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The Behavior of scientists in seeking and using documents

Helen L. Miller

To the Graduate Council:

I am submitting herewith a thesis written by Helen L. Miller entitled "The Behavior of scientists in seeking and using documents." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Information Sciences.

Douglas Raber, Major Professor

We have read this thesis and recommend its acceptance:

Carol Tenopir

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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THE BEHAVIOR OF SCIENTISTS IN SEEKING AND USING DOCUMENTS

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Helen L Miller

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ABSTRACT

Scientists deal in the commodities of knowledge and information Much of the information they produce is disseminated and acquired from publications, hence the interest in examining how different reading behaviors are associated with their profession Another goal of this thesis is to examine the reading behaviors of scientists and to discover relationships between these behaviors and the scientists' measures of professional success To do this, the results from a library needs assessment were used to obtain information on user needs, wants, and desires The assessment was done in 1993-1994 at the University of Tennessee, Knoxville (UTK) The survey was large, covering many aspects of present and future needs in services and facilities, and so was split into 17 parts, with each part answered by a different set of university-associated respondents The part used in this thesis focused on the reading behaviors of the faculty level users The data were analyzed to obtain information on the reading behaviors of scientists and nonscientists and information on the correlations of rewards (publication level, honors) with reading behaviors

Reading behaviors of the science and non-science faculty were generally similar Notable exceptions were their different emphases on document types and their specific concerns for electronic and print publications The differences between the reading behaviors of successful scientists and not-as-successful scientists were generally slight though fairly consistent among the success measures The largest differences were seen in the amount of readings and the use of personal funds to buy subscriptions

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CHAPTER 1

INTRODUCTION

The importance of understanding reading behaviors derives from the goal of improving the use of scant resources to achieve a desired product The products of science are different from that of other professions (Pinelli 1991) Scientists use information to produce more information and both the input and the output are generally verbal or in the form of writings, as opposed to concrete products (e g , a bridge built by engineers) Understanding scientists' reading behaviors can provide librarians, and other professions supporting scientists, with ways to better serve the scientific community and, further, understanding the successful scientists' reading behaviors can provide ways to support these scientists and encourage other scientists

Understanding reading behaviors can allow the more efficient use of major resources such as time and money Time and money are interrelated but not entirely interchangeable and so can be examined separately

The efficient use of money is necessary because the economic resources of scientists and the libraries they use are finite, and often decreasing Libraries need information on how to serve their particular clients and how to better provide for their users' needs Some factors to be considered are the type of documents to purchase, the amount of archiving that is needed, and even the type of furniture to provide for the kind of reading that is likely to be done

Administrators could use the information on reading habits of scientists to justify - or demand – resources from higher administration, legislative bodies, or funding sources Some issues may be determining whether departmental funds should be used to support travel to conferences, considering what is the best way to support new scientists, and establishing reasonable expectations of the use and output from a scientist's time

Federal government funding is the primary source of money for research in general (Rabino 1998, Greenberg 1999) Just as with any other entity, government sources need information on how science is conducted so that money can be allocated appropriately Further, the funding can be targeted so that measures of success that are of interest are effectively promoted

Time is irreplaceable and so the efficient use of time is important By not having access to information, research efforts may be duplicated Understanding and promoting the means that scientists use to communicate with each other can more quickly allow scientific developments to progress and, hence, society to benefit This understanding can be especially important for the training of graduate students and new scientists By promoting and supporting the participation of junior scientists in the communication mechanisms used by senior scientists, the novice scientists can "learn the ropes" without having to learn by direct experience Also, making available in a documented fashion the behaviors of successful scientists allows new scientists to examine their behaviors and consider adjustments For example, if it is learned that scientists just don't tend to go to trade shows, it would not be sensible to promote attendance at trade shows when seeking contacts for collaboration

A large part of this kind of cultural information is absorbed by students and scientists as they progress in their careers, but unless quantified and published, it remains essentially unknown to people outside that field – as is the case for cultures of any group And, as with any group, nurture and support of the group's institutions and culture allow the rest of society to benefit from the achievements of that group

This work employs the following definitions

document - professional reading of substance from any source (e g , journal, book)

scientist - person employed to do research or teaching in the areas of the natural or physical sciences

non-scientist - person employed to do research or teaching in the areas of the social sciences or humanities

successful scientist (SS) - person in the group of scientists having a greater number of publications or awards (depending on the criterion of success) than the NASS Divided into three categories

SS-aw - SS who have won an award in the past two years

SS-j - SS who have published more than one journal article in the past year

SS-auth - SS who have authored three or more published documents in the past year

not-as-successful scientist (NASS) - person in the group of scientists having a fewer number of publications or awards (depending on the criterion of success) than that category of SS

reading behaviors - activities involved in acquiring information for use in professional activities reading style – the means and manner of finding, getting, reading, and using documents

output – product or result of reading, a consequence of information use

outcomes – result of output, a consequence of information use

The data for this thesis are derived from the University of Tennessee Libraries 1993/94 Needs Assessment survey done by Donald W King of King Research, Inc Information needs assessments provide librarians with data about user awareness and user satisfaction with existing services, as well as provide indications of interest in new services The survey was part of a program to collect data on the information needs of UTK students, faculty, and staff The system of measures was intended to be broad enough to provide relevant information and data for library funders, library management, library staff, and users One of the parts of the survey provided background information on faculty reading behaviors This part was used to obtain some information on the reading habits of UTK faculty, specifically the methods used to find and get a document, information on the document read, the reading style, and the purpose and use of the document reading Also included were questions on the use and value of electronic sources

The survey questions were categorized into various aspects of reading behaviors 1) ways of locating the information, 2) means of obtaining the information, 3) styles of reading and information on the documents themselves, 4) uses made of the information, and 5) specific questions on the use of electronic sources

One portion of this thesis examines the reading behavior of scientists, in comparison with non-scientists Information was obtained on how scientists find, get, read, and use the documents they use in their work The other portion of this thesis was understanding the relationship between scholarly work by scientists and the achievement of desired outputs and outcomes from that work in order to provide understanding of ways to support and increase the production of desired outputs and outcomes One output and one outcome were measured in the survey publications and awards These consequences of information use were compared with the reading behaviors in order to see if greater information use resulted in increased positive outcomes

CHAPTER 2

REVIEW OF THE LITERATURE

SOCIAL ASPECTS OF SCIENTISTS AND SCIENTIFIC INFORMATION

Pure research or basic science is the province of the scholar, who is self-selected in following his or her own individual choices and is relatively impervious to sanctions other than the approval or disapproval of his peers - other scholars who are in the same field (SATCOM 1969) Most scientists' work goals are to work on projects of their own initiation, to become recognized as an authority in their field but outside their own institution, and to publish articles (Allen 1977) Engineers are often grouped with scientists in studies of scientists' behaviors, however, their goals, behavior, background, and personalities are different (Allen 1977) The majority of engineers' work goals are to be able to explore new technologies, to help their company make more money, and to know company management policies In fact, engineers are probably more similar to business managers than to scientists (Allen 1977)

Since WWII, major changes have occurred in sociological and economic aspects of science (Nelkin 1996) Prior to WWII, science was largely supported internally by institutional and private money Now, funding is largely provided externally by governmental, industrial, and medical institutions This "change in the location" of science has been accompanied by several changes in attitudes and values a change from the scientist as an independent intellectual to that of a professional worker, accompanied by a change from research for its own sake to a justification of scientific work in terms of bettering humanity The primary motives for doing science research have changed from only the private satisfactions of love of truth, curiosity, and freedom to follow one's own interests to including the socially and institutionally mediated values of salary, prestige, status, and promoting community welfare (Krohn 1961)

Science is more and more judged on its utility rather than as knowledge for its own sake The large funds provided by government and industry have shifted the focus from creativity of the scientist to the use of new technology Accomplishments then come to be seen as a product of the research conditions rather than of the scientist's creativity (Krohn 1961), so that equipment and materials receive greater funding support than personnel, and the production of data is emphasized over the examination of new ideas As a result of the change in focus, the emphases on reading material and the desired products have changed

Scientific information is in the form of ideas, research findings, interpretations, or observations Scientific communication differs from general communication by its reference to a well-established body of knowledge and its use of specific published formats Each communication is an extension, alteration, or refutation of previously held hypotheses, "truths", measures, and observations (Walker and Hurt 1990) Scientists have a high dependence on this archived cumulative formal body of knowledge and are consequently dependent on libraries for access to the published material (Pinelli 1991) Ideally the scientist makes investigations and then communicates the resulting information to the rest of the scientific community The community provides criticism and recognition for the common goal of advancing knowledge

The place of employment of a researcher greatly influences the formal communication form used (Walker and Hurt 1990) Most published research is produced by a relatively small number of scientists in academia In this scientific community, there are many traditions and norms to be followed if one expects to succeed Establishing priority, placing papers in certain media, being aware of intellectual politics, and knowing the rules are all part of science and, therefore, the resulting literature (Walker and Hurt 1990) Consequently, scientific communication has a social role, based as it is in some part on the desire for recognition and reward for one's work Thus, Walker and Hurt (1990) extend the argument, the motives to write are apparent but what are the motives to read? Accrding to them, scientific communication, both receiving (reading) and sending (writing), has seven functions 1) provide answers to specific questions, 2) stay abreast of new developments, 3) gain understanding of a new field, 4) identify the major trends of a field, 5) obtain additional evidence to verify information, 6) redirect or broaden a work/interest area, and 7) obtain critical response to one's work

PROBLEMS OF WHAT TO READ

The great and growing mass of science and technical information produces pressures and frustrations for all portions of the communication system 1) the physical impossibility that an individual scientist can read and remember all the literature that may be useful or interesting, 2) the economic impossibility of the scientist or organization to acquire all the information that may be of interest, and 3) the impossibility of information seeking tools being able to locate all the specific information needed (Passman 1969)

The use of scientific information can be distilled to three purposes current awareness, retrospective search for specifics, and exhaustive literature search (Passman 1969) In the Generation of Knowledge Cycle, users read, apply, and modify their thinking based on their readings and convert their ideas into their research projects The research is designed, conducted, written up, and submitted for publication Publishers reproduce and distribute the results, libraries acquire, organize, store, and make the results available Secondary services incorporate the records into their services so that users can locate them (Walker and Hurt 1990)

Scientists have many options from which to pick their reading material - and even whether or how much reading to do Over time, more journals become available, partly from an increase in the total number of scientists, partly because journals continually grow in size and sometimes split into more than one journal (King, et al 1981) Further, the evolution of multi-disciplinary areas, for example biophysics and geochemistry, have also provided more options in the form of more journals from which a scientist may find articles of interest (SATCOM 1969)

The new telecommunications media, such as e-mail, have been eagerly embraced by the research community (Button 1993) while electronic journals have not reached the acceptance of print journals (Speier et al 1999) The factors affecting the use of print journals and affected by their use have become important in understanding scientific communication and personal network developments (Button 1993).

JOURNALS

The scientist has the opportunity to choose from a wide variety of literature formats and the choices are made for intellectual and social reasons Ease of use is a major determinant of literature format and certain formats are better than others to transmit information in science (Walker and Hurt 1990) The medium of interaction between the scientist and the community are records of verbal or printed communications which can be accessed over distance, time, and culture (Passman 1969), most often through journals

The journal is a collection of original contributions or scientific papers intended to communicate new research findings, articulate new theories or concepts, report observations of events, or describe new phenomena The journal is considered to be one of the most prestigious forms of scientific and technical communication (Walker and Hurt 1990) The "average" journal has a regular, periodic issuance, a reasonably well-defined subject area, some quality control of contents, a fairly formal editorial structure, a format as impressive as the budget allows, and a subscription price (Committee 1969) A scientific paper in a journal is one that provides enough information for another worker to reproduce the experiment and obtain the same results (Passman 1969) Serials, periodicals, and magazines are other periodical publications that may effectively be journals

MEASURING THE VALUE OF READINGS

The principles of elementary economics are similar to those of elementary social behavior, once the particular conditions of each are taken into account (Homans 1961) Both areas of study deal with an exchange of goods or rewards In economics, the goods tend to be physical (apples, dollars) whereas in social behavior the rewards may not be (prestige, tenure)

Scientific Work

The value of a good, tangible or intangible, is what an individual would give in exchange for it, and knowledge is an intangible good (Machlup 1979) A large part of the input into the production of knowledge is other knowledge Many of the suppliers and consumers of scientific knowledge are other scientists (Button 1993) It is taken for granted that knowledge is important and that the work of scientists is the production of knowledge (Button 1993) Information can save time and/or money by avoiding duplicate research efforts, providing information on a preliminary question, or providing the means to make a better decision Knowledge is information that has been integrated into the understanding of a person, information is non-absorbed data (Machlup 1979), while communication is the act of imparting information Information is a commodity that can be exchanged by communication Communication of scientific information occurs via journals, books, presentations, conferences, telephone, e-mail, social meetings, etc

Value is the amount given (in time, money, etc) for a good, activity, or service (Griffiths and King 1994) The cost of a good, activity, or service is the value of the reward that using an alternative would have gained, had it been participated in On a small scale, to obtain the reward of a specific piece of information, a scientist may have the cost of reading to obtain that information The alternatives may be to conduct the experiment, spend time thinking out the problem, or rely on a personal network for the information On a larger scale, were a scientist not to spend time reading articles but instead, for example, spend it doing management and administrative tasks, the cost of reading is the promotions the scientist would have obtained These costs may have to be inferred since they are from activities that are not done and so cannot be observed directly

Much of a scientist's readings come from journals so access to journals is important Personal subscriptions are valuable but there are several costs involved, more than just the cost of the subscription There are the costs to the individual in terms of time as well as money for receiving, filing, storing, locating the journals and articles Libraries also have costs in addition to the subscription cost Tenopir and King (1997b) have found an initial average cost to a library of $266 10 to receive an individual new journal subscription issue ($255 average for subscription cost and $11 10 in time cost to process and retain the journal) Each "reading" (which includes browsing, looking up, actual reading, etc) is estimated to cost $3 60 With 19 being the average number of readings per individual subscription, the total cost of a journal is $334 50 per year or $17 60 per reading More readings and/or a lower subscription cost reduce the cost per reading

Journals read infrequently have a higher cost per use, and so it makes economic sense for scientists to depend on libraries to obtain these journals Distance to the library is one important factor that affects the choice of obtaining a personal subscription or using a library's The time cost for going to the library, locating the issue, photocopying, etc averages $11 50 for each reading (Tenopir and King 1997b)

One can see that there are sound economic reasons for choosing whether or not to purchase an subscription Electronic publishing of journals will alter the dynamics somewhat, but only within a range (Tenopir and King 1996) The direct costs to the publisher to produce an article is $2000 for rewriting, refereeing, editing, illustration preparation, copy editing, etc Indirect costs for marketing, lining up authors, maintaining subscriptions, etc costs at least $200 per article This initial cost of $4000 per article is the same whether the journal is print or electronic The cost to publishers of a print distribution is about $30 per subscription for paper, binding, mailings, etc Electronic distribution has its own costs for computers, staff, storage, software, maintenance, etc which must be less than $30 per subscription to be competitive with print (Tenopir and King 1996)

Scientific Products

Products are outputs, the result of the reading, and outcomes are results or consequences of the output (Griffiths and King 1993) An example of an output is a publication, an example of an outcome is election to the National Academy of Science It is difficult to measure scientific outcome or accomplishment, one reason is that there is a long lag time between the research and any product (output) thereof, so it is difficult to correlate specific efforts with specific results

The products of the different professions vary e g , engineers produce a physical change, politicians aim for a behavioral change (Pinelli 1991) While the main goal of science is the search for truth, the goal of technology (e g , engineering) is the conversion of scientific findings into usable products (SATCOM 1969) The products of science can be measured quantitatively (e g , number of publications) and qualitatively (e g , number of good publications) Each measure of scientific productivity has its drawbacks but circumstances limit what is plausible to measure

Since the value of an information product derives from its future use, it cannot be definitely measured before its use However, an "expected value" may be estimated by averaging all probable uses and number of each type of use (Bates 1988) Nonetheless, there are several ways attempts are made to measure the value of readings to scientists by measuring the number of outcomes or products One such measure of value is production of a scientific product, generally more journal articles, by a scientist or group of scientists

Another method infers the value of readings by measuring the time spent reading by recognized productive and/or creative scientists, but there is the difficulty of measuring quality Qualitative judgment of another scientist or of a scientist's work is difficult because of the limited number of people in a subject area capable of making that judgment (Gordon 1963) In some studies scientists are assumed to be able to make an appropriate judgment of the value of their own reading activity Attempts to correlate scientific accomplishment (e g , as determined by subjective evaluation by peers or superiors) with non-subjective, quantitative measures (e g , publication levels) have been inconclusive (Gordon 1963) Still, because of the ease of measurement, most papers analyzing research contributions use numbers of patents or publications despite having to make the assumption that certain rewards, such as grants and journal publications, are the appropriate and natural outcome for good scholarship (Machlup 1979)

In any case, the varying professional styles among scientists limit the usefulness of this method since some scientists divide their results into the smallest publishable unit while others selectively pursue patents And simply counting publications, etc does not necessarily give credit to the genuinely creative scientist over the ones that "milk" publications from their results Furthermore, the organizational setting itself promotes the kind of output that it is interested in (Gordon 1963) whether it is production of new ideas (e g , discovering DNA) or the use of ideas to produce new results (e g , measuring DNA in 50 different species) Such are some of the difficulties of measuring scientific accomplishment, the final product of a scientist's reading Nonetheless, as the only outcomes obtained in the UTK survey were the number of publications and the number of awards, these will be used as measurements of accomplishment for the purposes of this thesis

DOCUMENT READING BY SCIENTISTS

The process of reading a document occurs in four major, sequential steps finding, getting, reading, and using the document The behavior in each aspect of this process can vary from profession to profession and among subgroups in a profession, as well as being altered by individual factors

