The Internet: Changing the Way Horticulturists Communicate

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SUMMARY. This article examines opportunities for enhanced information access and dissemination available to professional horticulturists using the Internet. The intent, however, is not to provide a comprehensive cataloging of where and how to find various databases or sources for multimedia educational resources. While some of these resources are reviewed, the goals of this article are to provide a background of the Internet environment and to examine the communication impacts of the Internet on horticultural researchers and educators. Our view is that computer-aided communication is an opportunity challenge, which should be confronted by individual horticulturists and the discipline as a whole. Examples of these new resources that can have a positive impact on the accomplishment of work responsibilities of horticultural professionals are discussed.

ADDITIONAL INDEX WORDS. world wide web, electronic publishing

In the traditional model of scholarly research, scholars engage in a process of generating and disseminating information. This traditional model of scholarly activity can be characterized by a professor who conducts original experimentation or inquiry, either alone or in collaboration with peers, and then publishes findings in a scientific journal. Having passed the process of peer review, journal articles imply an endorsement of professional quality and serve to inform others of current developments in the field. Research results also are presented live at scientific meetings, an activity that provides wider audiences within the discipline an opportunity for interaction, evaluation, and feedback. Scrutiny of one's research by peers can initiate a process of reflection and refinement which leads to further investigation and generation of additional data. Ultimately, research occurs as a dynamic cycle of information dissemination and acquisition.

While the traditional model is focused primarily on information dissemination among peers, there are also implicit responsibilities to further disseminate information to the general public and commercial operators through teaching, extension, programs of professional societies, and popular media publications.

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Salaries and research support provided by state and federal funds appropriated to the Ohio Agricultural Research and Development Center, The Ohio State University. Manuscript no. 50-95.

The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked advertisement solely to indicate this fact.

HortTechnology is an example of a publication in which researchers place results before a specialized general public. Frequently, the responsibility of information dissemination to the general public is removed from the individual scholar and placed with professional editors and writers who work in extension or on the staffs of journal publications.

Enhancing the traditional model

The central issue to address is whether the traditional model of scholarly research and its methods of information acquisition and dissemination needs to be examined for weaknesses in light of recent developments in telecommunications technology. Framing this question more affirmatively, does computer-aided communication present opportunities for improvement of the traditional model? Answering this question calls for a review of the current state of computer use by horticulturists and a brief overview of the Internet computing environment.

Rapid communication always has been a key requirement and a fundamental characteristic of scientific research (Schatz and Hardin, 1994). Many horticultural professionals, therefore, have accepted readily and begun to use currently available computer technologies linked to the Internet to facilitate this disciplinary requirement. Colleges and universities offer local area networks where, for example, library collections are computerized and searchable, usually from one's personal office computer. Library information systems invariably offer access to databases organized along broad disciplinary categories, which enable searches of journals, dissertations, and print media titles. Electronic mail is beginning to be used commonly for communicating routine information throughout the immediate office environment. Once the e-mail habit is established, increased communication with colleagues at other institutions soon follows. Expanding on the one-to-one nature of e-mail, e-mail lists link scholars having common interests in specialized topics and enable them to communicate simultaneously their latest discoveries to everyone in the group. Many of these e-mail lists, of which there are hundreds, are announced publicly, but smaller groups sometimes form their own lists to maintain privacy among a select group of colleagues working in a common area.

To facilitate the collaborative development of manuscripts among geographically dispersed scholars, many increasingly are turning to electronic file transfer. This capability enables spreadsheet and word-processing documents and other digitized media, such as electrophoretic protein gels, to be transferred, worked on, or analyzed when re-

ceived, thus eliminating delays in physically transmitting documents via the mail. This explosion in electronic communication alternatives removes barriers to collaboration among geographically separated researchers and increases opportunities to access remote information from digital libraries and databases (Grimshaw, 1994).

While information acquisition is one of the principle benefits offered by the Internet environment, many educators may have avoided using Internet resources beyond basic services such as e-mail and library database searches because of the perception that the environment is too amorphous, consisting primarily of frivolous, trivial, extraneous, and difficult-to-access information. With so much out there, being able to find information of value and relevance to one's work has been a significant weakness of the Internet. Technological solutions, however, are arriving in response to this critical need, and the cryptic technicalities of many aspects of Internet use are declining (Hewson, 1994). The Internet is progressing rapidly toward a more seamless environment, in which the wealth of Internet-based information is presented as "the illusion of a single, very powerful computer, rather than a collection of disparate machines" (Grimshaw, 1994). These technical improvements have moved the Internet away from the esoteric tool it traditionally has been and opened its resources to whole new communities of users (Schatz and Hardin, 1994).

