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Carol Tenopir  
*University of Tennessee - Knoxville*, ctenopir@utk.edu

Donald W. King

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ELECTRONIC PUBLISHING: A STUDY OF FUNCTIONS AND PARTICIPANTS

Carol Tenopir and Donald W. King
University of Tennessee

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Abstract: As electronic publishing and distribution progress, participants in the publishing system will need to make critical economic and operational decisions concerning a myriad of rapidly evolving new technologies. The University of Tennessee, School of Information Sciences was awarded a Special Libraries Association research grant to produce relevant data and information to assist librarians, library funders, journal publishers, authors and readers, and other participants in dealing with electronic publishing in the future. In order to accomplish this goal, we have developed a framework for describing the system of scholarly journal publishing (particularly as applied in science). The dimensions of this framework include a context for journal publishing; principal functions performed; participants in the system; attributes of information and information products and services; and economic and systemic relationships among functions and services.

1. CONTEXT FOR SCHOLARLY JOURNAL PUBLISHING

The framework for scholarly journal publishing is developed with science and engineering as an example because electronic publishing appears to be moving faster and is likely to have a greater impact in the near future in science and engineering than elsewhere.

1.1 Definition of Scientific Information

There have been numerous definitions of scientific information, but we have adapted a definition developed under a National Science Foundation Study (Ref. 1). In a broad context, scientific information includes messages about basic and applied research resulting from the efforts of scientists and engineers. The messages can include new theory and information obtained from experimentation, observations, instrumentation, or computation in the form of text, numeric data, or images. Once information is created it may be further transformed, described, evaluated, and/or synthesized. The information may be recorded and distributed in several media including paper, microform, electronic, magnetic, or others in order to enhance communication and increase its usefulness and value to a wide spectrum of users and uses. There are three components of a scientific information message including:
• information content which conveys the meaning of messages.
• information form which consists of format and structure:
  - information format which is the "type" of information such as text, mathematical models, numeric data, coded data, imagery, graphics and so on.
  - information structure which is the means of expression of information content such as specific language used in text or syntactic or semantic structures used in text; type of mathematic models; pie charts, bar charts or other types of graphs; structure of numeric tables; and so on.
• information medium which is the "package" in which information is captured or recorded and communicated such as traditional print on paper, electronic, etc.

The scholarly journal system involves a number of processes which are performed on or involve information content, form and media. Integrating electronic technologies into these processes can have a significant bearing on attributes associated with the three information components. For example, information content should be meaningful, accurate, precise, etc. Peer review and editing are done to improve such attributes. Information should be in a comprehensible and usable form for whatever purposes it is needed. The information media should provide storage until the information is needed and then provide timely logical and physical access. Any changes in medium can affect costs and output attributes of journal system processes and, thereby, affect the use, usefulness and value of the information.

1.2 Scientific Journals in the Context of Research, Teaching and Other Scientific Endeavors

One must consider what scientists do and how scientific information affects, and is affected by, what they do. One simple model of this context is displayed in Figure 1 (Ref.1). At the heart of this model are all the activities that scientists perform. Many resources are used to do research, teaching, etc., including scientists' time, workstations, office and classroom space, and support staff. Scientific information has been shown to be one of the most important input resources for most scientific activities (Ref.2). Scientific information is also one of the most important outputs from scientific work. Journal articles are found to be an essential input resource for scientific activities and as an output from these activities. The fourth component of this simple model are all the information processes and services required to communicate information that is output to scientists (and others) who need it to do their work.

This model is important as a context because any changes in the way in which journals communicate scientific information must take into account the effects of resultant information on research, teaching and so on. Several information researchers have considered how scientific information serves as an integral part of research processes (see, for example, Refs. 3,4).