Finding

Serendipitous finding of information through browsing is important to all researchers (Hamilton 1990) Undirected browsing was the most common technique used by scientists to find documents 51% of the readings of a mix of government, academic, and industry scientists (Martin 1962), and 49% each of academic and industry scientists (Bayer and Jahoda 1979) Academic scientists, however, were often twice as likely as industrial scientists to use literature indexes, standard abstracts/contents, primary sources, and citations in other works (Bayer and Jahoda 1979)

Scientists in 1977 (King et al 1981) were most likely to use browsing to find a document The next most likely was searches - the bulk of which were printed indexes in 1977 (King et al 1981) and are computer-based now Ellis, et al (1993) concluded that there was little difference in the information-seeking behaviors (e g , following citation chains, browsing) of physicists and social scientists, although the emphases were different such as an increased use of books by social scientists

Broadbent (1986) studied the methods humanities faculty used to identify documents The largest percentage of faculty in Broadbent's study, 42%, used some form of search The use of citations was next at 23%, with browsing (18%) and word of mouth (14%) following Printed bibliographies and subject card catalog were far more used and preferred than computer searches

Getting

Allen (1977) found that the pattern of document acquisition was similar between scientists and engineers, with personal sources being the greatest source and colleagues the least used About 70% of both industrial and academic scientists routinely used their own collection of information (Bayer and Jahoda 1979)

However, even small price increases diminish personal subscriptions, leading to greater reliance on library subscriptions (Tenopir and King 1996) so that the source of the document has changed since 1977 In 1977 (Tenopir and King 1997b), 66% of readings for scientists were from personal subscriptions, more than three times as many readings as from the library In 1984 and the late 1980's (Griffiths et al 1991), the proportion of readings from a personal subscription declined while articles from the library increased In the early 1990's, university scientists (included social scientists) were more likely (54%) than non-university scientists (30%) to obtain their readings from a library And, in a study in 1995 including non-university scientists (Tenopir and King 1997b), 44% and 39% of readings came from personal subscriptions or libraries, respectively

Reading

The average time spent reading each article by an R & D professional was 1 4 hours (Griffiths & King 1993) However, when each of the different science fields was examined separately (King et al 1981), mathematicians spent a disproportionately large amount of time reading an article (225 minutes) while the rest of the fields varied from 30 to 70 minutes per reading

When measuring the total time spent reading, Martin (1962) found that chemists and physicists read about two hours per week Another study (Bayer and Jahoda 1979) found that 61% of academic scientists spent more than 4 hours per week reading professional literature, compared to 53% of industrial scientists

The pattern for depth of reading by professionals remained consistent from 1977 to the late 1980's with about 35% reading with great care, 55% with attention to main points, and about 10% just to get the idea (Griffiths et al 1991)

The average age of an article read by physical scientists was 2 3 years old with a half life (median age) of 0 2 years (King et al 1981) A different study of all scientists (King et al 1981) found that while 85% of readings were two years old or less, 24% were at least four years old, demonstrating the use of science literature for current awareness as well as a permanent record

Documents types read vary from profession to profession Engineers have a different pattern of literature use than university faculty Their predominant literature source is textbooks (about 28% of uses) Trade journals and controlled-circulation journals (with advertising) each account for 20% of uses and so together about 40% of the uses The use of journals is less, with 11% of the uses for professional engineering journals and 3% for science journals (Allen 1977)

Physical and social scientists were similar in their use of journals to obtain information for a recently completed activity The greatest differences occurred with physical scientists using more technical reports and meeting presentations and social scientists using more books, local colleagues, and students (Garvey et al 1979) The highest percentage of readings by professionals, summarized from 19 organizations

(Griffiths & King 1993), were from trade journals and reports rather than from other document types Of the documents yielding a beneficial impact to Exxon scientists (Weil 1980), 42% were journals, 14% were books, then trade publications, abstract bulletins, and patents each 8 or 9%

Using

Scientists used two major sources of information 1) local colleagues and students, and 2) journal articles These sources generally had different purposes journals were used to establish an understanding of a scientific problem and how it fit in with current knowledge while the social sources were most helpful in experimental design and data collection and analysis (Garvey et al 1979)

Scientists at Exxon reported that 40% of the documents they read influenced their work (Weil 1980) Professionals (Griffiths & King 1993) cited that 44% of their readings increased the quality of their primary activity while 19% of their readings provided "timeliness improvements " In 1977, 24% of readings by scientists resulted in a time savings (King et al 1981) Professionals rated the information found in documents for research at an importance rating of 4 out of 5 (5 = "absolutely essential") with 3 being "neutral" (Griffiths & King 1993)

In a bibliometric study (Van den Berghe, et al 1998) of science researchers at three Flemish universities, productivity was calculated in terms of science citation index (SCI) processed journals per full time equivalents available for doing research The medical faculty were the most productive (0 8-2 0 SCI publications/FTE/yr) followed by pharmaceutical faculty and then by non-medical science faculty (0 6-0 8

SCI/FTE/yr) The differences between the highly productive faculty groups and the less productive groups was less than three-fold

Electronic

Recent research (Liebscher et al 1997) shows that the majority of science faculty use networked services, though with some variations among institutions probably due to access and training Sixty-five percent of science faculty, which included 14% in administrative positions, from six small southeastern U S universities (Liebscher et al 1997) used e-mail in 1993, 81% of the small university science faculty used non-e-mail network services

THE RELATIONSHIP OF READING BEHAVIORS TO ACHIEVEMENT FOR SCIENTISTS

Finding and Getting

The number of subscriptions was one of the most effective predictors among the parameters measured to predict journal article publication rates for social scientists and humanists (Wanner et al 1981) However, for natural scientists, it was a less effective predictor of journal publication where it was overshadowed by number of grants (Wanner et al 1981)

Kasperson (1978) examined the relationship between information seeking (and use) and creativity (as determined by peer nominations) While he found that creative scientists used periodicals significantly more than non-creative/non-productive scientists, the differences between creative/productive scientists and non-creative/non-productive were best explained by five variables, four of which dealt with the use of people as an information source, thereby measuring social interaction

Research "stars" - individuals to whom the other members of the research group turn to for technical discussion or who were the sources of information that influenced a project - had a significantly increased use of communication channels outside the lab (Allen and Cohen 1969) The "stars" used personal friends, read more technical periodicals, and read more professional and scientific periodicals than their counterparts There was no significant difference in internal verbal communication between stars and non-stars The higher achieving professionals surveyed by Griffiths and King (1993) appeared to be consistently greater library users than their cohorts

Reading

The productivity of scientists was positively correlated with reading levels (Griffiths and King 1993) Scientists and engineers who were relatively high readers (actual levels varied among organizations) consistently had higher indicators of productivity publications, proposals, presentations, consultations, and reports Further, the usefulness and effectiveness of the high readers' outputs was greater in that more of their reports got read, their proposals were more likely to get approved, and their presentations were better attended

Several other studies have also shown a positive relationship between reading and productivity or creativity Lufkin and Miller (1966) found that reading levels for the vast majority of engineers were less than 5 hours per week However, engineers and scientists who had been given awards for outstanding creativity were found to read more than 9 hours per week Scientists who had published within the past five years read between 7 and 13% more than non-publishing scientists (Martin 1962)

Griffiths and King (1993) found that high achievers read more than their cohorts On a yearly basis (as estimated from a figure), "fast trackers" (peer-selected high achievers) read 271 documents while their cohorts read 131 and award winners read 251 documents while non-award winners read 189 Griffiths and King (1993) also looked at the specific documents read by award winners and by fast-trackers The award winners read more of each type of document Communication "stars" (Allen 1977), those who serve as technological gatekeepers, read more of particular types of literature than their cohorts The stars read more technical and refereed journals while tending to read trade journals to the same extent (Allen 1977)

Electronic

Electronic technology seems thus far to have only a minimal impact on formal scholarly communication Kaminer and Braunstein (1998) used data from computer logs, questionnaires, and publication lists of each scientist to measure the impact of internet use on publication productivity by university scientists Publications were weighted according to effort and/or input (e g , single author books counting for more than multi-author non-research articles) A 10% increase in the use of all log-in applications was associated with an increase of 0 21 publication units (where a single author journal article is two units) per year (Kaminer and Braunstein 1998)

Using citation rates, Harter (1998) concluded that scholarly, peer-reviewed electronic journals have minimal impact on scholarly communication The journals examined were in both the natural and social sciences and over 25% of the electronic journals also had a print counterpart

Relationships between peer-judged quality and publishing productivity

Productivity without quality does not correlate with being considered a "major" scientist, but eminent scientists do tend to be highly productive Among psychologists, publication level correlated fairly well with scientific awards (Garvey 1979) Gottfredson et al (1979) found a "very mild relation" between the quality of a publication and productivity by the authors of that publication In other words, so far as the quality of a publication (as opposed to a scientist) was concerned, there was very little predictive value for the subsequent publication level of the authors of that publication Pelz and Andrews (1978) found positive correlations for scientists and engineers among all their performance measures papers (journal articles, reports), contribution (to general knowledge), and usefulness (to their organization) The latter two criteria were judged by senior people in their laboratories

A study was conducted of performance-effectiveness of scientists in primarily academic or cooperative production R & D organizations of six European countries in the 1970's (Andrews 1979) Three of the outcomes surveyed were publications, recognition, and reports and algorithms Recognition was judged by an external panel on the scientist's international reputation and demand for his or her publications Report writing (internal) had little or no correlation with publications or recognition, even after adjusting the measurements for the type of organizations However, publications (journal and book) were correlated (r = 0 51) with recognition

Ph D s in development labs, which were non-academic (industry or government), were compared with Ph D s in research labs, which were 2/3 academic and 1/3 government (Pelz and Andrews 1978) In each, the highest correlations (greater than 0 5) were between "usefulness" and "contribution " The lowest correlations for academic scientists were for "reports" or "papers" and "usefulness" to the university (or government lab) The correlations for academic scientists were similar among papers, reports, and contributions Non-academic scientists, however, had low correlations between papers and reports and between reports and contributions, which is not surprising since reports may often be on proprietary information and so would not become part of general knowledge

Many studies of research productivity have looked for correlations of productivity with sociological measures such as age, gender, status of graduate program, institutional affiliation, etc (Wanner et al 1981) Even combinations of multiple factors and weighting of variables rarely explained more than half the variance in productivity

Rewards

What are rewards to a scientist? When different scientists were compared research and development, Ph D and non-Ph D , assistants and engineers, the research Ph D s had the highest level of desire for and achievement of self-actualization Ph D scientists had the lowest desire for status advancement Ph D researchers (Pelz and Andrews 1978) scored highest for total satisfaction, job provision (i e , whether the job provided factors that contributed to satisfaction), and job desires

While Ph D researchers were satisfied overall with their contributions and the provisions by the job to produce these contributions, they were dissatisfied with the distribution of power in determining their work goals But then, the most productive scientists were the ones not totally in agreement with the goals of the organization (Pelz and Andrews 1978)

Pay, of course, is another measure of value (of the scientist) The journals selected for subscription and readership by workers were examined in nine defense R & D labs (Hoyt 1962) The journal subscription lists of each category of worker, whether by pay, work description, or education level, contained two to four general news magazines (e g *Time*) in the top ten subscriptions The journal lists for the highest paid workers was most similar to those in the lowest pay category rather than the medium pay category Workers were also described as being in research, testing, or development The journal subscription lists of research workers had the least in common with those in the highest pay category, while workers in testing and development had more in common with those in the highest pay category The subscription list for Ph D s (9 6% of the sample), the group probably most comparable to academic scientists, were similarly dissimilar to the lists of each of the pay levels

CHAPTER 3

DATA SOURCE AND METHODS

SURVEY PARTICIPANTS

A series of focus group interviews were carried out by Donald W King, President of King Research, Inc , beginning in spring semester 1993, to determine particular areas of emphasis to assess user needs at the University Tennessee libraries Participants were staff and users of the UTK libraries The issues raised by the participants were incorporated in the preparation of the survey

The survey was comprehensive in order to allow for future monitoring of information needs and requirements and to serve as a baseline for future studies To accommodate the extensive amount of data this required, the burden on survey respondents was minimized by breaking the survey into multiple parts with each respondent receiving only one part As a result, a total of seventeen separate and customized questionnaires were designed for various groups of library users The complete survey, tabulations, and brief technical report are available through the IS ERIC Clearinghouse

Five of the questionnaires were designed for the professional university staff faculty, researchers, administrators, and other UTK-affiliated professionals These groups are referred to as faculty Three of the questionnaires covered portions of all the services provided by the libraries Another dealt with barriers to library use, and the usefulness and value of services The fifth (see Appendix), used in this thesis, was designed to provide a perspective on information used (as found in documents) and the role of the UTK Libraries in providing this information This questionnaire dealt with reading, information-seeking behavior patterns of users, and consequences of reading Aspects of electronic publications were also addressed Demographic information was collected on all surveys (see Appendix)

Faculty, administrators, and other professional staff were randomly sampled and sent one of the above five questionnaires The numbers of received and returned surveys are given in Table 1 While the response rate for the entire survey was 33%, the response rate for the information use portion was 50% Seventy and sixty surveys respectively were used in compiling data for the science and non-science professional staff Faculty answering one question or less were excluded as were faculty having only an administrative role since they were not likely to read to do research, six of the 136 returned surveys were discarded for meeting these criteria As a point of reference, the return rates to faculty of a survey on internet use at the Hebrew University of Jerusalem were similar to the one used in this thesis with 55% of non-scientists and 65% of scientists returning surveys (Lazinger et al 1997)

THE SURVEY QUESTIONS

The UTK Needs Assessment survey used the critical incident (Committee 1969) technique of focusing questions on the last read work-related document The primary reason for this procedure is to provide a cleaner picture of overall reading behaviors Information gathered from using the critical incident technique is more accurate than information on all events because it is easier to accurately remember

Table 1 Response levels (in numbers of personnel) of University for Tennessee, Knoxville, professional staff (including faculty and administrators) of questionnaires distributed November 1993 Percentages of faculty returning a survey version are shown in parentheses

Faculty	Numbers (Percent)
UTK faculty *receiving* surveys (all)	1349
UTK faculty *returning* surveys (all)	451 (33 4)
UTK faculty *receiving* information use version	270
UTK faculty *returning* information use version (IUV) of survey	136 (50 4)
UTK *science* faculty returning IUV	71 (26 3)
UTK *non-science* faculty returning IUV	65 (24 1)
UTK *science* faculty returning IUV & included in calculations	70 (25 9)
UTK *non-science* faculty returning IUV & included in calculations	60 (22 2)

the most recent event rather than to correctly estimate all events (Martyn and Lancaster 1981) And, by questioning the last event, the information gathered provides a random sampling of events for the entire population (Martyn and Lancaster 1981)

In order to understand the behaviors and needs that went into reading that document, questions were asked about the events and techniques involved in reading that document (see Appendix) Survey Questions 1-20 covered finding, getting, reading, and using the document Another set of questions, Questions 21-33, (included in all five faculty surveys) asked demographic questions about use of electronic services, educational level, awards and publications, work role, and number of subscriptions (see Appendix)

A detailed analysis including percentages, averages, and/or summation are provided for each question on the information use survey In questions where an answer is given as "other", the individual's responses was considered to ascertain if his/her response could be categorized with one of the survey's provided answers Since only the respondent answered the survey questions, it was assumed that their responses were true quantitatively (e g whether they last read a journal article) and qualitatively (e g whether they read it "with great care") Any of the questions could be analyzed in several ways For ease of comparison, where possible responses are given as percent of faculty In some questions, additional insight could be obtained by calculating the answers in different ways (e g responses from Question #2 are provided as percent faculty, average number of documents, etc) Non-responses were totally discarded from analysis of that question Descriptive statistics were used to examine differences between scientists and non-scientists for selected questions No statistics were carried out on SS and NASS data because of the low number of data points

SCIENTISTS

The faculty were split between those in the sciences and those in the humanities/social sciences Science faculty were determined by selecting, from the information use survey, respondents in a natural or physical science department (Question #23) Selection was confirmed by examining the title of their last reading

(Question #4) and ensuring their main work emphasis was in research or teaching (Question #24), in the assumption that being active in research or teaching demands maintaining currency in the science literature and therefore would provide a reading behavior of interest in this thesis Splitting the respondents between scientists and non-scientists allowed comparisons to be made between the reading habits of the two major disciplines while keeping the university setting and time frame the same

SUCCESSFUL SCIENTISTS

In order to achieve the goal of understanding the value of readings to scientists, correlations were made between success and their reading behaviors The measures of success provided by the survey were awards and publications The science faculty were first separated into award winning and non-award winning (Question #25)

Question #27 asked for level of authorship and co-authorship so publication levels were established at which "successful scientists" (SS) were separated from the "not as successful scientists" (NASS) The number of co-authored documents was added to the number authored to provide a single number for authorship of each type of document Since at least one journal article publication a year is practically a necessity in a university setting, I established success for the SS-j as more than one article a year Consequently, to increase the tendency of truly selecting for SS in terms of total publication levels, SS-au were established as those publishing three or more documents per year The number of faculty in each category are shown in Table 2

Table 2 Number of respondents for each category of SS and NASS

	Basis of Success					
	Award		Author		Journal	
	SS	NASS	SS	NASS	SS	NASS
Number of respondents	23	45	33	35	47	21

QUALITATIVE QUESTIONS

Questions #17b, #19, #20a, and #20b were open-ended or qualitative questions in the survey that were analyzed The procedures described by Glazier (1992), Tesch (1990), and Finch (1990) were followed to organize and categorize qualitative responses to allow summation and analysis The procedure was to read all the answers, establish categories of answers that appeared to be common, and then go through the answers and assign each to a category or categories The entire process was repeated several times for each question, refining the categories each time

Answers to Question #17b, on the role of the information, were easily divided into only five categories background, specific information, affirmation, future experiments (or studies), and/or analysis

Question #19 asked respondents to "specify the ways you believe usefulness might be affected" by electronic transmission of the document used Responses were varied and were divided them into positive and negative remarks for electronic transmission The answers were sorted into eleven categories convenient, time savings, space efficient, greater capability, current, hard to read, have to printoff, inconvenient, time consuming, less social, and poor printing

