

EVOLUTION

OF A SPECIES:

Science Journals Published On The Internet

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According to evolutionary theory, crisis in a natural environment may pressure species to adapt or become extinct. An existing population under stress may go through a period of rapid change, diversification, and experimentation. Eventually, through a process of genetic trial and error, a new population emerges, with characteristics well-suited to the environment. This population may include members of the original species, greatly changed, and/or entirely new species.

✓ A similar evolutionary process is now occurring in the science publishing environment. The combined effects of soaring subscription prices, shrinking budgets, the explosive growth in information production, and the increasing delays in publication time are causing a universal "serials crisis." The print science journal—long the dominant medium for communication among researchers and scientists—is under pressure, as publishers seek (and users demand) more cost-effective, efficient and quicker delivery of scientific information.

At the same time, scientists are communicating over worldwide networks, such as the Internet, with increasing regularity. They are applying network technology to develop new systems for exchanging ideas and information interactively, instantaneously.

In response to these changing conditions, new species of science journals are appearing on the Internet with increasing frequency. Sighted in various fields, from entomology to electronics, they are beginning to attract the interest of information professionals and the users we serve.

As we consider how best to integrate this new information source into existing collections and services, we face important questions and concerns. What are these new species of journals and what do they offer? Are they publishing oddities or are they forerunners of a new age in science publishing? How do we identify them, and where do we find them? What do we need to access them, and how do we use them?

For this article, I surveyed the science journals currently published on the Internet to find some answers to these questions. I identified 25 journals in the pure, applied or behavioral sciences (see the list sidebar), and examined three in closer detail (see the journal profile sidebars). Though each journal differs in its scope, format, and means of access and delivery, they all represent a shared vision of a dynamic new medium that transforms the way scientists communicate. In reading the following pages, keep in mind that any answers or suggestions posed are bound to change: the network science journal is still evolving, and diverse new species are sure to appear.

Beyond the scope of this article are a number of important issues—intellectual property rights, ergonomics, financial considerations, etc.—that relate to electronic publishing as a whole. Many of these topics are covered frequently in *DATABASE* and *ONLINE*.

A NOTE ABOUT NOMENCLATURE

We have a problem with semantics because, at present, there is no universally accepted nomenclature for full-text documents available over computer networks. Discussions in the published literature and in

various network conferences use the terms electronic, online, network-based and electronic-networked to modify the words text, serial, journal or publication. Often the terms are used interchangeably, and sometimes they carry meanings not entirely obvious to the reader.

For the sake of simplicity and consistency, I use the term "network science journal" to refer to the species identified in this survey. It is specific enough to represent all of the journals included on the sidebar, yet general enough to accommodate future developments as they evolve.

WHAT MANNER OF CREATURE ARE THESE JOURNALS?

It is not easy to recognize science journals among the vast sources of scientific information on the Internet. They may take the form of searchable databases, e-mail discussion groups, computer files, or hypertext systems linking sources from across the networks. Their units of access may be articles, not issues, and they may be updated continually, rather than in some periodic interval.

What guided the selection of Internet resources for this survey were the requirements of quality, authority, and enduring value. In other words, any journal selected had to meet the standards of critical review (usually peer-review), editorial quality control, universal access, and permanent archiving that characterize the print scientific journal. Were they anything less, network science journals would not merit serious consideration by the research community.

These criteria eliminate from consideration the more informal, less quality-controlled sources of scientific information available on the Internet

today: pre-print databases, electronic newsletters, digests, bulletins, discussion groups, and so on. Important in their own right, they serve a different purpose than the refereed research literature. Some of these sources are discussed in Ann Eagan's article "Order Out of Chaos: Science Databases on the Internet," published in the December 1993 issue of *DATABASE* [1].

What remains for consideration are many dozens of services and products offering full-text-and-graphics access to the scientific literature over the Internet:

- purely online journals
- electronic versions of existing print journals
- bibliographic databases on the many online databanks
- bit-mapped journal pages available from various document delivery services.

The latter two Internet resources are eliminated because they derive only from the print medium. As expeditious means of providing acquisition-on-demand, offering a cost-effective alternative to journal subscription, they do provide some relief for the serials crisis. But ultimately, they don't improve, in any significant way, the limited capabilities of the print medium. It is possible that, as they gain increasing acceptance and use, journals distributed by document-delivery systems may evolve into electronic-only publications. They may then be worth reconsidering.