1.3 Scientific Journals in the Context of the Life Cycle of Scientific Information

Once scientific information is created it is communicated in many ways over the years. Garvey and colleagues and Subramanyam have shown the many channels by which an information message is communicated (e.g., informal and formal presentations, technical reports, journal articles, books, etc.) and they observed time frames for the flow of information through these channels starting from time of creation, at which time the information is documented and reported by such means as laboratory notebooks, informal correspondence or interpersonal discussions, conference presentation and papers, research reports, dissertations, journal articles,
1.4 The Life Cycle of Scientific Information Found in Journals

Scientific information that is communicated through a journal publishing system can be characterized by a "spiral" of traditional generic processing functions (Refs. 8, 9). The spiral begins with information generation or creation from research. This information, at some time, is composed for article publication (i.e., written, received, edited, etc.). When ready for formal publication the information is recorded in a physical form which can be reproduced and distributed. In journal publishing, the time span from composition to initial publication distribution can range from few months to years (Refs. 6, 9). Of course there is also prior distribution to reviewers, peers and preprints.

The "life" of information found in articles, considered from initial publication to use, tends to follow a highly skewed distribution, not unlike a nuclear decay curve. Thus, the information must be acquired and stored for future physical access. Since use can involve journals that are not normally read by specific scientists or that are needed long after publication, it is necessary to organize and control the information to facilitate identification and location when needed. At any point in the journal life cycle, scientists must gain physical access to all or part of an article in order to assimilate and use the information for research, teaching, etc. Thus, the information becomes a resource for future scientific endeavors.

The reason that the life cycle context is important is that any changes in processes or participants are likely to affect economic and systemic relationships in the system, particularly over the life of the information. For example, some funders have been led to believe that electronic publishing has eliminated the need for libraries, at least their in-house collections. This ignores the fact that few older articles are currently available in electronic media and about 80 percent of readings of articles over two years old come from libraries. Some have suggested new or alternative processes in the life cycle such as interjecting library information processes earlier in the cycle (see, for example, Ref. 10).

2. FUNCTIONS OF THE SCHOLARLY JOURNAL SYSTEM

Descriptions and analysis of functions is certainly not new and continues to be described in the literature. A recent study and report of an Association of American Universities (AAU) Research Libraries Project presented a list of functions (Ref. 11). There are really two types of functions, the first describes generic processes involved in the scholarly journal system and a second is more accurately described by what the scholarly journal system should accomplish or do. To keep the distinction clear we will refer to the latter type of functions as roles.
2.1 Scholarly Journal Process Functions

A number of researchers have identified and described scholarly journal process functions (see, for example, Refs. 1,4,7,9,11,12,13). Some of these involve generic scientific communication functions, but are appropriate to the scholarly journal system nevertheless. Information-related process functions include:

- **Creation of Information** involves scientific processes such as development of new theory and hypotheses, performing experimentation, sampling, observations, correlating or linking information from several sources, evaluation and analysis, and so on. Some refer to this a generation of information or knowledge.
- **Composition** consists of documenting or writing about newly created information, including authorship of article text, models, tables, graphics, etc.
- **Transformation of Information Content** including translation from one language to another, subject or text editing, and so on.
- **Description and Synthesis of Information** such as describing the validity of information through peer review and preparation of secondary information including abstracts, indexes, catalogs for logical access to the information. It would also include incorporating information from articles into reviews, state-of-the-art reviews, and so on.
- **Logical access** involves identifying needed information and locating sources of the information through reference searching, referral, linking and other processes.
- **Evaluation and analysis of information** includes assessment of information on behalf of users including annotated search outputs.

Some process functions deal largely with information media or the way in which information is packaged. Examples of media-related process functions include:

- **Communications** (sometimes called information transfer, information exchange or distribution) among journal system participants.
- **Recording** refers to physically inputting information into various media such as page masters, computer storage, CD-ROM disks, and so on. Once physically recorded the information can be reproduced, distributed or stored.
- **Reproduction** involves processes for making multiple copies from or of physical media.
- **Physical transformation** is converting information from one medium to another such as paper to microform, electronic to paper and so on.
- **Storage** is holding and making available the various media such as in libraries, computer files and so on.
- **Preservation** includes processes required to ensure that information on media or the media themselves do not deteriorate over time and, if likely to deteriorate, the information or media be reproduced or restored.
- **Physical Access** includes processes that present the information medium to users or others such as receipt of a personal subscription, journal issues in libraries, photocopies through I.L.I., terminal displays, computer or workstation printouts and so on.