Questions #20a and #20b asked for reasons for a preference for electronic or paper (respectively) format When asked for the reasons for their preference, several respondents gave reasons for preferring both, and/or gave negative comments, which were treated as positive comments for the other format In several cases the same response term was used for each format but with a different meaning For example, convenience in an electronic format involved being able to obtain the information on demand whereas in paper format it was used to describe the ease of physically having and carrying the document As such, I retained "convenient" for the electronic format and assigned the term "portable" for the convenience characteristics of the paper format The categories and their connotations are

<u>Question #20a</u>

convenient able to obtain document whenever wanted

capability ability to cut and paste, do keyword searches

space efficient takes up less space

faster quicker to obtain, more current

<u>Question #20b</u>

comfort easier on eyes, more familiar

quality more likely to be peer-reviewed

access can see the paper in its entirety, can mark on the document

picture quality better quality figures and typesetting

portable able to physically carry around, no need for special hardware or software, can read at convenience in short time increments

A test for reliability of the coding was done by an independent coder who provided his own categories for the responses to a subsample (29 respondents) of the survey population This method allowed a clarification of the number of and areas of concern to the respondents The coder's categorization matched mine exactly or were similar for 65% of #17b, 73% of #19, 67% of #20a and 89% of #20b For the rest of the responses, the coder's terminology was very different or used a term used for another category so that the categorization of the responses would have differed

This research has the following hypotheses 1) The reading styles of scientist faculty differ from non-scientist faculty and 2) The reading behaviors of scientists and their use of information relate to their scholarly success as indicated by their scholarly output and outcome

CHAPTER 4

ANALYSIS AND FINDINGS

SCIENTISTS AND NON-SCIENTISTS

One of the five parts of the library user survey provided to UTK faculty in the fall of 1993 asked about reading habits, particularly focusing on the last read work-related document For analysis, the survey questions were grouped according to their coverage of each of the four steps of reading a document, outlining the process one goes through from first finding out about a document to getting it to reading the material to actually using the information

1) Finding the document - the technique used to identify a document of interest, e g , citation, database

2) Getting the document - the source from which the document was actually obtained, e g , library, electronic source

3) Reading the document - information about the document itself and the actual reading of it, e g , document age, reading time

4) Using the document - The purpose of the reading, e g , research, teaching

In addition, demographic questions were asked about the faculty, e g , level of authoring, e-mail habits

Finding

Question #12 asked how a document was found. Since an answer frequently given under "other" was "from a reference", it and the 13 provided options were merged into four basic techniques for finding a document

- browsing or serendipitous locating
- searching by carrying out a planned search using print or electronic databases
- being referred to the document by a colleague or specialist
- learning of the document from a citation in another source

Browsing was the most common method for UTK faculty to locate a document (Fig 1), being twice as likely to be used as the second most frequent method, database search Next in frequency was being referred to the document by a colleague, followed by learning of the document from another document (Fig 1) Science faculty, appeared more likely to use a database while non-science faculty were more likely to get a reference from a colleague

Getting

The next step toward reading a document is obtaining it Documents may come from libraries or personal collections, and they may be in print or electronic forms

The most likely source was a personal subscription (Fig 2) Although a personal subscription is intended for or obtained for the use of a particular faculty member, as described in Question #13, the subscription may be purchased by that

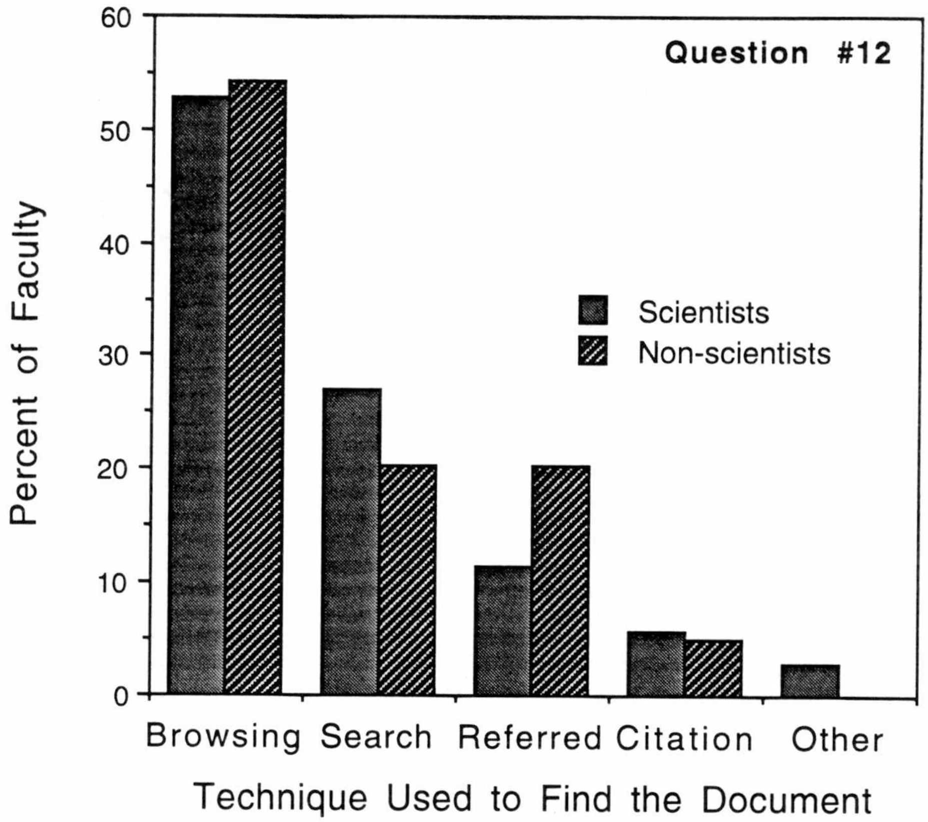

Figure 1. Method used by science and non-science faculty to find out about document.

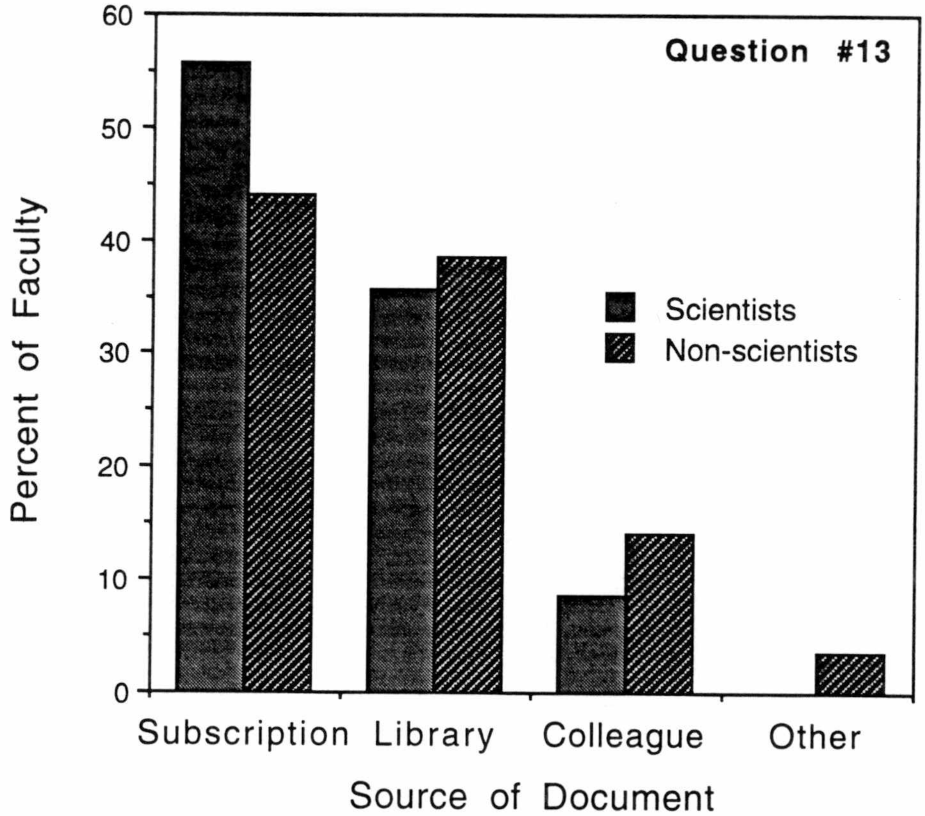

Figure 2. Source used by science and non-science faculty to obtain document.

member, the library, or the department Library-held documents were the second most common source, followed by obtaining the document from a colleague, author, or consultant Science and non-science faculty had similar patterns, though science faculty seemed to be more likely to have used a subscription source, while non-science faculty were more likely to have used a colleague to obtain the document (Fig 2)

If the usual (Fig 2) document sources were not available, 13% of science faculty and 21% of non-science would simply not get that document (Fig 3) Of those that would try to obtain the document, science faculty appeared equally likely to use colleagues or another library The most likely alternate sources for non-science faculty were also a colleague or another library, but at lower frequencies than science faculty A few science faculty would obtain the document from their own collection, indicating that though they held that document themselves, it was easier or more convenient to use another source (Fig 3)

Ten and eight percent of the science and non-science faculty (respectively) obtained the document in an electronic format (Table 3, Question #5) Around 40% of both faculties said that the usefulness of the document would be affected if the document were transmitted electronically (Table 3, Question #19) Of those that said that usefulness would be affected, many provided both negative and positive comments (Fig 4) Greater than 60% of the remarks from each faculty group, scientists and non-scientists, were negative (pro-paper) The predominant positive comment for electronic transmission concerned time savings Interestingly, several other respondents described electronic transmission as time consuming Overall, inconvenience was the negative comment most frequently given

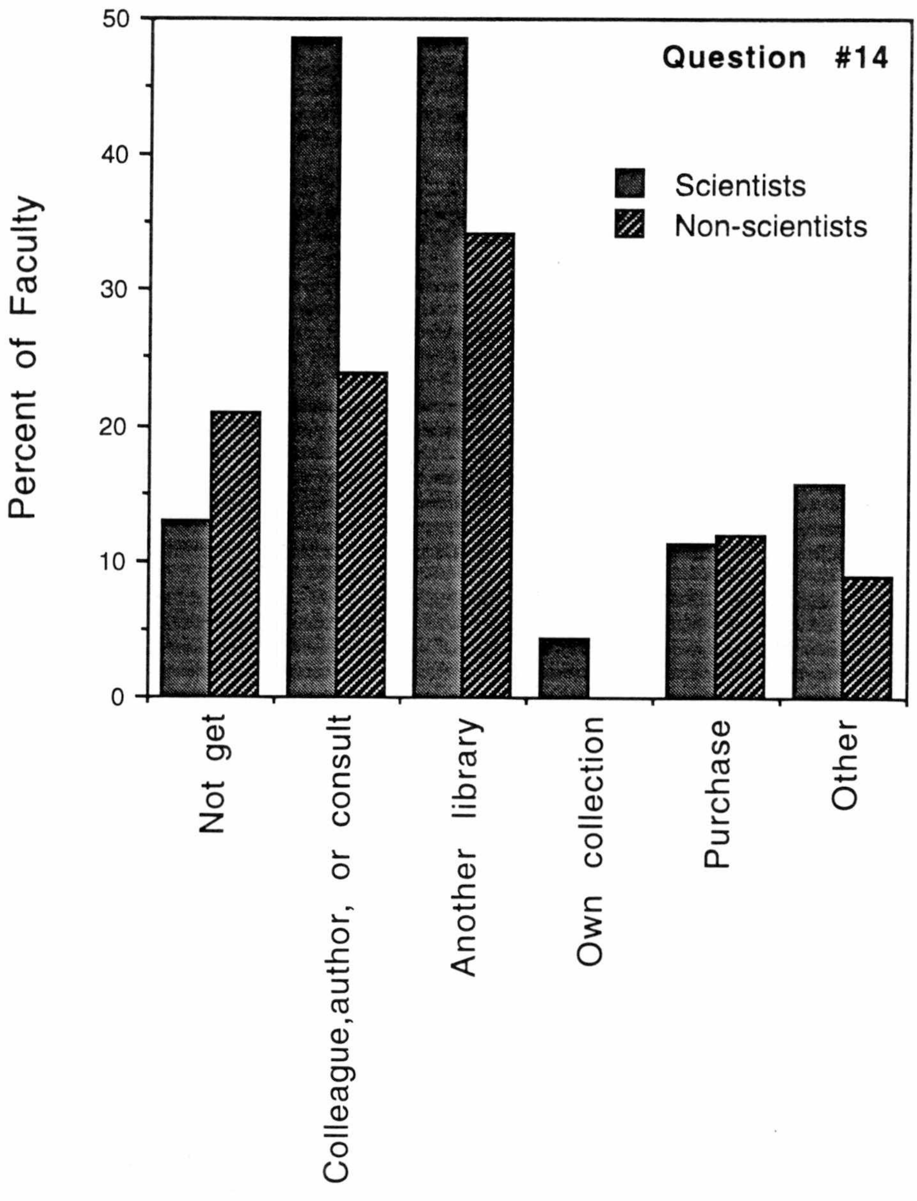

Figure 3. Alternate sources for obtaining documents by science and non-science faculty.

Table 3. Results from specified questions scientists vs non-scientists Three different statistical tests were used t-test for Questions 6, 11, 16b, 17c, 20, 27, 31b, chi-square for Questions 5, 7, 8, 19, 29, 31, 32, and Wilcoxon rank sum for Question 9

Question			Scientists	Non-Scientists
5	Electronic format used		10 1%	8 1%
6	Number articles read/journal		47 4	14 5 *
7	First time reading		52 9%	57 6%
8	Knew info already		58 8%	66 1%
9	Year of document	mean	1988 6	1985 7
		median	1993	1993
11	Time spent reading		88 6 min	101 4 min
16b	Importance to teaching		5 1 out of 7	4 9 out of 7
17c	Importance to research		5 2 out of 7	5 3 out of 7
19	Electronic affect use		41 4%	35 1%
20	Preference for paper		4 9 out of 7	4 8 out of 7
27	Number of doc's published/yr		9 5	4 7 **
29	Access or use of a computer		95 8%	86 4% *
31	Use e-mail		88 1%	85 7%
31b	Time spent on e-mail		2 4 hr/wk	2 0 hr/wk
32	Use non-e-mail network		70 0%	63 2%

Significance * = p < 01, ** = p < 001

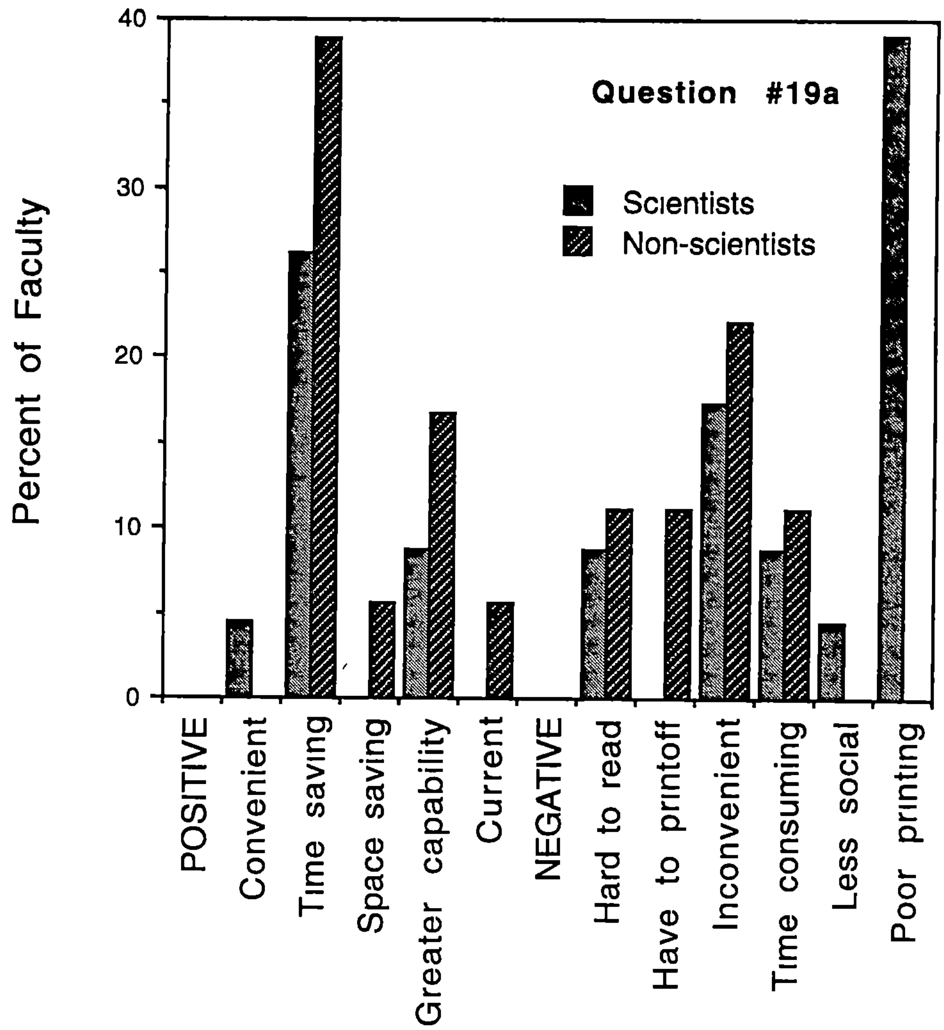

Figure 4 Ways electronic transmission would affect usefulness of document to science and non-science faculty

Differences between scientists and non-scientists were apparent in their areas of concern (Fig 4) A major concern, expressed by nearly 40% of the science faculty, was poor quality printing of electronically transmitted figures, graphs, tables of data, etc , which are important in science This concern was not shared by any of the non-science faculty Compared to scientists, non-scientists liked electronic transmission for its greater capability for specific tasks, space efficiency, and currency but found paper useful because electronic transmission still required printing off for perusal