Origins of the Internet

The Internet originated during the 1960s under the direction of the U.S. Dept. of Defense (USDOD) Advanced Research Projects Agency. This initial network, ARPANET, linked the Pentagon with computers at the Univ. of California-Los Angeles, Stanford Research Institute, Univ. of California-Santa Barbara, and the Univ. of Utah. ARPANET was designed as a means of decentralizing USDOD computing resources in the event of a nuclear attack. By 1971, there were 15 sites connected, but the initial military goal of the network was being replaced with the more scientific goal of networked information exchange (ARPANET was eliminated in 1990). By 1984, the number of host computers surpassed 1000, and in 1986, involvement by the National Science Foundation (NSF) sparked events that would result in the present configuration of the Internet. Under NSF coordination, linkage of thousands of universities occurred rapidly, starting first within the United States and soon after throughout the world. The number of Internet hosts (a host is an individual computer linked to the Internet) surpassed 1,000,000 in 1992, totaled 6.6 million by

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July of 1995, and has been predicted to reach 101 million by the end of the century (Treese, 1995).

Gopher software

A pivotal advance in information acquisition and dissemination via the Internet occurred in 1991 with the release of Gopher software by the Univ. of Minnesota. Before Gopher, accessing information generally required mastery of complicated operating commands to log into a remote host computer, whereupon one literally would have to root around through confusing layers of cryptically named file directories. For this reason, Internet users were primarily computer-science and other computer-based professionals. Using Gopher, novice users could move quickly between layers of descriptively titled information categories with simple text-oriented interfaces or point-and-click commands. This development quickly opened up the Internet to many more scholars outside of computer-science disciplines.

Associated with the release of Gopher was the development of sophisticated tools that permitted keyword searches of Internet Gopher servers. For example, using a Gopher search tool such as Veronica and entering the word horticulture would return a listing of world-wide Gopher sites where the term horticulture figures as a part of the descriptive title of a specific informational resource. The information resources could range from descriptive plant lists, information about educational programs in horticulture, to extension fact sheets. Gopher continues to be an important Internet resource today, with over 7000 Gopher servers on the Internet (Schatz and Hardin, 1994). In 1993, the annual growth rate of Gopher traffic on the Internet was 997%. However, in just 3 years, Gopher has been supplanted by newer information retrieval tools. As one observer noted: “In the current tremendous expansion of the Net we have the opportunity to watch and study the growth of a fantastically huge new industry, on a scale similar to the building of the public highway systems, postal systems, telephone, railroad, and electrical infrastructure” (Hardy, 1993).

The World Wide Web and browser programs

In 1989, 2 years before the release of Gopher, an initiative was launched by researchers at the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland, called the World Wide Web (WWW) project. The WWW was developed originally to allow information sharing within internationally dispersed teams and enhance the

dissemination of information by support groups. Originally aimed at the high-energy physics community, it attracted much interest and spread to other areas (McLaurin, 1995). Basically, the WWW consists of thousands of information resources located on a wide variety of computer systems and interconnected through hypertext links. The links, embedded within the body of the information being presented, contain computer addresses that connect one piece of information directly to another regardless of physical location. The resulting environment facilitates information dissemination of logically related subject matter in such a way that the user can navigate among many different network systems following a series of hypertext links. The WWW embodies the idea of “world-wide information space” (Schatz and Hardin, 1994) or seamless “enterprise-wide computing” (Grimshaw, 1994). The user is able to access information without the burden of technical considerations and irrespective of the location of the information in physical space. The end result is that the entire world of available Internet information resources exists as a streamlined total information space.