What remains for study are a modest, highly-varied assortment of journals produced, to varying extents, for network access. Their means of presentation, delivery, access and storage vary greatly. Most exist in electronic form only, with any print equivalent a by-product of the electronic process. A few of the journals are "parallel publications," existing in both print and online, at least for now.

While in the thick of an evolutionary period, it is not easy to tell what stage of the process we are in, or what kind of species will eventually emerge. We don't know if the network science journals we see today, now in their infancy, are merely forerunners of a more highly-evolved species. A look at

Network Science Journals: A Listing Of Titles In Planning Or Production

Each listing provides the journal title, publisher, publishing history, and ISSN, where available. Unless otherwise noted, each entry was verified in the Research Libraries Information Network (RLIN) catalog.

Architronic: The Electronic Journal of Architecture
Kent, OH: School of Architecture and Environmental Design, Kent State University
1992 -
ISSN: 1066-6516

Chicago Journal of Theoretical Computer Science
Cambridge, MA: MIT Libraries
In development as of 1994
ISSN: 1073-0486

Complexity International: A Hypermedia Journal of Complex Systems Research Canberra, AU: Research School of Physical Sciences & Engineering, The Australian National University
1994-
ISSN: 1320-0682
Verified on location on the WorldWide Web at ANU's server
(URL: <http://ife.anu.edu.au:80/ci/ci.html>)

Conservation Ecology
Ottawa, ON: Dept. Biology, Carleton University
ISSN: 1195-5449
In development
Verified on location at Harvard University's server on the WorldWide Web
(URL: <http://golgi.harvard.edu/journals.html>)

Earth Interactions: An Electronic Journal in the Earth System Sciences
A joint venture of the American Meteorological Society, the American Geophysical Union, the Ecological Society of America, and the Oceanographic Society.
In the planning stage
ISSN: not yet available
Verified through direct communication with Keith Seitter, Executive Associate Director of the American Meteorological Society.

Ejournal
Albany, NY: University of Albany with the State University of New York
1991-
ISSN: 1054-1053

Electronic Journal of Combinatorics
University of Pennsylvania, Georgia Institute of Technology with the American Mathematical Society
1994-
ISSN: none available
Verified on location at Georgia Tech's server on the WorldWide Web
(URL: <http://ejc.math.gatech.edu:8080/journal/journalhome.html>)

Electronic Journal of Differential Equations
San Marcos, TX: Dept. Mathematics, Southwest Texas State University with the University of North Texas
1993 -
ISSN: 1072-6691

Electronic Journal of Experimental Psychology
Ridgfield, CT: PsychNex, Inc.
1990-
ISSN: 0897-4411

Electronics Letters Online
Institution of Electrical Engineers (IEE) ; distributed by the OCLC Electronic Journals Online Service
ISSN: 1350-911X
Verified through direct communication with John Pierce, OCLC.

Flora Online
Buffalo, NY: Buffalo Museum of Science
1987 -
ISSN: 0892-9106

Florida Entomologist
Gainesville, FL: Florida Entomological Society with the Florida Center for Library Automation
In test phase; some sample issues available
ISSN: No separate number available for electronic edition
Verified through direct communication with Mark Hinnebusch, Project Director at the Florida Center for Library Automation.

Interpersonal Computing and Technology Center for Teaching and Technology, Academic Computer Center,
Georgetown University
1993-
ISSN: 1064-4326

Journal of Artificial Intelligence Research
San Mateo, CA: Morgan Kaufman Publishers
1993 -
ISSN: none available
Verified on location ([gopher to p.gp.cs.cmu.edu](gopher://p.gp.cs.cmu.edu)).

Journal of Computing in Higher Education
Amherst, MA: Graduate Research Center
ISSN: 1042-1726

continued

Network Science Journals (continued)

Journal of Statistics Education
Raleigh, NC: Journal of Statistics Education
1993 -
ISSN: 1069-1898

Modal Analysis: International Journal of Analytical and Experimental Modal Analysis
Blacksburg, VA: Scholarly Communications Project, Virginia Polytechnic Institute and State University, with the Society for Experimental Mechanics
1993 -
ISSN: 1066-0763

Modelling and Simulation in Materials Science and Engineering
London, England: Institute of Physics
ISSN: 0965-0393 applies only to parallel print edition
Verified on location at Radcliffe Science Library & Bodleian Library's server on the WorldWide Web
(URL: <http://rsl.ox.ac.uk/E-journals/MISMSE.html>)

New York Journal of Mathematics
Albany, NY: University of Albany
In planning stage
ISSN: To be announced

Online Journal of Current Clinical Trials
Washington DC: American Association for the Advancement of Science and OCLC Computer Library Center
1992 -
ISSN: 1059-2725

Online Journal of Knowledge Synthesis for Nursing
Indianapolis, IN: Sigma Theta Tau International
1994 -
ISSN: 1072-7639

Psyche: An Interdisciplinary Journal of Research on Consciousness
Australia
1993 -
ISSN: none available
Verified in Strangelove, p. 73. [3].