Reading

The faculty read a broad range of documents The largest percentage of faculty read journals, trade journals, and books with more scientists than non-scientists appearing to read each of these document types (Fig 5) When considering the number of documents that were read, the pattern is similar with more journals, trade journals, and books being read though the disparity in journal article readings between scientists and non-scientists is magnified (Fig 6)

Various aspects of the actual reading of the document itself were considered Science faculty tended to read a smaller variety of documents, and at lower levels, except for journals, than non-science faculty (Fig 7) Seventy-six percent of science faculty last read a journal article In declining frequency, they read books and then trade journals Only one science faculty member reported a last reading of an electronic document None reported using audio visual materials or other document forms Science faculty reading journal articles read more than three times as many articles from the same journal as non-science faculty (Table 3, Question #6)

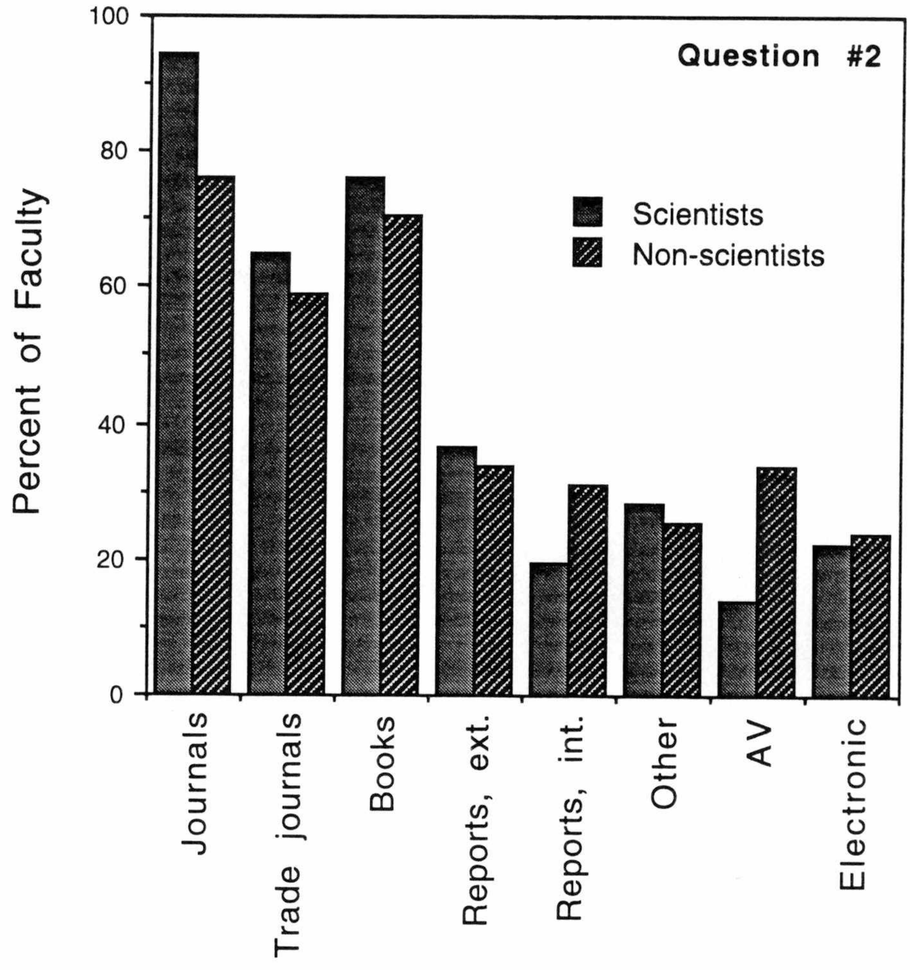

Figure 5. Percent of science and non-science faculty reading each type of document in the last month.

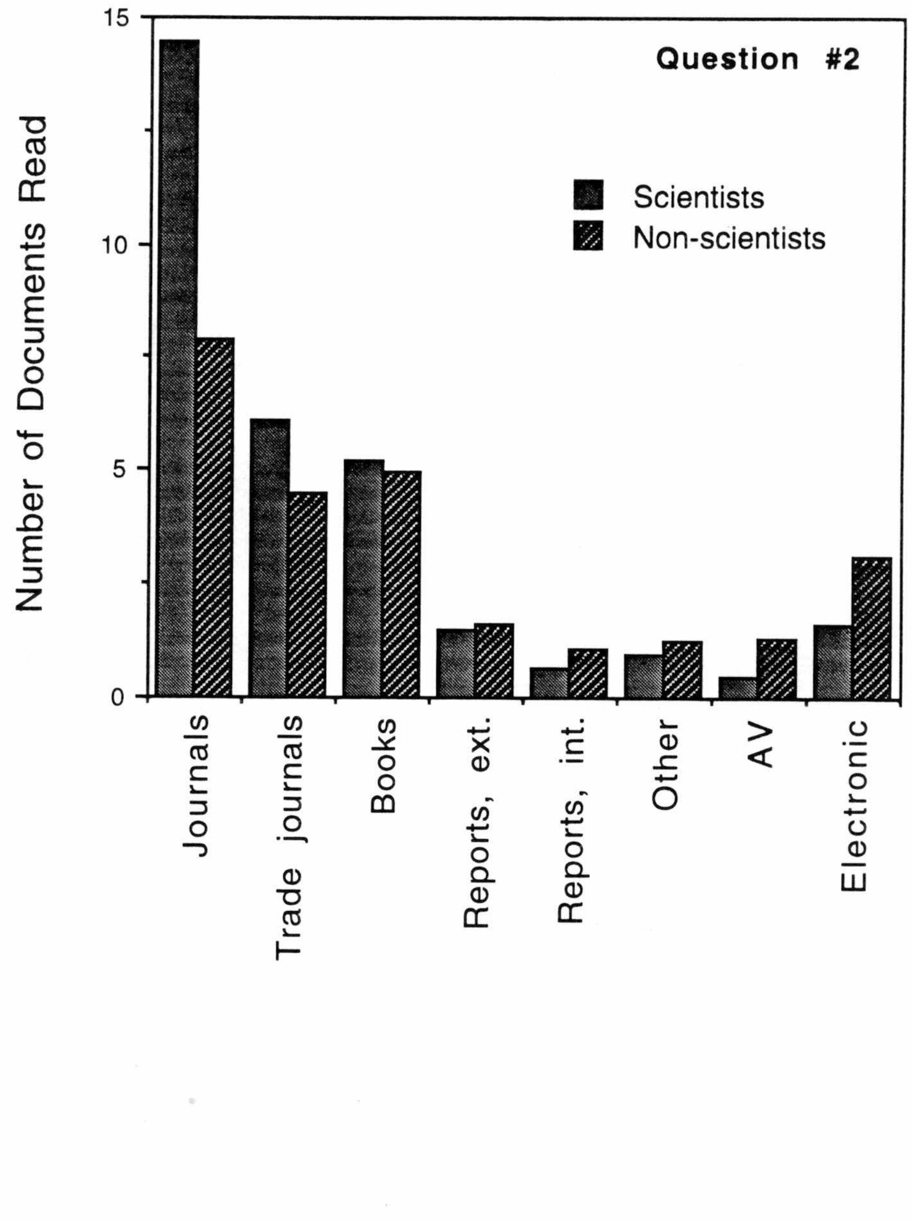

Figure 6. Average number of types of documents read by science and non-science faculty in the last month.

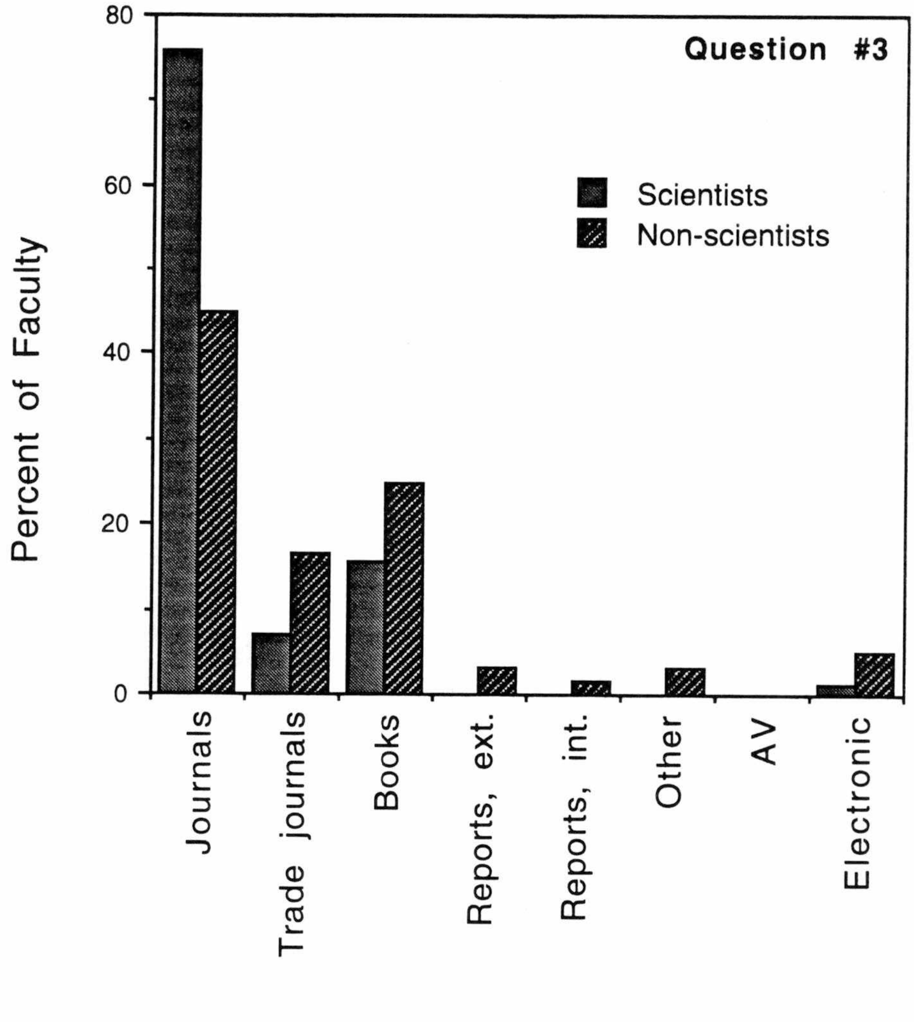

Figure 7. Type of document most recently read by science and non-science faculty.

The average year the document was published or written (Table 3, Question #9) was 1988 6 for the science and 1985 7 for the non-science faculty However, the median (and mode) year was the same for both faculty 1993 The percentages of faculty reading the document for the first time (Table 3, Question #7) and the percentages of faculty who already knew the information in the document they read (Table 3, Question #8) ranged from 53 to 66%

In considering depth of reading, non-science faculty were most likely to read a document "with great care" (Fig 8) Perhaps consequently, non-science faculty spent more time, 101 minutes, reading their documents (Table 3, Question #11) than science faculty (89 minutes) Each set of faculty was least likely to read a document "just to get the idea "

Science and non-science faculty had similar preferences (4 9 and 4 8, respectively, on a scale of 1 to 7) for documents to be in a paper format rather than electronic (Table 3, Question #20) When providing comments for Question #20, respondents generally had more than one reason for preferring paper or electronic format, with several providing comments on both formats Nearly twice as many of the non-science faculty made "pro-paper" comments as made "pro-electronic" comments, while for the science faculty the support for paper was even greater with two and a half times as many faculty making "pro-paper" comments

The most frequently given reasons for a preference for electronic transmission (Fig 9) by both faculty sets were convenience, faster transmission, and the increased accessibility (usefulness) of electronic features (e g , searching) The reasons for a preference for paper (Fig 10) were more numerous and varied The major reasons were printing quality, comfort level of reading, accessibility of having the whole

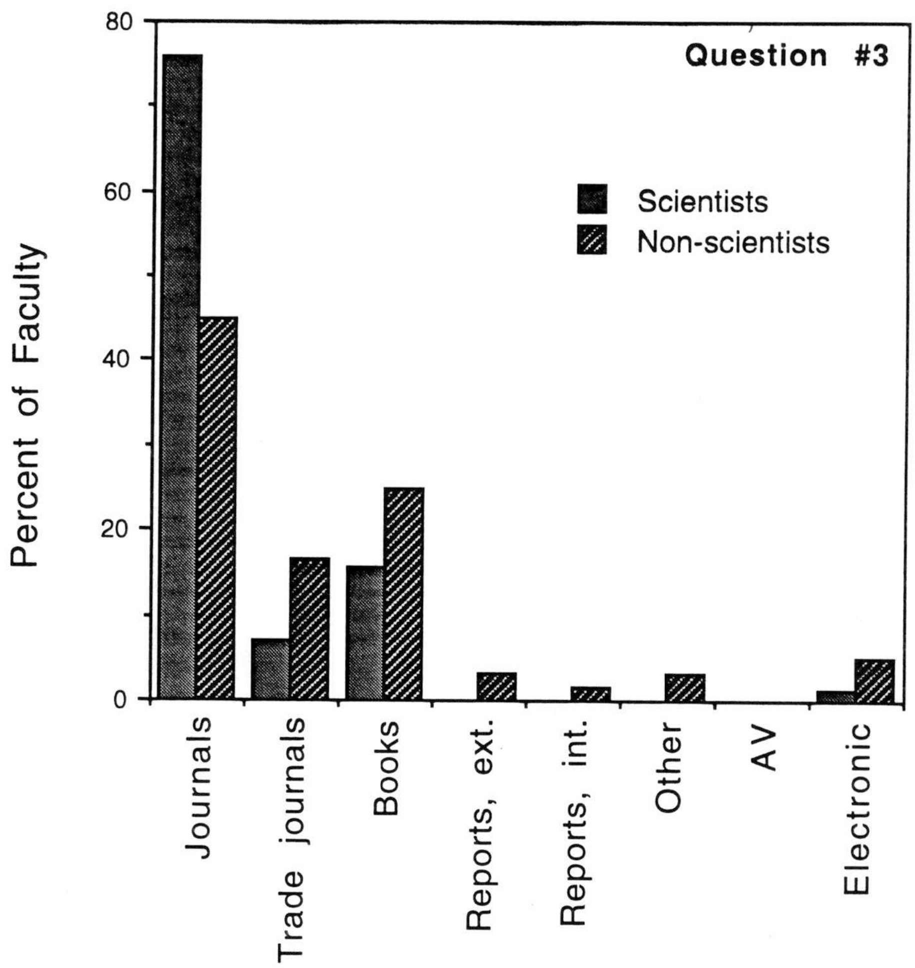

Figure 8. Thoroughness of document reading by science and non-science faculty.

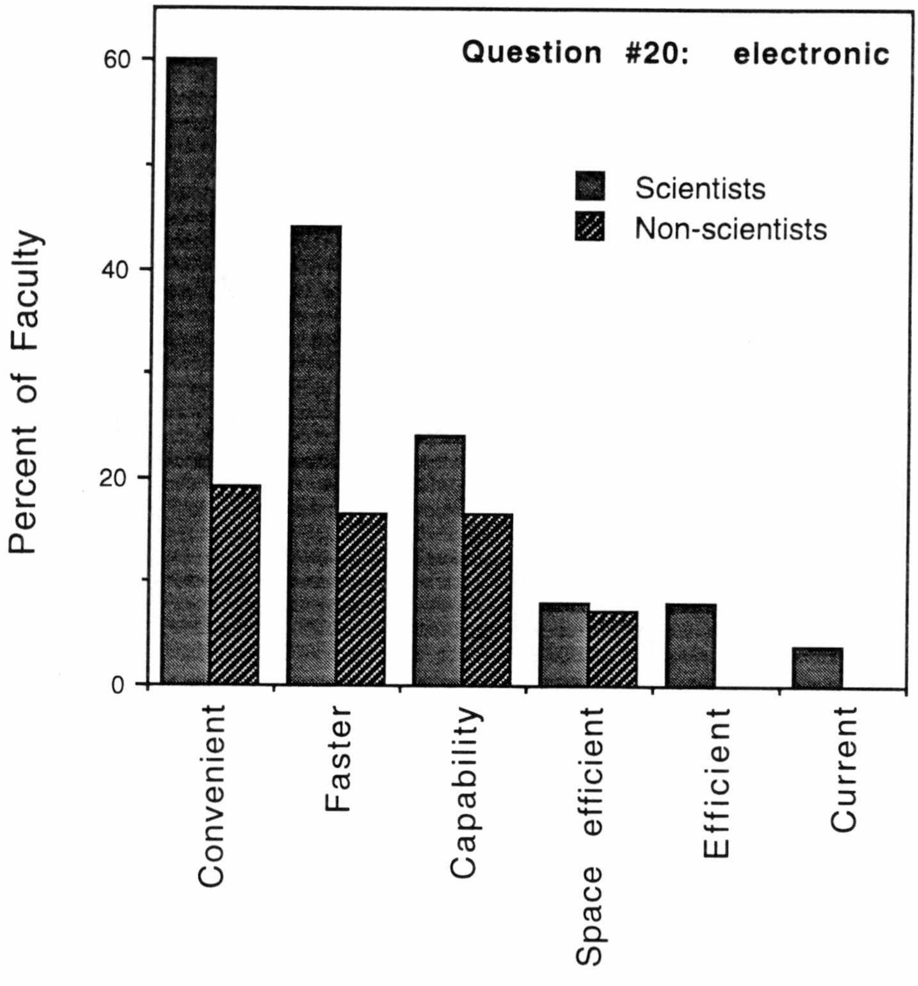

Figure 9. Reasons given by science and non-science faculty for preferences for electronic format of document.

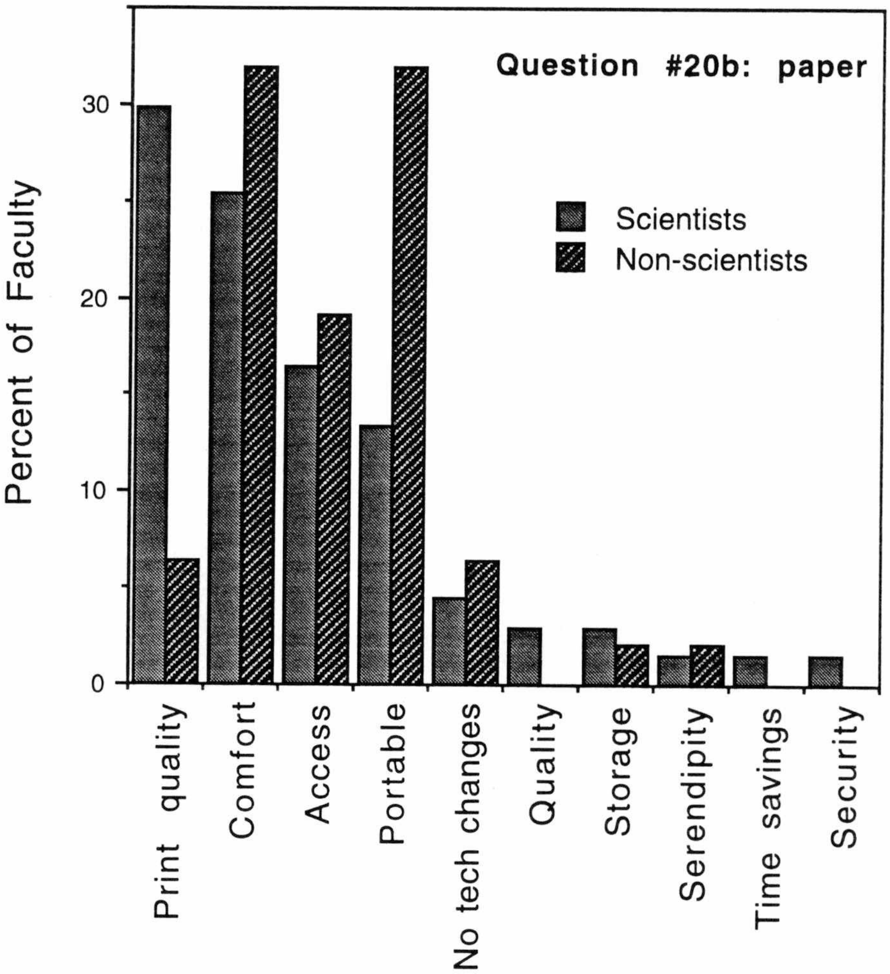

Figure 10. Reasons given by science and non-science faculty for preferences for paper format of document.

document (to scan), and the portability and convenience of the print copy to carry and read

Using

The documents were used for different purposes and often the same document was used in several ways Nearly 80% of the science faculty used their last read document for research and almost half also used it for teaching (Fig 11) No science faculty used the document for administrative purposes, although a few non-science faculty did Overall, science faculty showed greater variability in the kinds of uses of their readings while non-science faculty's purposes were more evenly distributed with no single use claimed by more than 21% of them (Fig 11)

The importance assigned to the information in their document was similar, between its importance in its use for both teaching (Table 3, Question #16b) or research (Table 3, Question #17c), for science and non-science faculty All the ratings for document importance were between "somewhat important" and "absolutely essential", with averages between 4 9 and 5 3 on a scale of 1 to 7

UTK science faculty ranked the importance of the information found for research at a little over 5 on a scale of 1 to 7 with 4 being “somewhat important” and 7 being “absolutely essential” (Table 3, Question #17c) Ninety-three percent of UT scientists (Fig 12) reported at least one effect on their work Sixty-seven percent of UTK science faculty responded that their reading specifically improved the quality of their work while 17% specifically noted that the reading “saved time ”

The predominant consequence of reading the document was an increase in the quality of the work of the faculty respondents (Fig 12) In fact, nearly 100% of science

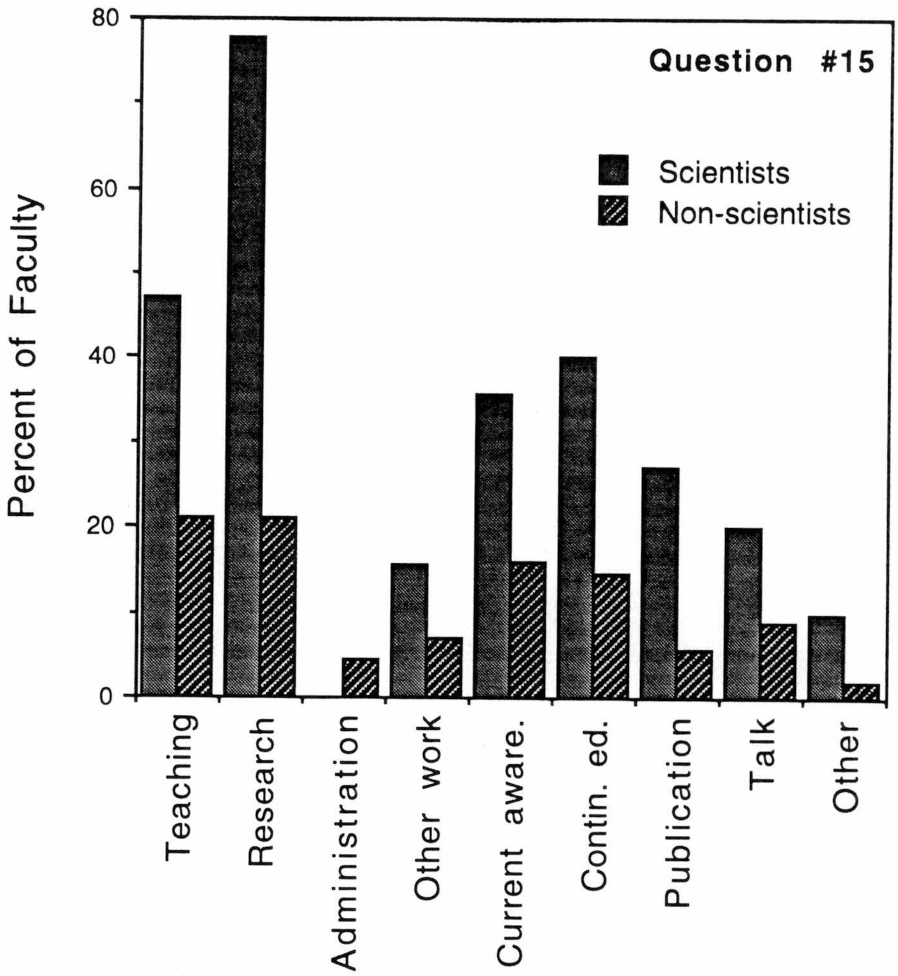

Figure 11. Purposes of the document reading by science and non-science faculty.

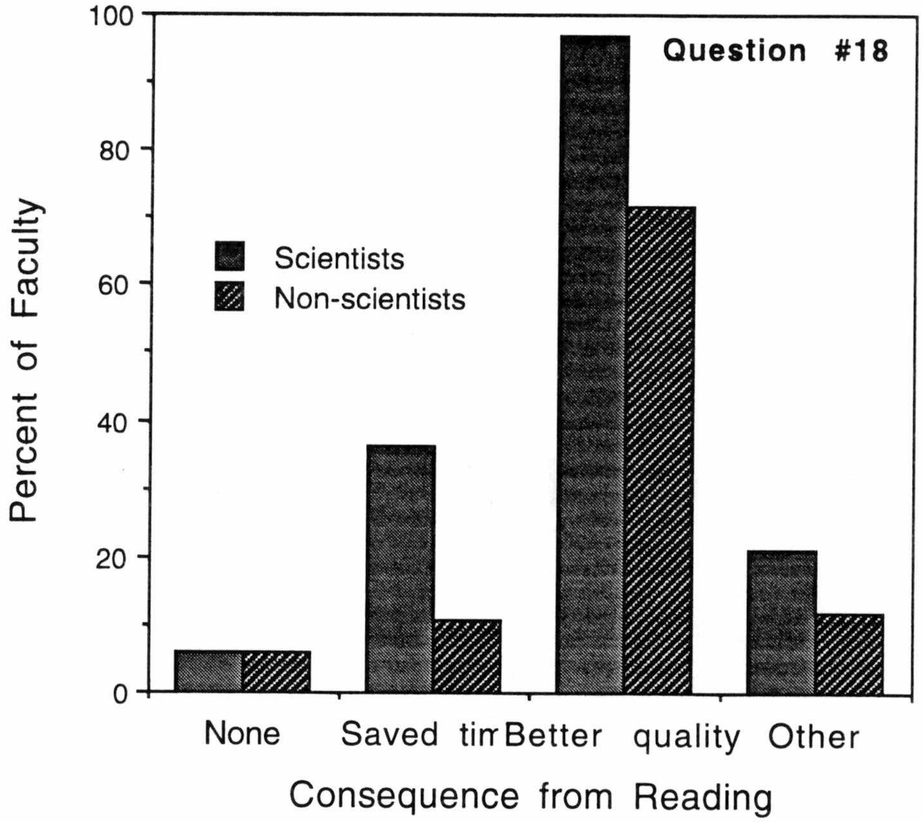

Figure 12. Outcomes of consequences of reading to the science and non-science faculty.

faculty reported an improvement in quality Thirty-six percent of science faculty also reported a savings in time

The role of the information in research was described by the faculty in terms that distilled to five categories (Fig 13) Background information was the use most often named by both science and non-science faculty Science faculty were more likely to have used the document for planning future experiments or studies and for specific information while non-science faculty were more likely to have used the document for background and for affirmation (support) of information they already had

Electronic

Scientists were more likely to have access to a computer (Table 3, Question #29) Scientists were also more likely to use e-mail (Table 3, Question #31) and non-e-mail (Table 3, Question #32) network services than the non-scientists, though the large majority of each faculty did use the electronic services Consistently, science faculty spent more time (2 4 hr/wk) than the non-science faculty (2 0 hr/wk) on e-mail (Table 3, Question #31b)

SUCCESSFUL SCIENTISTS AND NOT AS SUCCESSFUL SCIENTISTS

Science faculty were further divided into SS (successful scientists) and NASS (not as successful scientists) based on different types of "success" award winning (SS-aw), journal article authoring (SS-j), and overall authoring (SS-auth) Of interest was finding differences between SS and NASS in their reading behaviors with the aim

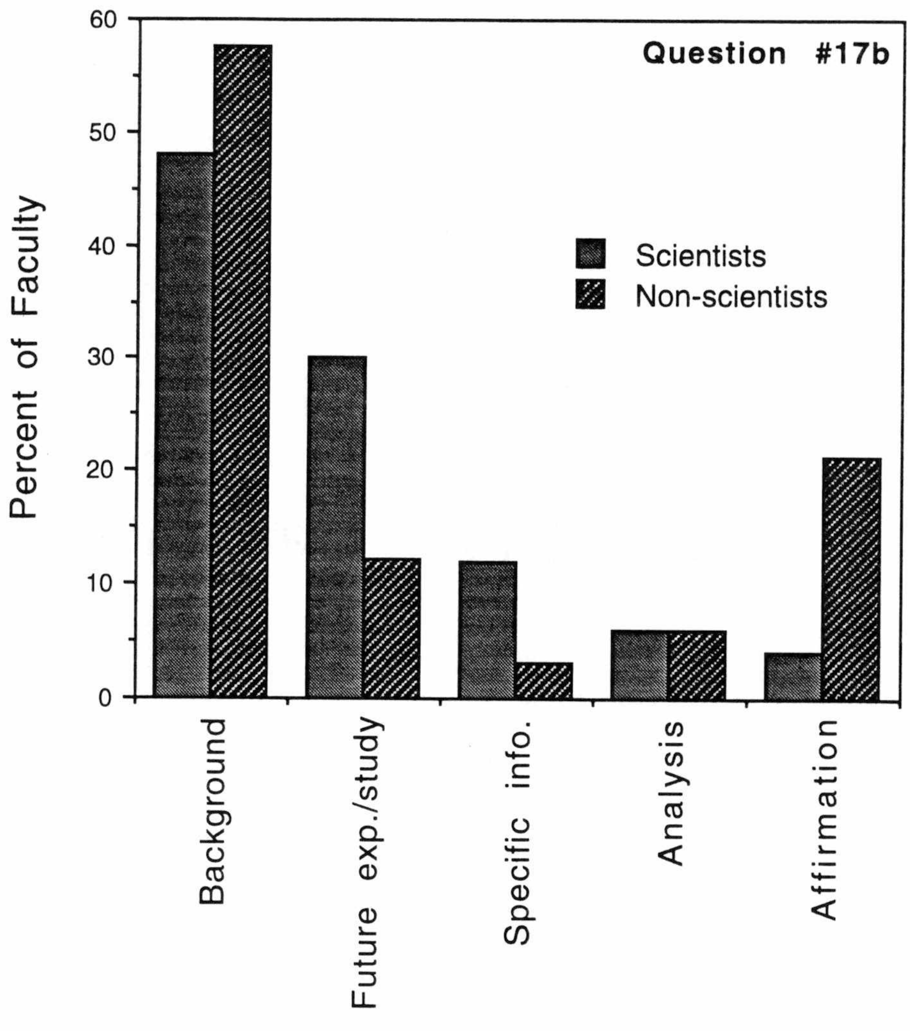

Figure 13. Role of the document in research of science and non-science faculty.

of gaining some understanding of what makes a successful scientist For each survey question tested, the pattern of responses by each type of SS (SS-j, aw, auth) were generally similar to each other, as were the responses among the NASS

Reading

The data on readings over a month (Question #2) can be expressed in many ways Selected here were *percent faculty* (Fig 14), the proportion of SS or NASS reading at least one of that document type, *average* (Fig 15), the average number of each document type read by each of set of SS or NASS, and *total* (Table 4, Question #2), the total number of documents read by each set of SS or NASS

The responses for last read document (Fig 16) were consistent with the responses for all documents read (Fig 14) as to the top document types read Little difference could be discerned between the type of documents read by SS and NASS, when considering the data on a percent faculty basis (Fig 14) When the data were calculated according to the numbers of each document type that was read, the SS-j and SS-auth read several times more journal articles than their NASS (Fig 15) Further, when all the documents read were totaled together (Table 4, Question #2), the SS of each SS/NASS set each read more than their NASS counterpart

Finding

Browsing was the most likely way that all scientists found the document that they last read (Fig 17) The least frequent method was finding the document from a