The CERN group began to release what are called browser programs during the early 1990s. Whereas with Gopher a user moves back and forth through hierarchical collections of information and ultimately arrives at a document that is the effective dead-end of that information search, the WWW and its hypertext links create a potentially continuous environment of interlinked information resources. The hypertext/hypermedia environment made simple access to multimedia resources including text, sound, movies, and photos. Currently, the most widely used browser program is Netscape. Netscape has surpassed Mosaic—the first sophisticated browser program developed in 1993 at the Univ. of Illinois National Center for Supercomputing Applications (NCSA)—in acceptance and popularity due to the enhanced graphical features and ease of use it offers. During 1994, use of all browser programs grew 11% each week, and use doubled every 6 weeks (Crawley, 1994). Netscape and NCSA’s Mosaic are freely distributed on the Internet to all academic users. Commercial Internet providers, such as Prodigy, CompuServe, and America OnLine, offer their own in-house Internet browsers.

From browsing to software agents

Powerful WWW search tools are being developed and new releases become available by the month. Some of these software agents have names such as Web spiders, wanderers,

crawlers, and snakes (Zakon, 1995). These agent programs are designed to search autonomously the Internet and locate information based on user-supplied search terms (Waldrop, 1994). At present, autonomous agent searches are feasible only for key words found in Web-server documents names and titles, for limited searches of document page content, or to find servers located within specified geographical areas. In the future, computing advances will occur that will permit greater specificity to information acquisition. Many of these advances, however, will require greater computing power than presently available and advances in bundling data traveling on the Internet. While Netscape and Mosaic represent the present end-point advance in an on-going process, future development will bring greater power in information dissemination and acquisition capabilities. Ideally, scholars will be able to enter a string of very specific search terms and have a software agent return customized information through a process termed interactive analysis (Schatz and Hardin, 1994). For example, one could query the Internet for "journal articles, greenhouse production, roses, nutrition, after 1992" and receive immediate access to extant full-text articles, with accompanying tables, graphs, and photographs. The National Science Foundation, the Advanced Research Projects Agency, and the National Aeronautics and Space Administration recently have funded a 4-year \$24.4 million effort in partnership with a consortium of leading universities and private sector corporations to develop systems for collecting, organizing, and storing digital information. These and other efforts will make a greater range of information more readily available to groups as varied as elementary school students and research scientists (Waldrop, 1994).

Interest in and access to the Internet also is occurring in the general population. Scarcely a day goes by without a popular media reference to the Internet, or the so-called information superhighway. During 1993, business and media began to take notice of the Internet (Zakon, 1995). The most basic Internet service, e-mail, has become a *de facto* requirement for progressive business people. Estimates place the number having electronic mail capability at 25 million, with expectations that another 25 million people, primarily from business, will be linked to the Internet within the very near future (Lewis, 1994). A growing number of communities throughout the United States offer basic Internet services through community free-nets, frequently administered through the public library system on terms similar in ease to signing up for a library card. Public access to Web servers, while not as available as e-mail,

is increasing. There is also growing public perception that more of the information the public desires, the questions they have, or the problems they wish to resolve have Internet-based solutions. For example, during a 2-week period in July 1994, 1.4 million users visited a WWW server offered by NASA's Jet Propulsion Laboratory to view images and movies of Comet Shoemaker-Levy's impact with the planet Jupiter (<http://www.jpl.gov/sl9/sl9.html>). By September 1995, 4.6 million Web browsers had accessed NASA's information on the comet. Commuters in southern California can access freeway system maps giving immediate readings on traffic flow speeds and can plan their routes home accordingly (<http://www.scubed.com/caltrans/transnet.html>).

Horticultural information resources

Many useful horticultural resources can be found today on the Internet. A listing of Gopher sites can be generated using Mosaic/Netscape and a search tool called Search Gopher Space (<http://galaxy.einet.net/gopher/gopher.html>). Entering the keyword "horticulture" returns over one hundred "hits," including the following Gopher servers: a) the Virginia Tech Horticulture Dept. which provides monthly news releases; b) the Univ. of Missouri, which provides Horticulture Guides; c) Iowa State Univ., which offers information on horticulture department curriculum, career opportunities, and faculty; d) Michigan State and Auburn universities, which supply general informational releases on horticultural subjects; e) the Univ. of Minnesota, which lists a directory of proposed federal environmental legislation; f) the Israeli Ministry of Agriculture, which lists research being conducted at the Institute of Horticulture; and, g) Pennsylvania State Univ., which offers a variety of horticultural information resources. The weakness of Gopher keyword searches, however, is that almost all returned Gopher information is text-only, and the lack of the hypertext links of WWW servers means that the relevance of information cannot always be discerned from file names.