Once physical access is achieved the information is assimilated and used. These functions are:

- **Assimilation of Information** involves processes for receiving and absorbing information through reading an article text, looking at charts and graphs and so on.
2.2 Scholarly Journal Roles

The scholarly journal system plays several important roles in science, including serving as (1) an important means of communicating scientific information, particularly beyond an author's primary community, (2) a permanent archive for scientific information, (3) a way of conveying prestige and recognition, and (4) a process for protecting against plagiarism, establishing ownerships, and ensuring uninhibited access to scientific information (Refs. 11, 14). Evolving electronic publishing and distribution must continue to fulfill these roles unless one or more of the roles are disregarded.

3. SCHOLARLY JOURNAL SYSTEM PARTICIPANTS

Each of the generic functions and specific processes involve one or more participants who can be characterized as belonging to types of persons (e.g., authors, editors, referees, publishers, vendors, libraries) or organizations or communities to which the persons or institutions belong (e.g., library and reader parent organizations, professional societies). Just as with processes functions some of the participants conduct the processes (e.g., publishers, libraries, scientists) and some exert external influences on journal publishing (e.g., funders of research, copyright authorities). In addition to functions, one must also consider participants because each is driven by their own motives, incentives and information needs and requirements.

3.1 Scholarly Journal System Process Participants

There are many participants in the scholarly journal system. These participants are described briefly below:

- **Creators** are the scientists, engineers and other professionals whose experiments, observations and so on create new information (or knowledge) to be communicated to others to be assimilated into a body of personal knowledge, applied, taught, reviewed, and so on. There are many motivations to "create" new knowledge ranging from the desire to discover and learn to being assigned research areas.

- **Authors**, usually the creators, document research and other results in several ways including scholarly journal articles. There are many motivations to write (see, for example, Ref.15) including the enjoyment of documenting one's work and the necessity to "publish or perish".

- **Reviewers and referees** provide autentificiation of the accuracy and validity of information in an article. They are usually unpaid, but do the reviews to reciprocate for review of their own manuscripts, to keep up with their peers' work, and as a "donation" to their profession.

- **Primary Publishers** of scholarly journals perform a number of important processes including, among others, starting a journal, acquiring solicited and unsolicited manuscripts, arranging for copyright ownership, subject editing, arranging peer review, managing interaction with authors, editors and referees, redaction, developing master images, reproduction, distribution, and so on. There are basically four kinds of publishers: commercial for-profit publishers; society publishers who provide journals as
a service to their membership; educational institutions who provide an outlet for their authors; and others such as non-profit organizations and government agencies who are advocates for a research field.

- **Secondary publishers** such as abstracting and indexing services provide description and synthesis of journal article information to achieve logical access to the information. They perform many of the same publication processes as primary publishers, but currently rely heavily on electronic media and access. They tend to cover scientific fields and specialties and many of them are non-profit and were at one time partially subsidized by the National Science Foundation and/or professional societies.

- **Second party distributors** are usually profit-making organizations who gain permission from a variety of publishers to distribute articles electronically through CD-ROM, online and magnetic tape. A royalty, typically based on use or units sold, is paid to the primary publishers. Some librarians serve this function by downloading databases available through Internet and then distributing to their users. Document delivery services also fall into this category.

- **Third party distributors** contract with a second party to provide further distribution of electronic publications for which the second party has obtained permission. They are often profit-making "vendors". The vendors may serve as a third party for some electronic publications, but also as a secondary party with others if they contract directly with the primary publisher.

- **Gateway organizations** provide access to third party online services. In this role they typically provide hardware, software and telecommunication links only.

- **Libraries** serve as intermediaries in that they acquire scholarly journals to be shared among their users and to serve as an archive, a facility to distribute and/or reproduce copies for subsequent use, a means of identifying, locating and obtaining copies of articles if needed.

- **Subscription agents** are profit-making organizations that have developed a niche for "brokerage" subscription negotiation, payment, claiming and renewal between libraries and primary publishers.

- **Information brokers** are profit-making organizations or individuals that provide reference search services, services to obtain copies of articles, and other related services to libraries and small companies.

- **Library networks** are unique organizations found throughout the country that were developed to serve groups of libraries through shared services (e.g., acquisitions, cataloging, etc.) in which economies of scale are achieved and by facilitating interlibrary lending.

- **Computer centers** in large academic, industry and government agencies store and provide access to electronic full-text and bibliographic databases.

- **Readers** are scientists, engineers and others who use scientific articles to perform their work. Evidence has shown that those who read these materials more tend to perform their work better and more productively (Ref.2).

3.2 Other Scholarly Journal System Participants

Some participants do not have a role in directly processing information or media, but can have a significant impact on the system. The first of these includes government or others who fund the research and development leading to creation of information. They determine the extent of research and, therefore indirectly the number of articles written. However, they often do not
provide adequate funding to ensure that resultant information is adequately communicated. Another type of funder includes parent organizations that support authors, readers, libraries, computer centers and other information-related processors. Copyright granting and royalty collection agencies also are important participants in the system. Professional societies also contribute substantially to the facilitation of scientific publications. Each of these participants affect and are affected by changes in scholarly journal processes.

4. SCHOLARLY JOURNAL SYSTEM ATTRIBUTES

There are generic attributes that the overall scholarly journal system should achieve and there are also specific attributes of the input resources and output of each process in the system. In a sense, the roles of the system could be stated in terms of generic attributes.

4.1 Generic Attributes of the Scholarly Journal System

Three examples of generic attributes follow. The first set given by Goodwin in 1959 (and recently cited by Penniman) includes (Ref.16):

- to get information desired,
- at time it is desired (not before or after),
- in briefest form,
- in order of importance,
- with auxiliary information,
- and indications of reliability,
- and authority of information (source),
- to exert minimum effort,
- to be screened from undesired or untimely information, and
- to know negative results are reliable.

The second set, first presented in the 1970s (Ref.17) suggest that information should be:

- accurate (i.e., created information should be factually described, with the correct meaning conveyed to both authors and readers);
- precise (i.e., conveyed in the right dosage that is needed by readers -- no more, no less);
- meaningful, comprehensible and usable;
- available in the required information form (format and structure) and medium;
- accessible where needed;
- provided in the required timeframe following creation (i.e., not before or after);
- provided in a timely manner when the need arises; and
- provided in an economic manner (i.e., in terms of price and ease of use).

A third set of generic attributes was prescribed in the AAU report (Ref.11) as follows:

- Ease of use
- Timeliness
- Responsiveness
- Accuracy
- Authenticity
• Predictability
• Adaptability (i.e., how flexible is the system in providing new approaches to information or providing access for unanticipated users?)
• Relevance
• Eligibility (i.e., who has access to information in the system?)
• Cost
• Recovery (i.e., how well is the system able to avert or recover from error?)
• Innovation (i.e., how well does the system perform research and development to provide system innovation?)
• Extensibility (i.e., how well does the system integrate between media? Between disciplines? What is the system's ability to extend itself without a total restructuring?)

4.2 Attributes of Specific Scholarly Journal System Processes

A process can be described by the input resources (i.e., staff, equipment, supplies, etc.) necessary to conduct the process and the output quantities of units, transactions, etc. produced from the process. There are attributes associated with both the input resources and the outputs. For example, attributes of staff include competence (knowledge and skills). Output attributes include such things as quality, timeliness of delivery, availability, accessibility, and so on. Most processes are designed to improve attributes that will make information or media more useful and valuable. The degree to which this is done could be considered the value-added contribution made by the process. Taylor refers to such attributes as values and has described such "values" in great detail (Ref.18). It is abundantly clear that the price one is willing to pay is dependent on the level of attributes purchased (see, for example, Ref.2).

5. CONCLUSION

What has been described thus far is a static environment. However, in reality the environment is anything but static. In order to better understand the scholarly journal system and how emerging new technologies are likely to affect the system, we must recognize the dynamic nature of the system and the interdependencies among functions and participants.

6. REFERENCES


Figure 1. A Model of Scientific and Technical InformationCommunication