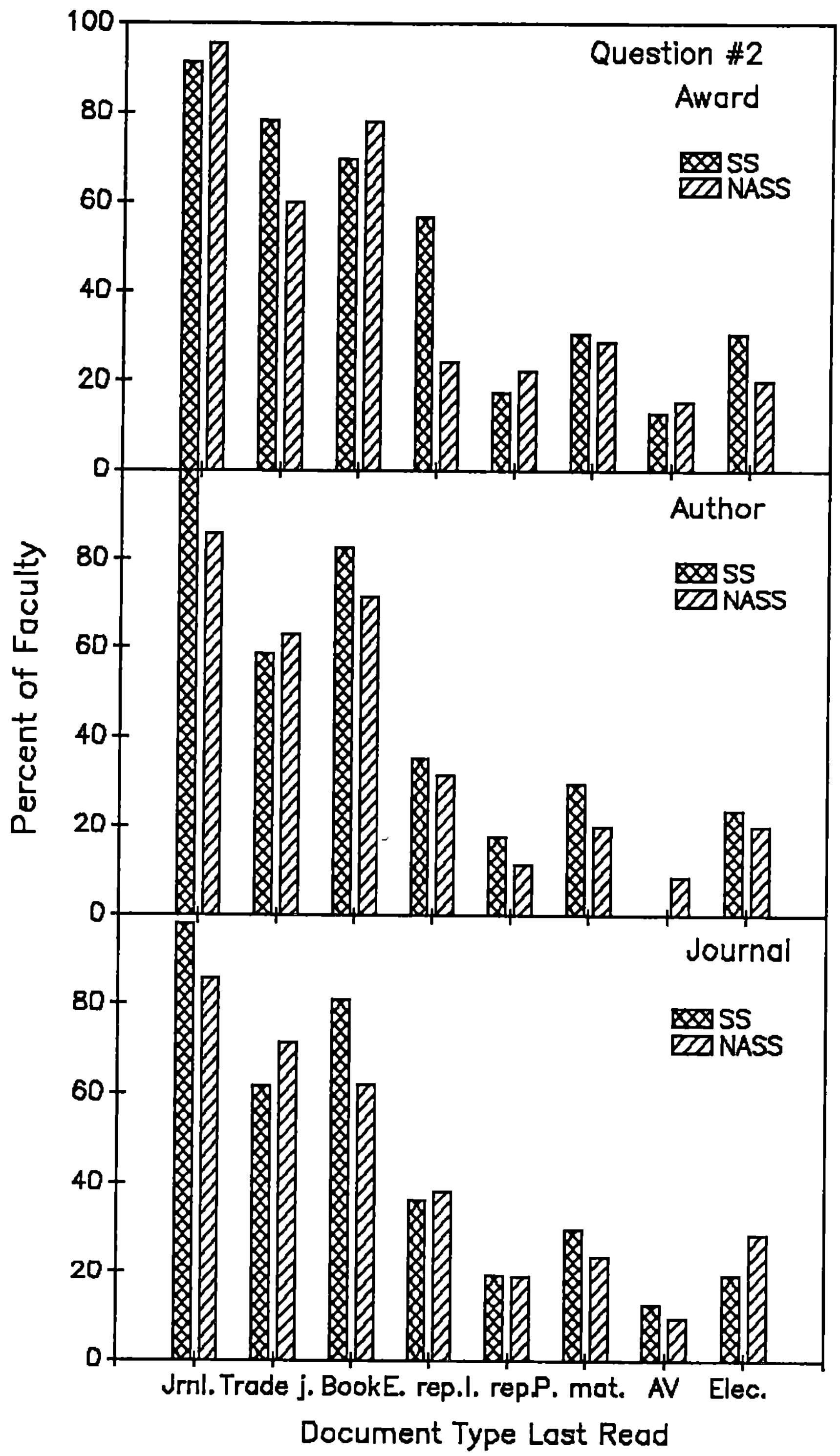

Figure 14 Document reading in the month previous by percent of faculty

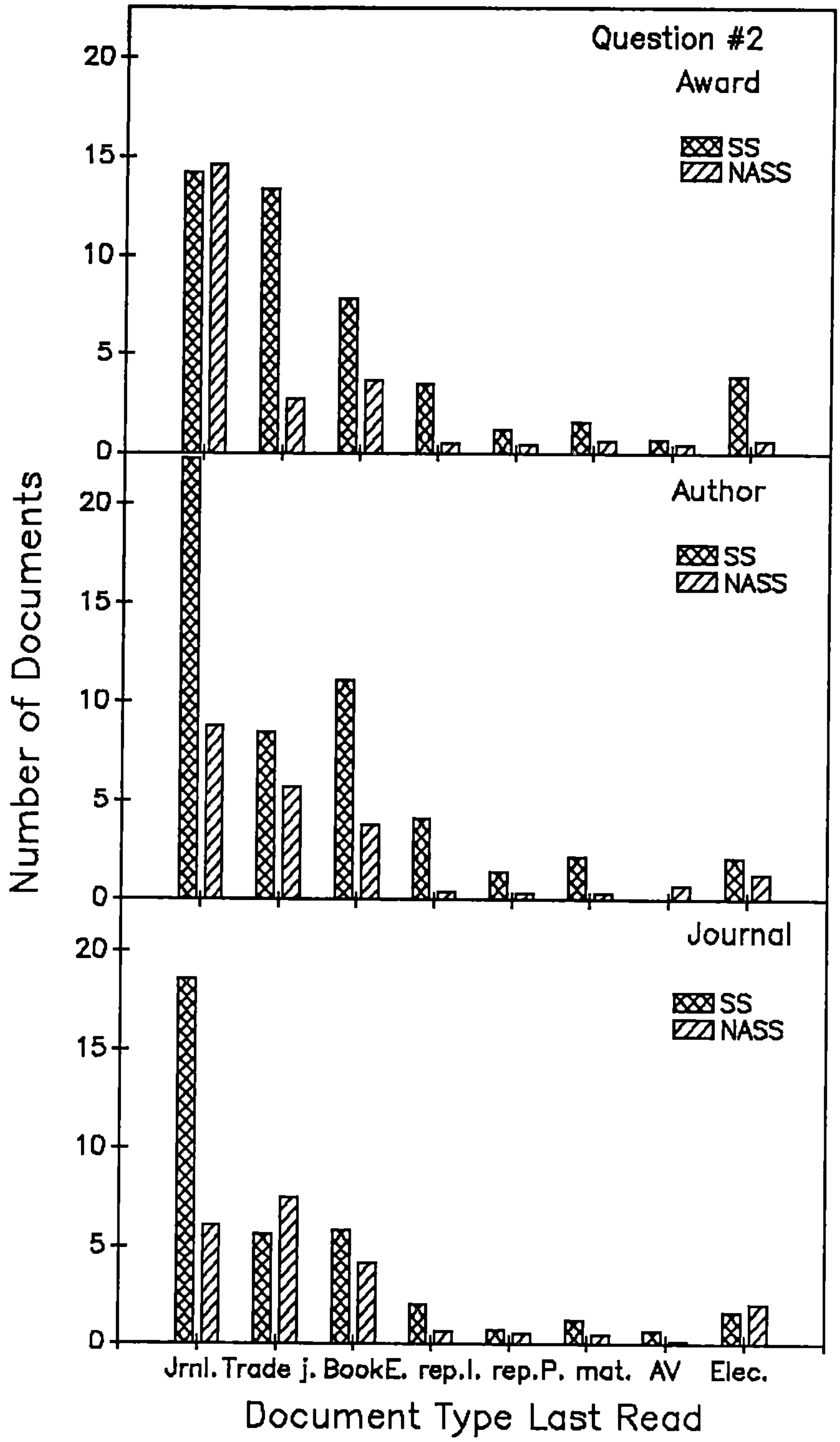

Figure 15 Document reading in the month previous by average number of documents

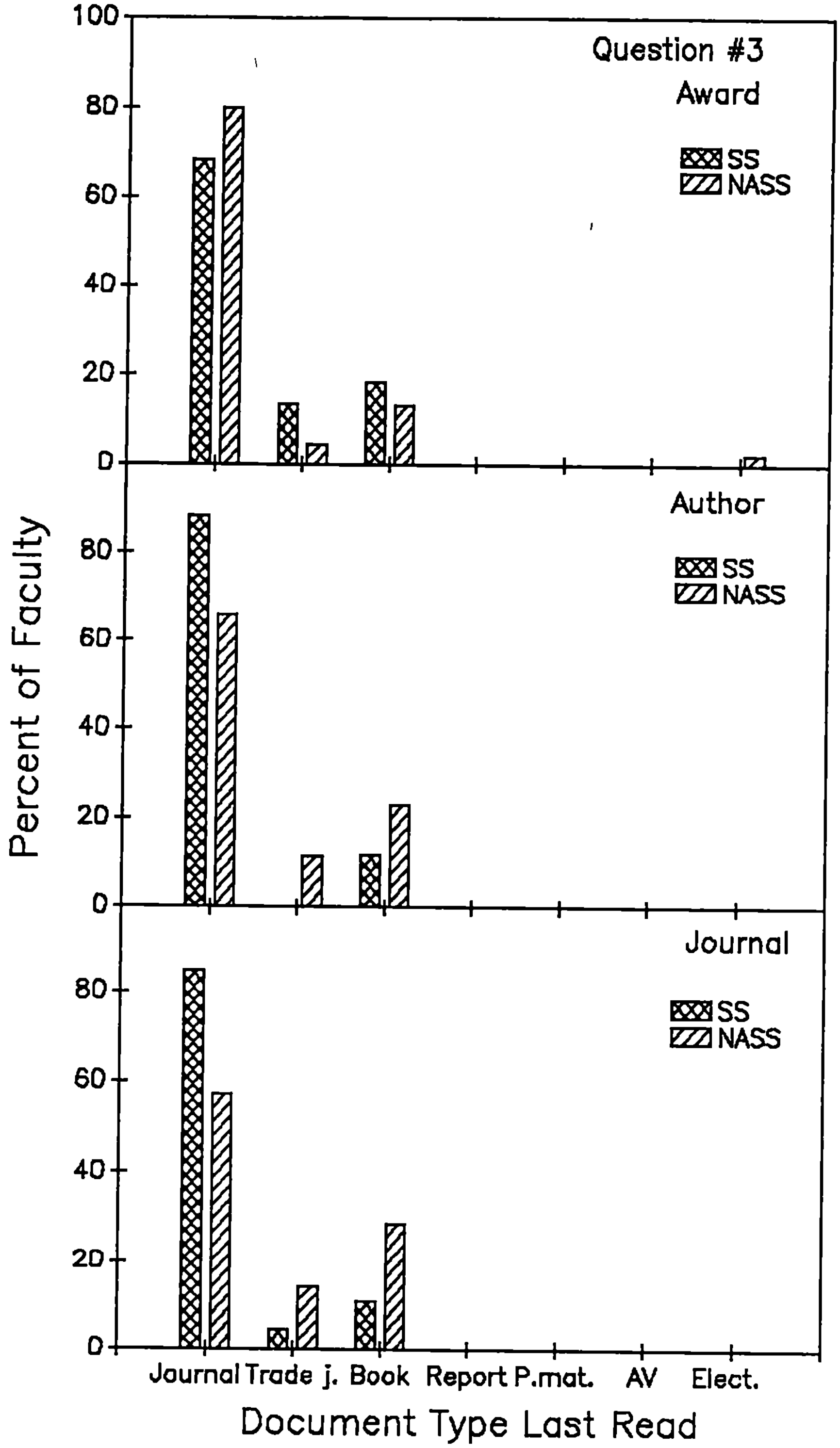

Figure 16 Type of documents last read for work-related purposes

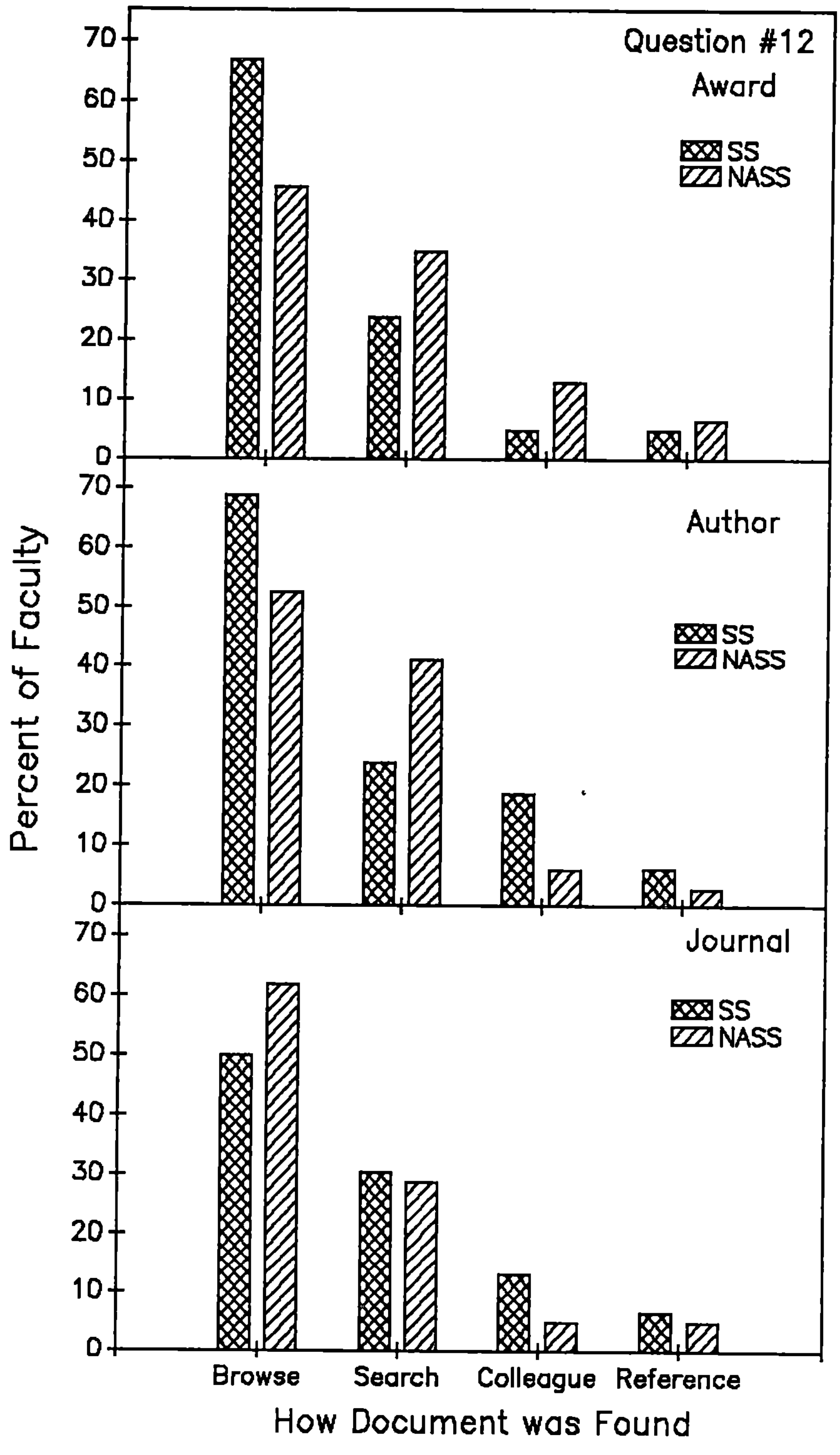

Figure 17 How this last document was found

Table 4 Results from specified questions SS vs NASS

		Basis of Success					
		Award		Author		Journal	
Question		SS	NASS	SS	NASS	SS	NASS
2	Total number of readings	46 3	23 5	51 6	21 0	36 0	21 3 doc/mon
31	Use e-mail	90 5	88 6	92 9	78 6	90 0	83 3 %
31b	Time spent on e-mail	35 1	24 5	28 3	23 7	26 2	35 1 min/day
32	Use non-email network	78 8	63 6	84 6	60 9	73 0	60 0 %
33a	Have funds for info	40 9	22 7	17 6	26 5	33 3	19 0 %
33b	Funds for info products	1008	381	1625	335	754	267 $

citation to it However, this method may have been more common but it was only given as a write-in under "other" techniques for finding documents and so was without the visual prompting of a preset category SS-aw and -auth were more likely than NASS to have found their document by browsing and less likely to have carried out a search

Getting

SS-aw and SS-auth appeared more likely to have obtained (Fig 18) their last read document from a collection "personally paid for" or purchased by others for their personal use and less likely than their NASS to have obtained the document from the library

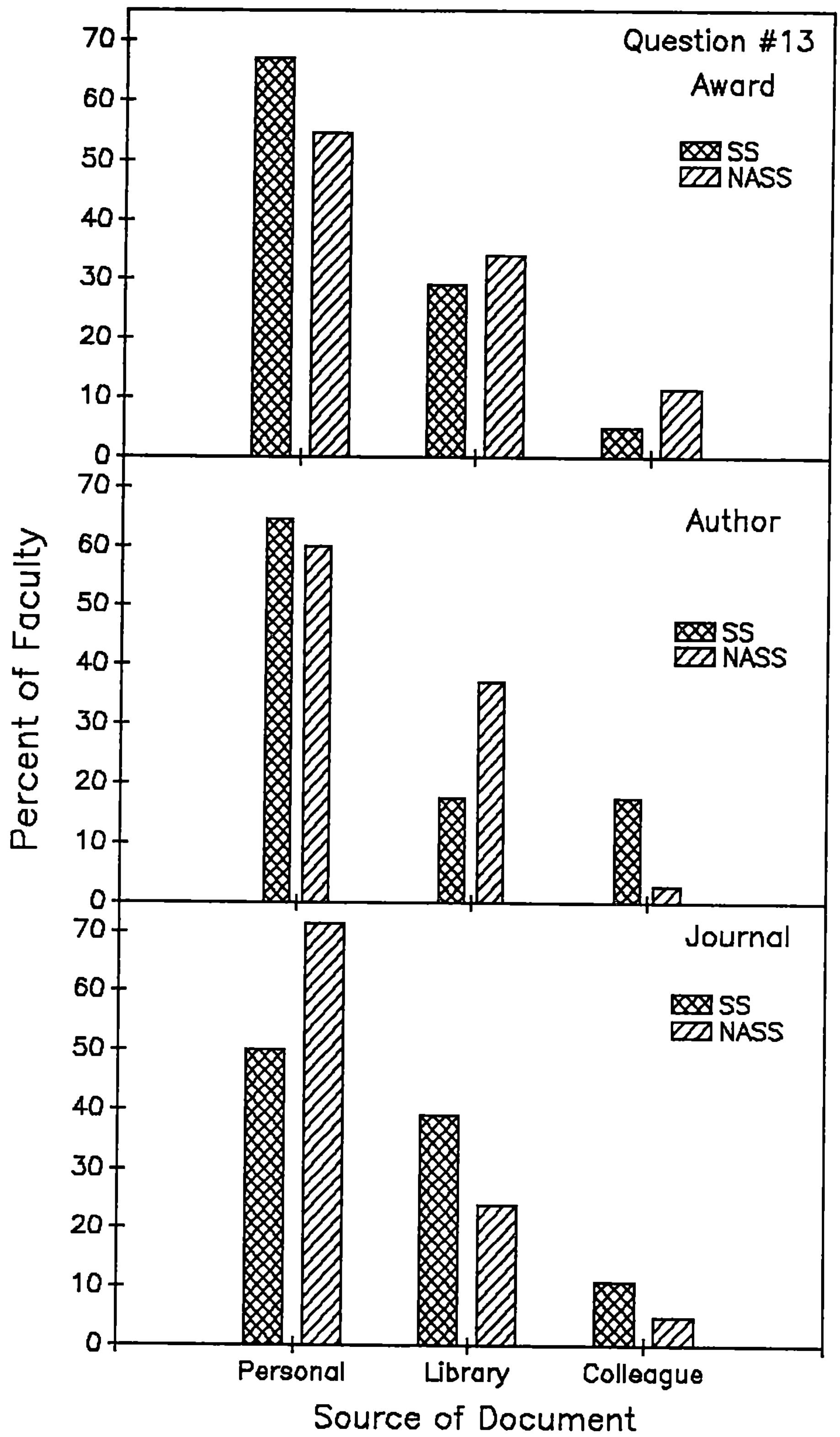

Figure 18 Source of this last document

When faced with choosing an alternate source to obtain their document (Fig 19), there was considerable disparity among the responses The differences varied, positive and negative, between the percentages of each SS and their NASS that would obtain the document from various alternate sources

Subscriptions

A higher percentage of SS than their NASS had at least one personal subscription (Fig 20) The difference in personal subscription levels varied less than 1 5 subscriptions between SS and NASS (Fig 21) There was, also, a greater tendency for SS (award and journal) to have money budgeted for information products (Table 4, Question #33a) This greater tendency was borne out by the amounts of money budgeted (Table 4, Question #33b) but few gave actual numbers and outliers scewed the averages

E-mail

SS-j seemed to spend less time on e-mail (Fig #31b) and use e-mail less frequently (Fig 22) than NASS-j Otherwise, there was some increased tendency for SS to use e-mail (Table 4, Question #31) but an even greater tendency was seen in the use of non-e-mail network services (e g , accessing databases) for all SS (Table 4, Question #32)

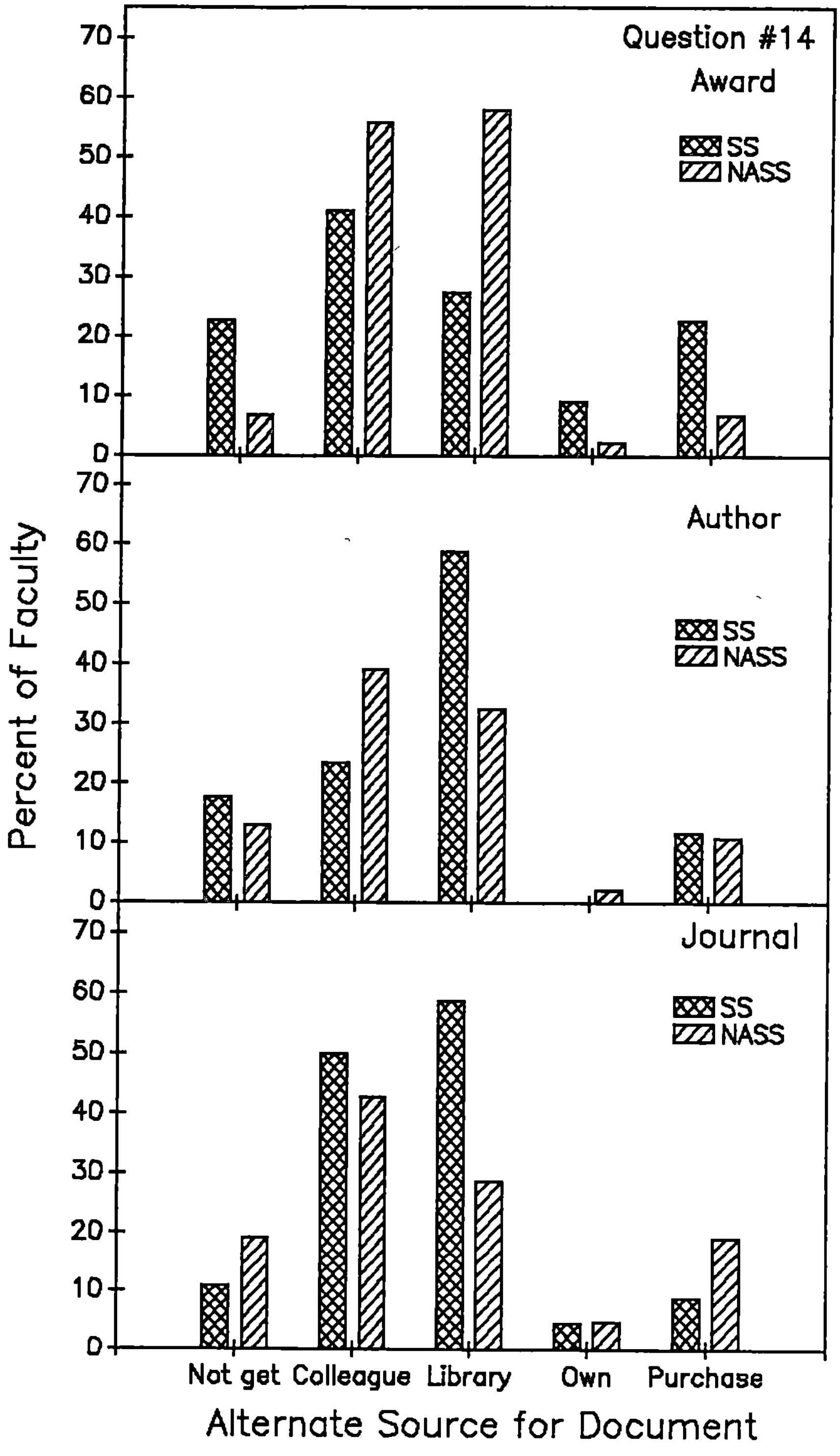

Figure 19 Alternate sources for this last document

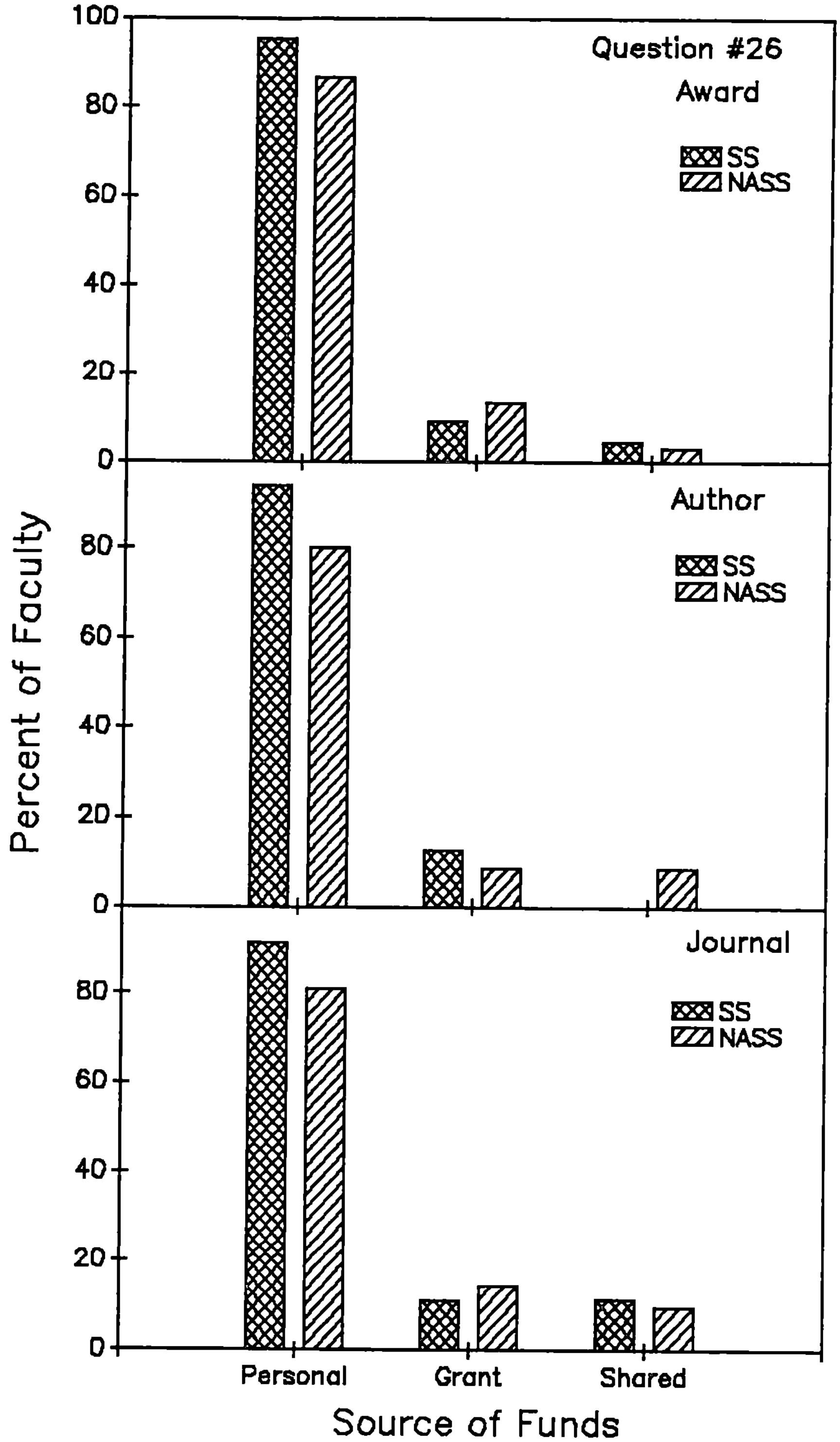

Figure 20 Personalized subscriptions to professional journals by percent of faculty

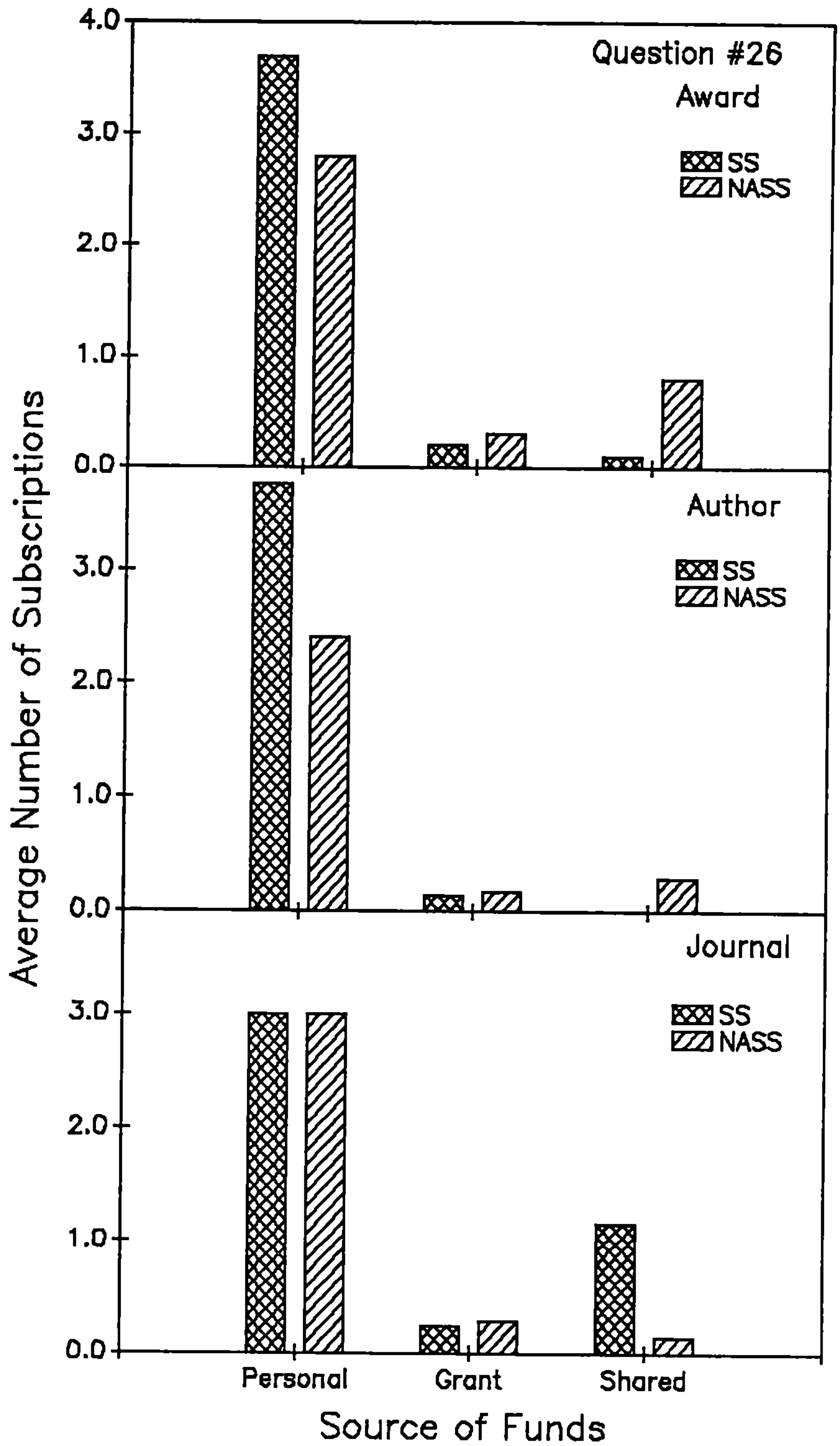

Figure 21 Personalized subscriptions to professional journals by average number of subscriptions

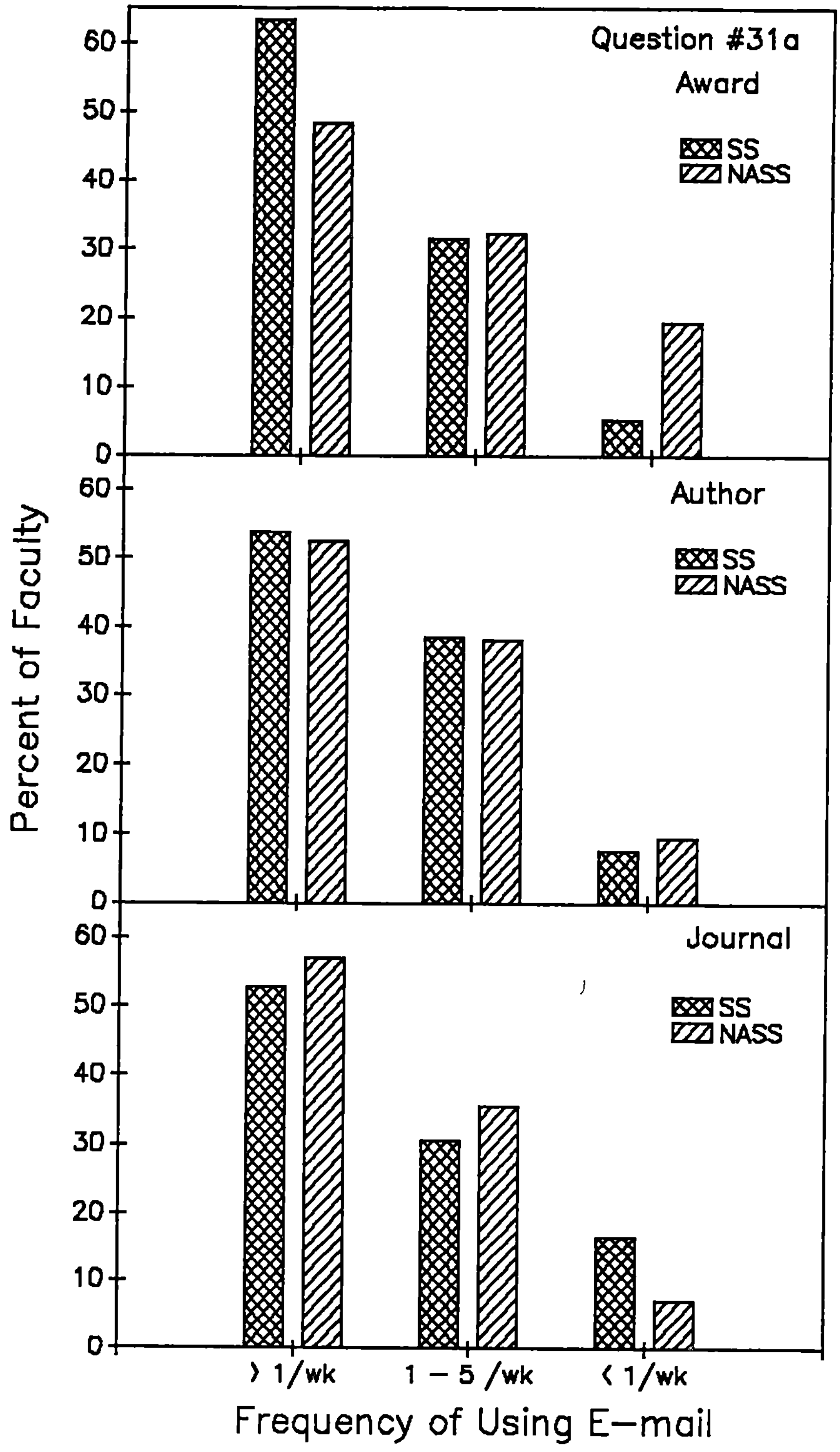

Figure 22 Frequency of e-mail use

CHAPTER 5

CONCLUSIONS

SCIENTISTS' READING BEHAVIORS

This study provides a baseline of information on reading behaviors of academicians at a major state-supported university These studies can provide useful information to assist scientists in doing their work and in promoting the success of scientists Measures were made of the reading behaviors of scientists and non-scientists in finding, getting, reading, and using documents with additional information on their use of and attitude to electronic resources The scientists were also separated into successful (SS) and not as successful (NASS) scientists, and the reading behaviors of these subgroups were also compared

Finding

The techniques used to find a document were similar between the science faculty at UTK in 1993 and scientists surveyed in 1977 (King et al 1981) with browsing being the most likely way a document was found Nearly 55% each of UTK scientists and non-scientists (Fig 1) used undirected browsing to find documents Broadbent (1986) speculated that the higher use by a humanities faculty of browsing, bibliographies, and card catalogs relative to computer searches was in part due to that faculty's unfamiliarity with the advantages of computer searches However, if such were the case, it seems likely, now that UTK has replaced their card catalog with computer terminals, that computer searching would be the predominant finding tool However, it appears that browsing holds that place.

Getting

UTK scientists (Fig 2) had a similar pattern of journal article acquisition as other scientists (Bayer and Jahoda 1979, Tenopir and King 1997b) with personal subscriptions predominating, followed by library sources Colleagues and "other" were much less likely sources In 1993, 56% and 44% of science and non-science faculty, respectively, obtained their last reading (Fig 2) from a personalized (for their use, either paid for by themselves, the department, or the library) subscription - of which 27% and 39%, respectively, were personally paid for (Fig 2)

Reading

Tenopir and King (1997b) found that university scientists averaged 190 journal article readings per year, while UTK scientists averaged 174 articles per year (Fig 6) The types of documents read by UTK scientists and non-scientists (Fig 6) were different than that of corporate professionals (Griffiths and King 1993) The pattern of document types last read by UTK scientists and non-scientists (Fig 7) closely matched the pattern of document types benefiting the work of Exxon scientists (Weil 1980) The reading styles of the UTK faculty (Fig 8) and of scientists from 1977 through the 1980's (Griffiths et al 1991) was most reading with great care and with attention to just the main points and few just to get the idea

Using

For corporate professionals, the primary consequence of reading a journal article was the reinforcement or affirmation of their hypotheses or results (Griffiths and King 1993), while it was the least commonly given consequence for UTK science faculty (Fig 13) Serving as background information was the most commonly cited consequence of reading by UTK faculty but was not even cited by the professionals in open-ended questions (Griffiths and King 1993)

UTK scientists published a higher number of documents than non-scientists (Table 2, Question #27) The high publication rate of UTK scientists may partly be an extension of the trend noted by Tenopir and King (1997b) of an increase in the number of publications by university scientists They found publication rates increasing from 1 0 to 2 1 articles per university scientist per year from 1977 to the 1990's Non-university scientists published at a lower rate (less than one per three years) which does not show signs of increasing

Electronic

Science faculty are more likely to be computer users than non-science faculty Sixty-one percent of scientists and 49% of non-scientists were computer users among the faculty of the Hebrew University of Jerusalem in 1995 (Lazinger et al 1997), while 96% of science and 86% of non-science faculty had access at UTK in 1993 (Table 2, Question #29) This trend between science and non-science faculty was seen at several other institutions which may be indicative of the perception or reality of accessability to computers between the different sets of faculty (Lazinger et al 1997)

The Jerusalem study (Lazinger et al 1997) also surveyed the time (in specified intervals) faculty spent on e-mail. There appears to be little difference between the science/agriculture and the humanities/social science faculty of Hebrew University in the time spent on e-mail with most respondents being in the 0 – 1 hour or the 2 – 5 hours per week groups UTK faculty reported similar e-mail use, about 2 hours per week (Table 2, Question #31b)

Overall, electronic communication, either as a complement to or in substitution of traditional forms (Ellis et al 1993), has had only a minor impact on information seeking activities by scientists Given a choice, the UTK faculty in 1993 seemed to have a marked preference (which may have lessened as the technology has changed) for direct paper transmission of information (Table 2, Question #19 and Fig 4) as well as for reading from paper (Table 2, Question #20 and Figs 9 & 10) with more faculty having positive comments for paper and more responses being in favor of paper in Questions #19 and #20 The general trend appears to be an appreciation of electronic format for specific tasks (e g , bibliographic check of a reference) while paper is preferred for general reading Since the latter is the primary use of a reading (Figs 11 & 13), it appears that paper will remain the predominant form for obtaining information

SUCCESSFUL SCIENTISTS

Among the UTK scientists, the SS of each group had four or more total personalized subscriptions while their NASS had fewer personalized subscriptions (Fig 21) The pattern was the same when looking at the percentage of faculty with personalized subscription (Fig 20)

The overall pattern of document types for readings for fast-trackers (Griffiths and King 1993), with their high numbers of trade journals and reports, doesn't match any of the patterns of UTK faculty (Figs 5 & 7), possibly expressing a difference in types of organizations since Griffiths and King primarily surveyed governmental and corporate workers Another difference, the professionals they surveyed read about three to five documents per month of each type while UTK science faculty read more in the 10 - 12 per month range (Fig 6)

The SS generally read a greater number of each document type (Fig 15) than their NASS When the total number of all documents read is counted (Table 3, Question #2), then each SS read more documents than their NASS, similar to the results of Griffiths and King (1993)

The most comparable group to Allen and Cohen's (1969) stars may be SS-aw since star status and awards are both conferred by one's peers For UTK (Figs 17-19), SS-aw were more likely than NASS-aw to use a social contact to get the document (Fig 18) but SS-aw were less likely to have used colleagues as a source in finding out about the document (Fig 17) or as an alternate source (Fig 19) The SS-j were the only group more likely than their NASS to use their social contacts for both finding and getting the document (Figs 17-19)

GENERAL CONCLUSIONS

The patterns and tendencies observed, while perhaps not statistically significant, may yet indicate real trends These trends may become more apparent if they are specifically tested A limitation of using secondary data, data gathered for a different purpose, is that the parameters measured have already been determined

The relative lack of differences observed between the reading behaviors of science and non-science faculty may be due more to the type of institution than to any difference between the disciplines and may or may not be generalizable to the entire population of scientists Greater differences may be able to be observed among scientists in government, industrial, and academic institutions, as well as between non-scientists in academic institutions and "think-tanks "

While some behaviors are indicated as being correlated with success for scientists, more conclusive data is needed To achieve this, a larger sample size, as well as a higher return rate, would be needed A study specifically designed to understand the differences in behaviors between SS and NASS would also provide more conclusive results

The small differences observed between the SS and NASS at UTK may be a result of trying to make differentiations among a group of generally successful scientists, at least by the parameters of this survey Different factors are considered "success" by different institutions Different behaviors, even among scientists, may contribute to the different successes It would be of value to gather data on other success measures in order find relationships between them and reading behaviors

One current important success measure is fund-raising, which can be expressed in terms of number of grants, funding sources, and total value of grants Other possible success measures are publicity in the general press of research, number of invited speaking engagements, number of successful (i e , published and/or grant-obtaining) collaborations within and without the institution, number of graduate students, and number of invited book chapters

This thesis has several potential uses to various groups Administrators will be able to provide support to their faculty for reading behaviors that promote their measures of success Science faculty will be able to see what reading behaviors have correlated with success in their peers Sociologists will have more data on university faculty behavior University librarians will be able to understand some of the concerns and motivations of their clients Publishers (electronic and print) can get an understanding of attributes to emphasize and problems to correct in their products

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APPENDIX

F5 ___ ___

UNIVERSITY OF TENNESSEE, KNOXVILLE, LIBRARIES SURVEY OF LIBRARY USE AND NEEDS

FACULTY, RESEARCHERS, ADMINISTRATORS, and OTHER PROFESSIONAL STAFF

SECTION 1 — INFORMATION INPUT

1. For each library below that you have used in the LAST MONTH, please indicate (A) the number of visits, including visits made by others for you; (B) number of additional uses (by calling, OLIS, etc.), including uses made by others for you; and (C) distance you are (in minutes) from the library.

Type of Library	(A) Visits in Last Month	(B) Additional Uses in Last Month	(C) Distance to Library You Use (Minutes)
Hodges (Main) Library			
UTK Libraries branch library:			
Map (CIC in Hoskins Building)			
Music (Music Department)			
Agriculture/Veterinary Medicine			
Special Collections (*e.g.*, rare books, manuscripts, etc.)			
University Archives			
Other libraries at UTK (*e.g.*, College of Law, UT Hospital, etc.) (specify) ________			
Collections in a UT academic department (specify) ________			

2. In the past month, approximately how many of each of the following types of documents have you read in connection with your teaching, research, or other work? (Reading is defined as going beyond the title, contents page, and abstract of the document.)

	No. of Readings/Uses in Past Month
Scholarly or professional journal articles	________
Trade journals, bulletins, non-technical magazines, newsletters, etc.	________
Scholarly, text, or professional books	________
External reports (*e.g.*, government documents, etc.)	________
Reports and other formal documents prepared at UTK	________
Other professional materials (*e.g.*, patents, standards, regulations, conference proceedings, etc.)	________
Television or multi-media programs or films	________
Substantive electronic documents not included above (*e.g.*, listserv, bulletin board, etc.)	________

SECTION 2
DOCUMENT READING

All questions in this section refer to the document that you read most recently (related to your worl professional development). Please note that it does not matter how long ago this last document was read.

3. What type of document did you most recently read for work-related purposes? (Circle THE ONI appropriate code.)
   - Scholarly or professional journal articles . . . . . .
   - Trade journals, bulletins, non-technical magazines, newsletters, etc. . . . . . .
   - Scholarly, text, or professional books . . . . . .
   - External reports (*e.g.*, government documents, etc.) . . . . . .
   - Reports and other formal documents prepared at UTK . . . . . .
   - Other professional materials (*e.g.*, patents, standards, regulations, conference proceedings, etc.) . . . . . .
   - Television or multi-media programs or films . . . . . .
   - Substantive electronic documents not included above (*e.g.*, listserv, bulletin board, etc.) . . . . .

4. What was the approximate title or topic of this last-read document? If the document was a journal please give the article title or topic, not the journal name.

   ____

5. Was this document provided to you in electronic format (medium)?

   No [circle 1 and skip to Question 6] . . . . . 1 Yes 2

   a. What was the source? (Circle ONE.)
      - Listserv . . . . . .
      - Bulletin Board . . . . . .
      - Online Database . . . . . .
      - CD-ROM Database . . . . . .
      - Other (specify) ________

   b. In what format(s) did you read the document?
      - Computer screen . . . . . .
      - Print-out . . . . . .

6. ANSWER ONLY IF THE LAST-READ DOCUMENT WAS A JOURNAL ARTICLE; otherwise, Question 7. Approximately how many articles have you read from the journal containing this article in year (12 months)? ________

7. Is this the first time you have read this particular document?

   No . . . . . 1 Yes 2

8. Did you know about the information reported or discussed in this document prior to reading about it?

   No . . . . . 1 Yes 2

9. In about what year was this particular document published or written? 1

10 How thoroughly did you read this document?

With great care	1
With attention to the main points	2
Just to get the idea	3

11 What is the approximate time in hours or minutes that you most recently spent reading this document?
__________ Hours or __________ Minutes

12. How did you initially find out about this last document? (Circle THE ONE most appropriate code)

Found while browsing	
• A personal copy or subscription	1
• UTK Libraries copy	2
• Shared collection in my department, unit, etc	3
Searched UTK catalog in library	4
Searched CD-ROM database in library	5
Searched external databases or catalogs via OLIS (Internet/Gopher) in library	6
Searched UTK catalog from office or home	7
Searched CD-ROM database in OLIS from office	8
Searched external databases or catalogs via OLIS (Internet/Gopher) from office or home	9
Suggested by UTK Libraries staff	10
From another person, the author, etc	11
Online bibliographic database search (*e g* , Dialog)	12
Printed index or abstract publication	13
Other (specify) __________	14

13 From what source did you obtain this last read document? (Circle THE ONE most appropriate code)

A journal subscription or document that I personally paid for	1
A journal subscription or document that UTK purchased or obtained for my personal use	
• Purchased by the UTK Libraries	2
• Purchased by my department or unit under grant, etc	3
A document located at the UTK Libraries (*i e* , Hodges and branches)	4
A document located at another UTK library (*e g* , College of Law, UT Hospital etc)	5
A document located in a shared department or unit collection	6
A document located at an external library (*e g* , public, academic, etc)	7
A colleague, co-worker, or author	8
Other (specify) __________	9

14 If you could not have used the source specified above, where would you have obtained the document or equally useful information? (Circle ALL that apply)

I would not have obtained the document or information	1
From a colleague or author	2
From a consultant	3
From another library (specify) __________	4
From my own collection	5
I would have bought it	6
Other (specify) __________	7

SECTION 3
PURPOSES AND CONSEQUENCES
OF THIS LAST READING OF A DOCUMENT

The library staff are interested in knowing how faculty and researchers communicate and how the Libraries ca facilitate communication in the future, particularly as new technology begins to affect information-seeking behavio and use This section deals with the variety of ways in which you identify, gain access to, and use informatio found in books, journals, etc We also address the usefulness and outcomes of using this information

The questions below continue to deal with the most recently read document reported in Section 2 Question 3

15 For which purposes have you used, or do you plan to use, the last document you read? (Circle ALL th apply)

- Teaching and related activities (*e g* , advising)
- Research
- Administration
- Other work-related purpose
- Current awareness/keep up
- Continuing education for self
- Prepare a formal publication (article, book, etc)
- Prepare a formal talk or presentation
- Other (specify) __________

16 If you answered "Teaching" in Question 15 above, please answer this question, otherwise, skip to Question 1

a. For which aspects of teaching did you read this document? (Circle All that apply)

- Class preparation
- Review for reading assignment
- Advising students
- Curriculum or syllabus development
- Practicum development
- Other (specify) __________

b How important is the information contained in this document to achieving your teaching objectives?

Not at All Important			Somewhat Important			Absolutely Essential
1	2	3	4	5	6	7

17 If you answered "Research" in Question 15 above please answer this question, otherwise, skip to Question 18

a. Please describe, in a few sentences, the nature of research being performed for which you sought the information in the document

____

____

____

____

____

____

____

b What role did the information in this (and other) document(s) play in this research?

____

____

____

____

____

____

____

c How important is the information contained in this document to achieving your research objectives?

Not at All Important			Somewhat Important			Absolutely Essential
1	2	3	4	5	6	7

18 What outcomes or consequences resulted from reading the document?

None other that I can think of	1
Saved time or money in work activity	2
Resulted in improved quality of the activity or purpose for which the document was read	3
Helped perform work better	4
Helped complete work faster	5
Other (specify) ______________________	6

A great deal is being said about electronic publishing and the UTK Libraries staff are concerned about how the can best facilitate your use of such new technologies The questions below relate to your potential use of thes technologies for the document you last read

19 Would it affect the information s usefulness to you if the document had been transmitted to you electronicall to be read on a screen or printed out?

No 1 Yes . 2

If "yes," please specify the ways you believe usefulness might be affected

____

____

20 Please indicate your preference for reading this document in electronic format (including print-out a workstation) or traditional paper format by rating from 1 to 7

Much Prefer Electronic Format			Neutral			Much Prefer Traditional Paper Format
1	2	3	4	5	6	7

a. If you prefer to receive the electronic file format, please indicate reasons why (*e g* , convenient get i quickly when needed, etc)

____

____

____

____

____

b If you prefer the traditional paper format please indicate reasons why (*e g* , graphics or pictures are likel to be better, concerned about loss of refereed/peer review of article, etc)

____

____

____

____

____

SECTION 4
DEMOGRAPHICS

In this section we ask you to provide personal information and automation capabilities that may affect current and future library use. Again, these data are all confidential and will be presented only in an aggregated form.

21. Please indicate your highest earned degree (circle appropriate code).
    - Bachelor's (B.A., B.S., or equivalent) 1
    - Master's (M.A., M.S., M.B.A. or equivalent) 2
    - Doctorate (Ph.D., M.D., or equivalent) 3
    - Other (specify)________ . . . 4

22. In what year did you receive your last/highest degree? . . . . . 19____

23. With which UTK academic department or program are you associated? ________

24. Which best describes your current principal area of work (*i.e.*, the area in which you spend the most time)? (Circle ONE.)
    - Teaching and related activities (*e.g.*, advising) 1
    - Research 2
    - Administration 3
    - Other (specify)________ . . . 4

25. In the past two years, have you received any awards or special recognition for your teaching, research, or other professional-related contributions?

    No . . . . . 1 Yes 2

    If yes, please specify the type or name of award (if more than one, give the one you consider most important).

    ____

26. How many personal subscriptions to professional journals do you receive, including those obtained as a member of a professional society? (Personal subscriptions are those which are personally addressed to you at your home, office, or lab.)
    - Subscriptions paid by myself . . . . . ______
    - Subscriptions purchased by grant or other source for my personal use . . . . . ______
    - Subscriptions purchased by grant or other source for shared use . . . . . ______

27. How many formal publications have you authored or co-authored in the past 12 months?

	No. of Publications	No. of Co-Authors
Scholarly or professional journal articles	______	______
Trade journals, bulletins, non-technical magazines, newsletters, etc.	______	______
Scholarly, text, or professional books	______	______
External reports (*e.g.*, government documents, etc.)	______	______
Reports and other formal documents prepared at UTK	______	______
Other professional materials (*e.g.*, patents, standards, regulations, conference proceedings, etc.)	______	______
Television or multi-media programs or films	______	______
Substantive electronic documents not included above (*e.g.*, listserv, bulletin board, etc.)	______	______

28. Approximately how many times in the past year have you or someone on your behalf searched the following databases: Bibliographic (*e.g.*, Chemical Abstracts, Biosis, COMPENDEX, Psych Abstracts; databases provided by Dialog, STN, BRS, Lexis, etc.); Numeric (*e.g.*, census, Predicast, standard data, D&B, etc.); or Other (*e.g.*, cartographic images with attributes, chemical structure, musical scores and sound, etc.). Do NOT include library catalogs.

Type of Database	Total Searches	SEARCHES DONE BY: Self	Colleague, Graduate Assistant, etc.	Librarian
Bibliographic				
Numeric				
Other				

29. Do you use or have personal access to a terminal or microcomputer?

    No [circle 1 and skip to Question 33] . . . . . 1 Yes 2

30. Is this terminal or microcomputer capable of communicating with remote computers?

    No [circle 1 and skip to Question 33] . . . . . 1 Yes 2

    a. Please indicate ALL relevant locations:
       - In your office 1
       - In your home 2
       - Elsewhere (specify)________ . . . 3

    b. On which computer(s) do you have an account? (Circle ALL that apply.)
       - UTKVX 1
       - UTKUX 2
       - UTKVM1 3
       - Other (specify)________ . . . 4
       - Don't know 5

    c. How often do you (or someone on your behalf) use it?
       - More than once a day 1
       - 1 to 5 times per week 2
       - Less than once a week 3
       - Never 4

31. Do you ever use electronic mail (e-mail)?

    No [circle 1 and skip to Question 33] . . . . . 1 Yes 2

    a. How many times do you (or does someone on your behalf) use electronic mail?
       - More than once a day 1
       - 1 to 5 times per week 2
       - Less than once a week 3

    b. Approximately how much time do you spend in a typical day preparing, sending, receiving, and reading electronic mail messages? . . . . . ______ minutes or ______ hours

    c. Approximately how much time does someone on your behalf spend in a typical day preparing, sending, receiving, and reading electronic mail messages? . . . . ______ minutes or ______ ho[illegible]

32. Do you use the network for accessing databases and purposes other than electronic mail?

No [circle 1 and skip to Question 33] 1 Yes 2

a. How many times do you (or someone on your behalf) use the network for purposes other than electronic mail?

More than once a day	1
1 to 5 times per week	2
Less than once a week	3

b Approximately how much time do you spend in a typical week using the network for purposes other than electronic mail? _________ minutes or _________ hours

c Approximately how much time does someone on your behalf spend in a typical day preparing, sending, receiving, and reading electronic mail messages? _________ minutes or _________ hours

33 Do you have a budget, discretionary funds or grant budget for purchasing information products (*e.g* , journals, books, etc) or services (*e.g* , online bibliographic searches, E-mail, etc)

No 1 Yes 2

If yes, approximately what is the annual amount? $ ____________

THANK YOU VERY MUCH!!!

VITA

Helen (nee Belefant) Miller graduated from Texas A&M University with a Ph D in Plant Physiology After working for several years she moved to Knoxville and began a second master's, in Information Sciences She graduated in May of 2000