IMPACT OF NEW INFORMATION HANDLING TECHNIQUES ON THE CREATIVE WRITING PROCESS OF SCIENTISTS

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ABSTRACT: New information acquisition and handling technologies have a significant impact on the manuscript and grant-proposal writing processes traditionally used by researchers. By combining word processing software and end-user electronic access to information networks, data files, and electronic journals the process of manuscript and grant-proposal preparation has been made more efficient. Active and passive electronic methods for the acquisition of information are considered. New areas of exploration for information access combining Internet and satellite transmission for researchers in the field are noted.

It is evident that patterns of microcomputer use by scientists vary widely. There are differences in use between and within scientific disciplines. These inter-disciplinary differences are affected by the nature of and frequency with which new information is generated (Palmer 1991a). Intra-disciplinary differences between individuals are primarily determined by their specific information seeking behaviors (Palmer 1991b). These differences notwithstanding, it is clear that, overall, the advent of the microcomputer as a tool for the acquisition and dissemination of scientific information is significant and increasing.

The advantages of microcomputer use for the management of information by scientists include: savings in time and expense by reducing the need to travel to several places to acquire information, increasing access to information databases, files and networks, and increased

control over the process of manuscript preparation (Snizek 1987). For these reasons, ownership and regular use of a computer has become almost a given for scientists.

The professional careers of scientists are determined to a large extent by their ability to produce significant results and disseminate those results via scientific journals for access and review by their colleagues. Although there are exceptions, it is generally true that published results are essential to grant acquisition, just as much as grant support is needed for the production of publishable results. Tenure, promotion, and the continuity of the funding and research productivity cycle depend largely on the efficiency of scientific communication in grant writing and reporting, and in the method of preparation of submission of manuscripts for publication. Consequently, any methodology or technology that affects these processes is of great and immediate importance to the scientific community.

New information acquiring and handling technologies have had a significant impact on the manuscript and grant-proposal writing processes, which are central to virtually all research activities. As recently as 10 years ago, the development of well-cited scientific arguments required an extensive investment of time and energy in the library, physically going through the stacks, retrieving volumes, and photocopying articles. For many university faculty members--especially those working in the field or away from a centralized campus--library access presented a serious problem (Brown and Coleman 1991). The physical information trail often led to materials which were not readily available or volumes were not in the collection, out on loan, in the process of being bound, or just missing. Some, but usually not all missing articles, could eventually be obtained by interlibrary loan or writing to the authors with reprint requests, although these methods of obtaining articles were somewhat unpredictable. Because the process of acquiring relevant citations by mail or interlibrary loan can take weeks or months, it has become a fairly typical practice of researchers to try to stay on top of reprint acquisition by requesting them more or less continuously.

Electronic acquisition has streamlined this process, eliminating or at least partially circumventing most of the major bottlenecks. Increasingly, on-site library research is being supplanted by desktop database searches via computers using modems or networks. The development of a manuscript or research proposal with a strong bibliography can be accomplished in less time than ever before by incorporating some or all of this emerging technology. For example, a well-networked scholar who wishes to document a scientific argument for publication might use some or all of the currently available technology:

- Develop a preliminary outline of points to be made in the preferred word-processing format.
- Log on to one or more databases to search for specific citations or related work of relevance to the themes in the outline.

- Evaluate abstracts for relevancy and perform follow-up searches for other relevant material mentioned in the recovered abstracts.
- Download a collection of abstracts or articles from the database to one's own computer.
- Import the downloaded material directly into the selected word-processing format, or into a personal reference-manger database such as ProCite (Personal Bibliographic Software, Ann Arbor, MI).
- Cut and paste citations from the selected articles into reprint requests when only abstracts have been available for downloading, then print and send reprint requests.
- Order document delivery of full articles if a document delivery service is available.
- Cut and past brief citations into appropriate place in manuscript, and full citations into Bibliography section.

A well referenced discussion can be generated without leaving one's desk, or for that matter, without exiting Windows software (Microsoft, Redmond, WA). By importing information from databases as outlined above, the researcher is able to develop segments of the manuscript or proposal simultaneously at the desktop and with a vastly reduced number of trips to the library and fewer interruptions to the creative writing process. More energy can be focused on critical review of the literature, as less is required for physical searches and acquisition of articles.

In addition to the interactive and fairly specific search mechanisms using keywords supplied by the investigator, other search tools have become available which facilitate passive searching. Citations can be received in a variety of formats from the Current Contents service including diskettes, CD-ROM and network versions. Various vendors offer SDI (Selective Dissemination of Information) services which will sort through the appropriate databases with user-defined keyword profiles and deliver new citations to the investigator by way of e-mail or fax on a regular basis. One example of this is a service commonly used at the University of Hawaii. By using the Colorado Association of Research Libraries (CARL) "Uncover" database the results of searches based on a pre-defined profile of interests are delivered via fax or e-mail on a regular basis directly to the researcher. Using this system the researcher sets up a search using the specific journals that he wants reviewed and the appropriate search terms to look for. Once the researcher is satisfied with the search statement it is sent to CARL electronically. Once per month the search is automatically run against the selected titles and search terms. All relevant articles are marked, gathered, and automatically forwarded to the researcher. The result is pre-selected information based on the specific interest of the investigator, resulting in a considerable amount of time saved in developing the final manuscript.

Researchers at the Hawaii Institute of Marine Biology, University of Hawaii have been taking advantage of this emerging technology for several years, by using a combination of Windows-based word processing, experimental remote access to CD-ROM databases, and document

delivery services. The remote CD-ROM access initially conducted on pilot scale (Brown and Coleman 1991) has grown in popularity and now experiences over 10,000 log-ons per year.

Remote access to Hamilton Library (Honolulu, Hawaii) databases has extended to Guam, although the operating cost of the experimental system in its present form is high because of the use of commercial telephone service between the host and remote sites. Some alternatives to the use of commercial phone lines are being explored.

We are attempting to combine the power of the Internet and satellite telecommunications in order to extend this search system to scientists at remote research facilities in the Pacific Islands. A cooperative effort between the nonprofit PEACESAT communications facility located at the University of Hawaii at Manoa campus, and the commercial vendor Cambridge Scientific Abstracts (Bethesda, MD) is being tested to extend the reach of the program to scientists at other remote research facilities in the Pacific region.

Using this system, researchers in the Pacific Islands can schedule "air time" on the satellite. Since the PEACESAT satellite is an Internet node, researchers are able to access the Aquatic Sciences and Fisheries Abstracts database which has been mounted on a file server by the vendor. Using WAIS (Wide Area Information Server) software, simple Boolean searches of the database are possible. WAIS provides search results ordered by degree of relevancy, which enables further refinement of the search strategy. Although WAIS software does not have the "mark and download" capability of CD-ROM, researchers are still able to access data that would be unavailable to them through any other timely means. As software capability evolves it is hoped that the features available to the CD-ROM user will be accessible via the satellite system.

Although there are problems typical to the region, such as lack of trained staff, perhaps not surprisingly many of the major limitations of the satellite telecommunication system so far have been administrative rather than technological. Because there are so many satellite ground stations competing for air time the amount of time that each site is allotted is not sufficient to allow thorough searching of the databases by all of the potential end-users. On-line time has typically been limited to less than 20 minutes, which does not allow time for thorough searching or follow-up of interesting and potentially useful leads. This sort of problem may be resolved as satellite capacity and data handling speeds increase.

If successful, this system could facilitate satellite-transmitted database access to Internet users, raising the possibility of broader worldwide access to scientific abstracts. While site licensing, data traffic load, and satellite access scheduling concerns remain to be resolved, this form of access for remote users could certainly reduce the scientific isolation of the Pacific Island scientists and others in distant locations.

The electronic innovation that will probably have the greatest impact on research for this century is the Internet. As this system evolves, new uses, and with them new products as well as implications, are being realized.

One such product is Cambridge's Internet Database Service, accessible via the World Wide Web and WAIS. It provides the most recent data available, updated monthly and searchable electronically before the print journal is published. An added benefit compared to the print version is that subscribers to the Internet Database Service can search a five-year back-file archive at no additional cost. (An archive back to 1978 is also available.)

Researchers using the Internet gain a time advantage over other electronic formats also, as the CD-ROM versions are updated only quarterly. The basic Internet Database Service subscription allows unlimited usage through two passwords/workstations; site licenses are also available for a modest surcharge.

To subscribe to the Internet Database Service users need full access to the Internet and either World Wide Web or WAIS client software. The recommended method of access is through the World Wide Web using the Netscape "browser" software. The search software operating behind the scenes comes from WAIS Incorporated, and this provides basic search capabilities including the use of Boolean operators, limiting to specific fields, and the truncation of search terms to retrieve word variations.

As the volume of electronic information increases rapidly, the need arises for navigational tools and reference guides to Internet resources. The recently introduced Environmental Routnet is one example of this new type of service. It goes beyond bibliographic databases to include environmental news (updated daily), grant and funding sources, legislation and regulation, directories of experts, and links to hundreds of other Internet resources. Scientists using this new type of information tool can build more than just literature searches into their creative writing process.

Another significant factor that will affect the use of computers by scientists for the management of information is the advent of the electronic journal. Although the future of this medium presents many as yet unanswered questions it represents a qualitative change in information access. The electronic journal adds a new role for electronic information. Databases and technical information sources are already available on the Internet, and some of these are updated daily. Many of these systems serve as pointers to sources of information, whereas the electronic journal becomes the final source itself. This raises questions about how to use and cite information which can change so rapidly, as compared with conventional journals. Information users are just now beginning to ponder the problems of archiving such a volatile medium for long term use and review. The rapid dissemination of data results even before the associated manuscript is finished

will add yet another complication to the dissemination and interpretation of information by the science community.

Some caution must be exercised as the technology of remote access to scientific databases expands and develops; the easy acquisition of scientific results by microcomputer based telecommunication could be conducive to less thorough and critical consideration of published data. The rapid exchange of scientific information that is being facilitated by the development of electronic communications may call for a re-examination of scientific quality-control measures. The Internet, in its infancy, is an unregulated free-market of ideas and information and as such it lacks many of the checks and balances that are used in the conventional publication of scientific results. One can post research results for worldwide consumption without having subjected them to editorial or peer review. Even databases comprised of carefully reviewed articles in reputable journals can often provide only abstracts, which can be subject to misinterpretation when cited without careful review of the complete article. Although scientific abstracts are designed to stand alone and to represent the content of an article, they do not always do this adequately. An examination of methods and consideration of the alternative interpretations is needed for conservative assessment of published reports. Many of the conclusions stated more or less factually in abstracts are subject to qualifications that are presented in the discussion section of the complete article.

It is clear that the science community is just now beginning to feel the effects of computer access and manipulation of information. The impact of this technology will present an ongoing challenge for the information users and providers alike.

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