Psychology: A Refereed Journal of Peer Commentary in Psychology, Neuroscience, and Cognitive Science
Washington DC: American Psychological Association, Science Directorate
1990 -
ISSN: 1055-0143

SOLSTICE: An Electronic Journal of Geography and Mathematics
Ann Arbor, MI: Institute of Mathematical Geography
1990 -
ISSN: 1059-5325

Ulam Quarterly
West Palm Beach, FL: Gordon Science Publishers with Palm Beach Atlantic College and the University of Florida
1992 -
ISSN: 1068-601

the visionary thinking from one expert in our profession gives some insight.

Anne Okerson, Director of the Office of Scientific and Academic Publishing at the Association of Research Libraries, paints two different visions of the network journal in her article "The Electronic Journal: What, Whence, and When," published in *PACS Review* in 1991 [2].

A conservative vision sees network journals as mere digital analogs of the printed pages, with the added benefits of fast, point-of-use delivery and possible cost savings. "This electronic journal," she writes, "parallels and mimics the current paper journal format, except that it may be article- rather than issue-based." These journals may exist parallel to print equivalents or replace them entirely.

A revolutionary vision of the network journal "offers the potential to re-think informal and formal systems of scholarly communication, and alter them in ways that are most effective and comfortable for specific disciplines and individuals..." The "revolutionary e-journal" is based entirely on the network, with paper distribution occurring secondarily, if at all. It takes full advantage of the network medium, linking all manner of files, data, graphics, sound, video, electronic conference discussions, datasets, and more into an "instant," "interactive," "global," "intermedia" system. In contrast to the print medium, it allows researchers to express fully their ideas and data, without the constraints of time, space or place. In this way, the network journal has the potential to transform

fundamentally the way scientists communicate.

Okerson suggests that these two visions of the network journal may represent different stages of an evolutionary continuum. The conservative journal, in her view, may represent a possible first step toward transformation. As she notes in her article, "...the moment information becomes mobile, rather than static, this transformation fundamentally alters the way in which information is used, shared and eventually created. Changing the medium of journal distribution, even with so modest, cautious, and imitative a vision, carries unpredictable consequences" [2].

Comparing the current population of network science journals with those envisioned by Okerson, we see that most species appearing today lean toward the conservative view (see the profile of *Florida Entomologist* for an example). A few represent bolder experiments with hyperlinked files and resources (see the profile of *Electronics Letters Online*). Just a few journals, one now online, the others in the planning stage, promise to fulfill the revolutionary vision of intermedia (see the profile of *Earth Interactions*). Evidently, we are in the early stages in the evolution and transformation of the network science journal.

HOW TO FIND NETWORK SCIENCE JOURNALS

The best place to start is Michael Strangelove's *Directory of Electronic Serials*. This popular directory provides essential information for all kinds of electronic publications, including peer-reviewed journals. Each entry provides the title, description, initial date of publication, ISSN number, file format, distribution methods, subscription information, access instructions for back files, etc. Older versions of the complete Strangelove file are available on the networks, by sending mail to listserv@uottawa or listserv@acadvm1.uottawa.ca with the message:

```
GET EJOURN1 DIRECTORY
GET EJOURN2 DIRECTORY
```

An abridged version of Strangelove's directory is also included in the print *Directory of Electronic Journals, Newsletters and Academic Discussion Lists*

FIGURE 1
Searching veronica on the Terms "Ulam Quarterly"
Turned up Several gopher Sites Where the Journal is Archived
on the Internet.

```

Internet Gopher Information Client 2.0 pl10
Veronica server at UNR: ulam quarterly

→ 1. Ulam Quarterly/
   2. Ulam Quarterly/
   3. Ulam Quarterly.
   4. Ulam Quarterly/

Press ? for Help, q to Quit, u to go up a menu   Receiving Directory./

Internet Gopher Information Client 2.0 pl10
Ulam Quarterly

→ 1. About ULAM.
   2. ULAM, 1992, Issue 1.
   3. ULAM, 1992, Issue 2.
   4. Volume 1/
   5. ulam.tex.

Press ? for Help, q to Quit, u to go up a menu   Page: 1/1

.....
Ulam Quarterly

You will find the journal in several directories. Volume 1 Issue 1 is in the directory
volume1/issue1. Within those directories you will find both TeX, *.tex, files and Postscript,
*.ps, files. The filenames and the contents are given below for Volume 1 Issue 58

Title Page
title.tex
title.ps

Table of Contents
cont.tex
cont.ps

Magnus' Method in the Theory of Free Groups N. Jacobson
jacob.tex
jacob.ps

Products of Symbol Algebras That Ramify Only on a
Nonsingular Plane Elliptic Curve
Timothy J. Ford
ford.tex
ford.ps

A Vector Measure Approach to the Optional
Stochastic Integral
James K. Brooks and David Neal
brooks.tex
brooks.ps

On Fibrations of Cylinderlike Surfaces
Cassandra Cox
cox.tex
cox.ps

[PageDown: <SPACE>]   [Help: ?]   [Exit: u]

```

available from the Association of Research Libraries [3]. As with any print directory of electronic resources, however, this publication may become out-of-date quickly.

 The most up-to-date sources of information about network journals are, not surprisingly, on the Internet. Two electronic discussion groups focus primarily on electronic journals. The list NewJour-L@e-math.ams.org, coordinated by the Association of Research Libraries, is the place for

announcements of "newly planned, newly issued, or revised ELECTRONIC NETWORKED journals or newsletters" [4]. The list vpiej@vtvm1.cc.vt.edu, moderated by James Powell at VPI's Center for Scholarly Communications, addresses issues concerning e-journal publishing, archives and access. The group serialst@uvmvm covers the technical issues of electronic journal publishing.

Discussion groups designed for specific subject areas are also a good

source of information about new electronic journals in a particular field. For example, I learned about a new electronic journal in earth systems science from a posting on iamslic@ucsd.edu, a discussion group for the International Association of Aquatic and Marine Science Libraries and Information Centers. I was then able to contact the publisher, the American Meteorological Society, to get a complete description and title for the journal Earth Interactions, profiled in this article.

Another source of electronic journal information is the network journal EJOURNAL. Issues are delivered free to subscribers through electronic mail. Send subscription requests via BITNET to listserv@albany, or via Internet to: listserv@albany.edu. In the message field, type: subscribe ejrnl. To get a list of back issues, send a message to listserv@albany with the message: get ejrnl contents [3].

One can also identify titles of interest by browsing through the subject-oriented collection at CICNET's centralized archive of public-domain electronic journals and newsletters. The Uniform Resource Locator (URL) for the CICNET gopher is: gopher://gopher.cic.net:70/11/e-serials. To learn more about the CICNET and its electronic journal archive, you may read the introductory files available on their gopher: "Revised Proposal to Develop a Centralized CIC Archive of Electronic Journals and Newsletters" (URL: gopher://gopher.cic.net:70/00/e-serials/about/cicnet.pro.gz) and "A Chronology About the History of the Collection" (URL: gopher://gopher.cic.net:70/00/e-serials/about/History.gz).

If you still can't locate a journal of interest, and it is in the public domain, you may find it using a navigational tool, such asarchie or veronica. A veronica search on the keywords "Ulam Quarterly" turned up several entries, as shown in Figure 1. One of the sites veronica will inevitably locate is the CICNET archive, since it provides access for all network journals in the public domain.

These systematic methods are effective in finding many titles, but for others it's a matter of serendipity. For example, while prospecting on a World-

Wide Web site offered by Harvard's Department of Biology (URL: <http://golgi.harvard.edu/biopages.html>), I found a home page for the journal Conservation Ecology, now under development, with an expected first issue in Fall 1995. At another site, I discovered the journal, Modeling and Simulation in Materials Science and Engineering, available for keyword searching, browsing, and downloading at the Radcliffe Science Library and Bodleian Library Web server at the University of Oxford, England (URL: <http://rsl.ox.ac.uk/E-journals/MSMSE.html>).

To verify bibliographic details about network science journals, one may search the research-oriented online catalog of RLIN, the Research Libraries Information Network. A title search in RLIN retrieved records for 15 of the titles surveyed in this article (note that all had ISSN numbers). Moreover, many records included not only the bibliographic data, but also helpful notes including means of access and file format. See Figure 2 for an example of the RLIN

FIGURE 2
The RLIN Record for the Electronic Journal of Differential Equations, Showing Complete Access Information and System Requirements.

TITLE: Electronic journal of differential equations [computer file] 1993/01-

PUBLISHED: [San Marcos, Tex. : Published jointly by the Dept. of Mathematics, Southwest Texas State University, and the Dept. of Mathematics, University of North Texas, c1993-

PHYSICAL DETAILS: v.

OTHER AUTHORS: Southwest Texas State University. Dept. of Mathematics. University of North Texas. Dept. of Mathematics.

ABBREVIATED TITLE: Electr. J. differ. equ.

OTHER TITLES: EJDE.

SUBJECTS: Differential equations—Periodicals.

NOTES: Irregular.

Mode of access: Available online through internet via FTP (login: ftp), gopher, and telnet (login: edje) to "ejde.math.swt.edu" or to "ejde.math.unt.edu".

System requirements: VT100 emulation; ability to display and/or print text and postscript files. Identical electronic texts are originated and maintained online at Southwest Texas State University and at the University of North Texas. Description based on: online "Scope and dissemination" information.

CONSER: 93-2021
ISSN: 1072-6691

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Profile—Earth Interactions

An ecologist researching the effects of atmospheric mercury deposition on Midwest rivers logs onto her network-connected workstation to read articles from the primary journal in her field. With a keyword search she retrieves a relevant paper just published and delivered to the system. She navigates between windows of text, describing a complex data processing technique and a three-dimensional, animated visualization of the model. She then downloads to her PC, the modeling software described in the article and selects one of the large sets of global satellite data hyperlinked to the article. After replicating the published results on her own workstation, she extends the research by applying her own processing to the dataset. She then finalizes the results of her work and submits a "manuscript" electronically to the journal. After a few weeks of peer-review, editing, and final revision, the article is accepted by the journal editors and immediately added to the collection of articles accessible to subscribers.

The journal uses the full capabilities of the network medium to encourage authors to express their research results fully and to invite readers to apply and interact with the information immediately. Is network journal publishing close to realizing this vision?

Keith Seitter, Associate Executive Director of the American Meteorological Society (AMS), believes it is. In conjunction with three other scientific societies, AMS is planning to publish Earth Interactions, a network journal focusing on global change (Refer to the sidebar listing titles for details). Recognizing that scientists in this field rely heavily on complex processing techniques, computer visualization, and enormous, interrelated datasets, the publishers intend the journal "to take advantage of the capabilities of the electronic medium for display and interaction that are being used by the scientific community but cannot be incorporated into traditional paper publications [10]."

To accommodate the widest range of media, the publishers of Earth Interactions plan to produce text structured in SGML, with graphics and data conforming to standards that can be linked to the SGML format. They are exploring a number of Internet-specific standards for delivering various media, including Hypertext Markup Language (HTML) and Multipurpose Internet Mail Extensions (MIME).

Because the final format for Earth Interactions has yet to be decided, the software and hardware requirements for subscribers have not been worked out. Subscribers will certainly need an Internet-connected computer workstation with a graphical user interface. However, to keep user support costs at a minimum, the publishers hope to use one of the growing number of off-the-shelf or public-domain document viewing software packages that can work with SGML files.

Given its potential for fast, interactive, multimedia exchange of ideas and data, Earth Interactions represents a more advanced stage in the evolution of the electronic science journal. As its publishers work to bring it from vision to reality, we are challenged to get ready for the transformation.

AUTHOR'S NOTE

Since the time this article was prepared, we have seen the announcement of a new network science journal that offers full text and graphics via the World-Wide Web. The Electronic Journal of Combinatorics, a refereed journal covering discrete mathematics, is available for viewing using MOSAIC or another Web browser (URL: <http://ejc.math.gatech.edu:8080/journal/journalhome.html>). This newly-announced title takes us one step closer to realizing the visionaries' revolutionary e-journal.

record for The Electronic Journal of Differential Equations, with full access information and system requirements.

In the science indexes and abstracts, access to the network journal literature is still pretty limited. Both Index Medicus and Biological Abstracts cover the Online Journal of Current Clinical Trials. Physics Abstracts and Computer and Control Abstracts selectively index the Journal of Computing in Higher Education. These examples represent the minority, however. Publishers have a long way to go in assuring reliable bibliographic access to their network journals.

WHAT YOU WILL NEED TO ACCESS AND USE NETWORK SCIENCE JOURNALS

At this stage, publishers are experimenting with all facets of submission, production, delivery, presentation, and storage to develop a marketable, cost-effective or cost-beneficial network science journal. As users of the information, we are mostly interested in the factors determining how we will access and use network science journals; namely, how the information is delivered, and in what formats it is presented and stored.

Delivery Methods

Currently, network science journals are delivered in one of two ways:

1. Articles are delivered to a network node and stored there as files of text and/or images (e.g., Florida Entomologist, Ulam Quarterly, and others).
2. Articles are delivered to a network node for use online, with downloading or printing, if available, as a sec-

ondary option. Secondary delivery by another online system, or by computer disk, CD-ROM, or print may also be available. Examples include Electronics Letters Online, the Online Journal of Current Clinical Trials, and the newly-announced Earth Interactions.

Presentation And Storage Formats

Currently used formats for presentation and storage fall into three principal categories:

1. A complete print article may be scanned and stored as bit-mapped images in encapsulated postscript format (Florida Entomologist).
2. Articles may be captured in parts, with the text available as an ASCII or TeX file and the images in one of the many graphics formats, such as Graphic Interchange Format (GIF), (Journal of Statistics Education).
3. Article texts are encoded with tags usable by a variety of applications. This more sophisticated category includes the markup formats LaTeX, Standardized General Markup Language (SGML), or Hypertext Markup Language (HTML). Markup specifies the fields used for retrieval in online searching or the codes that drive a typesetter. It may also show the points of the document that are linked to

As users of the information, we are mostly interested in the factors determining how we will access and use network science journals; namely, how the information is delivered, and in what formats it is presented and stored.

other documents, useful in a hypertext or hypermedia system.

This latter category, not yet in wide use among network science journals, holds the greatest transformational potential. Using markup formats, publishers can create a logically-structured text that is flexible enough to accommodate the range of current applications and future ones as they develop. As noted by Susan Hockey, in her paper presented to the 1992 Symposium on Scholarly Publishing on the Electronic Networks, sponsored by the Association of Research Libraries [5]:

In a fully electronic world, a standard format which can be used for many different purposes provides a way forward which will pay back the investment in it and yield texts which will be usable for many years.

For network science journals, one of the most promising markup formats is Hypertext Markup Language (HTML), which structures documents with hypermedia links. HTML-formatted journals can be accessed

and used on the Internet through the World-Wide Web, with graphical browsers such as Mosaic, Cello, or MacWeb, or text-only browsers such as LYNX.

There is evidence that publishers are ready to experiment with HTML-formatted journals. In a recent e-mail message James Powell writes, "We are working our way toward creating hypertext versions of various titles we (The Scholarly Communications Project) publish..." He invites visitors to look at some prototypes (of nonscience journals): point a World Wide Web client to borg.lib.vt.edu. (*Editor's Note: For more information, see the article by Powell in the February 1994 issue of DATABASE, "Adventures With the World Wide Web: Creating a Hypertext Library Information System," pp. 59-66. —PH*) Keith Seitter of the American Meteorological Society indicates that the publishers of Earth Interactions are also looking into HTML formats for their newly-announced network journal, Earth Interactions.

Technical Requirements

As publishers continue to experiment with methods for delivering, presenting, and storing their journals, standards will most likely emerge to make access and use more routine. Until that time, however, those interested in using network science journals face a confusing and complicated array of technical requirements. Basic requirements are as follows:

1. Internet Access: At a minimum, dial-up access to an Internet node is needed to retrieve (by FTP, gopher, electronic mail) the files corresponding to the desired articles. The user then must be able to download them to a personal computer for viewing or printing.

For the journals used online, direct Internet access is almost always necessary either through a local area network or a serial (SLIP or PPP) connection. For those journals available on the World-Wide Web, dial-up access is adequate for reading textual information online, using the text-only browser, LYNX.

2. Hardware: Users require a personal computer and a modem or network

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Profile—The Florida Entomologist: An Experiment In Parallel Publishing

With a vision of global, speedy, convenient and free access to scientific literature, the Florida Entomological Society (FES) has developed a prototype system for distributing their peer-reviewed journal, *The Florida Entomologist*, over the Internet [8]. Working with the Florida Center of Library Automation (FCLA), the Society is evaluating various formats for presenting, storing and distributing their journal by electronic network.

At this early stage, the publishers use a format and delivery method easily available to most researchers and libraries. They encode articles in encapsulated PostScript, an ASCII-based pagemaking language that can be viewed with PostScript-viewing software or printed on PostScript-capable printers. They mount the uncompressed files at the Florida Center for Library Automation (FCLA) FTP archive. Users may retrieve the files by anonymous FTP, gopher, or electronic mail, and then download and view or print the articles from their own personal computers. For complete instructions on retrieving, viewing or printing files from the Florida Entomologist over the Internet, see their informational document [8].

In testing the Florida Entomologist prototype, I was interested in comparing the quality of the articles distributed electronically with the print version of the journal. I was even more curious to see if I could actually do the entire test—from FTP to print—with the average equipment in my office, in a reasonable amount of time.

Using a Macintosh IIfx with a hardwired connection to the campus VAX 8800 (with data transmission speeds of 19200 baud), I retrieved several articles of the Florida Entomologist by FTP and transferred them to my Mac using MacKermit. Without PostScript viewing software, I had to download the files directly to the Apple LaserWriter (with 2MB memory) for printing. The article presented in this profile was Hall and Cherry's six-page article about wireworms with four graphs, retrieved as file fe76p155.eps.

The results of my test were mixed. On the positive side, the high-quality output was comparable to that of the print journal. Figure 3 shows a sample page with text and graphics, printed from file fe76p155.eps.

On the negative side, however, was the time necessary to retrieve and print each article. It took less than ten minutes to FTP and transfer each file, and less than two minutes to print two text-only pages. However, printing a page containing graphs, as shown in Figure 3, took over thirty minutes. Given the current format for this electronic journal—large encapsulated PostScript files that are difficult to view and painfully slow to print—I can't foresee its widespread acceptance among researchers or libraries any time soon.

Nevertheless, the publishers of *The Florida Entomologist* are optimistic about developing an electronic product that parallels, and possibly supplants, their print journal. In their vision statement, they predict that "... extrapolation of present trends in hardware, software, and information networks suggests that universal electronic publishing of society-published scientific journals could be achieved in less than ten years" [8]. Perhaps the journal, in its current implementation, will turn out to be an important first step in realizing this vision.

connection and a high-resolution monitor and/or laser printer. Connection speeds of at least 9600 baud are advised to accommodate large graphics files. The ultimate quality of the articles received will depend on the quality of the user's output device. The computer and printer should also have sufficient memory to accommodate very large files, reaching sizes up to 1MB or more.

3. Software: Dial-up Internet users require standard telecommunications software and applications for decompressing and translating various storage formats. For files retrieved and downloaded, you will need one or more applications for local display or printing. Several off-the-shelf packages, such as Aldus Pagemaker, Microsoft Word, and Adobe Illustrator, can import Encapsulated PostScript, TIFF, and other image formats.

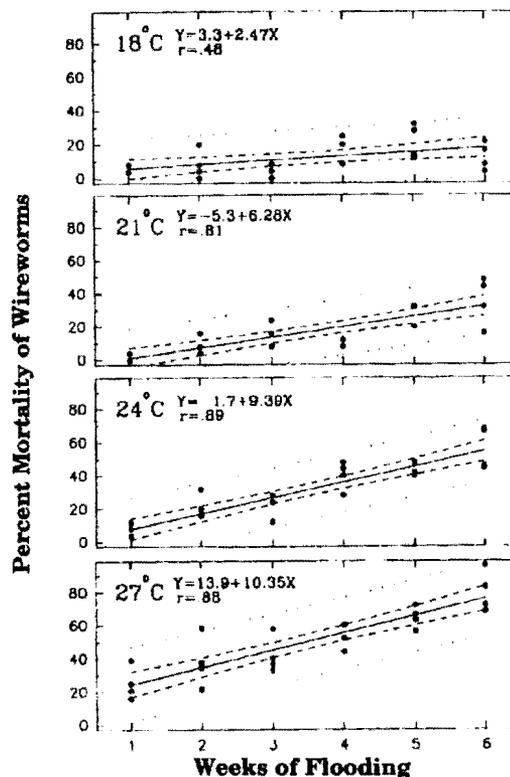
For journals used online, a graphical user interface must be loaded on

the user's computer. The OCLC journals use the graphical user interface GUIDON, available to journal subscribers as part of the subscription price. The publishers of *Earth Interactions* are evaluating commonly available graphic interfaces, such as MOSAIC.

Even in this early evolutionary stage, it is clear that subscribers to network journals will require advanced, expensive technology to access and use the information. Going to a purely electronic means of production and publication may save money and time for the publisher, leading to reduced subscription prices; but it will translate to additional costs in hardware, software, telecommunications costs and training for subscribers and libraries. Therefore, what we may see is not a net gain in savings for libraries, but rather a shift in how the money is spent.

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FUTURE TRENDS

The rate at which network journals will continue to grow and whether they will ever supplant the print journal are matters of debate. A cautious prediction comes from Charles Bailey, writing in *Information Technology and Libraries* [6]. He predicts that electronic serials will not supplant print journals in the next ten years, but may "become an increasingly important parallel form of communication." The editors of *Postmodern Culture*, Eyal Amiran, Elaine Orr, and John Unsworth, predict in *Advances in Library Automation and Networking*, that the trend in electronic journal publishing will continue due to economical and technological factors. They also believe that print journals will begin to move in the direction of electronic publishing as well [7]. Equally optimistic is Anne Okerson, who predicts that by 1995, academics

Profile—Electronics Letters Online

Electronics Letters Online (ELO) is the electronic version of Electronics Letters, a peer-reviewed biweekly title from the Institution of Electrical Engineers (IEE). ELO offers the same brief research articles published in Electronics Letters, but that is where the similarity ends.

More database than journal, ELO combines the best of full-text searching, hypertext navigation, and the speed and currency of network-based information with a high-quality, easy-to-use interface. Hyperlinks between text, figures, equations, and references let subscribers find information quickly and easily.

Online searchers will find the search engine and indexing in ELO to be first-rate. Boolean, keyword and proximity searching cover over 20 fields, including an "all" index and a basic index comprising the title, abstract, and IEE descriptors.

Among the most powerful features of ELO are its seamless links to other sources of online information. For example, while displaying the full text of an article the user may select, from the reference list, additional articles to be searched in IEE's bibliographic database, INSPEC. Instantly, a window opens, displaying the complete bibliographic record and indexing for each selected article. Users may also open windows showing notifications of subsequent correspondence or errata related to the displayed article. These features demonstrate some of the unique capabilities of the network journal.

Output options in ELO include the standard bibliographic formats, keyword in context, full text, table of contents, INSPEC-style tagged records, and more.

Users can print locally, send by mail or fax, or save specific documents in SGML, text or other formats. Including a variety of output options, to meet each user's tastes, reflects the thoughtful design of this system.

Subscribers of Electronics Letters Online must meet several hardware and software requirements. For full functionality, they must use GUIDON, OCLC's graphical user proprietary interface, while running Microsoft Windows 3.1 on a 386 or higher personal computer. The computer must be directly connected to the Internet by either network or SLIP connection or have modem access to OCLC at 9600 baud. The subscription price covers the interface and unlimited access to the journal.

Electronics Letters Online falls somewhere between Okerson's conservative and revolutionary visions, combining information derived from the print medium with the enhanced functionality of electronic formatting and access and the powerful interconnectivity of network information. It will be interesting to see if the valued-added features of ELO will eventually send the print Electronics Letters into extinction.

NOTE: Two other science journals also accessible using OCLC's Guidon interface are the Online Journal of Current Clinical Trials (OJCC7) and the Online Journal of Knowledge Synthesis for Nursing. Another journal, Applied Physics Letters Online, will be available in January 1995. For a complete discussion of OJCC7 and GUIDON, see Andrea Keyhani's article in the February 1993 issue of DATABASE [9].

will produce over 100 peer-reviewed electronic journals, and that by the year 2000, the market for "serious academic journals" will be split close to 50/50 between paper publication and its electronic alternatives [2]. Though differences in opinion are widespread, those interested in scholarly communication—scientists, learned societies, academic institutions, commercial publishers, and libraries—seem to agree that the time is right to begin experimenting with and evaluating network journals.

Through a process of trial and error, and through the natural selection of format, delivery and access modes, a population of highly-evolved science journals will emerge, able to take fullest advantage of the network environment. They will be produced quickly, efficiently, and cost-effectively, alleviating today's serials crisis. And just as importantly, they will permit scientists to fully express and exchange their ideas and research results, in a format most comfortable and effective for their particular specialties. In this way, network science journals will transform the way scientists communicate and, ultimately, the way knowledge is created.

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