A handful of newly developed Web sites present horticultural and related discipline information. Two of the most comprehensive servers targeted for those interested in applied horticultural information are the Centre for Landscape Research at the Univ. of Toronto (<http://www.clr.toronto.edu:1080/clr.html>) and the Australian National Botanic Gardens (<http://155.187.10.12/index.html>). The stated goal of the Centre for Landscape Research server is to encourage a "collaborative environment

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for the exploration of ideas relative to the design, planning, and policies of the environment” and “promote the use of electronic media to foster more informed decision-making.” The Australian National Botanic Gardens server features activities and programs of the gardens and is strong in its presentation of photos of Australian flora. A third Web site, the Univ. of Delaware Botanic Gardens (<http://bluehen.ags.udel.edu/udgarden.html>), offers the user a map of the garden’s layout, photographic images, and identification information on selected species.

To date (February, 1996), there are 14 departmentally oriented Web servers associated with programs offering undergraduate and graduate education in horticulture. Each of these servers generally provides curriculum information, course-specific information, announcements, research programs, listings or biographies of personnel, and links to other Web sites. These programs and their Web addresses are presented below:

- Department of Horticulture at Clemson Univ. can be reached at (<http://agweb.clemson.edu/Hort/Hort-Main.htm>).
- Dept. of Floriculture and Ornamental Horticulture of Cornell Univ. can be reached at (<http://www.cals.cornell.edu:80/cals/dept/flori>).
- Department of Agronomy and Horticulture at New Mexico State Univ. can be reached at (<http://taipan.nmsu.edu/aght/agronomy.html>).
- Department of Environmental Horticulture at Univ. of California, Davis, can be reached at (<http://envhort.ucdavis.edu>).
- Department of Horticulture at Texas A&M Univ. can be reached at (<http://aggie-horticulture.tamu.edu/>).
- Department of Horticulture at the Univ. of Illinois can be reached at (<http://gopher.ag.uiuc.edu/Hort/Horticulture.Home.Html>).
- Department of Horticultural Science at the Univ. of Minnesota can be reached at (<http://www.soils.umn.edu:8003/>).
- Department of Horticulture at Univ. of Nebraska can be reached at (<http://129.93.226.104>).
- Department of Plant and Soil Science at the Univ. of Delaware can be reached at (<http://bluehen.ags.udel.edu/homepage/plsc/plschome.html>).
- Department of Horticulture and Crop Science at Ohio State Univ. can be reached at (<http://hortwww-2.ag.ohio-state.edu/hvp/HVP1.html>).
- Horticulture Dept. at Purdue Univ. can be reached at (<http://www.hort.purdue.edu/hort/hort.html>).
- Horticultural Sciences Dept. at the Univ.

of Florida can be reached at (<http://gmv.ifas.ufl.edu/WWW/AGATOR/HTM/HORTICUL.HTM>).

- Department of Horticultural Science at North Carolina State Univ. can be reached at (http://www2.ncsu.edu/ncsu/cals/hort_sci/homehort.html).
- Department of Horticulture, Forestry and Recreation Resources at Kansas State Univ. can be reached at (<http://witch.oznet.ksu.edu/dep/HFRR>).

While these 14 sites provide valuable information on a variety of topics, the full potential of these new information resources will be realized when they begin to develop and offer instructional, research, and outreach programs jointly through their respective servers. Currently, an Internet user can sample information from each server but fail to arrive at a comprehensive view of the discipline of horticulture.

Impacts on the traditional model

Given this overview of the Internet, what is the likely impact of Internet information resources on the traditional model of scholarly activity? An editorial in *Science* (Brauman, 1994) noted that “computers and computing have changed the modern world, but the effects on the practice of science have been especially profound.” In scientific practice, increased computational power has permitted scientists to explore and analyze more intricate and complicated datasets, leading to greater complexity in the modeling of natural phenomena. These advances, along with access to a richer information matrix, represent, however, only a quantitative progression in the conduct of scientific inquiry. In this view, computers and the Internet are merely tools a scientist uses to enhance the quality of the scientific method of inquiry. The basic attribute of the scientific process, rigorous testing of hypotheses formulated through observations of natural phenomena, remains unchanged. There are nonetheless qualitative impacts on the disciplinary culture and conduct of science specific to Horticulture.

Four key elements in the discipline of horticulture provide a strong incentive to use the Internet for computer-aided information acquisition and dissemination, and create a dynamic that will have an impact on the traditional model. First, a strong visual component characterizes horticultural knowledge and study. Given that knowledge related to plant identification and use is central to the undergraduate horticulture curriculum and that there is no substitute for a high-quality picture, most educators develop one or more slide sets to compliment their teaching programs. However, in most cases, when the

professor changes institutions or retires these slide resources often are lost. Fortunately, we are now seeing more plant image databases on the Web (example: Harvard Herbarium at <http://golgi.harvard.edu/>). Professors are able to pull individual images from these databases and insert them into presentation software for classroom lectures. Alternatively, students can access these same resources out of class for review and self-study.

The second key element that links horticulture to the Internet is the technical and practical element contained in the undergraduate curriculum, which, similar to plant identification, requires that students are presented highly visual information. Examples are plant grafting techniques and growth medium preparation. The Web environment is very conducive to a type of instruction that is facilitated through the use of self-paced tutorials or lab assignments on subjects requiring step-by-step instructions, accompanied by audio and video clips to explain what is happening. An example of this type of interactive resource that a Web server can provide is the frog dissection tutorial available from the Univ. of Virginia (<http://curry.edschool.Virginia.EDU:80/~insttech/frog/>).

The third element linking horticulture to the Internet involves new efficiencies in the communication of information and research results. Research activity within some subdisciplines of horticulture moves so rapidly that scholars' exclusive dependence on the traditional publication cycle of a monthly or quarterly journal might prohibit them from keeping up with breaking developments. Horticulturists involved in biotechnology were among the early adopters of Internet communication. Through a commitment to rapid dissemination of research results via the Internet, these scientists are able to perform comparative searches on comprehensive databases and be fairly confident that the latest findings are included. An editorial in *Science* (Winograd and Zare, 1995) singled out the *Journal of Biological Chemistry* as an example of an on-line journal offering valuable features such as full-text articles, search engines to search contents quickly and efficiently for information, and a means to print desired pages for extended examination (<http://www-jbc.stanford.edu/jbc/>). The editorial noted that, in time, the electronic journal may replace the printed scientific journal and result in accelerated scientific progress. Similarly, in the area of providing information to industry and public clientele groups, use of the Internet to communicate late-breaking information about regulatory issues, environmental conditions, and/or disease outbreaks will emerge as a valuable disciplinary tool.

The fourth key element that links horticulture to the Internet is the issue of format. For example, researchers involved in electrophoretic gel protein sequencing commonly use digitizing software to render and interpret sequences more precisely. Consequently, a traditional photographic rendition of a gel within the pages of a journal article offers less utility, because the preferred format for greater accuracy in interpretive analysis is the digital format. These same scholars also rely heavily on Internet-based protein databases such as the Univ. of Geneva's 2-D protein electrophoretic gel database (<http://expasy.hcuge.ch/ch2d/ch2d-top.html>). In terms of information dissemination to industry professionals, format possibilities offered by the Internet include image-based maps showing the latest areas of insect or plant disease outbreaks, current soil moisture conditions, and quality of crop development. Each of these information resources, of course, depends on digitized format for their creation and dissemination over the Internet.

Opportunities for the future

The Internet, and the associated broad advances in telecommunications and computer software it encompasses, provides scholars with opportunities for strengthening the discipline of horticulture in many ways. The ability to network with colleagues using e-mail and electronic file transfer has brought people, ideas, and information together in a more efficient manner and has enhanced collaborative efforts. As horticulturists develop Web servers to present teaching materials, course syllabi, research results, or late-breaking developments, they will collaborate more frequently with colleagues in other academic disciplines who have gone before them and discovered the pitfalls and challenges of developing information for the Internet. Likewise, discovering that colleagues already have developed similar courses and that their materials can be shared and accessed electronically provides many obvious benefits. As more and more secondary schools use instructional computer labs with Internet access, teachers logically will look to universities as sites for discipline-related curriculum materials to present to their students. Finally, continuing education programs and employee development programs will benefit from increased availability of curriculum materials and mini-courses developed for specific learning goals. As one observer noted: "Learning can be independent of time and place, and available at all stages of a person's life. The learning context will be technologically rich. Learners will have access not only to a wide range of media, but also to a wide range of sources of education" (Bates, 1993).

"There is an obvious need for leadership to facilitate the development of electronic information resources"

What is needed?

French sociologist Jean-François Barbier Bouvet, who studies the impact of computers on society, wrote: "if in the past the culture of someone could be defined as the capacity to keep, memorize and recall information, today it should be defined as the capacity to wisely use information; in other words to be able to retrieve the information when it appears necessary" (Bouvet, 1993). In his view, incumbent on the practicing scientist will be recognition of the importance of integrating the intellectual products of scientific inquiry into the world-wide information space of the Internet. As horticulturists generate and disseminate research results within an information-rich environment, using an evolving array of computer-based tools, there will be inevitable impacts on the traditional disciplinary model of scholarly activity, most notably in the area of self-publishing. Research scientists who rapidly communicate research results to world-wide communities of peers, and scholars who make their curriculum materials, lecture outlines, lab assignments, and self-paced tutorials available on the Internet, are in effect self-publishing. However, the Internet does not transmit merely to students and professional peers. As wider and more diverse groups of knowledge seekers discover the immediate availability of university-generated information, they may ask for more. Given the advantages of timeliness, multimedia-compatibility, and ease of acquisition, horticulturists soon may be devoting increased amounts of time to electronic-publishing in order to satisfy an ever-growing demand for digital information. Extension professionals or private consultants may become less valued as people who have exclusive access to information, and more valuable as interpreters and synthesizers of information. This evolution toward an increased importance of Internet self-publishing may lead to the irony that the published journal article, the *sine qua non* of the traditional model of scholarly activity, could become less significant to many. This suggests that reevaluation and possible redefinition of standards of academic excellence are warranted.

At the same time, there is an obvious need for leadership to facilitate the development of electronic information resources. A coordinated effort, led either by ASHS or horticulturists working in the Internet environment, is needed to assess and record thoroughly the horticultural resources on the Internet. This would minimize duplicative efforts and help give shape to the evolving presence and presentation of the discipline of Horticulture on the Internet. Integral to this

process is development of criteria for peer-review evaluation for the purpose of maintaining professional standards. Much can be learned from colleagues in other fields that have been even faster to take up electronic publishing. If Internet activity is to be adopted more widely by horticulturists and accepted as a recognized and rewarded scholarly activity, identified standards and definitions of quality will be required.

Literature Cited

- Bouvet, Jean-François Barbier. 1992. Lire la page comme un image. In: Alain Bentolila (ed.). Les Entretiens Nathan. Parole, Ecrit, Imag. p. 225-239. Nathan, Paris.
- Brauman, John I., Voss, David F. and Tim Appenzeller. 1994. Editorial: computing; networks and modeling. Science. Vol. 265, 12 Aug.
- Crawley, James. 1994. For lucky ones, mosaic offers the world. The San Diego Union-Tribune, p. 8. 5 July.
- Grimshaw, Andrew S. 1994. Enterprise-wide computing. Science. Vol. 265, 12 Aug.
- Hardy, Henry Edward. 1993. The history of the Net. MS thesis. Grand Valley State Univ. 28 Sept. e-mail: seraphim@umcc.umich.edu.
- Hewson, David. 1994. The wired-up revolution. Sunday Times, London. 26 June.
- Lewis, Peter H. 1994. Getting down to business on the net. New York Times. 19 June. Section 3, p. 1.
- McLaurin, Alistar. 1994. About the world wide web; history of the world wide web. London Science Museum WWW site: <http://www.nmsi.ac.uk/usage/histweb.html>.
- Schatz, Bruce R., and Joseph B. Hardin. 1994. NCSA mosaic and the world wide web: global hypermedia protocols for the internet. Science. Vol. 265, 12 Aug.
- Treese, Win. 1995. The internet index. Number 10, October 14, 1995. WWW distribution address: <http://www.openmarket.com/diversions/internet-index/>.
- Waldrop, M. Mitchell. 1994. Culture shock on the networks. Science. Vol. 265, 12 Aug.
- Waldrop, M. Mitchell. 1994. