefore, currently active scientists are producers of current scholarly artifacts.

(2) the journals used in this study should have high impact factors in each field. An impact factor is

> "a measure of the frequency with which the 'average article' in a journal has been cited in a particular year. The JCR impact factor is basically a ratio between citations and citable items published. Thus, the impact factor of journal X would be calculated by dividing the number of all current citations of source items published in Journal X during the previous two years by the number of articles Journal X published in those two years." (SSCI®Journal Citation Reports, 1995, p.10)

The impact factor is useful in evaluating the significance of absolute citation frequencies. It tends to discount the advantage of large journals over small ones; of frequently issued journals over less frequently issued ones (weeklies vs. quarterlies or annuals); of older journals over newer journals. In each such case the first is likely to produce or have produced a larger citable corpus than the second. All things being equal, the larger the corpus, the more often a journal will be cited. So the impact factor normalizes the different journals. Impact factor measures not so much impact of a journal itself, but the impact of the typical articles appearing in the journal. Thus, it does not discriminate among journals according to the number of articles published in a given year or their longevity (Harter, 1996). As high impact journals by definition have high average numbers of citations to their articles, they are seen to be important to the research of a discipline. Such journals, then, can be seen to be a good sample source for scientists who all also important to their disciplines.

(1) the journals selected should also be refereed journals. There are different understandings of what a refereed journal is. "A refereed journal has a structured reviewing system in which at least two reviewers, excluding in-house editors, evaluate each unsolicited manuscript and advise the editor as to acceptance or rejection" (Miller & Punsalar, 1988, p. ix). Katz (1995) thought that the refereed journal "is used to indicate that manuscripts submitted to a magazine are examined both by the editor and one or more specialists in the

individual field before approval is given to publish"(p. xiv). The refereed journal implies that all articles are validated by peers before publishing, which provide a control for the quality of publications in the sample.

(2) scientists selected from these journals for this study must be currently active in academic writing. If the scientists are not currently active in academic writing, they will not be selected for this study. By using "scientists who are currently active in writing," the researcher means scientists who published articles in the issues of the selected years of the selected sixty academic journals. The Journal Citation Reports is usually published at least one year later than the journals it covers. The latest data of the impact factors for 1995 was just published when the present research was conducted and the impacts of these journals will continue in one year later. The latest Journal Citation Reports was chosen in order to reflect the latest scholarly communication activities. Because the transition is a time-related trend in formal scholarly communication, scientists who are not active in writing do not participate in the transition process and thus their behaviors are not typical of scientists at the time of the present study.

(3) only articles which report original research will be selected for this study since this type of article reflects current research and current scholarly communication in a given field. Some scientific articles written for advanced students, which deliver basic knowledge in a given field are not typical

scholarly artifacts that report current research so these may not exactly reflect the current transition in formal scholarly communication.

3. 3. 3 Rationale for Data Source Selection

As indicated above, journals with high impact factors are the basic sources for the research data. The reason for using journals as a source of data collection is because a journal is the most important medium for scientists to communicate with each other in formal scholarly communication among all media used by scientists, including journals, monographs, newsletters, and others. Science as we know it is hardly imaginable without the scholarly journal. The first scholarly journal, *Journal des Scanvans*, was published as a new medium of communication in 1665, and was soon followed by the *Philosophical Transactions for the Royal Society.* For more than three centuries the journal has played a pivotal role in the creation and transmission of knowledge by serving as the primary medium of scholarly communication and thus has remained essentially unchanged in form and function over its lifetime (Harter, 1996). Most human knowledge has taken the form of journal articles. For example, journal articles accounted for 70% of the total number of documents in library and information science (Bottle & Efthimiadis, 1984).

Moreover, the journal also serves as an archive for scientists and contains the traces of scientists' behaviors in formal scholarly communication. In scholarly journals, scientists release their affiliation information. Traditionally, the affiliation information was composed of mailing address, institution, and so on. Currently, scientists tend to release their electronic identities such as email address and homepage URL in addition to

traditional affiliation information when they publish their articles. The journal, therefore, retains the trace of scholarly communication among scientists and reflects the primary behavior of scientists in the exchange of information and ideas. By surveying two groups of journals with high prestige, we can not only learn what has happened as a result of the impact of the global computer networks, but also whether there are any differences between the two groups in their transition to the virtual world caused by the electronic environment.

The Journal Citation Reports (JCR) also played a very important role in the selection of the sample because it provides us with the impact factor of different journals that can be used as a standard to judge the influence of the journal and the scientists who are publishing articles in it. "The JCR is an essential, comprehensive, and unique guide to scientific and technical publishing" (JCR, 1995, p. xi). It includes virtually all specialties in natural science, technology, and the social sciences as well as over 3,000 publishers from 60 countries. The natural science edition of the JCR includes 4,700 leading international science journals, covering topics from Agriculture to Zoology. The social science edition includes 1,500 leading social science journals, covering topics from Anthropology to Women's Studies. Therefore the JCR has become a useful tool for bibliometric studies in many disciplines.

The JCR reports the average number of current citations to articles for a journal published in the previous two years. This allows for comparison between a journal's "impact factor" with the average impact factor for an appropriate set of peer publications or to the baseline for all JCR-indexed journals. A journal can have a high impact factor,

but because it published only a few articles each year, or because it has just commenced publication, it may have a very small overall influence on the scholarly community. In other words, through the impact factor, the Journal Citation Reports can reflect the impact of scientists who publish articles in the journal on average. Therefore, the articles selected from the highest impact journals will generally reflect the behavior of the scientists who have strong influence in scholarly communication in a given field through the citation list, their affiliation, and their research topics. Since these scientists play the roles of gatekeeper and communication star in scholarly communication, their behaviors will have a significant influence on their fields in the transition to the virtual world in formal scholarly communication. Thus, studying their current behavior in formal scholarly communication will help us predict the future of formal scholarly communication as a whole.

In this study, two time slices were chosen for comparing the longitudinal development of the transition of formal scholarly communication to the virtual world. The study started in 1997 so the latest data was from journals published in 1997. The year 1994 was chosen because the first World-Wide Web (WWW) browser (software for hypertext navigation and display) was introduced publicly in 1993 and since then, the Internet has come to be recognized as a worthwhile tool for productive scholarly work. The WWW took the world by storm and within a few months it became the widest known, used, and talked-about technology for fast, elegant, and simple provision and reception of large volumes of coherently structured online information. The WWW explosion (from less than 1,000 Web servers in January 1994 to over 6,000,000 in March

1998) has made a major worldwide impact on research and tertiary education organizations (Ciolek, 1998).

3. 4 Indicators Used to Measure the Transition

As indicated in the first chapter, this study will rely on scholarly artifacts as the research data source. A scholarly artifact is composed of its information, the creator of its information, validation of the information, and a carrier of the information. In this study, the information is the main body of an article; the creator is a scientist who publishes the article; the validation of information can be both the refereeing of an article and the references or citations to the article; and the carrier of information is the journal in which the article is published. The validation of information includes both self-validation and objective-validation. The former is that author cites other articles or sources to support his/her opinions or theory. S/he validates the information released in the article by the author. The later is that the article is refereed by a panel of peers or cited by others. Although both validation processes are very important, this study defines the validation of information as the self-validation. A scholarly artifact must be produced in a certain process, namely the publishing process. After it is published, it has to be publicized to its potential readers under certain process, such as subscription, advertising, exhibits and so on. Theoretically, if formal scholarly communication transfers into the virtual world, all these aspects and processes should be transferred into the virtual world. Therefore the indicators used to describe the transition should cover at least these aspects. Based on this assumption, the indicators used to measure the transition to the virtual world in

formal scholarly communication can be categorized into: (1) electronic publicity of journals, (2) electronic accessibility of information, (3) acceptance of electronic submission, (4) electronic publicity of scientists, and (5) utilization of electronic information resources.

(1) Electronic publicity is the state of being publicized by means of electronic vehicles, such as electronic mail, Web technology, the Internet, and so on. It can be operationally measured by the number of journals that have been publicized through the Internet and in other electronic ways. If a journal has set up a Web site address, email address, or permits electronic subscription, or publishes electronically, this journal is publicized electronically. If more journals in the natural sciences than the social sciences adopt these electronic vehicles, the natural science journals are more electronically publicized than those in the social sciences. Electronic publicity includes setting up a World Wide Web homepage for the journal, publishing journal contents, or abstracts of the articles electronically, releasing email address for subscription or releasing electronic subscription forms on the Internet by which the journal will take the subscriptions automatically. Many journals have already begun this practice, for example, the *Journal of the American Chemical Society* has already set up a homepage on the Internet, and many other journals also release their email addresses for connection.

(2) Electronic accessibility of information refers to the ability to access information in electronic form via local computer network, the Internet or other commercial online services such as Lexis/Nexis, DIALOG and so on. If information can be accessed through any of these electronic means, this information is considered

electronically accessible. There are three levels of electronic access to information. The first is access to bibliographic information, including titles, authors, sources (such as journal title), and so on. The second level is access to abstracts of the articles in addition to the bibliographic information. The third level is access to actual full text of the articles. For the purpose of this research, electronic accessibility of academic information was measured by the number of journals that have been electronically indexed and abstracted, and/or fully digitized. By using this indicator, the researcher will measure whether there is a difference in electronic accessibility between the natural sciences and the social sciences.

(3) Acceptance of electronic submission is defined as a journal's acceptance of manuscripts in electronic form for publication. Acceptance is the willingness within a certain group to employ something. For example, Dillon and Morris (1996) defined "user acceptance" as "the demonstrable willingness within a user group to employ IT (information technology) for the tasks it is designed to support" (p. 4). The essence of the concept of acceptance is use or adoption, as Dillon and Morris noted, "the concept is not being applied to a situation in which users claim they will employ it without providing evidence of use or to the use of a technology for purposes unintended by the designers or procurers" (p. 4). Therefore, the term, acceptance of electronic submission, is based on the fact that electronic forms are currently in use for accepting manuscripts. There are different ways to submit manuscripts electronically, such as disk, electronic mail system, FTP files, Internet homepage address, and so on. As long as one of these electronic forms is accepted by journals for submission, electronic submission is permitted. In this study,

acceptance of electronic submission was measured by the number of journals accepting submission in one of these electronic formats.

(4) Electronic publicity of scientists can be defined as the state in which scientists are being publicized electronically in formal scholarly communication. Basically, there are two ways scientists to publicize themselves electronically. One way is to release their electronic mail addresses. The other way is to release their Web site addresses. Both can publicize scientists very well because they can be approached by electronic means by a wide range of audiences in electronic forms. In this study, electronic publicity of scientists was operationally measured by (1) whether scientists in a particular journal release their email or Web site addresses, and (2) the frequency of sample journal issues in a field in which at least one scientist releases his/her electronic mail address, the Web site addresses, and other electronic identities, if any. Since there are often many co-authors in the natural sciences, sometimes only one, normally the head of a research team or contact person tends to release his/her email address or Web site address. If there are more scientists in one discipline who release their electronic identities than in another discipline, the scientists in the first discipline are more electronically publicized than the second. When a scientist releases his/her electronic mail address and/or Web site address on the Internet in the article s/he published, s/he is being publicized electronically. Actually, it is very common to publicize scientists through releasing email addresses or Web site addresses since others can easily communicate further with them. Scientists have been historically publicized themselves by releasing their affiliations and mailing addresses in addition to their names in journal articles. But now, more and more people

are using electronic mail and/or URLs (Universal Resource Location) to publicize themselves since email and URL addresses can deliver their affiliation information while building more connections to the whole academic world.

(5) Utilization of electronic information resources refers to electronic information sources being used by one or more scientists in researching and writing published articles in journals. The term "electronic information resources" refers to an information resource that appears in the form of a Web site address, FTP file, Gopher file, electronic journal, or other electronic forms. There are two kinds of utilization of electronic information sources. In the first situation, scientists use electronic information resources while doing research and in writing the articles, but these information sources are not cited as references in their articles. In the second situation, scientists use electronic information resources in research and in writing articles and these resources are cited as references in their articles. In this study, the meaning of utilization of electronic information resources is limited to the second situation; that is, utilization of electronic information resources refers to electronic information resources that are cited in the articles published by these scientists. The utilization of electronic information sources was measured by (1) whether electronic information sources were cited in the journals, and (2) the number of journals in which at least one electronic information source is cited. If there are more electronic information resources in one journal than in another, the electronic information resources will be said to be used more frequently in the first than in the second.

Table 3.1 Indicators to Measure the Transition

Categories	Indicators
Electronic Publicity of Journals	
	Journal's Web site address
	Publisher's Web site address
	Journal's email address
	Permitting electronic subscription
	Electronic publishing
Electronic Accessibility of Information	
	Journal being indexed electronically
	Journal being abstracted electronically
	Journal being fully digitized
Acceptance of Electronic Submission	
	Disk submission
	Plain email submission
	Formatted FTP file submission
Electronic Publicity of Scientists	
	Releasing scientist's Web site address
	Releasing scientist's email address
Utilization of Electronic Information Resources	
	Citation of Web site documents
	Citation of FTP file documents
	Citation of Gopher file documents
	Citation of electronic journal documents
	Citation of other electronic file documents

The five categories of indicators listed above describe the transition to the virtual world at three levels: journal, article, and citation and measure the transition in the whole process of formal scholarly communication from submitting, to editing, and publishing, to publicizing journals and scientists, to access to and use of information. The first three categories of indicators, electronic publicity of journals, electronic accessibility of information, and acceptance of electronic submission, were used for describing the journals. The fourth one, electronic publicity of scientists, was used to describe the scientists who published articles in the journals. The fifth one, utilization of electronic

information resources, was used to describe citations used in these articles. In all cases, frequency of occurrence was used for measuring those indicators. A summary of all indicators under these five categories that were produced by this study is listed in the above table 3.1.

3. 5 RELIABILITY AND VALIDITY OF THE STUDY

The issues of reliability and validity are both important and contentious enough to warrant independent consideration for any study. Reliability can be defined as whether "a particular technique, applied repeatedly to the same object, would yield the same result each time" (Babbie, 1995, p. 124). In survey and experimental research, a great deal of importance is placed upon reliability as a criterion for the evaluation of research (Braddlee, 1993). If findings are reliable, they provide a basis on which one may generalize findings to a population with greater confidence. One step for dealing with reliability in this study was to collect data from scholarly artifacts unobtrusively so the scientists and their behaviors would not be influenced by the researcher. Another step adopted was to clarify the criteria for selecting the journals, the articles, and the scientists. Following these criteria and procedures, anyone else would gather the same data. Based on the similar data and methods used in this study, replication would obtain the same results. Clarity and specificity in sampling will avoid a great deal of unreliability and grief (Babbie, 1995), and thus improve the reliability of the research.

Regarding the issue of validity, we may turn once again to Babbie (1995) for a working definition. "In conventional usage," he writes, "the term validity refers to the

extent to which an empirical measure adequately reflects the real meaning of the concept under consideration" (p. 127). While he recognizes that concepts do not have "real meanings," he observes that there are several ways in which validity can be assessed. Kirk (1986) suggests three different notions of validity. There is apparent validity (or face validity), instrumental validity, and theoretical validity. Apparent validity is the ability of a measure to be a credible indicator of what is being measured. For example, asking the number of bananas a person eats to determine the overall status of their nutrition is a method lacking in apparent validity. Eating bananas is insufficiently linked to other nutritional practices to be a valid indicator of the desired concept, overall nutrition. On the other hand, taking a person's temperature with a thermometer is accepted to be an accurate measure with apparent validity if we want to know if a person has a fever. Instrumental validity, also known as criterion-related validity, is based on the way a measure relates to other measures within a system of relationships. If I use a mercury thermometer, I should expect similar readings of temperature taken with an alcohol thermometer, or a digital instrument. Theoretical validity (known as construct validity) is achieved, "if there is substantial evidence that the theoretical paradigm rightly corresponds to observations" (Kirk, 1986, p. 22). Babbie (1995) gives the example of "marital satisfaction" as a concept. If the researcher develops a number of measures, attempting to assess marital satisfaction, and then discovers that "satisfied" men were as likely as "unsatisfied" men to assault their wives, then the measure would not be an indicator of sufficient consistency regarding the theory it was designed to assess.

In order to improve the validity of this study, three different fields from each of the natural sciences and each of the social sciences, and ten different journals from each field were taken as data sources. Also numerous indicators have been developed to measure the transition to the virtual world in formal scholarly communication. The three different fields selected from the natural sciences and the three different fields from the social sciences not only make the sample more representative, but also make the conclusions drawn based on data from these fields more credible and more easily to be generalized to the whole of the natural sciences and social sciences than using a single field as a data source. Moreover, these six fields are all considered classic in both the natural sciences and the social sciences respectively. Namely, they are all recognized unanimously as members of their respective classes, unlike other fields, such as history (social science or humanities) whose placement is ambiguous. Thus, the data from these fields are not only typical in their disciplines but may also be typical to whole areas of science to some extent. Ten journals with high impact factors from each field make the data from this particular field more representative in this field than a single journal as a data source. There are many journals in each field, but not all journals are good enough for the study in terms of representativeness. Even high impact journals may not be research-oriented in which case they would not reflect current formal scholarly communication. Thus selecting ten different research journals with high impact factors from each of three fields and using only articles reporting research minimized bias.

Since the transition to the virtual world in formal scholarly communication is a gradual process dependent upon the progress of electronic information technologies, the

measurement of the transition has become very complicated. To improve the validity of measurement, a widely used technique is to use multiple indicators (Chadwick, Bahr, Albrecht, 1984). In other words, one way to achieve validity is to measure different aspects of what is being studied. This study developed five different categories of indicators to measure different aspects of the transition in formal scholarly communication. As stated earlier, formal scholarly communication has many aspects, and involves publishers, scientists, and librarians. Any changes in each aspect from paper-based communication system to electronic communication will lead the transition to some degree. Thus, the measurement of the transition should include any possible changes in formal scholarly communication associated with the Internet or with electronic features. Because the five categories of indicators were drawn from formal scholarly artifacts – journals, articles, and citations, the researcher specifically intended to measure the transition in *formal* scholarly communication and not the whole scholarly communication process. Meanwhile, the researcher also claims that the conclusions of this study are appropriate for the selected natural science and social science fields only. Thus this study definitely guarantees to measure what really want to be measured and further discourage the over-generalization mistakes made in the research.

Because the data were collected unobtrusively, which avoids intruding on the scientists who are being studied, and the criteria used in selecting the sample and the specific procedures for data collecting are clear, it should be possible to replicate with the same or similar results. By diversifying fields and journals, controlling for the quality of journals and articles which warrant the most influential and currently active scientists

being included in this study, limiting the scope to formal scholarly communication which avoids the problems of over-generalization, and choosing five categories of indicators which cover many of the possible aspects of the transition to the virtual world in formal scholarly communication, the researcher believes this study generates conclusions that are both reliable and valid.

CHAPTER FOUR DATA GATHERING AND ANALYSIS

4.1 SELECTION OF DATA SOURCES

Two groups of classic science fields were selected in this study. One group, the natural sciences, is composed of biology, physics and geology. The other group, the social sciences, is composed of economics, political science, and sociology. The present research is based on the data of transition to electronic formal scholarly communication in these selected six fields. As indicated in the last chapter, the data sources will come from three layers: journals, articles/scientists, and citations. The different data sources will reveal different aspects of the transition in formal scholarly communication. Therefore, the data gathering process emphasized different aspects of the data according to different objectives.

4.1.1 Selection of Journals

This study drew two groups of prestigious journals that are research-oriented, refereed journals with high impact factors in the selected six classic fields of the natural sciences and the social sciences. Based on the criteria established for data collection, the procedures for journal selection are as follows and are shown in Figure 4.1. .

(1) to identify the highest impact factor journals from the latest issue of the ISI (Institute for Scientific Information) Journal Citation Reports (1995) for each

selected field of the natural sciences and the social sciences, including biology, physics, geology, economics, political science, and sociology.

(2) to check with Magazines for Libraries (Katz, 1995), and Ulrich's International Periodicals Directory (1997) to find out which of the journals selected are refereed. The eighth edition of Magazines for Libraries is an annotated listing by subject of nearly 7,000 periodicals, in which the titles have been selected from over 147,000 possibilities and represent what the editors and consultants believe to be the best and most useful for the average elementary or secondary school, public, academic, or special library. In this book, most magazines are indicated whether they are refereed or not. Ulrich's International Periodicals Directory (1997) upholds its reputation for excellence in the provision of serials information. "In the 64 years since it was first published, Ulrich's has established itself as the premier serials reference source in the world, providing serials users with essential bibliographic and access information" (Ulrich's International Periodicals Directory, 1997, p. vii). In volume five of its 35th edition, it lists all refereed periodicals. Therefore, both reference books can provide the peer review status of a particular journal. In cases when neither book provided this information for a particular journal that looks pretty much like a refereed journal, further consultation with reference librarians and the journal's editors, or review of the editorial policy were also conducted.

(3) to examine all the selected journals individually, from high impact factor to low impact factor, to select those journals that are designated for publishing

original research articles. If the main body of a journal was not research-oriented but rather review articles, the journal was excluded from the sample even if it had a very high impact factor.

(4) to pick ten journals from each of the three selected fields of the natural sciences and those of the social sciences, which fit the three criteria, namely, high impact, research-oriented, and refereed at the same time. In cases when the impact factor went half way down the journal list (which was ranked by impact factors in JCR in a specific field), less than ten journals would have been accepted. However, according to research pre-test and real process, this situation did not occur in this study.

(5) to finalize two journal lists for the natural sciences and the social sciences in which all journals are refereed, research oriented, and available at time of the study with high impact factors in each of the selected fields for this study.

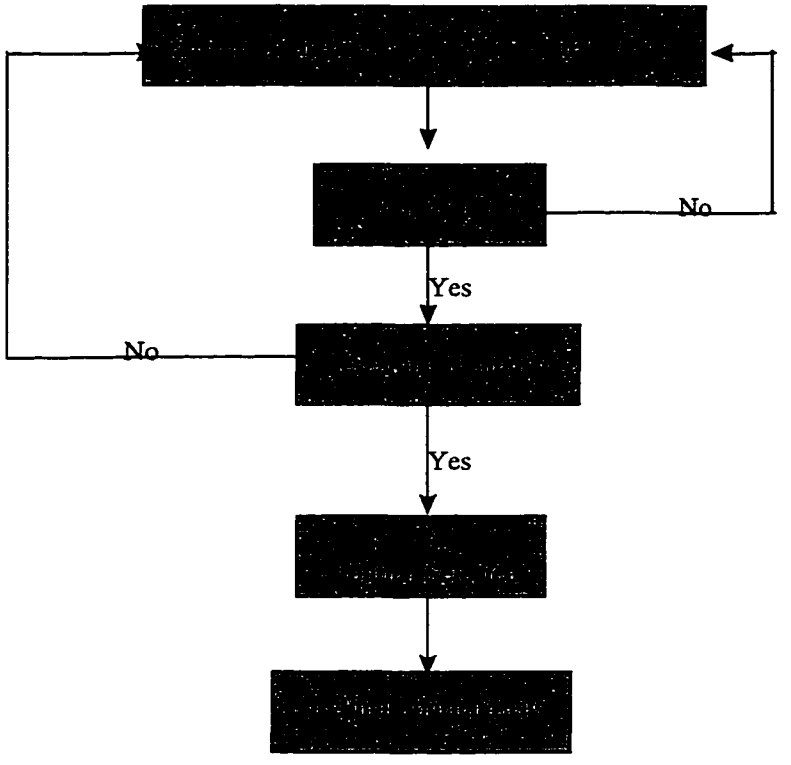


Figure 4.1 Procedure of Journal Selection

4.1.2 Selection of Articles and Scientists

The term, "article" used in this study refers to each unique academic composition which forms an independent part of a journal. Articles vary in many aspects, such as length, type, purpose, and so on. In this study, only the articles that report original research results were selected for the study. The following procedures were used in selecting articles and scientists in this study.

(1) to check each article in the first issues of the years 1994 and 1997 of the sixty selected journals (or the next issues to the first issues in these years, or the last issues of the previous years if the first ones are unavailable) individually and

to accept those articles that report research results. These articles are the most typical and important articles in current scholarly communication because they reflect current research activities in the sciences.

(2) to exclude review articles from the selection since they may not reflect the latest progress of scientific research in the selected fields and thus they cannot represent current scholarly communication. A "review article" contributes a retrospective overview of progress or history of a discipline, sub-discipline, or field. There are three kinds of review articles. One is that which appears in a journal whose title contains terms "review", "progress", "trend", and so on. This kind of review article was excluded at the stage of journal selection. The second kind of review article is that which appears in the review section of a journal whose main body is research-oriented articles. This kind of article was also excluded from the study. The third kind of review article is that which appears in the regular section with other research-oriented articles in a journal. This kind of review article is actually a semi-review article because it usually includes a review section, but its main purpose is to report original research. This kind of article was counted as a non-review article, and therefore was selected for this study.

(3) to exclude book reviews, publication news and other news, advertising items, editorials, columns, and short articles from the study since they are not typical scholarly artifacts and cannot reflect typical formal scholarly communication.

(4) to copy all content pages of all selected issues of the selected journals for further reference.

It is assumed in this study that all authors who publish research articles in these high impact, research-oriented, refereed journals are natural scientists or social scientists. Therefore, in this study, a scientist refers to the author who is publishing research articles in these selected natural sciences and social sciences journals. It includes individual authors, co-authors, and organizational authors such as a research team, research laboratory, or institution. The term scientist does not include authors of the citations or references in the journals, or authors of review articles, book reviews, news, publication news, announcements, editorials, and columns in these journals.

4.1.3 Selection of Citations

A citation refers to the document used by scientists as a source of evidence, fact, origin, or argument while writing papers. "When one document (A) mentions or refers to another document (B), the latter has been cited by the former as a source of information, as support for a point of view, as authority for a statement of fact, etc. ..... Citation and reference are frequently used interchangeably" (SSCI Journal Citation Reports, 1995, p. 10). There are two kinds of citations. One is in the form of references which appear at the end of a article. Usually the references appear in alphabetical order or in the sequence of their appearance in the article. The other is in the form of footnotes which appear at the end of each page in articles. Both kinds of citations that existed in electronic forms were selected as data sources for this study. Such electronic forms include Web site

documents, FTP file documents, Gopher file documents, electronic journal documents and other computer files. Only the citations from the selected research-oriented articles were used for the study. The other citations in book reviews, columns, editorials, typical review articles, and other short articles were excluded from this study.

4.2 PROCEDURE FOR DATA COLLECTION

The data collected for this study were used to describe the electronic publicity of journals, electronic accessibility of information, acceptance of electronic submission, electronic publicity of scientists, and utilization of electronic information resources. In order to facilitate the data gathering, two survey instruments were created and used in the data gathering process (See Appendix 3 and 4). These data came from three different layers of data sources; the different data collection procedures are described below.

4.2.1 Electronic Publicity of Journals

Three kinds of data on journals were collected in this study, including the electronic publicity of journals, acceptance of electronic submission, and electronic accessibility of information. As defined earlier, electronic publicity of a journal refers to the journal's state of being publicized by electronic means, such as electronic mail system, the Internet, and so on. Specifically, the electronic publicity of a particular journal is measured by whether the journal and publisher have set up a homepage or Web site, whether the editorial body releases its email address, whether the journal permits

electronic subscription, and whether the journal has a parallel electronic version. In order to get the data, the researcher took the following two steps:

(1) first, check each individual journal. Usually journals will release their Web site addresses or home page address, email addresses, and electronic subscription information in print versions if they do have them. If the issues of the journals do not provide this information, additional issues before and after the selected issues were also examined. As long as the journal has an email address, electronic subscription address, or Web site address, the journal was counted as being electronically publicized.

(2) Second, look up two electronic journal directories and the Internet to find out whether the journals selected have an electronic version. One was, the Directory of Electronic Journals, Newsletters and Academic Discussion Lists, 6th edition, published by the Association of Research Libraries, which collected nearly 1,700 electronic journals in 1996's version (Okerson, 1996). The other one, published by Mecklermedia, was the Internet Worlds on Internet 94: An International Guide to Electronic Journals, Newsletters, Texts, Discussion Lists, and Other Resources on the Internet. Both directories together have covered most electronic journals, and other electronic documents. In the instance that neither directory provided this kind of information on a specific journal, the investigator did an Internet search to double check if it has electronic version. The search engines used in this study were AltaVista, Lycos, Infoseek, HotBot, and Web Crawler.

4.2.2 Electronic Accessibility of Information

Information refers to all kinds of information including full text, abstract, and bibliographic information. The term electronic accessibility of information refers to any kind of information that can be accessed through computer networks or any online information service. The scope and size of databases are different in the natural sciences and the social sciences. Usually, the natural science databases are bigger than they are in social sciences. The scope of databases in the natural sciences is also broader than that in the social sciences. It is possible for several natural science fields to be indexed in a single database; and for a single social science to be indexed in several databases. Therefore, if journal A is indexed by more databases than journal B, it doesn't necessarily mean that journal A is more accessible than journal B but means that both journal A and journal B can be accessed electronically. However, the overall frequency of journals indexed, abstracted or digitized in the sciences will reveal the electronic accessibility of academic information. The electronic accessibility of information is measured by whether the selected journal has been indexed, abstracted, or digitized electronically. For research purposes, the researcher looked at (1) the number of journals that have been indexed in a database in electronic form, (2) the number of journals that have been abstracted in a database in electronic form, and (3) the number of journals that have been fully digitized. In order to get information on whether the information in a particular journal can be accessed electronically, the following procedures were performed in this study:

(1) the journal itself was examined first to find out whether it is indexed, abstracted, or fully digitized in any computer files, CD-ROM, or Web site. Usually journals provide their readers with information on whether and where they have been indexed, abstracted, or digitized, since being indexed or abstracted by prestigious indexing/abstracting services is one of indicators of the importance of these journals.

(2) reference books were consulted to find out whether journals can be accessed electronically. Both Magazines for Libraries, and Ulrich's International Periodicals Directory indicate whether a journal can be accessed via online systems or CD-ROM. Therefore they are good sources for judging whether a journal is accessible electronically.

(3) if a journal didn't release this kind of information, and neither did other reference books, the investigator also checked with major indexing/abstracting services such as DIALOG and DATASTAR. For example, some social science journals did not include this kind of information, but they were still counted as electronically accessible after the investigator discovered they are indexed by some databases in DIALOG.

4.2.3 Acceptance of Electronic Submission

Electronic submission refers to the use of electronic vehicles for submitting manuscripts to journals in scholarly communication. Acceptance of electronic submission means that journals accept the electronic submission of manuscripts. If a

journal accepts an electronic submission, it means that authors can submit manuscripts to the journal through electronic forms such as disk, electronic mail system and/or the Internet. Whether a journal accepts submission in electronic form was used in this study to measure the acceptance of electronic submission. The researcher looked at each journal individually to find out (1) whether a journal accepts submission on disk, (2) whether a journal accepts submission in the form of electronic mail, (3) whether a journal accepts submission in the form of formatted FTP files. FTP (File Transfer Protocol), is a method of transferring files between computers on the Internet. Usually a journal releases this kind of information in the guidelines for submission, or guidelines for authors, or preparation for manuscript. In case the journal did not provide this kind information but had an email address, the editor of the journal was also consulted through email or telephone by the researcher.

4.2.4 Electronic Publicity of Scientists

As noted earlier, scientist refers to the authors who publish research articles in the journals selected. Electronic publicity of scientists means that scientists publicize themselves in formal scholarly communication by releasing electronic mail addresses and/or their Web page addresses in the articles they published. The number of journals in which at least one scientist publishes electronic mail or Web page addresses was used to measure the electronic publicity of scientists. The researcher examined each article selected to find out (1) whether a scientist released his/her electronic mail and/or Web site addresses, and (2) the number of scientists who released their electronic mail addresses.

If the individual scientist could not be identified, the group name or organization name was counted as a scientist. Otherwise, each author of the article was considered as a single scientist for counting purposes.

4.2.5 Utilization of Electronic Information Resource

Electronic information resource refers to information existing in electronic form or information that can be accessed through computer networks, such as Web site documents, FTP file documents, Gopher file documents, electronic journal documents, and others. A Web page is designated as an independent part for presenting some information for a certain purpose. It can be a separate article, or the supplementary materials of an article, or a piece of an article. FTP (File Transfer Protocol) is also cited sometimes as an information source. Gopher is a successful method of making menus of material available over the Internet. Some articles also cite Gopher files as information resources. There are many Internet sites that have established publicly accessible repositories of materials that can be obtained by using FTP and Gopher.

Utilization of electronic information resources means that at least one citation in the references of an article exists in electronic form, such as a Web site document, FTP file, Gopher file, or electronic journals. The number of journals in which at least one electronic information resource is cited was used in this study to measure the utilization of electronic information resources. The researcher examined each selected research-oriented article to find out (1) whether this journal has electronic citations, (2) how many Web site documents among all the references were cited in the article, (3) how many FTP

file documents among all the references were cited in the article, (4) how many Gopher file documents among all the references were cited in the article, and (5) how many electronic journal sources among all the references were cited in the article. In case if the journal surveyed had both print and electronic versions, the citation was counted as it was in the reference. In another case, if both print and electronic versions of the same journal were cited, the electronic citation was still counted.

4.3 STATISTICAL ANALYSIS METHODS

Two kinds of variables are available to measure the transition of formal scholarly communication in this study. One variable is nominal and the other is interval. Nominal variables are those which are properly defined with logically exhaustive and mutually exclusive categories (Babbie, 1995). For example, in this study the electronic publicity of journals, acceptance of electronic submission, and electronic accessibility of information, publicity of scientists, and utilization of electronic information resources were all measured by nominal variables. Interval variables include the logical and ranking features of ordinal and nominal variables, but in addition, their categories are defined in terms of a standard unit of measurement, such as the individual "social actor," the year of age, or the inch (Babbie, 1995). For example, the number of articles per journal that have electronic citations and the number of articles per journal in which at least one scientist releases his/her email or homepage address are both interval variables. However, in this study not enough interval variables were found so only nominal variables were used for measuring the transition. According to the nature of the variable, descriptive and

inferential statistics were employed to analyze the indicators developed for describing the transition.

The field of descriptive (or summarization) statistics is concerned with ways of making sense out of the data at hand. The most important descriptive statistics are the total, average, mean, range, distribution, and so forth, which are used analytically to investigate the distributions of single variables and the relationships between two or more variables. In this study, descriptive statistics such as means, percentages, and rates were used to describe the transition to the virtual world in formal scholarly communication, as represented by the five categories of indicators.

Inferential statistics can be used for two purposes: to aid scientific understanding by estimating the probability that a given statement is true or is not true, and to aid in making sound decisions by estimating which alternative among a range of possibilities is most desirable (Simon & Burstein, 1985). In this study, inferential statistics were used only for the first purpose, that is, for testing the basic hypotheses developed. Based on the data collected, we obtained the data for the nominal variables of each five categories of indicators. Therefore, the researcher ran the Chi-square and other tests appropriate to nominal data, in order to test the hypotheses.

Given that population distributions are unknown, the most appropriate statistical procedure is the Chi-square test to analyze frequency data – those that come from counting things (Dickens, 1989), such as in this study. An essential part of a statistical test based on X^2 is the comparison to a X^2 distribution. The correspondence between the sampling distribution X^2 and the theoretical X^2 distribution depends on several

assumptions. These assumptions can be divided into three parts, relating to the independence of the observation, the similarity of their distribution, and the sample size (Wickens, 1989). But the most important assumptions for using the chi square test in this study are: (1) that separate observations are probabilistically independent. "In practice, the assumption of independence is usually reduced to the principle that each observation comes from a different subject. Generally, this is a wise rule to follow, since different subjects usually behave independently" (Wickens, 1989, p. 28); (2) The number of observations is large. By their nature, frequencies are discrete; thus, any statistic calculated from a particular sample takes one of a finite set of values. The continuous X^2 distribution is used to approximate its distribution. Strictly, this approximation is accurate only in the limit as the sample size tends to infinity. In large samples, the jumps in the sampling distribution of X^2 are insignificant and a X^2 distribution can be used for testing, but for small samples, the X^2 approximation is inaccurate. In this study, the observations conform to these two assumptions. First of all, each observation comes from a different journal, or article. This will guarantee the observations are probabilistically independent from each other since each journal is different from the others, and each article is different from the others. In this study, the sixty journals are completely different, each article can only be published once in these journals. Moreover, the sizes of the two samples are large enough to run the X^2 test. At the journal level, the sample size for both the natural sciences and the social sciences is thirty.

Since this study has two samples from two populations, the issue is whether or not they are the same in their transition to the virtual world, the two-way tables or two-level

tables were used to test the hypotheses. First, a set of expected frequencies was constructed that are consistent with the row and column marginal sums and for which the null hypothesis holds. The observed frequencies should be close to the expected frequencies in order to accept the null hypothesis. To check this, the two sets of numbers are compared by calculating a measure of discrepancy, known as the *Pearson goodness-of-fit statistic* (Dickens, 1989), denoted X^2. In essence, X^2 is an adjusted sum of the squared differences between observed and expected frequencies. Large values of the X^2 indicate big discrepancies between the two sets of frequencies, and small values indicate a close fit. There are a family of X^2 distributions, which differ in the value of a positive integer known as the degree of freedom. For the two-way test in this study, the degree of freedom is the product of the numbers of rows and the number of columns, each reduced by one. Critical values of the X^2 distribution can be found in most statistics textbooks.

In order to learn if there was a significant difference between 1994 and 1997 in transition to the virtual world, Wilcoxon Matched-Pairs Signed-Ranks test ("Wilcoxon test") was also used in this study. The Wilcoxon Matched-Pairs Signed-Ranks test is a non-parametric procedure used with two related samples to test the hypothesis that two variables have the same distribution. It makes no assumptions about the shapes of the distribution of the two variables. This test takes into account information about the magnitude of differences within pairs and gives more weight to pairs that show large differences than to pairs that show small differences. The test is based on the ranks of the absolute values of the differences between the two variables. In this study, since the same journals published in 1994 and 1997 were chosen, the sample from 1994 and the sample

from 1997 are related to each other. Thus Wilcoxon Matched-Pairs Signed-Ranks test was used in this study.

CHAPTER FIVE THE RESULTS (I)

Based on the criteria established in the research design, sixty journals published in 1994 and 1997 were investigated during the period between May 1997 and October 1997. Among the sixty journals, half of them were selected from the natural sciences and half from the social sciences. The average impact factor of the sixty journals was 1.95 in 1995 with 2.41 in the natural sciences and 1.49 in the social sciences. The details of the sixty journals are listed in tables 5.1 and 5.2 below. Of the sixty journals, in 1994 the average frequency of publication was 11.4 issues with 18.2 in the natural sciences and 4.6 in the social sciences. There were 1027 items published in 1994 with 577 in the natural sciences and 450 in the social sciences. Among these items published, 67.7% were research articles in 1994. Average items per journal are 19.2 (with 14.7 research articles) in the natural sciences and 15 (with 8.5 research articles) in the social sciences in 1994.

In 1997 the average frequency of publication was 12.1 issues with 19.3 in the natural sciences and 4.9 in the social sciences. There were 1056 items published in these journals in 1997 with 661 in the natural sciences and 425 in the social sciences. Among them, 75.9% were research articles in 1997. Average articles per journal were 21 (with 17.6 research articles) in the natural sciences and 14.2 (with 9.2 research articles) in the social sciences in 1997.

This chapter will give a descriptive profile of both the longitudinal transition to the virtual world and a cross-sectional comparison of the transition between the natural

sciences and the social sciences in formal scholarly communication based on the selected sixty journals.

Table 5.1 Basic Data of the Sixty Journals in 1994

Fields	Natural Sciences	Social Sciences	Average
Publication Frequency per Year	18.2	4.6	11.4
Total Items Published	577	450	513.5
Average Items per Journal	19.2	15	17.1
Total Research Items Published	441	254	347.5
Average Research Items per Journal	14.7	8.5	11.6

Table 5.2 Basic Data of the Sixty Journals in 1997

Fields	Natural Sciences	Social Sciences	Average
Publication Frequency per Year	19.3	4.9	12.1
Total Items Published	661	425	528
Average Items per Journal	21.0	14.2	17.6
Total Research Items Published	556	275	401
Average Research Items per Journal	17.6	9.2	13.3

5.1 CROSS-SECTIONAL COMPARISON OF THE TRANSITION

5.1.1 Comparison between the Natural Sciences and the Social Sciences

A comparative analysis of electronic vehicles adopted between the natural sciences and the social sciences as well as among the fields within the natural sciences and within the social sciences was conducted in this study. The electronic vehicles adopted include journal's web site, journal's email address, electronic subscription, electronic publishing, electronic access to information, electronic submission, electronic publicity of journal, author's web site, author's email address, as well as electronic citation. The data are presented in tables 5.3 through 5.8.

5.1.1.1 Cross-sectional Comparison in 1994

In 1994, some electronic vehicles were adopted by the journals in both the natural sciences and the social sciences, but others were only adopted in the natural sciences. Table 5.3 lists the different electronic vehicles used in both the natural sciences and the social sciences. The results indicate that the proportion of the journals adopting electronic vehicles to the total journals investigated in both the natural sciences and the social sciences is very low except for computerized indexing and abstracting, with a slightly higher proportion of the journals adopting electronic vehicles in the natural sciences than in the social sciences.

Based on the study, in 1994 most journals in both the natural sciences and the social sciences were not electronically publicized by means of establishing the journal's web site, email address, electronic subscription, or by publishing the whole journal or part of the journal electronically. However, all of these electronic means were adopted to some extent in the natural sciences. Email address was used most frequently by these journals. There were 63.3% journals in the natural sciences that used email address. Three journals in the natural sciences had web sites, two adopted electronic subscription through email, and one published electronic table of contents and abstracts. However, except for journal's email address, no journal in the social sciences had a web site address, electronic subscription, or had adopted electronic publishing. Only four journals (13.3%) in the social sciences used an email address.

In terms of electronic access to bibliographic information and abstract, there is no difference between the natural sciences and the social sciences. All the journals in both

the natural sciences and the social sciences were equally indexed and abstracted in computerized databases. However, the proportion of fully digitized journals in both the natural sciences and the social sciences was very low. Full text of only 6.7% journals in the natural sciences and 3.3% in the social sciences could be accessed electronically.

Electronic submission vehicles including disk, plain text email message, and formatted FTP file, were all adopted in the natural sciences but only disk submission was adopted in the social sciences. Among the electronic submission vehicles, 60% of the journals in the natural sciences accepted disk submission, as opposed to 16.7% in the social sciences.

Both author's web site and author's email address were adopted in the natural sciences in electronically publicizing the scientists; only author's email was adopted in the social sciences. However, the proportion of the journals that adopted author's web site and email address remains very low in both the natural sciences and the social sciences. In the natural sciences, there was only one journal in which a scientist released his web site address in his article. In the natural sciences 36.7% of the journals contained scientists' email addresses while in the social sciences only 6.7% of the journals did.

The authors in the journals in both the natural sciences and the social sciences in 1994 used electronic information sources. In the natural sciences 6.7% of the journals cited electronic information resources, but in the social sciences 20% of the journals did. The results indicate that the electronic information resources cited by the authors in the journals in the natural sciences, included web site documents, FTP files, gopher files, electronic journals, and "other computer files." However, none of them, except "other

computer files," was cited by the authors in the journals in the social sciences. This use of "other computer files" contributes to the higher proportion of citing electronic information resources in the social sciences than in the natural sciences.

Table 5.3 Frequency and Percentage of Electronic Vehicles Adopted in 1994

Disciplines	Social Sciences		Natural Sciences		Total	
	Occurrence	%	Occurrence	%	Occurrence	%
Journal's Web site address	0.0	0	3	10	3	5
Journal's email address	4	13.3	19	63.3	23	38.3
Electronic subscription	0	0	2	6.7	2	3.3
Electronic publishing	0	0	1	3.3	1	1.7
Index/Abstract service	30	100	30	100	60	100
Digitized Full-text	1	3.3	2	6.7	3	5
Disk submission	5	16.7	18	60	23	38.3
Plain text email submission	0	0	4	13.3	4	6.7
Formatted FTP submission	0	0	7	23.3	7	11.7
Author's Web site	0	0	1	3.3	1	1.7
Author's email address	2	6.7	11	36.7	13	21.7
Electronic citation	6	20	2	6.7	8	13.3

5.1.1.2 Cross-sectional Comparison in 1997

In 1997, all electronic vehicles were used by the journals in the natural sciences. Except for formatted FTP submission and author's web site address, most electronic vehicles were also adopted by the journals in the social sciences. The details are listed in table 5.4.

More than two third of the journals in both the natural sciences and the social sciences were publicized electronically by releasing the journal's web site and email addresses; permitting electronic subscription; and publishing the table of contents, abstracts, or full-texts. Most journals in both sciences had a web site; there was only one journal in the natural sciences and two journals in the social sciences without a web site. Of the journals, 86.7% in the natural sciences and 70% in the social sciences had

journal's email addresses, including the editor's, publisher's, editorial board members' as well as other email addresses related to the journals. Of the journals, 86.7% in the natural sciences could be subscribed to electronically by means of email or online subscription as opposed to 66.7% in the social sciences. In the natural sciences, 96.7% of the journals and 80% in the social sciences published the contents electronically by publishing electronic full-text, electronic table of the contents, or electronic abstract. Among those journals with electronic publishing, 53.3% of the journals in the natural sciences published full-text electronically as opposed to only 6.7% in the social sciences. Of the journals, 90% in the natural sciences published an electronic table of contents as opposed to 76.7% in the social sciences; 40% of the journals in the natural sciences published abstracts electronically as opposed to 33.3% in the social sciences.

In terms of electronic access to bibliographic information and abstract, there was no longer a difference between the natural sciences and the social sciences. All journals in both the natural sciences and the social sciences were equally indexed and abstracted electronically. However, only half of the journals in both the sciences listed where they had been indexed and abstracted. In terms of electronic access to full-text information, many more journals in the natural sciences were fully digitized than in the social sciences. Of the journals, 53.3% in natural sciences published their full-text electronically while only 10% of the journals in the social sciences did so.

Among electronic submission vehicles adopted, disk submission was used most frequently by the journals in both the natural sciences and the social sciences, but acceptance rates were different between them. Disk submission was accepted by 66.7%

of the journals in the natural sciences accepted as opposed to only 33.3% in the social sciences. Of the journals, 40% in the natural sciences accepted plain email submission while only 3.3% of the journals in the social sciences did so, including full manuscript submission, abstract submission, and data submission. In the natural sciences, 30% of the journals accepted electronic submission through formatted FTP file but none of the journals in the social sciences accepted such submissions.

Both author's web site and author's email address were used by the journals in the natural sciences for publicizing scientists, but only author's email address was used in the social sciences for this purpose. Only 13.3% of the natural science journals contained one or more author's Web site address while no journal did so in the social sciences. Of the journals, 70% in the natural sciences listed at least one scientist's email address as opposed to 43.3% in the social sciences.

The proportion of electronic information utilization was higher in the social sciences than in the natural sciences in 1997. Only 10% of the journals in the natural sciences contained articles in which the authors cited electronic information resources, but 26.7% of the journals in the social sciences contained articles in which the authors cited electronic information resources. Among the electronic information resources cited, was web site document, FTP file, gopher file, electronic journal, and "other computer file" were all cited by the authors in the journals in the natural sciences with percentages of 10%, 3.3%, 3.3%, 3.3%, and 3.3% respectively. However, only web site document, FTP file, electronic journal and "other computer file" were cited by the authors in the journals in the social sciences with percentages of 13.3%, 3.3%, 6.7%, and 26.7%

respectively. From the data, it is easy to see that the use of "other computer file" contributes to the higher proportion of the journals using electronic information resources in the social sciences.

Table 5.4 Frequency and Percentage of Electronic Vehicles Adopted in 1997

Disciplines	Social Sciences		Natural Sciences		Total	
	Occurrence	%	Occurrence	%	Occurrence	%
Journal's Web site address	28	93.3	29	96.7	57	95
Journal's email address	21	70	26	86.7	47	78.3
Electronic subscription	20	66.7	26	86.7	46	76.7
Electronic publishing	24	80	29	96.7	53	88.3
Index/Abstract service	30	100	30	100	60	100
Digitized full-text	3	10	16	53.3	19	31.7
Disk submission	10	33.3	20	66.7	30	50
Plain text email submission	1	3.3	12	40	13	21.7
Formatted FTP submission	0	0	9	30	9	15
Author's Web site	0	0	4	13.3	4	6.7
Author's email address	13	43.3	21	70	34	56.7
Electronic citation	8	26.7	3	10	11	18.3

5.1.2 Comparison among the Fields within the Natural Sciences

Transition to the virtual world in formal scholarly communication is different among the fields within the natural sciences in both 1994 and 1997. The details are listed in table 5.5 and table 5.6 respectively.

5.1.2.1 Comparison within the Natural Sciences in 1994

As indicated in the above section, a journal's email address was the most popular electronic vehicle used in 1994 to publicize the journals in the natural sciences. The proportion of journals that adopted journal's email address in physics, biology and geology was 100%, 60% and 30% respectively. A few journals in physics and geology

also adopted a web site as a means of publicizing the journal. Only one journal in physics and one in biology could be subscribed to electronically. Only one journal in physics published an electronic table of contents and electronic abstracts.

All journals in each of the three fields of the natural sciences were indexed and abstracted electronically, so there was no difference among the three fields in terms of electronic access to their bibliographic information and abstracts. However, only two journals in biology in 1994 had their full-texts available electronically through either online or CD-ROM service.

Disk submission was adopted by the journals in all three fields by 90% of the journals in physics, 70% in biology, and 20% in geology respectively. Electronic submission via plain text email message was only adopted by two journals in physics and by two in biology. Of the journals, 60% in physics and 10% in biology adopted electronic submission through formatted FTP file.

Author's email address was adopted as a means of publicizing scientists in each of the three fields by 70% of the journals in physics, 10% in biology, and 30% in geology respectively. However, only one journal in physics contained author's web site in 1994.

Electronic information resources were only cited by the authors in two journals in physics. None of the authors in either biology or geology cited electronic information resources.

Table 5.5 Electronic Vehicles Adopted within the Natural Sciences in 1994

Disciplines	Physics		Biology		Geology	
	Occurrence	%	Occurrence	%	Occurrence	%
Journal's Web site address	2	20	0	0	1	10
Journal's email address	10	100	6	60	3	30
Electronic subscription	1	10	1	10	0	0
Electronic publishing	1	10	0	0	0	0
Index/Abstract service	10	100	10	100	10	100
Digitized full-text	0	0	2	20	0	0
Disk submission	9	90	7	70	2	20
Plain text email submission	2	20	2	20	0	0
Formatted FTP submission	6	60	1	10	0	0
Author's Web site	1	10	0	0	0	0
Author's email address	7	70	1	10	3	30
Electronic citation	2	20	0	0	0	0

5.1.2.2 Comparison within the Natural Sciences in 1997

In 1997, journal's web site address, journal's email address, electronic subscription and electronic publishing were all used by 100% of the journals in physics for publicity purposes. In biology, 100% of the journals adopted a web site address, 70% adopted journal's email address, 90% adopted electronic subscription, and 100% adopted electronic publishing. Ninety percent of the journals in geology adopted a web site address, 90% adopted email address, 70% adopted electronic subscription, and 90% adopted electronic publishing.

All journals in the three fields of the natural sciences were indexed and abstracted electronically so that there was no difference among the three fields in electronic access to bibliographic information and abstracts. But there is a slight difference among the three fields in electronic access to full-text information. In biology, 70% of the journals, 60% in physics, and 30% in geology had their full-texts available electronically through online or CD-ROM service.

Disk submission was again a common means for electronic submission in these three fields of the natural sciences. In both physics and biology, 80% of the journals, and 40% in geology accepted electronic submission through disk. All three fields with a proportion of 80% of the journals in physics, 20% in biology, and 20% in geology accepted plain email message submissions. Electronic submission through formatted FTP file was only adopted by 80% of the journals in physics, by 10% of the journals in biology and none in geology.

Both author's web site address and author's email address were adopted in all three fields in the natural sciences for publicizing scientists. The proportion of journals that included the author's web site address was very low, only 20% of the journals in physics, 10% in biology, and 10% in geology. However, the proportion of journals incorporating the author's email address was quite high with 80% in physics, 80% in biology, and 50% in geology.

Electronic information resources were equally cited in all the three fields of the natural sciences. The proportion of journals in which electronic information was cited was again very low at 10% in each of these three fields. Among the electronic information resources cited, web site document was the only electronic information resource cited by the authors in all the three fields. However, all kinds of electronic information resources investigated were cited by the authors in the journals in physics.

Table 5.6 Electronic Vehicles Adopted within the Natural Sciences in 1997

Disciplines	Physics		Biology		Geology	
	Occurrence	%	Occurrence	%	Occurrence	%
Journal's Web site address	10	100	10	100	9	90
Journal's email address	10	100	7	70	9	90
Electronic subscription	10	100	9	90	7	70
Electronic publishing	10	100	10	100	9	90
Index/Abstract service	10	100	10	100	10	100
Digitized full-text	6	60	7	70	3	30
Disk submission	8	80	8	80	4	40
Plain text email submission	8	80	2	20	2	20
Formatted FTP submission	8	80	1	10	0	0
Author's Web site	2	20	1	10	1	10
Author's email address	8	80	8	80	5	50
Electronic citation	1	10	1	10	1	10

5.1.3 Comparison among the Fields within the Social Sciences

Transition to the virtual world in formal scholarly communication is different among the three fields within the social sciences in both 1994 and 1997. The details are listed in table 5.7 and table 5.8 respectively.

5.1.3.1 Comparison within the Social Sciences in 1994

As indicated above, there were a few journals in the social sciences that were publicized electronically in 1994. The only electronic vehicle adopted for publicizing journals in the social sciences was the journal's email address, which was adopted by 30% of the journals in political science and 10% in sociology.

There was no difference among the journals in the three fields in electronic access to bibliographic information and abstracts since the journals in all three fields were all indexed and abstracted electronically. There was one journal in political science that had full-text available electronically in the form of CD-ROM.

Disk submission was the only means for electronic submission in all the three fields, but the proportion was very low at 10% in political science, 10% in sociology, and 30% in economics. Electronic submissions via plain text email message and formatted FTP file were not accepted by the journals in any of these three fields.

Very few journals in the social sciences published the author's email address. There was only one journal in political science and in sociology that published the author's email address. No journal published an author's Web site address.

The overall rate of citation of electronic information resources by the authors in the social sciences was very low. 20% of the journals in political science and 40% in sociology contained articles in which the authors cited electronic information resources. However, no author in economics cited any electronic information resources in 1994.

From table 5.7, it is not hard to see that electronic submission via disk and indexing/abstracting services were the only electronic vehicles that had been adopted in economics in 1994. No other electronic vehicles were adopted in economics.

Table 5.7 Electronic Vehicles Adopted within the Social Sciences in 1994

Disciplines	Economics		Political Science		Sociology	
	Occurrence	%	Occurrence	%	Occurrence	%
Journal's Web site address	0	0	0	0	0	0
Journal's email address	0	0	3	30	1	10
Electronic subscription	0	0	0	0	0	0
Electronic publishing	0	0	0	0	0	0
Index/Abstract service	10	100	10	100	10	100
Digitized full-text	0	0	1	10	0	0
Disk submission	3	30	1	10	1	10
Plain text email submission	0	0	0	0	0	0
Formatted FTP submission	0	0	0	0	0	0
Author's Web site	0	0	0	0	0	0
Author's email address	0	0	1	10	1	10
Electronic citation	0	0	2	20	4	40

5.1.3.2 Comparison within the Social Sciences in 1997

In 1997, almost all electronic vehicles were adopted in all three different fields within the social sciences. Of the journals, 80% in economics, 100% in political science and 100% sociology had a web site. Of the journals, 70% in economics, political science, and sociology had email addresses. Of the journals, 60% in economics and political science, and 80% in sociology had electronic subscription services. In each of the fields of economics, political science and sociology, 80% of the journals had electronic publishing. The most common form of electronic publishing was the electronic table of the contents.

Again there is no difference among the three fields in electronic access to bibliographic information and abstracts in the social sciences, since all the journals were indexed and abstracted. But there was one journal in economics, and two in political science, which had full-text, available electronically.

Disk submission was adopted in all the three fields within the social sciences with a proportion of 30% in economics, 50% in political science, and 20% in sociology. But electronic submission through formatted FTP file was not used at all in these three fields, and only one journal in political science accepted submission via plain text email message.

Author's email address was the only means by which social scientists were publicized electronically. But the proportion of social scientists who were publicized electronically by releasing their email addresses in these three fields was different, with 70% of the journals in sociology, 50% in political science, and 10% in economics releasing authors' email addresses.

Electronic information resources were cited by the authors in very few journals in the social sciences in 1997. Only 40% of the journals in political science, 40% in sociology, and none in economics contained articles that cited electronic information resources in1997.

Table 5.8 Electronic Vehicles Adopted within the Social Sciences in 1997

Disciplines	Economics		Political Science		Sociology	
	Occurrence	%	Occurrence	%	Occurrence	%
Journal's Web site address	8	80	10	100	10	100
Journal's email address	7	70	7	70	7	70
Electronic subscription	6	60	6	60	8	80
Electronic publishing	8	80	8	80	8	80
Index/Abstract service	10	100	10	100	10	100
Digitized full-text	1	10	2	20	0	0
Disk submission	3	30	5	50	2	20
Plain text email submission	0	0	1	10	0	0
Formatted FTP submission	0	0	0	0	0	0
Author's Web site	0	0	0	0	0	0
Author's email address	1	10	5	50	7	70
Electronic citation	0	0	4	40	4	40

5.2 LONGITUDINAL TRANSITION

5.2.1 Longitudinal Transition between 1994 and 1997

While there is a cross-sectional difference between the natural sciences and the social sciences in general in using electronic vehicles in formal scholarly communication, the study shows an obvious longitudinal trend in transition to the virtual world in formal scholarly communication in all five aspects investigated by this study.

The results indicate: (1) more journals publicized themselves electronically in 1997 than 1994; (2) more full-text articles could be accessed electronically in 1997 than in 1994; (3) more journals in 1997 than 1994 accepted electronic submission through disk, plain email message, and FTP file; (4) more scientists in 1997 than 1994 publicized themselves electronically in journals; and (5) more electronic information resources were cited in these journals in 1997 than 1994. The results are listed in table 5.9 below.

In 1997, 95% of the journals had a web site for themselves or their publishers as opposed to only 5% in 1994. Of the journals, 78.3% in 1997 as opposed to 38.3% in 1994 provided the journal's email address, including email address for the journal, editors, editorial board members, or other email addresses related to the journal (such as an email address for sales and advertising purposes). In 1997, 76.7% of the journals could be subscribed to electronically through email or online subscription as opposed to only 3.3% of the journals in 1994 that could be subscribed to electronically. Of the journals, 88.3% in 1997 and 1.7% in 1994 were published electronically, including electronic publishing of full text, table of contents, or abstracts.

While there was no change between 1994 and 1997 in electronic access to bibliographic information and abstracts of the journals investigated, there is a big difference between 1994 and 1997 in electronic access to full-text information of these journals. In 1997, 31.7% of the journals were fully digitized as opposed to only 5% in 1994.

Electronic submissions through disk, plain text email message, and formatted FTP file were accepted already in 1994. Disk submission was the major means of electronic submission in both 1994 and 1997. Half of the journals in 1997 accepted disk submission as opposed to 38.3% in 1994. Of the journals, 21.7% in 1997 accepted submission through plain text email message as opposed to only 6.7% in 1994. Of the journals, 15% in 1997 accepted electronic submission via formatted FTP file as opposed to 11.7% in 1994.

In both 1994 and 1997, author's web site address was seldom used for publicizing scientists electronically. Of the journals, 6.7% in 1997 contained articles in which at least one author released his/her web site address in his/her articles, as opposed to 1.7% in 1994. In contrast to the author's web site address, author's email address is a major tool for scientists to publicize themselves. There were 56.7% of the journals in 1997 in which at least one scientist released his/her email address while publishing articles in the journals, contrasted with only 21.7% in 1994.

Electronic information resources were cited by the authors in very few journals in both 1994 and 1997. Of the journals, 18.3% in 1997 and 13.3% in 1994 cited electronic information resources. Among the electronic information resources cited, web site

documents, FTP files, gopher files, electronic journals, and "other computer files" were all cited in both 1994 and 1997. However, there is a trend in citing web site documents, electronic journals, and "other computer files" from 1994 to 1997. In 1994, there was only one journal in which web site documents were cited, but there were seven in 1997. There was one journal in 1994 and three in 1997 in which the electronic journals were cited. There were seven journals in 1994 and seven in 1997 in which "other computer files" were cited by the authors.

Table 5.9 Comparison of Electronic Vehicles Adopted between 1994 and 1997

Year	1994		1997	
	Occurrence	Percentage	Occurrence	Percentage
Journal's Web site address	3	5	57	95
Journal's email address	23	38.3	47	78.3
Electronic subscription	2	3.3	46	76.7
Electronic publishing	1	1.7	53	88.3
Index/Abstract service	60	100	60	100
Digitized full-text	3	5	19	31.7
Disk submission	23	38.3	30	50
Plain text email submission	4	6.7	13	21.7
Formatted FTP submission	7	11.7	9	15
Author's Web site	1	1.7	4	6.7
Author's email address	13	21.7	34	56.7
Electronic citation	8	13.3	11	18.3

5.2.2 Longitudinal Transition in the Natural Sciences

While a transition is seen from 1994 to 1997 in using electronic vehicles in formal scholarly communication, there is also a trend in the natural sciences. Table 5.10 describes this trend in the natural sciences in detail.

In the natural sciences, the proportion of journals that had a web site address was only 10% in 1994, but increased to 96.7% in 1997. The proportion of journals that had an email address was 63.3% in 1994 with an increase to 86.7% in 1997. Only 6.7% of the

journals could be subscribed to electronically through email or online order form in 1994, but the proportion increased to 86.7% in 1997. Only one journal had electronic publishing in the form of electronic table of contents and abstracts in 1994, but the proportion of electronic publishing increased to 96.7% in 1997, including publishing electronic full-text, electronic table of contents, and electronic abstracts. Among 96.6% of the journals with electronic publishing in the natural sciences, 53.3% were fully digitized and the full-text could be accessed electronically; 90% had electronic table of contents service; and 40% had abstracts available online.

While only 6.7% of the journals provided full-text access electronically in 1994, 53.3% of the journals provided full-text electronic access in 1997. However, the accessibility of bibliographic information and abstracts remained the same over the two years surveyed.

Disk submission was still the major means for electronic submission in the natural sciences in the two years surveyed. Of the journals, 60% in 1994 accepted electronic submission via disk as opposed to 66.7% in 1997. There was a big increase from 1994 to 1997 in accepting electronic submission through plain text email and formatted FTP file. In 1994, 13.3% of the journals accepted electronic submission in the form of plain text email messages with an increase to 40% in 1997. In 1994, 23.3% of the journals accepted electronic submission through formatted FTP files with an increase to 30% in 1997.

There was also an increase in using electronic vehicles to publicize scientists from 1994 to 1997. Only one journal in 1994 used author's web site address to publicize scientists, but 13.3% of the journals did so in 1997. Of the journals, 36.7% in 1994

contained articles in which at least one author released his/her email address while publishing his/her article in the journal as opposed to 70% in 1997.

Electronic information resources were not used very frequently in the natural sciences in either 1994 or 1997, although there was an increase in using electronic information resources from 1994 to 1997. In 1994 only 6.7% of the journals cited electronic information resources, but 10% of the journals in 1997 were doing so. Among them, two journals cited FTP file documents in 1994 and three journals cited web site documents in 1997.

Table 5.10 Transition from 1994 to 1997 in the Natural Sciences

Year	1994		1997	
	Occurrence	Percentage	Occurrence	Percentage
Journal's Web site address	3	10	29	96.7
Journal's email address	19	63.3	26	86.7
Electronic subscription	2	6.7	26	86.7
Electronic publishing	1	3.3	29	96.7
Index/Abstract Index	30	100	30	100
Digitized full-text	2	6.7	16	53.3
Disk submission	18	60	20	66.7
Plain text email submission	4	13.3	12	40
Formatted FTP submission	7	23.3	9	30
Author's Web site	1	3.3	4	13.3
Author's email address	11	36.7	21	70
Electronic citation	2	6.7	3	10

5.2.3 Longitudinal Transition in the Social Sciences

In contrast to the transition in natural sciences, the transition in the social sciences is even more obvious from 1994 to 1997 in using electronic vehicles. Table 5.11 describes the trend in using electronic vehicles in formal scholarly communication in the social sciences in detail.

In 1994, no journal had a web site address, electronic subscription, or electronic publishing, but in 1997 most journals in the social sciences had a web site address, electronic subscription, and electronic publishing in place -- the proportion was 93.3%, 66.7% and 80% respectively. In both 1994 and 1997, the journal's email address was used for publicizing journals. Of the journals, 13.3% in the social sciences in 1994 had journal's email address with an increase to 70% in 1997.

In electronic accessibility of information, there was not much difference between 1994 and 1997 in the social sciences. In both years, 100% of the journals had been indexed and abstracted electronically. One journal in 1994 had been fully digitized and three in 1997.

There was an increase in the acceptance of electronic submission via the form of disk from 1994 to 1997. Only 16.7% of the journals in 1994 and 33.3% in 1997 accepted electronic submission on disk. However, electronic submission via plain text email message and formatted FTP file were not accepted at all in 1994 in the social sciences. While electronic submission through formatted FTP file was not accepted in 1997 either, submission via plain text email message was accepted in 1997 in the social sciences.

While the author's web site address was not published in the journals in the social sciences in both 1994 and 1997 for publicizing scientists, the author's email address was used in some journals. Only 6.7% of the journals in 1994 adopted the author's email address, publicizing scientists in the social sciences as opposed to 43.4% in 1997.

Electronic information resources were used in both 1994 and 1997 in the social sciences. Of the journals, 20% in 1994 and 26.7% in 1997 cited electronic information

resources in the social sciences. However, "other computer files" contributed most to the use of electronic information resources.

Table 5.11 Transition from 1994 to 1997 in the Social Sciences

Year	1994		1997	
	Occurrence	Percentage	Occurrence	Percentage
Journal's Web site address	0	0	28	93.3
Journal's email address	4	13.3	21	70
Electronic subscription	0	0	20	66.7
Electronic publishing	0	0	24	80
Index/Abstract service	30	100	30	100
Digitized full-text	1	3.3	3	10
Disk submission	5	16.7	10	33.3
Plain text email submission	0	0	1	3.3
Formatted FTP submission	0	0	0	0
Author's Web site	0	0	0	0
Author's email address	2	6.7	13	43.3
Electronic citation	6	20	8	26.7

5.2.4 Longitudinal Transition within the Natural Sciences and the Social Sciences

While there was a general trend of using electronic vehicles in both the natural sciences and the social sciences from 1994 to 1997, there was also a similar trend in each field studied within the natural sciences and the social sciences. Tables 5.12 through 5.17 list the occurrence and percentage of electronic vehicles adopted in different fields within the natural sciences and within the social sciences respectively.

5.2.4.1 Longitudinal Transition in Physics

Journal's email address was adopted by 100% of the journals in physics in both 1994 and 1997. In 1994, journal's web site address, electronic subscription, and electronic publishing were rarely used in publicizing journals in physics; the proportion of these electronic vehicles adopted by the journals was 20%, 10%, and 10% respectively.

However, in 1997 these electronic vehicles were adopted by 100% of the journals in physics.

There was no change between 1994 and 1997 in electronic access to bibliographic information and abstracts of the journals in physics. However, electronic accessibility of full-text information in physics had broken through from zero in 1994 to 60% in 1997.

There was an increasing trend in the acceptance of electronic submissions from 1994 to 1997 except for disk submission. Of the journals, 90% in 1994 as opposed to 80% in 1997 accepted electronic submission on disk. Only 20% of the journals in 1994 accepted electronic submission through plain text email message as opposed to 80% in 1997. Of the journals, 60% in 1994 accepted electronic submission through formatted FTP file as opposed to 80% in 1997.

Author's web site address was rarely used in both 1994 and 1997 in publicizing scientists in physics. There was only one journal in 1994 and two in 1997 in which one author released his/her web site address in his/her published article. However, author's email address was used by quite a lot of the journals in physics in both 1994 and 1997 for the purpose of publicizing a scientist. Of the journals, 70% in 1994 and 80% in 1997 contained articles in which at least one author released his/her email address.

Electronic information resources were rarely used in either 1994 or 1997 in physics journals. There were two journals in 1994 and one in 1997 in which electronic information resources were cited. In both 1994 and 1997, web site documents, FTP files, gopher files, electronic journals and "other computer files" were all cited by the authors in physics journals. FTP file was cited in two journals in physics in 1994 but only once in

1997, probably because there were more web site documents available in 1997 than in 1994.

Table 5.12 Transition from 1994 to 1997 in Physics

Year	1994		1997	
	Occurrence	Percentage	Occurrence	Percentage
Journal's Web site address	2	20	10	100
Journal's email address	10	100	10	100
Electronic subscription	1	10	10	100
Electronic publishing	1	10	10	100
Index/Abstract service	10	100	10	100
Digitized full-text	0	0	6	60
Disk submission	9	90	8	80
Plain text email submission	2	20	8	80
Formatted FTP submission	6	60	8	80
Author's Web site	1	10	2	20
Author's email address	7	70	8	80
Electronic citation	2	20	1	10

5.2.4.2 Longitudinal Transition in Biology

In 1994, journal's web site address and electronic publishing were not adopted at all in biology for publicizing journals. But 100% of the journals in 1997 adopted web site address and electronic publishing for publicity purposes. Journal's email address was adopted by 60% of the journals in 1994 and 70% in 1997 for publicity purposes in biology. While there was only one journal in 1994 which had electronic subscription, 90% of the journals in biology in 1997 could be subscribed to electronically.

There was no change between 1994 and 1997 in electronic access to bibliographic information and abstracts of the journals in biology. However, electronic accessibility of full-text information of these journals grew from 20% of the journals in 1994 to 70% in 1997.

Electronic submission on disk was accepted by most journals in biology in both 1994 and 1997. Of the journals, 70% in 1994 and 80% in 1997 accepted disk submission

in biology. However, electronic submission by plain text email message and formatted FTP file were rarely accepted in either 1994 or 1997 in biology. Only two journals accepted electronic submission by plain text email message and one accepted formatted FTP submissions in both 1994 and 1997.

There was an increasing trend in using electronic vehicles to publicize scientists from 1994 to 1997. There was no journal in 1994 using author's web site address but one did in 1997 to publicize scientists in biology. There was only one journal in 1994 in which at least one author published his/her email address in the journal, but 80% did in 1997.

There was no journal in which electronic information resources were cited in 1994, but one appeared in 1997.

Table 5.13 Transition from 1994 to 1997 in Biology

Year	1994		1997	
	Occurrence	Percentage	Occurrence	Percentage
Journal's Web site address	0	0	10	100
Journal's email address	6	60	7	70
Electronic subscription	1	10	9	90
Electronic publishing	0	0	10	100
Index/Abstract service	10	100	10	100
Digitized full-text	2	20	7	70
Disk submission	7	70	8	80
Plain text email submission	2	20	2	20
Formatted FTP submission	1	10	1	10
Author's Web site	0	0	1	10
Author's email address	1	10	8	80
Electronic citation	0	0	1	10

5.2.4.3 Longitudinal Transition in Geology

In geology, journal's web site address was adopted by only one journal in 1994, but by 1997, 90% of the journals used it for publicizing purposes. Journal's email

address was adopted by 30% of the journals in 1994 in geology, but by 90% in 1997. In 1994, both electronic subscription and electronic publishing were not adopted in geology. However, 70% of the journals adopted electronic subscription and 90% adopted electronic publishing in 1997.

There was no change from 1994 to 1997 in electronic access to bibliographic information and abstracts in geology. However, electronic accessibility of full-text information of the journals in geology grew from zero in 1994 to 30% in 1997.

There was also an increasing trend in accepting electronic submissions in geology from 1994 to 1997. Of the journals, 20% in 1994 and 40% in 1997 accepted electronic submission on disk. No journal accepted electronic submission by plain text email message in 1994, but 20% accepted electronic submission via plain text email message in 1997. However, electronic submission via formatted FTP file was not accepted at all in either 1994 or 1997.

There was a small change in the electronic publicity of scientists from 1994 to 1997 in geology. No journal in 1994 published author's web site address for publicity of geologists but one did in 1997. Of the journals, 30% in 1994 published author's email address while publishing his/her article in the journals in geology as opposed to 50% in 1997.

Electronic information resources were not used at all in 1994 but one journal in 1997 cited a web site document.

Table 5.14 Transition between 1994 and 1997 in Geology

Year	1994		1997	
	Occurrence	Percentage	Occurrence	Percentage
Journal's Web site address	1	10	9	90
Journal's email address	3	30	9	90
Electronic subscription	0	0	7	70
Electronic publishing	0	0	9	90
Index/Abstract service	10	100	10	100
Digitized full-text	0	0	3	30
Disk submission	2	20	4	40
Plain text email submission	0	0	2	20
Formatted FTP submission	0	0	0	0
Author's Web site	0	0	1	10
Author's email address	3	30	5	50
Electronic citation	0	0	1	10

5.2.4.4 Longitudinal Transition in Economics

In 1994, none of the journals in economics was publicized electronically in terms of adoption of a journal's web site address, journal's email address, electronic subscription, or electronic publishing. However, over half of the journals in 1997 adopted web site addresses, email addresses, electronic subscription, and electronic publishing. The percentage of the journals adopting a web site address, email address, electronic subscription, and electronic publishing for publicizing purposes in 1997 was 80%, 70%, 60%, and 80% respectively.

There was no change between 1994 and 1997 in electronic access to bibliographic information and abstracts of the journals in economics. There was no journal that was fully digitized in 1994, but there was one journal in 1997 and its full-text could be accessed electronically.

There was no change in acceptance of electronic submission between 1994 and 1997. Of the journals, 30% accepted electronic submission on disk in both 1994 and

1997. Electronic submissions through plain text email message and formatted FTP file were not accepted in either 1994 or 1997.

In 1994, electronic vehicles were rarely used in publicizing scientists. Only one journal in 1997 published an author's email address. No journal in 1997 published an author's web site address.

Electronic information resources were not cited at all by the authors in economics in either 1994 or 1997 in these journals.

Table 5.15 Transition from 1994 to 1997 in Economics

Year	1994		1997	
	Occurrence	Percentage	Occurrence	Percentage
Journal's Web site address	0	0	8	80
Journal's email address	0	0	7	70
Electronic subscription	0	0	6	60
Electronic publishing	0	0	8	80
Index/Abstract service	10	100	10	100
Digitized full-text	0	0	1	10
Disk submission	3	30	3	30
Plain text email submission	0	0	0	0
Formatted FTP submission	0	0	0	0
Author's Web site	0	0	0	0
Author's email address	0	0	1	10
Electronic citation	0	0	0	0

5.2.4.5 Longitudinal Transition in Political Science

A big jump occurred from 1994 to 1997 in using electronic vehicles to publicize journals in political science. In 1994, only 30% of the journals had an email address devoted to publicizing journals in economics. However, in 1997 journal's web site address was adopted by all journals surveyed in political science; journal's email address was adopted by 70%; electronic subscription was adopted by 60%; and electronic

publishing was adopted by 80%. Among the journals accepting electronic subscription in 1997, 50% accepted email subscription and 30% accepted online subscription.

There was no change in electronic access to bibliographic information and abstracts of these journals from 1994 to 1997, but there was a small change in electronic access to full-text information in political science. There was only one journal in 1994 that was fully digitized and its full texts could be accessed electronically. But there were two journals in 1997 being fully digitized and their full texts could be accessed electronically.

There was an increasing trend in accepting electronic submission on disk from 1994 to 1997 in political science, but no sign that other electronic submissions were accepted. Only 10% of the journals accepted electronic submission on disk in 1994, but 50% of the journals accepted disk submission in 1997.

Author's web site address was not used in either 1994 or 1997 for publicizing political scientists at all, but author's email address was published in 1994 by 10% of the journals and the proportion increased to 50% in 1997.

Utilization of electronic information resources also increased from 1994 to 1997 in political science. The proportion of journals in which electronic information resources were cited by authors was 20% in 1994 and increased to 40% in 1997. In 1994, web site documents, FTP files, gopher files and electronic journals were not cited at all by authors in political science but "other computer files" documents were cited. However, in addition to "other computer files" documents, the authors in political science also cited web site documents and FTP files in 1997.

Table 5. 16 Transition from 1994 to 1997 in Political Science

Year	1994		1997	
	Occurrence	Percentage	Occurrence	Percentage
Journal's Web site address	0	0	10	100
Journal's email address	3	30	7	70
Electronic subscription	0	0	6	60
Electronic publishing	0	0	8	80
Index/Abstract service	10	100	10	100
Digitized full-text	1	10	2	20
Disk submission	1	10	5	50
Plain text email submission	0	0	1	10
Formatted FTP submission	0	0	0	0
Author's Web site	0	0	0	0
Author's email address	1	10	5	50
Electronic citation	2	20	4	40

5.2.4.6 Longitudinal Transition in Sociology

The situation in sociology is pretty much similar to that in political science in terms of using electronic vehicles to publicize journals. There was a big jump from 1994 to 1997 in using electronic vehicles. In 1994, journal's web site address, electronic subscription, and electronic publishing were not used at all in sociology, but journal's email address was adopted by 10% of the journals. However, in 1997, the proportion of journals that had a web site address, email address, electronic subscription, and electronic publishing jumped to 100%, 70%, 80% and 80% respectively.

There was no change from 1994 to 1997 in the electronic accessibility of information for these journals in sociology. In both 1994 and 1997, bibliographic information and abstracts of all journals in sociology could be accessed electronically. However, there was no full-text information available electronically for these journals in either 1994 or 1997.

Electronic submission was rarely accepted in either 1994 or 1997 in sociology. Only one journal accepted electronic submission on disk in 1994 and two in 1997. However, none of the journals accepted electronic submission via plain text email message or formatted FTP file.

Author's web site was not published at all in either 1994 or 1997 in sociology. However, 10% of the journals in 1994 and 70% in 1997 published authors' email addresses.

The proportion of the journals using electronic information resources remained the same in 1994 and 1997. However, the types of electronic information resources cited by the authors in sociology changed from 1994 to 1997. In 1994, only "other computer files" documents were cited by the authors in sociology. However, in 1997, web site documents, electronic journals, and "other computer files" were all cited by the authors in these journals in sociology.

Table 5.17 Transition from 1994 to 1997 in Sociology

Year	1994		1997	
	Occurrence	Percentage	Occurrence	Percentage
Journal's Web site address	0	0	10	100
Journal's email address	1	10	7	70
Electronic subscription	0	0	8	80
Electronic publishing	0	0	8	80
Index/Abstract	10	100	10	100
Digitized full-text	0	0	0	0
Disk Submission	1	10	2	20
Plain text email submission	0	0	0	0
Formatted FTP Submission	0	0	0	0
Author's Web site	0	0	0	0
Author's email address	1	10	7	70
Electronic citation	4	40	4	40

CHAPTER SIX THE RESULTS (II)

This chapter reports the results of Chi-square tests for the difference between the natural sciences and the social sciences in the transition to the virtual world based on the data collected from the selected sixty journals. In order to test the hypotheses on the difference between the natural sciences and the social sciences, the statistical software package SPSS was used to process the data. In order to learn if there was a significant difference between the natural sciences and the social sciences in adopting electronic vehicles, the Chi-square test and Fisher's exact test (if the frequencies were too small to use the Chi-square) were used (Wickens, 1989).

There are one-tail and two-tail tests based on how much information was learned on the direction of the test. Because it is not clear whether the natural sciences transfer to the virtual world faster than the social sciences, two-tail tests were run in this study. In order to learn if there was a significant difference between 1994 and 1997 in adopting electronic vehicles, the Wilcoxon Matched-Pairs Signed-Ranks test ("Wilcoxon test" was used in this chapter) was also used in this study. Wilcoxon test is a non-parametric procedure used with two related samples to test the hypothesis that two variables have the same distribution. It makes no assumptions about the shapes of the distribution of the two variables. This test takes into account information about the magnitude of differences within pairs and gives more weight to pairs that show large differences than to

pairs that show small differences. The test is based on the ranks of the absolute values of the difference between the two variables. Because it is very clear that adoption of electronic vehicles had an increasing trend from 1994 to 1997, only one-tail tests were used in this study to test the hypotheses of difference between the two years. The following sections will deal with the results of Chi-square tests, Fisher's exact tests, and Wilcoxon tests on the data collected in this study.

6.1 ELECTRONIC PUBLICITY OF JOURNALS

6.1.1 Journal's Web Site Address

In 1994, only a few journals had a web site address in either the natural sciences or the social sciences. Because the expected frequency was smaller than 5, Fisher's exact test was run in this study to test if there is a significant difference between the natural sciences and the social sciences. Fisher's test result indicates that there was no significant difference in the adoption of journal's web site address between the natural sciences and the social sciences (p=0.2373). However, three years later, in 1997 most journals had a web site in both the natural sciences and the social sciences. The results of Fisher's exact test indicate that there was no significant difference in the adoption of journal's web site address between the natural sciences and the social sciences in 1997 (p=0.3633). The results are listed in table 6.1.

The Wilcoxon test result indicates that there was a significant difference between 1994 and 1997 in adopting web site by the journals in both the natural sciences or the social sciences (p=0).

It was found that pattern of adoption of Web site addresses by journals in the natural sciences is similar to that in the social sciences. The adoption of a journal web site address had not happened at all in 1994 in either the natural sciences or the social sciences, and the transition was almost completed in 1997 in both science areas.

Table 6.1 Web Site Address Adopted by Journals

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with Web site address (1994)	3 (10%)	27 (90%)	0 (0%)	30 (100%)	0.2373 (Fisher's Exact Two-Tail Test)
Journal with Web site Address (1997)	29 (96.7%)	1 (3.3%)	26 (86.7%)	4 (13.3%)	0.3533 (Fisher's Exact Two-Tail Test)
P-value** (Wilcoxon Test)	0		0		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.1.2 Publisher's Web Site Address

In 1994, there was only one publisher that had a web site. Fisher's exact test indicates that there was no significant difference between the natural sciences and the social sciences in the adoption of web site address by the publishers (p=1.0000). Contrary to the situation of 1994, most publishers in 1997 had a web site address. The results of Fisher's exact test indicate there was no significant difference in adopting web site by the publishers for publicity between the natural sciences and the social sciences (p=1.0000).

The Wilcoxon test results indicate that there was a significant difference between 1994 and 1997 in adoption of a web site address by the publishers in both the natural sciences and the social sciences (p=0). There was also a significant difference in

releasing the web site in the journals in both the natural sciences and the social sciences between 1994 and 1997.

Table 6.2 Web site address adopted by publishers

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Publisher with Web site Address (1994)	1 (3.3%)	29 (96.7%)	0 (0%)	30 (100%)	1 (Fisher's Exact Two-Tail Test)
Publisher with Web site address (1997)	29 (96.7%)	1 (3.3%)	28 (93.3%)	2 (6.7%)	1 (Fisher's Exact Two-Tail Test)
P-value** (Wilcoxon Test)	0		0		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

It was found that publishers in both the natural sciences and the social science follow the same pattern in adopting Web site addresses. In the early years of the invention of Web technology, the publishers in both science areas did not adopt Web site addresses at all. However, the adoption of Web site addresses was almost completed within three years in 1997 among publishers. This pattern coincides with the pattern with which journals adopted Web site addresses.

6.1.3 Journal's Email Address

In 1994, only 13.3% of the journals in the social sciences had an email address, including those for journals, editors, editorial board members, and others related to the journals, as opposed to 63.3% of the journals in the natural sciences. The Chi-square test results indicate that there was a significant difference between the natural sciences and the social sciences in using email for publicity purposes (p=0.0001). It was that journals' email addresses were adopted more quickly in the natural sciences than in the social

sciences. However, three years later, in 1997, email addresses were adopted by most journals (86.7%) in the natural sciences and most journals (70%) in the social sciences. The Chi-square rest results indicate that there was no significant difference between the natural sciences and the social sciences in using email address in 1997 (p=0.1172). The results are listed in table 6.3.

The Wilcoxon test results indicate that there was a significant difference between 1994 and 1997 in the adoption of journal's email address in both the natural sciences (p=0.0382) and the social sciences (p=0.0003).

Table 6. 3 Email Address Adopted by Journals

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with email address (1994)	19 (63.3%)	11 (36.7%)	4 (13.3%)	26 (86.7%)	0.0001
Journal with email address (1997)	26 (86.3%)	4 (13.3%)	21 (70.0%)	9 (30.0%)	0.1172
P-value** (Wilcoxon Test)	0.0382		0.0003		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

It is likely that the adoption of email addresses by journals started earlier than 1994 since quite lot journals (63.3%) in the natural sciences had adopted email addresses already in 1994 although few journals (13.3%) in the social sciences did so. It appears that the adoption of email addresses by journals was almost completed in both the natural sciences and the social sciences in 1997 since over two-thirds journals in both science areas had adopted email addresses by then.

6.1.4 Electronic Subscription

Electronic subscription was defined as ordering journals through electronic vehicles such as email and online subscription form. Electronic subscription would subscribe both print journals and electronic journals. For those journals published electronically, the delivery of journals is also electronic. Listserve software delivers the issues of the journal requested by subscribers automatically as long as it receives a subscribing command from the subscribers. For those published in print, the delivery means is still traditionally post mail services. The function of electronic subscription to these printed journals is to send a subscription request electronically. The publisher still needs to mail the issues requested by subscribers via postal services.

6.1.4.1 Acceptance of Email Subscription

In 1994, less than one-third of the journals in both the natural sciences and the social sciences accepted email subscription. Fisher's exact test results indicate that there was no significant difference between the natural sciences and the social sciences in accepting email subscription by the journals (p=0.4915). In 1997 more than half of the journals in the social sciences and two-thirds in the natural sciences accepted email subscription. However, the Chi-square results indicate that there was no significance difference between the natural sciences and the social sciences in acceptance of email subscription (p=0.2918). The results are listed in table 6.4.

The Wilcoxon test results indicate that there was a significant difference between 1994 and 1997 in adopting email subscription in either the natural sciences or the social

sciences (p=0.0004 for both science areas). Thus we have enough confidence to accept the assumption that there was a significant difference in the adoption of email subscription between 1994 and 1997.

Based on the results, it was found that the transition to email subscription in subscription to journals virtually did not happen in 1994. The publishers accepted email subscription after they adopted email addresses of journals. The process by which publishers accepted email subscription was also slower than that of email address adoption by journals.

Table 6. 4 Acceptance of email subscription by Journals

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal accepting email subscription (1994)	2 (6.7%)	28 (93.3%)	0 (0%)	30 (100%)	0.4915 (Fisher's Exact Two-Tail Test)
Journal accepting email subscription (1997)	20 (66.7%)	10 (33.3%)	16 (53.3%)	14 (46.7%)	0.2918
P-value** (Wilcoxon Test)	0.0004		0.0004		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.1.4.2 Acceptance of Online Subscription via Web

None of the journals in either the natural sciences or the social sciences accepted online subscriptions in 1994, and there was no significant difference between them in accepting online subscriptions. Three years later, in 1997 around half of the journals in both the natural sciences and the social sciences accepted online subscriptions. The Chi-square results indicate that there was no significant difference between the natural science domains and the social sciences in accepting online subscriptions (p=0.4383). Thus we

have to reject the assumption that there was a significant difference between the two sciences in accepting electronic subscription. The details are listed in table 6.5.

The Wilcoxon test results also indicate that there was a significant difference between 1994 and 1997 in adopting online subscription by journals in both the natural sciences (p=0.0003) and the social sciences (p=0.001).

Based on the results, it was found that the transition to online subscription in subscription to journals did not happen at all in 1994. In 1997, about half of the journals had completed the transition and could be subscribed to electronically via online subscription. Compared to the previous section, it appears that the adoption of online subscription happened after the publishers and journals adopted Web site addresses.

Table 6. 5 Acceptance of online subscription by Journals

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal accepting online subscription (1994)	0 (0%)	30 (100%)	0 (0%)	30 (100%)	
Journal accepting online subscription (1997)	17 (56.7%)	13 (43.3%)	14 (46.7%)	16 (53.3%)	0.4383
P-value** (Wilcoxon Test)	0.0003		0.0001		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.1.5 Electronic Publishing

"Electronic publishing" in this study is defined as dissemination of graphic or textual materials in electronic form through the global computer networks or the Internet. Three forms of electronic publishing were investigated in this study, including electronic table of contents publishing, electronic abstract publishing, and electronic full-text journal publishing. In this study, the dissemination of information via traditional postal service is

not accounted as electronic publishing even if the materials are in digital form such as CDROM products, software and so on.

6.1.5.1 Electronic Table of Contents Publishing

Electronic publishing of a journal's table of contents was a preliminary stage of the transition of formal scholarly communication to the virtual world. As long as a journal has an email address and subscribers have email addresses, it is easy to distribute the table of contents electronically to the subscribers. Listserve software make this process easy to realize. In 1994 there was only one journal in the natural sciences publishing an electronic table of contents. There was no significant difference between the natural sciences and the social sciences in electronic publishing of journal's table of contents (p=1). Electronic publishing of a journal's tables of contents developed greatly by 1997, and most journals published their table of contents electronically prior to the paper print. However, the Chi-square results indicate that there was no significant difference between the natural sciences and the social sciences in the electronic publishing of the table of contents (p=0.1658). Thus we have to reject the assumption there was a significant difference between the natural sciences and the social sciences in electronic publishing of journal's table of contents. The details are listed in table 6.6 below.

The Wilcoxon test results indicate that there was a significant difference in electronic publishing of a journal's table of contents in both the natural sciences and the social sciences between 1994 and 1997 (p=0 for the both science areas).

It was found that publishing tables of contents electronically did not happen in 1994 although the journals had already adopted email addresses then. This result is quite different from the results of email address adoption but similar to the acceptance of email subscription in 1994. However, the transition to publishing table of contents electronically was finished by most journals three years later. The results are similar to the results of the adoption of email addresses by journals in 1997 but the proportion of journals publishing table of contents is higher than that of journals adopting email addresses. It is clear that publishers adopted electronic table of contents publishing faster than the journals adopted email addresses.

Table 6.6 Journals with Electronic Table of Contents

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with electronic table of contents (1994)	1 (3.3%)	29 (96.7%)	0 (0%)	30 (100%)	1 (Fisher's Exact Two-Tail Test)
Journal with electronic table of contents (1997)	27 (90.0%)	3 (10%)	23 (76.7%)	7 (23.3%)	0.1658
P-value** (Wilcoxon Test)	0		0		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.1.5.2 Electronic Abstract Publishing

Electronic abstract publishing was also at a preliminary stage of the transition of formal scholarly communication to the virtual world. In 1994, there was only one journal in the natural sciences publishing its abstract electronically; none of the journals in the social sciences published an electronic abstract. There was no significant difference between the natural sciences and the social sciences in the electronic publishing of abstracts in 1994 (p=0.313). In 1997 more than one-third of the journals published their

abstracts electronically in both the natural sciences and the social sciences. However, the Chi-square test result indicates that there was no significant difference between the natural sciences and the social sciences in the electronic publishing of abstracts (p=0.5921). The details are listed in table 6.8 below.

The Wilcoxon test results indicate that there was a significant difference in the electronic publishing of abstracts in both the natural sciences (p=0.0033) and the social sciences (p=0.0051) between 1994 and 1997.

The results indicate that there is a similar pattern in adopting publishing abstracts and publishing table of contents electronically in its early stage. The transition to publishing abstracts electronically did not happen in 1994. However, only slightly more than one-third of journals published their tables of contents electronically three years later, which is less than those that adopted electronic table of contents publishing. Based on this result, it seems that publishers adopted electronic abstracts publishing slower than they adopted electronic table of content publishing.

Table 6.7 Journals with Electronic Abstracts

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with electronic abstract (1994)	1 (3.3%)	29 (96.7%)	0 (0%)	30 (100%)	1 (Fisher's Exact Two-Tail Test)
Journal with electronic abstract (1997)	12 (40%)	18 (60%)	10 (33.3%)	20 (66.7%)	0.5921
P-value** (Wilcoxon Test)	0.0033		0.0051		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.1.5.3 Electronic Full-text Publishing

Electronic full-text journals are most similar to the traditional print journals. Publishing full-text journals electronically is predicted to be an indicator of the transition of formal scholarly communication by many scholars. The results indicate that there was no journal in either the natural sciences or the social sciences in 1994 publishing full-text electronically. Thus, there was definitely no significant difference between the two sciences at all. However, three years later, in 1997 electronic full-text publishing was developed very well in the natural sciences with 16 journals being published electronically. The Chi-square test results indicate that there was a significant difference between the natural sciences and the social sciences in electronic publishing of full-text (p=0.0008). The results were listed in table 6.6 below.

The Wilcoxon test results indicate that there was a significant difference between 1994 and 1997 in the electronic publishing of full text in the natural sciences (p=0.0004). However, the Wilcoxon test results also indicate that there was no significant difference between 1994 and 1997 in electronic publishing of full-text in the social sciences (p=0.1797).

It is very clear that the transition to publishing full-text journals electronically did not happen at all in 1994. It is also obvious that the transition to publishing full-text journals is happening faster in the natural sciences than in the social sciences.

Table 6.8 Journals with Electronic Full Texts

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Electronic Full-text Journal (1994)	0 (0%)	30 (100%)	0 (0%)	30 (100%)	
Electronic Full-text Journal (1997)	16 (53.3%)	14 (47.7%)	2 (6.7%)	28 (93.3%)	0.0008
P-value** (Wilcoxon Test)	0.0004		0.1797		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.2 ACCEPTANCE OF ELECTRONIC SUBMISSION

Electronic submission is one means by which a manuscript can be sent to journals for publication consideration in electronic forms. Electronic submission includes submission on disk, via plain text electronic mail message, and formatted FTP files.

6.2.1 Disk Submission

Disk submission was the earliest form of electronic sub mission and has both traditional and modern features. The manuscript was stored in electronic format but the delivery from author to journal was through the postal service. This process does not save any time in the delivery process but it does save some time in publishing process. In 1994, some journals in both the natural sciences and the social sciences accepted electronic submission on disk. The Chi-square test result indicates that there was a significant difference between the natural sciences and the social sciences in accepting electronic submission on disk (p=0.0056). Therefore, we have enough confidence to accept the hypothesis that there is a significant difference between the natural sciences and the social sciences in the acceptance of electronic submission on disk in 1994. Three

years later, in 1997 electronic submission on disk was developed in both the natural sciences and the social sciences in formal scholarly communication. The Chi-square test still indicates that there was a significant difference between the natural sciences and the social sciences in accepting electronic submission via disk (p=0.0098). Thus we have enough confidence to accept the hypothesis that there is a significant difference between the natural sciences and the social sciences in the acceptance of electronic submission on disk in 1997. Based on the data gathered, it can be concluded that electronic submission via disk was more accepted in the natural sciences than in the social sciences in formal scholarly communication in both 1994 and 1997. The results are listed in table 6.9 below.

The Wilcoxon test result indicates that there was no significant difference in accepting disk submission in the natural sciences between 1994 and 1997 (p=0.5286). However, there was significant difference in the acceptance of submission on disk in the social sciences between 1994 and 1997 (p=0.0431).

Based on these results, it is clear that the transition of submission from paper manuscript to disk manuscript happened earlier than 1994 since some journals already accepted disk submission in 1994. It seems that disk submission is more easily accepted in the natural sciences than in the social sciences because more journals in the natural sciences accepted disk submission than in the social sciences in both 1994 and 1997.

Table 6. 9 Acceptance of Disk Submission by Journals

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal accepting disk submission (1994)	18 (60%)	12 (40%)	5 (16.7%)	25 (83.3%)	0.0006
Journal accepting disk submission (1997)	20 (66.7%)	10 (33.3%)	10 (33.3%)	20 (66.7%)	0.0098
P-value** (Wilcoxon Test)	0.5286		0.0431		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.2.2 Plain Text Email Submission

Plain text email submission was a new form of electronic submission. It saves time in both the delivery and publishing processes. However, the editor or publisher has to reformat the manuscript in order to publish it in the journal's standard format. In 1994, no journals in the social sciences accepted electronic submission in the form of plain text email message, but some journals in the natural sciences accepted plain text email submission. Since cells with the expected frequency were fewer than 5, Fisher's exact test was used in this case. The results indicate that there was no significant difference between the natural sciences and the social sciences in the acceptance of electronic submission via plain text email message (p=0.1124). Three years later, in 1997 electronic submission via plain text email was developed quite well. The Chi-square test results indicate that there was a significant difference between the natural sciences and the social sciences in the acceptance of electronic submission through plain email message (p=0.0006). The results are listed in table 6.10.

The Wilcoxon test results indicate that there was a significant difference in the acceptance of electronic submission via plain text email message in the natural sciences

between 1994 and 1997 (p=0.0414). However, there was no significant difference in accepting electronic submission via plain text email message in the social sciences between 1994 and 1997 (p=0.3173).

The results indicate that electronic submission via plain email message was accepted no later than 1994 in the natural sciences but it was not accepted at that time in the social sciences. It is also very clear that journals in the natural sciences tended easier to accept plain email message subscription than those in the social sciences did.

Table 6. 10 Acceptance of Plain Email Submission by Journals

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal accepting email submission (1994)	4 (13.3%)	26 (86.7%)	0 (0%)	30 (100%)	0.1124 (Fisher's Exact Two-Tail Test)
Journal accepting email submission (1997)	12 (40%)	18 (60%)	1 (3.3%)	29 (96.7%)	0.0006
P-value** (Wilcoxon Test)	0.0414		0.3173		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.2.3 Formatted FTP File Submission

Formatted FTP file submission is the most convenient form of electronic submission in formal scholarly communication. Usually the manuscript is submitted in a ready-to-publish format after it is accepted by a journal. The editor does not need to do much extra work in order to print the manuscript in a standard form. In 1994 no journals in the social sciences accepted formatted FTP file submission; a few journals in the natural sciences accepted this kind of submission. Since there was one cell with an expected frequency of smaller than 5, Fisher's exact test was run in this case. The

Fisher's exact test result indicates that there was a significant difference between the natural sciences and the social sciences in accepting formatted electronic submission in 1994 (p=0.0105). Three years later, in 1997 there were still no journals in the social sciences that accepted formatted FTP file submission. The Fisher's exact test result indicates that there was a significant difference between the natural sciences and the social sciences in accepting formatted FTP file submission (p=0.0019). We have enough confidence to accept the hypothesis of difference between the natural sciences and the social sciences in accepting formatted FTP file submission based on both years' data. Based on the data, we can also conclude that electronic submission via formatted FTP file was more acceptable in the natural sciences than in the social sciences in formal scholarly communication.

The Wilcoxon test results indicate that there was no significant difference between 1994 and 1997 in the acceptance of electronic submission via formatted FTP file in either the natural sciences (p=0.4631) or the social sciences (p=1.0000).

From the results, it was learned that journals in natural sciences started accepting electronic submission via formatted FTP file no later than 1994 and the adoption of formatted FTP file submission is not achieved as fast as disk submission. Journals in the social sciences were still reluctant to accept electronic submission via formatted file in 1997. It seems that diffusion of electronic submission via formatted FTP file has had more difficulties in the social sciences than in the natural sciences.

Table 6. 11 Acceptance of Formatted FTP Submission by Journals

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal accepting formatted FTP file submission (1994)	7 (23.3%)	23 (76.7%)	0 (0%)	30 (100%)	0.0105 (Fisher's Exact Two-Tail Test)
Journal accepting formatted FTP file submission (1997)	9 (30%)	21 (70%)	0 (0%)	30 (100%)	0.0019 (Fisher's Exact Two-Tail Test)
P-value** (Wilcoxon Test)	0.4631		1		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.3 ELECTRONIC ACCESSIBILITY OF INFORMATION

6.3.1 Electronic Access to Bibliographic Information and Abstracts

Electronic access to bibliographic information and abstracts was the first step towards making information accessible electronically. Traditionally, secondary information services agents such as DIALOG, Datastar, and so on published bibliographic information and abstracts. As indicated earlier, journals in both the natural sciences and the social sciences have been fully indexed and abstracted electronically by these services. Based on the data of the two years studied, there was no difference between the natural sciences and the social sciences in access to bibliographic information and abstracts. However, some journals released the location where the journal was indexed and abstracted and some did not.

The Wilcoxon test results indicate that there was no significant difference in accessing bibliographic information and abstracts in either the natural sciences or the social sciences between 1994 and 1997. It was found that there were more journals publishing where the journals had been indexed and abstracted in 1997 than 1994, but the difference was not statistically significant at all.

The results clearly indicate that the transition of electronic access to bibliographic information and abstracts was finished before 1994.

6.3.2 Electronic Access to Full-Text Information

Electronic access to full-text information would be the final stage of the transition to the virtual world in formal scholarly communication. In 1994, there were only a few journals with electronic access to their full-texts in either the natural sciences or the social sciences. Since there were cells with an expected frequency of less than 5, Fisher's exact test was run to handle the data. Fisher's exact test result indicates that there was no significant difference between the natural sciences and the social sciences in electronic access to the full text of the journals (p=1). Three years later, in 1997 more journals in the natural sciences began to digitize their full-text. The Chi-square test results indicate that there was a significant difference between the natural sciences and the social sciences in digitizing full-text (p=0.0003). Based on the data, it can be concluded that more journals in the natural sciences were digitized than in the social sciences in 1997. The details are listed in table 6.12.

The Wilcoxon test result indicates that there was a significant difference in accessing full-text information in the natural sciences between 1994 and 1997 (p=0.0382). There was also a significant difference in accessing full-text information electronically in the social sciences between 1994 and 1997 (p=0.0277). Therefore, we have enough confidence to accept the assumption of difference between 1994 and 1997 of publishing full-text electronically.

The transition to electronic access to full-text information should be similar to the transition to publishing full-text journals electronically. But since we limited the electronic publishing to distributing journals via the Internet or the global computer networks, the results are little bit different between them. The results indicate that before publishers published full-text journals electronically, some journals had been digitized already. The results obviously show us that the transition to publishing electronic full-text journals is faster in the natural sciences than the social sciences.

Table 6. 12 Electronic Accessibility of Full-Text Information

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with digitized full text (1994)	2 (6.7%)	28 (93.3%)	1 (3.3%)	29 (96.7%)	1 (Fisher's Exact Two-tail Test)
Journal with digitized full text (1997)	16 (53.3%)	14 (46.7%)	3 (10%)	27 (90%)	0.0003
P-value** (Wilcoxon Test)	0.0383		0.0277		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.4 ELECTRONIC PUBLICITY OF SCIENTISTS

6.4.1 Scientist's Web Site Address

Scientist's web site address is defined as the address of a web page released by the author who was publishing an article in the journal. Author's web site address is a very effective way to publicize scientists electronically since web sites can deliver multiple formats of information, including sound, moving images, and the text. In both 1994 and 1997, no scientists in the social sciences released his/her web site in his/her article; there were a few scientists in the natural sciences who released their web sites addresses in their articles. For both years, there were not enough cases per cell to run a Chi-square test

so that the Fisher's exact test was run. The Fisher's exact test results for both years indicate that there was no significant difference between the natural sciences and the social sciences in adopting author's web site for publicizing scientists in 1994 (p=1.0000) and in 1997 (p=0.1124). The details are listed in table 6.13 below.

The Wilcoxon test result indicates that there was no significant difference in adopting scientists' web site in either the natural sciences (p=0.1088) or the social sciences (p=1.0000) between 1994 and 1997.

The results indicate that scientist's Web site addresses have not been adopted in either the natural sciences or the social sciences. The transition in this regard has not happened in formal scholarly communication.

Table 6. 13 Scientist's Web Site Address Adopted by Journals

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with author's Web site address (1994)	1 (3.3%)	29 (96.7%)	0 (0%)	30 (100%)	1 (Fisher's Exact Two-tail Test)
Journal with author's Web site address (1997)	4 (13.3%)	26 (86.7%)	0 (0%)	30 (100%)	0.1124 (Fisher's Exact Two-tail Test)
P-value** (Wilcoxon Test)	0.1088		1		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.4.2 Scientist's Email Address

Scientist's email address is defined as the email address released by authors who are publishing articles in the journals; it is also a way to publicize scientists electronically. In 1994 very few journals in the social sciences contained one or more scientists email addresses; about one-third of these natural sciences journals did. The Chi-square test results indicate that there was a significant difference between the natural sciences and

the social sciences in adopting scientists' email addresses in formal scholarly communication (p=0.0048). Three years later, in 1997 more scientists released their email addresses while publishing articles in both the natural sciences and the social sciences. The Chi-square test result indicates that there was a significant difference between the natural sciences and the social sciences in adopting scientists' email addresses in 1997 (p=0.0371). Based on the two years' data, it can be concluded that there were more scientists' email addresses adopted in the natural sciences than in the social sciences. The details are listed in table 6.14.

The Wilcoxon test results indicate that there was a significant difference between 1994 and 1997 in adopting scientists' email addresses in both the natural sciences (p=0.0108) and the social sciences (p=0.0071).

Unlike Web site addresses, scientists' email addresses were adopted no later than 1994 in both the natural sciences and the social sciences according to the results. Over one-third of the journals in the natural sciences adopted scientists' email addresses in 1994 and over two-thirds in 1997. The pattern of adoption of scientists' email addresses is similar to that of adoption of journals' email addresses. It indicates that adoption of scientists' email addresses in the natural sciences is faster than in the social sciences.

Table 6. 14 Scientist's Email Address Adopted by Journals

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with author's email address (1994)	11 (36.7%)	19 (63.3%)	2 (6.7%)	28 (93.3%)	0.0048
Journal with author's email address (1997)	21 (70%)	9 (30%)	13 (43.3%)	17 (56.7%)	0.0371
P-value** (Wilcoxon Test)	0.0108		0.0071		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.5 UTILIZATION OF ELECTRONIC INFORMATION RESOURCES

6.5.1 Web Site Citation

Web site citation is defined as a Web site document being cited in an article published in a journal. In both 1994 and 1997, there were very few web site documents cited in the journals in both the natural sciences and the social sciences. Based on the data for two years, Fisher's exact test was used to process the data. Fisher's exact test results indicate that there was no significant difference between the natural sciences and the social sciences in citing web site documents in either 1994 (p=1.0000) or 1997 (p=1.0000). The details are listed in table 6.15.

The Wilcoxon test results indicate there was no significant difference between 1994 and 1997 in citing web site documents in either the natural sciences (p=0.3613) or the social sciences (p=0.0679).

It seems clear that the diffusion of Web technologies is slower among the scientists than among the publishers. In 1994 the proportion of publishers adopting Web site addresses was the same as that of Web site documents cited by the scientists. However, three years later, while most publishers and journals adopted Web site

addresses in both sciences areas, Web site documents were still seldom cited by scientists in formal scholarly communication. It also appears that the transition to citing Web site documents in the social sciences may have been faster than in the natural sciences.

Table 6. 15 Web Site Documents Cited

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with Web site citation (1994)	1 (3.3%)	29 (96.7%)	0 (0%)	30 (30%)	1 (Fisher's Exact Two-Tail Test)
Journal with Web site citation (1997)	3 (10%)	27 (90%)	4 (13.3%)	26 (86.7%)	1 (Fisher's Exact Two-Tail Test)
P-value** (Wilcoxon Test)	0.3613		0.0679		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.5.2 FTP File Citation

FTP file document was another kind of electronic information resource. FTP file citation is defined as the FTP file document being cited in an article published in a journal. The number of articles citing FTP file documents in both the natural sciences and the social sciences in either 1994 or 1997 was very low. Based on the two years' data, Fisher's exact test was run to process the data. Fisher's exact test results indicate that there was no significant difference between the natural sciences and the social sciences in citing FTP file documents in either 1994 (p=0.4915) or 1997 (p=1.0000). The details are listed in table 6.16 below.

The Wilcoxon test results indicate that there was no significant difference between 1994 and 1997 in citing FTP file documents in either the natural sciences (p=0.5930) or the social sciences (p=0.3173).

The results indicate that the transition to citing FTP file documents had virtually not happened in either the natural sciences or the social sciences as there was an extremely low rate of journals that contained at least one FTP file citation. The transition to citing FTP file documents in the natural sciences was as difficult as in the social sciences.

Table 6. 16 FTP File Documents Cited

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with FTP file citation (1994)	2 (6.7%)	28 (93.3%)	0 (0%)	30 (100%)	0.4915 (Fisher's Exact Two-Tail Test)
Journal with FTP file citation (1997)	1 (3.3%)	29 (96.7%)	1 (3.3%)	29 (96.7%)	1 (Fisher's Exact Two-Tail Test)
P-value** (Wilcoxon Test)	0.5930		0.3173		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.5.3 Gopher File Citation

In both 1994 and 1997, there were no journals in the social sciences citing gopher file documents; there was one journal in the natural sciences citing gopher file documents. Fisher's exact test results indicate that there was no significant difference between the natural sciences and the social sciences in citing Gopher file documents in either 1994 (p=1.0000) or 1997 (p=1.0000). The details are listed in table 6.17.

The Wilcoxon test results indicate that there was no significant difference between 1994 and 1997 in citing gopher file documents in either the natural sciences (p=1.0000) or the social sciences (p=1.0000).

It is clear that citing Gopher file documents in formal scholarly communication follows the same pattern of citing Web site documents and FTP file documents. The extremely low rate of Gopher file documents cited indicates that Gopher file documents have not been accepted as a valid citation in formal scholarly communication in either science areas. However, the natural sciences started to use Gopher file documents as citations in 1994 but the speed of adoption has not changed since then.

Table 6. 17 Gopher File Documents Cited

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with Gopher file citation (1994)	1 (3.3%)	29 (96.7%)	0 (0%)	30 (100%)	1 (Fisher's Exact Two-Tail Test)
Journal with Gopher file citation (1997)	1 (3.3%)	29 (96.7%)	0 (0%)	30 (100%)	1 (Fisher's Exact Two-Tail Test)
P-value** (Wilcoxon Test)	1		1		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.5.4 Electronic Journal Citation

The electronic journal document is most similar to the traditional media of formal scholarly communication. Electronic journal citation is defined as the electronic journal document being cited in the references of an article published in a journal. Since the electronic journal is very a new product in scholarly communication, there were only a few journals citing electronic journals in both 1994 and 1997. Based on the data for two years, Fisher's exact test was run to process the data. Fisher's exact test results indicate that there was no significant difference between the natural sciences and the social sciences in citing electronic journal documents in either 1994 (p=1.0000) or 1997 (p=1.0000). The details are listed in table 6.18 below.

The Wilcoxon test results also indicate that there was no significant difference between 1994 and 1997 in citing electronic journal documents in either the natural sciences (p=1.0000) or the social sciences (p=0.3613).

The electronic journals have the most similar format to traditional print journals, but the pattern of citing electronic journals is similar to that of citing Web site documents, FTP files, and Gopher files, namely the rate of citing electronic journals was extremely low. It is clear that electronic journals have not been accepted as valid reference by majority of these scholarly communities.

Table 6. 18 Electronic Journal Documents Cited

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with electronic journal citation (1994)	1 (3.3%)	29 (96.7%)	0 (0%)	30 (100%)	1 (Fisher's Exact Two-Tail Test)
Journal with electronic journal citation (1997)	1 (3.3%)	29 (96.7%)	2 (6.7%)	28 (96.7%)	1 (Fisher's Exact Two-Tail Test)
P-value** (Wilcoxon Test)	1		0.3613		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

6.5.5 Other Electronic Document Citation

Other electronic documents include computer database files and software. These documents were also cited in some journals investigated in this study, but these documents were not cited very frequently in either 1994 or 1997. Fisher's exact test results indicate that there was no significant difference between the natural sciences and the social sciences in citing other electronic documents in either 1994 (p=0.1028) or 1997 (p=0.1028). The details are listed in table 6.19 below.

The Wilcoxon test results indicate that there was no significant difference in citing other electronic information resources in either the natural sciences or the social sciences between 1994 and 1997 (p=1.0000 for the both science areas).

The results indicate that utilization of electronic information resources shared a similar pattern, namely, the citation rate is extremely low. It seems clear that social scientists started to use other electronic documents as references earlier than natural scientists did. Furthermore, other electronic information resources were cited more frequently in the social sciences than in the natural sciences.

Table 6. 19 Other Electronic Information Resources Cited

	Natural Sciences		Social Sciences		P-value*
	Yes (%)	No (%)	Yes (%)	No (%)	
Journal with other electronic document citation (1994)	1 (3.3%)	29 (96.7%)	6 (20%)	24 (80%)	0.1028 (Fisher's Exact Two-Tail Test)
Journal with other electronic document citation (1997)	1 (3.3%)	29 (96.7%)	6 (20%)	24 (80%)	0.1028 (Fisher's Exact Two-Tail Test)
P-value** (Wilcoxon Test)	1		1		

*Chi-Square Test unless indicated. **One-tail test for differences between 1994 and 1997 unless indicated.

CHAPTER SEVEN DISCUSSION

In this study, sixteen indicators in five categories related to formal scholarly communication in the virtual world were investigated. No significant difference was found between the natural sciences and the social sciences in the electronic publicity of journals, electronic access to published information, or utilization of electronic information resources in formal scholarly communication with few exceptions. Significant differences were found between the natural sciences and the social sciences in terms of the electronic submission of manuscripts and the electronic publicity of scientists with few exceptions. Significant differences were also found between 1994 and 1997 in the transition to the virtual world in all five categories.

7.1 ELECTRONIC PUBLICITY OF JOURNAL

7.1.1 Adoption of Web site Address and Email Address

No significant difference was found between the natural sciences and the social sciences in adopting Web site addresses for the journal or publishers in either 1994 or 1997. The reasons for the lack of difference, however, were different in 1994 from 1997. In 1994, only a few of the journals investigated and their publishers adopted a Web site address in either science domain, which resulted in the insignificant difference between them. However, in 1997 most journals and their publishers in both the natural sciences

and the social sciences had already adopted a Web site, which again resulted in an insignificant difference between them.

The World Wide Web was first publicly available on the Internet in early 1993. Since then, the number of sites providing information over the Web has been growing exponentially (Krol, E. & Ferguson, P., 1995, p. 117). The Web is also a powerful publishing tool for scholarly communication; many publishers have adopted it very quickly for publicizing themselves and the journals they are publishing. The rapid development of Web technology from 1994 to 1997 encouraged most publishers to adopt Web technology to publicize themselves and their products (scholarly journals); therefore, there was a significant difference between 1994 and 1997 in adopting Web site addresses by journals and their publishers. The reason publishers quickly adopted a Web site address in 1997 could be from both the advantages of the Internet and competition in the market. The key advantages of Internet presence are interaction, convenience, timely report on the contents. Nowadays, publishers, companies, radio broadcasters and others have quickly established an Internet presence, some with significant marketing budgets spent on well-placed ads and hot links (buttons or underlined and highlighted text which can be clicked to take the viewer to another site) to "capture eyeballs" (Margherio, et al, 1998). Those that do not have a presence could potentially lose market share to existing competitors or new ones that connect with this audience first.

The creation of email is bound to the creation of ARPANET in 1969, the first successful distributed, wide-area, packet-switched network of computers ever built (Hardy, 1997). ARPANET, the technological forebearer of today's Internet, was also the

first interactive computer network used to deliver email. Electronic mail service was one of the earliest functions developed on the ARPANET in the early 1970s and is still the most widely used function on the Internet today. However, by 1994, not many journals (13.3%) in the social sciences had adopted an email address, although over half of the journals (63.3%) in the natural sciences had adopted an email address by then. However, three years later, email addresses had been adopted by 70% of the journals in the social sciences. Although there was also an increase in adopting email addresses by the journals in the natural sciences, it was only a 23.4% increase, from 63.3% in 1994 to 86.7% in 1997. Thus the difference in adopting email addresses by the journals between the natural sciences and the social sciences became non-significant in 1997.

7.1.2 Electronic Subscription

There are two ways to subscribe to a journal electronically. One is by email subscription and the other is by interactive online subscription on the Internet.

Email subscription was accepted by very few journals in 1994, with two in the natural sciences and none in the social sciences. Therefore the difference between the natural sciences and the social sciences in the acceptance of email subscription by journals in 1994 was not significant since the proportion of journals accepting email subscription in both sciences was so low. However, in 1997, more than half of the journals (20 in the natural sciences and 16 in the social sciences), accepted email subscription. The increase in rates of adopting email subscription in the two science domains are similar: 60% in the natural sciences and 53% in the social sciences. Thus the

difference in the acceptance of email subscription by the journals between the natural sciences and the social sciences was not significant in 1997. However, the increases of adopting email subscription in both the natural sciences and the social sciences were significant from 1994 to 1997.

Online subscription is one application of electronic commerce to journal distribution, which is widely used in other businesses. Some companies or publishers create an electronic order form on the Internet so that customer can fill out the form to send the order to the companies or publishers. Online subscription is interactive and the receiver will handle the order automatically. Based on the results, there was no significant difference between the natural sciences and the social sciences in the acceptance of online subscription by journals in either 1994 or 1997. However, the reason for the lack of difference is different for the two years. In 1994, online subscription was not accepted at all by the journals investigated so there was no difference between the natural sciences and the social sciences. In 1997, the proportion (56.7%) of journals adopting online subscription in the natural sciences was not significantly larger than that (46.7%) in the social sciences. However, the change in the adoption of online subscription was obvious, and statistically significant, from 1994 to 1997 in both the natural sciences and the social sciences. Comparing with the adoption of Web site addresses, it was found that the adoption of online subscription happened after the publishers and journals adopted the Web site addresses. Online subscription is bound to the Web technologies. A Web site page may be one of the earliest applications of the Web technologies since they provide a tool for publishers, companies and other

organizations to present themselves in the virtual world. Use of Web technologies for other commercial purposes was developed later. Therefore, although publishers and journals started to adopt Web site addresses in 1994, online subscription was not adopted then by any publisher or journal investigated.

7.1.3 Electronic Publishing

Publishing could be defined as issuing printed or otherwise reproduced textual or graphic materials or computer software for sale or distribution to the public. Electronic publishing covers a wide range of media products. Electronic publishing is broadly defined as the dissemination of graphic or textual materials in electronic form to the public through a computer network. Wilson (1997) summarized the characteristics of electronic publishing that distinguish it from print publication as following: (1) rapid production and dissemination, (2) the ability to update and correct electronic text immediately, (3) the ability to be made collaborative and interactive, involving several authors and readers, (4) the ability to be disseminated world-wide without need for separate rights negotiations and without the costs of distribution or reprinting. In this study, electronic publishing includes the electronic publishing of full-text journal, table of contents, and abstracts.

The simplest form of electronic publishing is to publish a journal's table of contents electronically. While this form is fairly straightforward, there was only one journal in 1994 that published its table of contents electronically so the difference in electronic publishing table of contents was not significant then between the natural

sciences and the social sciences. Three years later, in 1997, most journals in both the natural sciences (90%) and the social sciences (76.7%) published their tables of contents electronically. But the difference in adopting the electronic publishing of the table of contents was not significant between the natural sciences and the social sciences since the proportion of journals adopting electronic publishing of tables of contents in the natural sciences is similar to that in the social sciences. In this study, it was found that electronic publishing of the table of contents developed very rapidly from 1994 to 1997 in both the natural sciences and the social sciences. The differences in adopting electronic publishing of table of contents between 1994 and 1997 in both the natural sciences and the social sciences were statistically significant.

Electronic publishing of abstracts is another form of electronic publishing, but its adoption rate and the reason for the adoption rate are similar to those of electronic publishing of the table of contents. In 1994, only one journal in the natural sciences published its abstracts electronically and no journal in the social sciences did so. The proportion of journals publishing their abstracts electronically in the two sciences were similar to each other so that the difference between them was not significant statistically. Three years later, in 1997, about one-third of the journals in both the natural sciences and the social sciences published their abstracts electronically. The proportion of journals publishing their abstracts electronically in the two science domains were also similar to each other in 1997. However, the difference between 1994 and 1997 in publishing abstracts electronically in both natural sciences and the social sciences was significant because there was a big change from 1994 to 1997 in publishing abstracts electronically.

The rate of journals publishing their abstracts electronically increased from zero in 1994 to 33.3% in 1997 in the social sciences and from 3.3% in 1994 to 40.0% in 1997 in the natural sciences.

Electronic publishing of a full-text journal would be the most difficult form of electronic publishing because the full-text journal needs more storage space than the abstract or the table of contents, and may contain images or motion pictures that increases the difficulties of electronic publishing. Electronic full text is equivalent to the text of the paper version, which contains exactly the same content and format of the text in the printed journal. In order to publish full-text journal electronically, the publisher not only has to handle the content of text in electronic form, but also needs to handle the format of its printed version in electronic form. In order to keep a consistent journal format of print version and electronic version, some publishers adopted the Acrobat program to publish full text electronically. However, Acrobat can only handle textual and stable graphic materials; it still can not present motion pictures and sound information. If full text contains motion pictures or sound information, the electronic publishing process will have to involve many other technologies to manipulate the motion pictures and sound with more sophisticated software such as VideoShop, SoundRecorder, Director, Adobe Premiere and so on. In 1994, no journal published its full text electronically, and so, of course, there was no difference between the natural sciences and the social sciences in the adoption of publishing full text electronically. Three years later, electronic publishing of full text developed in both the natural sciences and the social sciences but the rate of adoption varies between the natural sciences and the social sciences. Over half of the

journals (53.3%) in the natural sciences published their full texts electronically, but only a few journals (6.7%) in the social sciences published their full texts electronically; thus, the difference in the adoption of publishing full-text journal electronically between the natural sciences and the social sciences in 1997 was significant. While publishing full texts electronically was adopted rapidly in the natural sciences during the three-year period, it seems that it was reluctantly adopted in the social sciences. The difference in adopting electronic publishing journal's full text was not significant at all in the social sciences between 1994 and 1997.

In this study, it was found that there is an increasing trend in electronic publishing in both the natural sciences and the social sciences. This finding matches with most results of recent study on electronic publishing. For example, a ten-country study undertaken during 1996/1997, concluded that "the Internet is quickly becoming the most significant electronic publishing media, by the year 2000 it will be bigger than all other publishing media" (McDermott & Fay, 1997, p5). This study also found that the pace of growth in electronic publishing in the natural sciences is faster than in the social sciences. Hawkins et al (1992) studied the forces shaping the electronic publishing industry of the 1990s and concluded that technology, economics, social trends, government policies, application growth, and industry trends played key roles in shaping the industry. In this study, technology and economic factors seemed to play their roles in differentiating between the natural sciences and the social sciences in the adoption of the publishing a full-text journal electronically. Formal scholarly communication in the natural sciences seems to take more advantage of information technologies than that in the social sciences.

Online information retrieval systems, optical storage media, videotex, artificial intelligence/expert systems, multimedia, to name a few information technologies, are all developed very well in the natural sciences and all of them are actually based on theories of the natural sciences. Thus scientists in the natural sciences are close to information technologies so new information technology is perhaps more easily adopted by natural scientists.

Although it is widely speculated that producing a refereed journal in electronic form would save money, there is a strong demand that journals continue to be produced in the old paper form as well as in the electronic form. Preparing the electronic materials for both paper and electronic delivery is a significant additional cost that makes electronic production a break-even proposition at best (Boyce & Dalterio, 1996). Since electronic publishing costs extra money, economic factors play an important role in adoption of electronic publishing. Research budgets in the social sciences are usually smaller than in the natural sciences. A project with over $1,000,000 is very common in the natural sciences, but is less commonly seen in the social sciences. Large budgets in the natural sciences definitely facilitate scholarly communication and help transfer print journals into electronic journals. With the contemporary crisis in scholarly communication (Thatcher, 1995), many scholarly journals are facing economic crises in publishing print versions; they do not have extra money to publish journals electronically. Therefore the evolution of electronic publishing is slow because "the scholarly publishing business is full of inertia and perverse economic incentive" (Odlyzko, 1997).

Another possible reason for the slow process of electronic publishing may be related to the attitudes and perception of people (especially policy makers) on electronic publishing. Based on Lancaster's (1995) study, electronic publishing is completely new to many of the academic administrators and they do not consider the academic community well equipped to take on an enterprise of this kind. Thus they would not give it a high priority in allocation of university resources. If this situation continues, the process of adopting electronic publishing will continue to be slow.

7.2 ACCEPTANCE OF ELECTRONIC SUBMISSION

Three ways to submit manuscripts electronically were studied, including electronic submission on disk, via plain text email message, and formatted FTP file. The results indicate that there was a significant difference between the natural sciences and the social sciences in both 1994 and 1997 in all of these three forms. In both 1994 and 1997, electronic submission in all three forms was acceptable by more journals in the natural sciences than in the social sciences. This result may relate to the environments in which natural and social scientists work and the different research methodologies they have been using. Usually natural scientists work in a laboratory and depend upon computers for calculation or data processing, while social scientists may work in the field and depend on survey and interview methods for research. The processing of final research results may be more or less related to the application of computer technology in the natural sciences. Many natural scientists thus may be more familiar with and feel more comfortable with the application of computer technology than social scientists.

Lazinger, Bar-Ilan and Peritz's study (1997) also found that faculty in sciences and medical sciences tend to use computers and the Internet more intensively than faculty in social sciences and humanities. This comfort level may contribute to the higher acceptance level of electronic submission in the natural sciences.

The longitudinal study results also provide evidence that electronic submission was adopted earlier by the journals in the natural sciences than in the social sciences. For example, the results indicate that there was no significant difference between 1994 and 1997 in the acceptance of electronic submission on disk in the natural sciences, but there was a significant difference between 1994 and 1997 in the social sciences. 60.0% of the journals in the natural sciences adopted electronic submission on disk in 1994 but only 16.7% in the social sciences did so then. In 1997, 66.7% of the journals in the natural sciences accepted electronic submission on disk but only 33.3% in the social sciences did so.

In contrast to disk submission, plain text email submission is a newer form of electronic submission. The results also show that this new form of submission was accepted more quickly by journals in the natural sciences than in the social sciences. The results indicate that there was a significant difference from 1994 to 1997 in the acceptance of electronic submission via plain text email message in the natural sciences since the proportion of journals accepting email submission rose from 13.3% in 1994 to 40.0% in 1997. However, there was no significant difference in the acceptance of electronic submission via plain email message between 1994 and 1997 in the social

sciences since there were so few journals in the social sciences adopting it in either 1994 or 1997.

In the natural sciences, the proportion of journals accepting electronic submission via formatted FTP file rose from 23.3% in 1994 to 30.0% in 1997, but the difference between these two years was not significant. In the social sciences, the electronic submission via formatted FTP file was not accepted at all in either 1994 or 1997. This is one of the few areas in which the longitudinal transition towards the electronic was not found in this study. It may be related to the complexity of the technology required for formatted FTP file submission. Different journals may have different format requirements for submission. In order to submit a manuscript via formatted FTP file submission, email software has to be able to transfer the files in different formats such as ACSII, binary, or others. The complexity of the technology definitely increases the difficulties in using this technology and it may take more time for both scientists and publishers to adopt it.

7.3 ELECTRONIC ACCESSIBILITY OF INFORMATION

One consistent phenomenon in this study is that there was no significant difference in electronic access to bibliographic information and abstracts of the journals either between the natural sciences and the social sciences or between 1994 and 1997. Computers were first applied in the field of library and information science in the early 1950s (Kilgour, 1970) and bibliographic information processing was among the early areas where computer technology was applied. In 1960 the National Library of Medicine

began design of MEDLARS and four years later the system became operational for batch searching (Neufeld & Cornog, 1986). The first public demonstration of online bibliographic searching dates back to 1960 and the first "production search service" (Lockheed's DIALOG, serving NASA Headquarters) to 1967 (Bourne, 1980). In the mid-1980s, the number of databases grew to over 2400 (Williams, 1985). In the 1990s, computerized indexing and abstracting services were pervasive in most fields including the fields investigated in this study. Therefore, there was no significant difference in electronic access to the bibliographic information and abstracts between the natural sciences and the social sciences or between 1994 and 1997 because this practice had been developed and accepted well a long time before 1994. All the high-impact journals studied in this research are well covered in one or more electronic database.

Full-text information databases made their appearance in the early 1960s, but the first full-text database was not operational until 1973 (Neufeld & Cornog, 1986). But the number of full-text databases was still very small in the 1980s. Access to full-text information via the Internet is one of the most recent development of the application of computer technology in information processing. This study's findings indicate that there was no significant difference between the natural sciences and the social sciences in 1994 in electronic access to full-text of journals because there were too few journals whose full texts could be accessed electronically (one in the social sciences and two in the natural sciences). However, the results show that there was a significant difference between the natural sciences and the social sciences in 1997 in electronic access to full-text journals already (53.3% in the natural sciences and 6.7% in social sciences). The significant

difference between 1994 and 1997 also indicates that full-text information retrieval was developing very rapidly in the mid-1990s.

7.4 ELECTRONIC PUBLICITY OF SCIENTISTS

Two electronic means for publicizing scientists that were investigated in this study are author email address and author Web site address. No significant difference between the natural sciences and the social sciences was found in either 1994 or 1997 in publishing the author Web site addresses. However, the reasons for this were similar in 1994 and 1997: the number of the journals in which authors released their Web site addresses are too small. The World Wide Web first came out publicly in 1993, so there may not have been enough time for scientists to adopt the technology to set up a Web site by 1994. Three years later, Web technology had been applied well in scholarly communication and most journals and their publishers adopted this technology and set up their own Web site. However, the number of journals in which authors released their Web site addresses was still very small in 1997.

There are at least three possible reasons for this. First of all, Web technology is more complicated than email and requires more computer skills, so that many scientists may not have set up their own personal Web pages. Therefore they did not have their Web site address for releasing when publishing their articles in the journals. Second, journal editorial policy may have discouraged authors from releasing their Web site address in journals. Actually, no journal investigated in this study required that authors submit their Web site addresses when submitting their articles. If a journal does not

allow the author to releases his/her Web site address in the journal, his/her Web site address definitely will be removed when the journal is published even if s/he does submit his/her Web site address. However, it was found that there were several authors in the several journals in the natural sciences releasing their Web site addresses in both 1994 and 1997. It seems difficult to conclude that there is a policy of excluding Web site address releasing in the journals investigated in this study. Third, scientists may have lacked appropriate perception on function of a Web site address in formal scholarly communication. If a scientist does not give Web site address enough weight in formal scholarly communication, s/he may not submit his/her Web site address when s/he submits articles to a journal even if s/he does have one. Since this study did not investigate perceptions of social scientists nor natural scientists, it is unclear if this was the major reason for lack of publication of author Web site addresses.

In contrast to the Web site address, the author email address has fewer visual effects than a Web site in publicizing scientists, since email is basically a text-based communication tool. The results indicate that there were significantly more journals in the natural sciences releasing author email addresses than those in the social sciences in both 1994 and 1997. The results also indicate that there were significantly more journals in 1997 releasing author email addresses than in 1994. This difference may be related to the history of the electronic mail application. Based on Hardy's study (Hardy, 1997), electronic communication was first adopted in the natural sciences among the ARPANET technical researchers. Because electronic mail communication was applied to scholarly communication in the early 1970s, electronic mail was already adopted widely in the

1990s. However, author email address was not adopted by as many journals in the social sciences as in the natural sciences.

7.5 UTILIZATION OF ELECTRONIC INFORMATION RESOURCES

Nowadays, more and more information is available online in electronic form. The computer is widely used in the publishing process so most information products are easily transferred into digital form even if the final products are not in electronic form. As Schauder (1994) concluded, "publication via printed journals is extensively electronically assisted. The generation of manuscripts by academics is today almost universally by word processor." (Schauder, 1994, p. 94) The current document world is composed of both print materials and digitized materials. In order to learn how extensively electronic information resources are used in formal scholarly communication, this study investigated several specific forms of electronic information resources including Web site documents, FTP file documents, Gopher file documents, electronic journals, and "other computer files". However, the results indicate there was no significant difference between the natural sciences and the social sciences in using each of these electronic information resources in either 1994 or 1997. And there was no significant difference between 1994 and 1997 in using each of these electronic information resources in formal scholarly communication in either the natural sciences or the social sciences.

7.5.1 Citation of Electronic Journal Documents

For this study, the electronic journal is the computer network equivalent of its printed counterpart. Both submission to and distribution of the final product are done over the network. Although electronic journals have been under development since 1976 (Turoff & Hiltz, 1982), electronic journals in their non-experimental phase did not begin until the 1990s (Harter & Kim, 1996). Electronic journals have grown very rapidly since 1991. The first peer reviewed, full-text electronic journal, including graphics, was the *Online Journal of Current Clinical Trials*, published in 1992 (Keyhani, 1993). Based on the Directory of Electronic Journals, Newsletters and Academic Discussion Lists, electronic journals have grown from 27 in 1991 to 1093 in 1996 (Okerson, 1996). As of April 8, 1998, more than 3,617 magazines and 2813 newspapers can be found on the Internet (http://www.mediainfo.com/ephome/npaper/nphtm/statistics.htm).

However, in contrast to the increasing availability of electronic journals, this study does not show any obvious corresponding trend in the citation of electronic journals. The proportion of journals in which electronic journals were cited by authors in both the natural sciences and the social sciences in both 1994 and 1997 is extremely low. There was only one author in the natural sciences in each of the years 1994 and 1997, and two authors in the social sciences in 1997, who cited electronic journal documents. The results of this study coincidentally match the findings from Harter's study (1996, 1998) about the impactsof electronic journals on scholarly communication. He found that "the most significant of all the findings of this research was that the great majority of the electronic journals studied have been cited seldom or not at all by the mainstream print

journals that comprise the source journals of the ISI databases." He concluded that the great majority of scholarly, peer-reviewed e-journals have essentially no impact on scholarly communication in their respective fields (Harter, 1996, 1998). However, he did not explain why it happened in this way.

As indicated above in this chapter, one possible reason is that the electronic journal as a new type of document has not been accepted as a scholarly publication in formal scholarly communication. Budd and Connaway (1997) concluded that there is a lack of trust in electronic journals (or at least a lack of confidence that electronic journals allow authors to reach their intended audiences and junior faculty to earn tenure). Another possible reason is also related to the legitimacy of electronic journals in scholarly communication. Kling (1997) found that too few scholars perceive electronic journals to be legitimate means of communication for them to become major media soon. Over half (16) of the journals in the natural sciences and two journals in the social sciences, were published electronically with their parallel print versions. These journals are the most prestigious journals based on their impact factors in their fields so theoretically they should be cited very frequently, and thus increase the proportion of citations of electronic journal documents. However, the results do not show a positive correlation between the citation of electronic journal documents and the proportion of journals with both print and electronic publishing. The correlation coefficient between the journals being published electronically and the utilization of electronic journals is not significant (p=0.252 in 1997 and a negative value in 1994).

In this study, it was found that even if a scientist cites a journal that does have an electronic version, s/he does not cite its electronic source but rather its print source. For example, *Physical Review A* has been cited quite frequently in the physics journals studied, but its electronic version was never cited by any authors in these journals investigated. The reference within an article does not mark out the electronic sources of those journals with both electronic and print versions. Although electronic journals have many advantages over their print counterparts, it may be hard for scientists to locate a specific article in electronic journals. For example, most electronic journals do not have consistent pagination, unlike their print counterparts. Even if a scientist cites an article from an electronic journal, s/he may still have difficulty giving the exact location of the article in the journal. By contrast, print journals do not have this problem so it is easy for him/her to just cite the article's print version source. Some electronic journals are published in Acrobat format that contains the same pagination. However, the pagination of electronic journals with Acrobat format does not indicate the location of articles on the Internet but location of the articles in the print journal. Thus if an article is published in both a print and electronic journals, it is hard to figure out if the scientists cite the article from the electronic version or from the print version.

The low citation rate of electronic journals may also be related to the lack of a standard format for citing electronic journal documents, or scientists may not be aware of how to cite them. The citation formats for print materials have existed for a long time and many learned societies such as the American Psychological Association have published writing style manuals. Scientists in their own application fields have become

familiar with these formats already. It is easy for them to cite the paper version of the journal instead of the electronic version. But only recently have electronic citation guides become available. Scientists may not have enough experience to use this kind of guidance. Therefore, the proportion of citation of electronic journal documents is extremely low.

Schaffner (1994) concluded in a discussion of the future of electronic journals that they must meet the same needs that print journals have met. Functions of scientific journals include (1) building the knowledge base, (2) communicating information, (3) validating quality, (4) distributing rewards, and (5) building scientific communities. Electronic journals must serve the most basic of functions in science – the creation of published knowledge. Publication itself is central to the scientific process (Latour & Woolgar, 1986); a research study is not complete until published (Crane, 1967). Scientific knowledge is defined by being published (Schaffner, 1994). In this sense, electronic journals do have such a function – building a collective knowledge base through publishing. For the second function, electronic journals do provide a new way for scientists to communicate well and fast, but exclude those without Internet access, and so is possibly not seen as being as convenient as print on paper. In this sense, electronic journals do not have the informality features that print journals have. For example, people can read print journals in any locations and in any circumstance. In order to read electronic journals, people must at least be able to access computers.

As to the third function, only some electronic journals can validate quality of research through peer review process; most electronic journals are not peer-reviewed.

Those without a peer-review process can not validate quality. Another function of scientific journals is to distribute rewards. Scientific journals serve to establish priority in research, and protection of such priority claims is important to researchers. Scientists produce publications as gifts to the community in exchange for the rewards of recognition and acknowledgement. However, the rewards go only to those who are first. Electronic journals at this moment have not set up this kind of function yet partly because of the lack of trust, and partly because of immaturity. Finally, journals often serve to cement together a group of researchers, an invisible college, in many ways (Schaffner, 1994). Undoubtedly, electronic journals especially in the form of listservs do serve this kind of function – building scientific communities since electronic communication has democratic features – everyone can publish his/her own opinion without authority validation. This way may facilitate scholars communicate to each other and thus help form scientific communities.

In an observation of electronic mail communication among the library and information professional group, Tsai (1992) found that the degree of validity and credibility of email communications might be determined by the format of the email message used for communication, speed of distillation of messages, coordination of both time and participants, and familiarity of subject knowledge fields. In formal scholarly communication, these factors may not all be relevant to the use of electronic journals. Based on this study, it seems that even if an electronic journal meets the same needs that print journals have met, it may not necessarily be used as much as a print journal because the electronic journal is short of credibility in formal scholarly communication.

Investigations of the diffusion of other innovations suggest that acceptance and adoption are significantly influenced by innovation characteristics and adopter perception (Hahn & Schoch, 1997). Electronic journals, as an innovation in formal scholarly communication, do have some characteristics in common with the print version, but are not accepted by most scientists in formal scholarly communication. Electronic journals can make paper available immediately after peer review, can eliminate backlogs, can recapture some of the interactive quality of early journals, or can allow researchers to present new computer simulations (Schaffner, 1994). These characteristics are the foundation on which electronic journals will be adopted. However, perceptions of scientists on electronic journals also play a key role in the diffusion process. If scientists, as adopters of electronic journals, do not accept the electronic journals as formal scholarly artifact, electronic journals will not be diffused among them. The extremely low rate of citation of electronic journals is good evidence for this. It seems likely that the acceptance of electronic journals by scientists and their habits of citing literature do play a key role in citing electronic journal documents.

7.5.2 Citation of Web Site Documents

The World Wide Web (WWW) is the newest information service to arrive on the Internet. The Web is based on a technology called hypertext, which allows documents to be connected to one another. The World Wide Web is currently the most powerful and flexible Internet navigation system around. The Web is also the fastest growing information service based on the Internet. Although the number of sites providing

information over the Web has been growing exponentially (Krol & Ferguson, 1995), the citation rate of Web site documents was found to be extremely low in this study. Tona (1995) also found that networked information sources received a very few citations in the top-ranked print journals. This may indicate that the Web site document as a new type of scholarly resource has not been widely accepted in formal scholarly communication. Currently, scholarly publication as it relates to the merit and promotion process is generally defined as publication in refereed journals or as publishing scholarly books (Langston, 1996). Since most Web site documents are non-refereed, and are not quality controlled, and are not validated for authority, they are hardly cited by scientists in either the natural sciences or the social sciences as a rigorous source to support or prove their opinions or as a basis for scientific arguments.

The results also indicate that the use of Web site documents is somewhat less frequent by the authors in the journals in the natural sciences than in the social sciences. This finding is the opposite of other findings in this study; namely, in most situations, natural scientists tended to adopt an innovation more quickly than social scientists. The natural sciences have a very long history since the time of Aristotle (Cohen, 1993) and have formed a set of rigorous norms in scholarly communication, including the insistence on quality control by peer review in formal publication. The Web site document as a new type of document may be harder to be accepted as a formal scholarly publication by natural scientists. For this reason, Web site documents may be less trusted and thus less cited, even if natural scientists use Web site documents a lot in their research. The social sciences are more recently developed since the late eighteen-century (Cohen, 1993) and

the norms of communication may be not as rigorous as those in the natural sciences. Thus Web site documents may have less difficulties or resistance for being accepted as a formal scholarly publication by social scientists. Moreover, the Internet is not only a tool for scholarly communication in the social sciences (as in the natural sciences) but also constitutes a subject of study because its impact on social life and behavioral aspects of human beings. For example, the article published by Bovey in *European Journal of Political Research* (1997) is about the relationship between political science and global computer networks, in which the author cited 21 Web site documents. Another article that cited Web site documents is about the application of computers in sociology (Thye, 1997). The results of this study coincide with another study by Lin and his colleagues. They found that the majority of articles with respect to the Internet is in library and information science because the Internet will start to cause attention in those academic fields where computers and telecommunications are their realm of research (Lin, et al, 1994).

Furthermore, the lack of awareness of Web site documents may also contribute to the low rate of citation of Web site documents in both the science areas. Bane and Milheim (1995) found that many academics are still not aware of its resources and possibilities. Finally, it may also be related to the accessibility of Web site documents. Lin et al (1994) pointed out that articles published in electronic form are not adequately indexed and abstracted in standard reference tools. Meanwhile, not all foreign countries have access to Internet services.

7.5.3 Citation of FTP and Gopher File Documents

The results of this study indicate that FTP file documents were barely cited in formal scholarly communication by the authors in either the natural sciences or the social sciences in either 1994 or 1997. There may be three reasons for this phenomenon. First of all, FTP files are not as visible as Web site documents or electronic journals, thus, a user must know the directory of an FTP file, its sub-directory, and its exact file name in order to use the FTP file document. Therefore it is not very convenient for scientists to use FTP file documents. Moreover, FTP is a service based on the Internet, rather than a document stored on the Internet. A document from FTP usually has its own identities such as author, place of publication, and so on. Therefore, even if a scientist uses a document obtained from FTP, the FTP identity may not have been used in the reference list in the journals. Furthermore, FTP file documents may not be accepted as a formal scholarly publication by the scientists in either the natural sciences or the social sciences. Thus scientists are reluctant to use FTP file documents as a citation even if they do use FTP file documents in their research or in writing their research reports. Additionally, since the FTP file documents are updated so easily and quickly by the owner, they may be less consistent than print journals and thus more difficult for scientists to relocate them for reference.

Gopher file documents were also barely cited in either the natural sciences or the social sciences in either 1994 or 1997. It indicates that Gopher file documents as citable documents were not widely accepted as formal scholarly publication either. This may be caused by the nature of Gopher file documents. Gopher is a lookup tool that lets users

prowl through the Internet by selecting resources from menus. It started out in April 1991 as a distributed campus information service at the University of Minnesota, home of the "Golden Gophers." Gopher organizes information by topic, so that the Gopher looks like one large database, rather than hundreds of smaller databases. A Gopher file looks more like a computerized classification catalog or a searching tool than a document. A catalog or bibliography basically provides secondary information or sources of information, which could not be used as a citation so that Gopher file documents were seldom cited by authors in formal scholarly communication. Moreover, the World Wide Web came out publicly shortly after Gopher. Since the Web is more convenient than Gopher, and Gopher files also exist in the form of Web site documents, the use of Gopher file documents may have been largely superseded by the use of Web site documents and other electronic resources.

7.5.4 Citation of "Other Computer Files"

In addition to electronic journals, Web site documents, Gopher file documents, FTP file documents, "other computer files" such as personal email messages, software, and databases were also cited by some authors in the journals investigated. No significant difference was found in citing "other computer files" by the authors in the journals either between the natural sciences and the social sciences, or between 1994 and 1997. It was found that the proportion of journals in which at least one "other computer files" was cited by the authors in the social sciences was higher than in the natural sciences in both 1994 and 1997. "Other computer files" were cited by six authors in the journals in the

social sciences in both 1994 and 1997 as opposed to only one in the natural sciences in both 1994 and 1997.

A thorough study of the citation of "other computer files" finds that the authors in economics journals did not cite any "other computer files" at all in either 1994 or 1997. The proportion of journals citing "other computer files" came from the authors in sociology and political science in both 1994 and 1997. In 1994 "other computer files" were cited by two authors in the journals in political science and by four authors in the journals in sociology. In 1997 "other computer files" were cited by three authors in the journals in political science and by three authors in the journals in sociology. This may be related to the contents of political science and sociology. Both disciplines deal with people and need to use demographic data, thus the most frequently cited "other computer file" was the statistical census of the United States. None of the disciplines in the natural sciences investigated in this study needs to use such demographic data so they did not cite any database file or software. In the natural sciences, even if a database or software is used in research, it will not be listed as a citation since a database file or piece of software is just considered as a tool of research instead of a source of information, and research tools are rarely cited in the natural sciences.

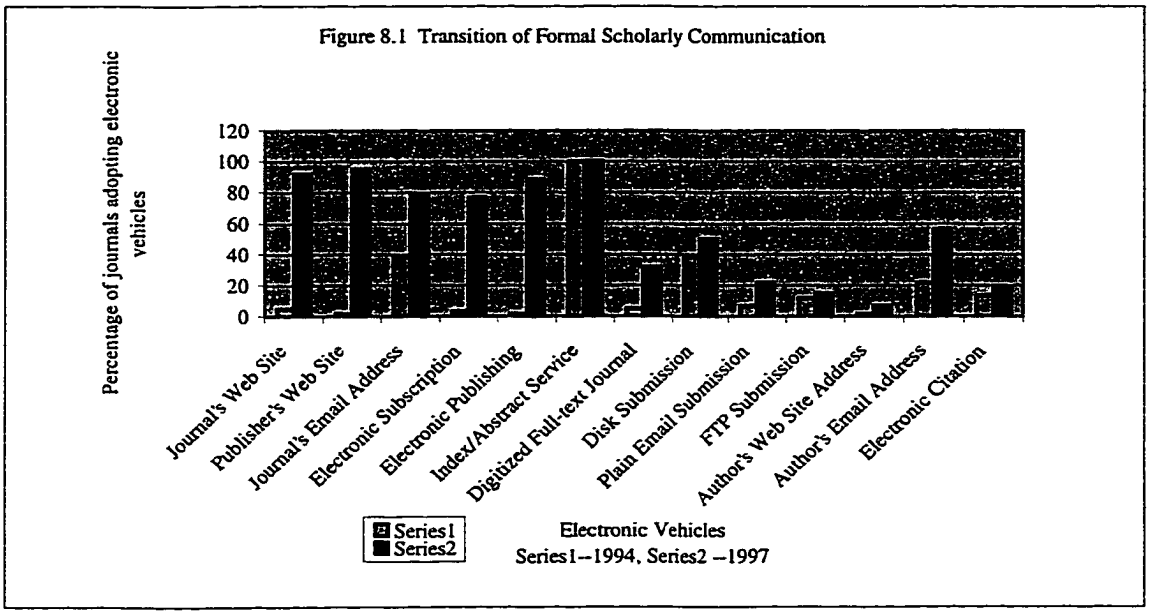
CHAPTER EIGHT CONCLUSIONS

This study reveals the degree to which the transition of formal scholarly communication from a paper-dominated communication system to an electronic-based communication system has taken place in physics, biology, geology, economics, political science, and sociology. It also makes clear that the two science areas share a similar pattern in the electronic publicity of journals, electronic accessibility of information, and utilization of electronic information resources, with a few exceptions. The significant difference between the two science areas was found in this study in the acceptance of electronic submission and the electronic publicity of scientists, with the exception of using Web site address for publicizing scientists.

8.1 CONCLUSIONS

Formal scholarly communication includes submission, editing, publishing, publicizing (including distribution and subscription), and access to and use of information. A scientist first submits his/her manuscript to a journal. The journal editorial board screens the manuscript and sends it to a panel for peer review. After the manuscript is validated by the panel, the manuscript enters the publishing process. The publisher publishes the manuscript in print format and/or electronic format. The product of publication, namely the scholarly journal or work, is distributed to subscribers (end-

users or libraries). Other scientists access the product of the publication and use the information within the publication for preparing their own manuscripts and then submit their own manuscripts to journals. The transition of formal scholarly communication to the virtual world involves the adoption of electronic vehicles in every step of formal scholarly communication, from submission of the manuscript to editing, to publishing, to distributing information, to access to, and use of information. The conversion of any of these processes into electronic format will help the whole of scholarly communication transfer into the virtual world. Because the time when electronic vehicles were created and were applied in scholarly communication are various, some electronic vehicles have been completely applied in some activities in scholarly communication, but some others have just started the transition process. Figure 8.1 presents the status of the transition of different activities in formal scholarly communication from 1994 to 1997, which is represented by adoption rates of different electronic vehicles based on this study.



Internet technologies are already widely used by journals and publishers in formal scholarly communication nowadays in both the natural sciences and the social sciences for publicizing journals. Web sites provide information about scientists, journals, and publishers through the complicated combination of textual and graphic materials with three-dimensional features. Email addresses provide the fastest means by which a reader can get information from the scientist who publishes an article in a journal. Although not many scientists release their Web site addresses in formal scholarly communication yet, Web site addresses are likely to be used widely in formal scholarly communication and become an ingredient of scholarly communication in the near future. First of all, a Web site address can provide detailed background information on scientists and their research, and through links on those Web pages, other scientists can get related information and thus learn about progress in their fields quickly. A combination of email and Web

technology will make communication closer to face-to-face communication through a delivery of motion pictures and sounds. Moreover, there is a strong basis for scientists to use email and Web site addresses. Most scientists in developed countries have used email communication and established Web pages for quite a while, so that it is easy for them to attach their email and Web site addresses to their submission as long as journal editorial policy requires or permits them to do so. The use of email addresses and Web site addresses has diffused from developed countries to developing countries so that email addresses and Web site addresses will soon be available to most scientists in the world. Furthermore, based on the fact that most journals and publishers release their email and Web site addresses, it seems that there is no resistance from publishers or journals in allowing scientists to release their email and Web site addresses. Therefore, email addresses and Web site addresses of scientists, are likely to become parts of the affiliation information in formal scholarly communication.

Electronic publishing and subscription will become more available in the future than before, but they are not likely to completely replace the print journal and traditional subscription mechanism soon. More full-text journals will be published electronically in both the natural sciences and the social sciences, perhaps at a faster pace in the natural sciences. It is hard to predict the impact of electronic publishing on formal scholarly communication because the citation rate of electronic information is extremely low in both the natural sciences and the social sciences. Technology, economics and perceptions of electronic publishing, among other factors, impact electronic publishing in formal scholarly communication.

As more and more people surf on the Internet, the problems caused by "traffic jams" will be a new challenge for the electronic publishing industry since network traffic will cause delays in downloading journal text from the Internet. Economic factors determine the feasibility of electronic publishing as well. Based on the current study, electronic publishing actually costs more than the traditional publishing model since all journals with an electronic version published print versions as well. This means that the publishers not only spend money for publishing print journals but also have to pay for the electronic version.

Finally, the perceptions of scientists and publishers of electronic publishing also play a key role in transferring traditional print journals into electronic journals in formal scholarly communication. If publishers do not like electronic publishing or they do not realize its importance, they will definitely not publish scholarly journals electronically. Electronic publishing will lose support from scientists if the scientific communities can not accept electronic publishing products even though publishers are willing to produce them. The end-users of electronic publishing products are scientists so their perception of electronic publishing will ultimately determine the form of publications. Therefore, electronic publishing must gain its legitimacy among scientists before it dominates formal scholarly communication.

Electronic submission is still a supplementary means of submission in formal scholarly communication. It is only acceptable in formal scholarly communication after a journal's editorial board finally accepts a manuscript. No journal investigated accepted electronic submission for the first draft manuscript. Based on the convenience provided

by the three types of electronic submission, disk submission is the most acceptable in current formal scholarly communication. Plain email message submission has the feature of immediate delivery, but the editor has to reformat the manuscript submitted via email so this technology will likely not be used widely in the future. Electronic submission via formatted FTP file has both the immediacy feature of email submission and the integrity feature of disk submission, so it will likely be more acceptable in the future. Although this kind of electronic submission is not accepted in the social sciences and not accepted very widely in the natural sciences, it will probably become the most appropriate means of electronic submission in formal scholarly communication in the future.

Electronic access to full-text scholarly information will be still a major issue in scholarly communication. Electronic publishing provides scientists with a new medium for scholarly communication, but scientists will access scholarly information in whatever forms they feel an easy and comfortable in order to do research effectively and efficiently. Electronic vehicles generally are the easiest and fastest way for scientists to access scholarly information. Currently, all bibliographic information and abstracts for the journals surveyed are available electronically. In the future more full-text information will be available electronically, but the number of electronic full-text journals in the natural sciences will probably still be higher than in the social sciences. Between 1985 and 1990, the number of full-text databases grew by more than 50 percent each year (Malinconico, 1992). In this study, from 1994 to 1997, the rate of journals with electronic full-text increased by 6.7% in the social sciences, and by 46.6% in the natural sciences.

Utilization of electronic information resources in formal scholarly communication is an indicator of how well electronic information is accepted by scientists since it reflects not only that scientists use electronic information in their research but also that scientists use electronic information as a formal source for research or as evidence for supporting their theories and methodologies, or as a basis for argument. The validity of citation as a measure of journal impact has been criticized, and to the extent that this research depends on the meaning of citations, it is subject to the same criticisms. However, it seems clear that while the meaning of citations can be debated and certainly needs further study, citations do reflect an influence or impact of some kind on the author citing the articles, even while the precise nature of this influence may not be known (Harter, 1998). Based on this study, we can conclude that electronic information resources including Web site documents, FTP file documents, Gopher file documents, electronic journals and other electronic information resources, have not established their legitimacy in formal scholarly communication. Utilization of electronic information resources not only depends on the ability of electronic information resources to provide all functions that their parallel print materials can provide, but also depends on whether scientists accept them as a formal scholarly publication. Even electronic information that appears in the same format as a refereed journal, will not be cited as a reference in formal scholarly communication if scientists do not accept it as a legitimate scholarly work. In this study, it was found that scientists are not used to citing information in electronic format. In order to use electronic information resources more effectively and efficiently, it is necessary to establish and promote standards for citing electronic information resources and to

improve electronic information publishing in the areas of portability, comfort, convenient access, permanence, and serendipity if electronic journals are to gain wide acceptance (Steward, 1996).

Kuhn (1970) advanced the dominant model of scientific change. Scientific discovery and change follow a particular pattern: awareness of an anomaly, the gradual emergence of recognition, and consequent change of paradigm categories and procedures accompanied by resistance. This leads to a growing state of crisis that is ultimately resolved by "large-scale paradigm destruction." Based on this study, electronic scholarly communication, as a new paradigm in formal scholarly communication, is definitely in its preliminary stages: being aware and recognized gradually. The change of paradigm categories and procedures has not come yet in formal scholarly communication. Nowadays, users still need to read comfortably in and from diverse locations (Schauder, 1994). Wilson (1997) also concluded that the "book has a future – it has been around now for a very long time and there are established social and organizational mechanism for its creation, archiving, preservation and conservation. It will take some considerable time before electronic publications have such an assured basis for their existence" (p. 6).

The gradual evolution towards electronic scholarly communication is not surprising. It is common for the transition to a new technology to take many years (Odlyzko, 1996). Even the compact disk took a decade to displace the vinyl disk. However, electronic scholarly communication does have its enthusiastic aspects, and some of its impacts on formal scholarly have been in place for quite a long time already. However, Wilson (1997) concluded that electronic publishing still reaches only a

minority of potential users or customers, because it demands access to relatively advanced technology. Many potential users do not have access to electronic forms of publication. He concluded that it would be some considerable time before electronic publications replace print publications. He argued that the informality of using a print publication can not be replaced by electronic publication. For example, people can read a book in all occasions in bed, on the train, in the bath, while walking, but people cannot read electronic materials on these occasions.

8.2 Implications

The findings answer some basic research questions that were unanswered before and thus make a basic contribution to the body of scientific knowledge. These findings help us understand the status of the transition of formal scholarly communication and the differences and similarities of this transition between the natural sciences and the social sciences. These findings have implications for scholarly communication studies, academic publishing industries, design of information retrieval interfaces, library service, and study of diffusions of the Internet in academic fields.

Scholarly communication studies used to focus on "the social structure of scholarship" and "its social processes" (Lievrouw, 1990), citation analysis and the invisible college are typical research topics in the field. However, many areas in scholarly communication have remained almost untouched such as editorial policy, and scholarly publicity. And the impact of information technology, especially the impact of the Internet on formal scholarly communication, has not gotten enough attention in

academia. In some senses, this study provides a pioneer research in some areas such as the acceptance of electronic submission, publicity of scientists, publicity of journals, and electronic subscription of journals. These activities are all part of formal scholarly communication and may affect the scholarly communication process to some degree. Further research on these activities will definitely enrich the content of scholarly communication studies and aid understanding of the process of scholarly communication. Moreover, this study implies a new research question: how to measure the transition of scholarly communication to the virtual world. A set of sixteen indicators developed in this study may give some clues to how to measure the transition of formal scholarly communication or the impacts of the Internet. However, more work needs to be done in order to establish a set of widespread accepted indicators to measure transition in scholarly communication. In this sense, this study may stimulate new research in scholarly communication studies.

The findings suggest that the Internet is an important tool for academic publishing industries and will increase in importance. Given that most journals and publishers adopted Web site addresses and email addresses and permit electronic subscription, the academic publishing industries will continue to depend on the Internet. Actually, electronic publishing started in the early 1960s – when computers were used merely to produce conventional printed products (Lancaster, 1995). Nowadays, electronic publishing industries have moved towards networked scholarly publishing. Academic publishing industries should definitely take advantage of Internet technologies for publicizing themselves and their products, producing products (scholarly journals and

other works), and communicating with readers or users. The findings also suggest that electronic full-text journals will be one of the dominant products of academic publishing industries. Given the fact that nearly half of the full-text journals in the natural sciences were published electronically, the investigator believes that more full-text journals will be published electronically in both science areas. The academic publishing industries should continue publishing full-text journals electronically. However, the study also suggests that electronic journals still have some weaknesses and have not been accepted as legitimate scholarly work in the scholarly community. If academic publishing industries make enough improvements in the areas of portability, informality, and format, the scientists may finally accept electronic journals.

Given the differences between the natural sciences and the social sciences, these results suggest that the differences need to be considered while redesigning information systems; given the similarities between two science domains, these results suggest that similar pattern should be considered in redesigning information system. Given the fact that more journals are published electronically, these results suggest that the need for designing new information system with a browsing function, an ability provided in Internet search engines such as AltaVista, Lycos, InfoSeek and so on. This study also suggests the importance of collecting more electronic publications and providing electronic access to these publications. This study found that more than half of the journals in the natural sciences are published electronically. Another study found that full-text databases grew by 50 percent each year between 1980 and 1990 (Malinconico, 1992). Traditional information retrieval systems were designed for printed materials and

provided access to these materials through secondary information. Access to full texts of these materials came later. With more electronic scholarly works available on the Internet, access to full-text information will be increasing. Most current library online catalog do not provide access to full-text information but only to bibliographic information. In order to get full texts, users have to search in libraries based on the bibliographic information. Considering the differences and similarities between the two science areas and the current trends of electronic publishing, system designers can tailor information retrieval systems to address scientists' specific needs and habits in using electronic information.

This study will benefit improvement of library and information service. Librarians are used to providing printed information to users, and electronic services are new to them. Users are used to using printed materials, and may be unfamiliar with electronic information resources and how to use them. With more electronic journals and other works available, the demand for electronic information will rise in the future and libraries will have to collect electronic information products in order to meet the rising demands. The results suggest that libraries need to "collect" electronic journals while also collecting their print versions, index them, and make them available to users online. It is hard for users to determine if a journal has an electronic version and where to locate the electronic version. Considering the electronic availability of journals and other works, catalogers and indexers can reflect electronic features of materials. The study found that 76.7% of the journals in the social sciences and 90% in the natural sciences provided electronic tables of contents. If libraries can provide users in specific fields with

electronic table of contents service, users will definitely benefit from this kind of timely service and libraries do not need to spend extra money since all the electronic tables of contents provided by publishers are free of charge. The findings also reveal that electronic information resources are virtually not used in formal scholarly communication by scientists. Based on this fact, libraries can provide training programs to instruct users on how to find electronic information resources and how to use them in formal scholarly communication.

The findings of this study may also help us understand the pattern of diffusion of the Internet in scholarly communication. This study suggests that in addition to scientists, there are several players in the transition process of formal scholarly communication. Among them, publishers are of special importance. Nowadays academic journals are published by some major commercial publishers. Electronic publishing still threatens their profit so far. Thus even if all scientists and other players such as librarians accept electronic publishing, publishers still would be resistant to it if they do not find a way to make enough profit. The findings also suggest that electronic vehicles are adopted faster in the natural sciences than in the social sciences with a few exceptions. It was found that it took about three years for publishers and journals to adopt Web technology but may be take longer than three years for scientists to adopt Web technologies. The findings also reveal that economics may be the most difficult field in which to adopt electronic publishing in scholarly communication.

8.3 SUGGESTIONS FOR FUTURE RESEARCH

This study provides us with some basic answers to the questions about whether the transition of formal scholarly communication in the natural sciences into the virtual world occurs differently from that in the social sciences and how well these two science areas have been converted to the electronic communication system. However, one study cannot solve all questions and many questions remain unanswered and new ones are raised in the process of the research. Further study is desired for answering these questions.

This study finds that scientists are reluctant to cite electronic information resources and analyzes possible reasons for their reluctance. However, this study does not answer how well the citation indicators represent all information resources that scientists used in their research and what exact factors impede them from citing electronic information resources. Further study should focus on what percentage of information resources of the information resources actually used by scientists are then *cited* in scientists' scholarly work and what role electronic information resources play in their research. As discussed in the last chapter, there may be many reasons for scientists to not cite electronic information resources, but lack of acceptance of electronic information resources, as a legitimate scholarly source may be the major reason.

This study also reveals that Web technologies are not well used by journals to publicize scientists; only a few scientists released their Web site addresses when publishing their articles. However, the underlying reasons are unclear. The reason may come from both the journals side and the scientist side. If journals do not encourage

scientists to submit their Web site addresses, the scientists' Web site addresses will not appear in journals. If scientists do not want to be easily contacted by strangers, they will not publish their Web site addresses in journals even if journals encourage them to do so. Further research should investigate both scientists and journals in order to figure out the problems and find out the ways to solve the problems. Web site addresses and email addresses are both important channels for scientists to communicate informally with each other. Both informal and formal communications are very integrated parts of science research. Journals provide scientists with a formal forum to communicate to each other, but further communication beyond the content of the articles will have to use informal channels since journals cannot publish everything. If the journals also publish scientists' Web site addresses and email addresses, scientists can communicate with each other easily and quickly through the Internet, and thus journals that publish scientists' Web site addresses and email addresses will facilitate science research.

The purpose of this study was to describe the status of the transition of formal scholarly communication to the virtual world, but it does not reveal cognitive aspects of the transition. A further qualitative study should explore cognitive aspects of the transition, such as perception and acceptance of the transition by all the players in the scholarly communication process including scientists, publishers, vendors, administrators, and librarians. These participants play different roles in formal scholarly communication and its transition to the virtual world. Therefore, a study of their perceptions of the transition will not only help us understand the transition of formal scholarly communication, but also help formal scholarly communication move into the

virtual world more smoothly than otherwise, and in such a way as to meet well the needs of all stakeholders in the process.

APPENDICES

Appendix 1: Issues of the Thirty Journals in the Natural Sciences

Journal Titles	Volumes (Issues)	
	1994	1997
Physics		
Physical Review Letters	72(2)	78(1)
Physics Letters B	321(1/2)	390(1/4)
Physical Review A	49(1)	55(1)
Annals of Physics	229(1)	253(1)
Journal de Physique I	4(1)	7(1)
Journal of Physics A -- Mathematical and General	27(1)	30(1)
Physica D	70(1/2)	99(4)
Physica A	202(1/2)	235(1/2)
Physics Letter A	184(2)	224(3)
Proceedings of The Royal Society of London Series A -- Mathematical & Physical Sciences	444(1920)*	453(1956)*
Biology		
The Plant Journal	5(1)	11(1)
Current Biology	4(1)	7(1)
Molecular and Biochemical Parasitology	63(1)	84(1)
Proceedings of The Royal Society of London Series B – Biological Sciences	255(1342)*	264(1374)*
Life Science	54(1)	60(6)
Philosophical Transactions of The Royal Society of London Series B – Biological Sciences	343(1303)*	352(1349)*
Journal of Biological Rhythms	9(1)	12(1)
Chemico -- Biological Interactions	90(1)	103(1)
Evolutionary Ecology	8(1)	11(1)
Journal of Experimental Biology	186(1)	200(1)
Geology		
Paleoceanography	9(1)	12(1)
American Journal of Science	294(1)	297(1)
Journal of Geophysical Research	99(1)	102(A1)
Quaternary Research	41(1)	47(1)
Geological Society of America Bulletin	106(1)	109(1)
The Journal of Geology	102(1)	105(1)
Journal of Structural Geology	16(1)	19(1)
AAPG Bulletin -- American Association of Petroleum Geologist	78(1)	81(1)
Journal of Sedimentary Petrology	A64 (1)	67(1)
Palaios	9(1)	12(1)

*Serial number.

Appendix 2: Issues of the Thirty Journals in the Social Sciences

Journal Titles	Volumes (Issues)	
	1994	1997
Economics		
Econometric	62(1)	65(1)
Journal of Accounting and Economics	17(1/2)	23(1)
Journal of Financial Economics	35(1)	43(1)
Quarterly Journal of Economics	CIX(1)	CXII(1)
Journal of Political Economy	102(1)	105(1)
Economic Geography	70(1)	73(1)
American Economic Review	84(1)	87(1)
Review of Economic Studies	61(1)	64(1)
Journal of Monetary Economics	33(1)	39(1)
Journal of Law and Economics	XXXVII(1)	XL(1)
Political Science		
American Political Science Review	88(1)	91(2)
Journal of Conflict Resolution	38(1)	41(1)
British Journal of Political Science	45(1)	27(1)
Political Geography	13(1)	16(1)
East European Politics and Societies	8(1)	11(1)
Journal of Theoretical politics	6(1)	9(1)
European Journal of Political Research	25(1)	31(1/2)
Electoral Studies	13(1)	16(1)
Political Research Quarterly	47(1)	50(1)
Political Science Quarterly	109(1)	112(1)
Sociology		
American Journal of Sociology	100(1)	102(4)
American Sociological Review	59(1)	62(1)
Journal of Marriage and The Family	56(1)	59(1)
Journal of Leisure Research	26(1)	29(1)
Social Force	72(3)	75(3)
Social Problems	41(1)	44(1)
Sociological Forum	9(1)	12(1)
Theory and Society	23(1)	26(1)
Sociological Quarterly	35(1)	38(1)
British Journal of Sociology	45(1)	48(1)

Appendix 3: Survey Instrument Used in Data Gathering (for Journals)

I. Basic Information

1. Name of Journal _____

2. Issue Sampled _____ Frequency of Publication _____

3. Total items published _____ Number of research article _____

Publisher _____ Publication Year _____

II. Electronic Publicity of Journals

4. Does the journal have a Web site address?

[ ] No.

[ ] Yes. [ ] Web site address for the journal itself [ ] Web site address for the publisher

5. Does the journal have an email address?

[ ] No.

[ ] Yes. [ ] Email address of the editor [ ] Email address of the journal
[ ] Email address of anyone on the editorial board [ ] Other email address related to the journal

6. Does the journal permit electronic subscription?

[ ] No.

[ ] Yes. [ ] Electronic subscription through email [ ] Interactive online order form

7. Is the journal published electronically?

[ ] No.

[ ] Yes. [ ] Full text available electronically [ ] Abstract available electronically
[ ] Table of contents available electronically [ ] Both table of contents and abstract available electronically

III. Electronic Accessibility of Information

8. Is the journal indexed by any computerized database?

[ ] No.

[ ] Yes. [ ] The name of database: [ ] The database is listed in the journal

_____

9. Is the journal abstracted by any computerized database?

[ ] No.

[ ] Yes. [ ] The name of database: [ ] The database is listed in the journal

_____

10. Is the journal fully digitized?

[ ] No.
[ ] Yes. [ ] The address where it is digitized _____ [ ] The address is listed in the journal

IV. Acceptance of Electronic Submission

11. Does the journal accept submission by disk?
[ ] No.
[ ] Yes. [ ] format required: _____ [ ] no format required

12. Does the journal accept electronic submission (plain text file within email message)?
[ ] No.
[ ] Yes.

13. Does the journal accept electronic submission (formatted FTP file via attachment)?
[ ] No.
[ ] Yes.

V. Electronic Publicity of Scientists

14. Do any of the author(s) of the articles in the issue release his/her Web site address?
[ ] No.
[ ] Yes. [ ] the number of articles in which at least one author releases his/her Web site address

15. Do any of the authors of the articles in the issue release his/her email address?
[ ] No.
[ ] Yes. [ ] the number of articles in which at least one author release his/her email address

VI. Utilization of Electronic Information Resources

16. Does any article in the journal cite document in the form of Web site?
[ ] No.
[ ] Yes. [ ] the number of articles citing document in the form of Web site

17. Does any article in the journal cite document with FTP file address?
[ ] No.
[ ] Yes. [ ] the number of articles citing document with FTP address

18. Does any article in the journal cite document with Gopher address?
[ ] No.
[ ] Yes. [ ] the number of articles citing document with Gopher address

19. Does any article in the journal cite document from electronic journal?
[ ] No.
[ ] Yes. [ ] the number of articles citing documents from electronic journal

20. Does any article in the journal cite any other kind of computerized document rather than Web site, FTP, Gopher, electronic journal?

[ ] No.
[ ] Yes. [ ] the type of computerized document [ ] The number of articles citing other computerized document

_____ [ ]
_____ [ ]

Appendix 4: Survey Instrument Used in Data Gathering (for Articles)

I. Basic Information

1. Name of Journal _____

2. Issue Sampled _____ Page _____

3. Total number of author _____ Authors _____

II. Electronic Publicity of Scientists

4. Do any of the author(s) of the articles in the issue release his/her Web site address?

[ ] No.

[ ] Yes. [ ] the number of articles in which at least one author releases his/her Web site address

5. Do any of the authors of the articles in the issue release his/her email address?

[ ] No.

[ ] Yes. [ ] the number of articles in which at least one author release his/her email address

III. Utilization of Electronic Information Resources

6. Does this article cite document in the form of Web site?

[ ] No.

[ ] Yes. [ ] the number of articles citing document in the form of Web site

7. Does this article cite document with FTP file address?

[ ] No.

[ ] Yes. [ ] the number of articles citing document with FTP address

8. Does this article cite document with Gopher address?

[ ] No.

[ ] Yes. [ ] the number of articles citing document with Gopher address

9. Does this article cite document from electronic journal?

[ ] No.

[ ] Yes. [ ] the number of articles citing documents from electronic journal

10. Does this article cite any other kind of computerized document rather than Web site, FTP, Gopher, electronic journal?

[ ] No.

[ ] Yes. [ ] the type of computerized document [ ] The number of articles citing other computerized document

_____ [ ]

_____ [ ]

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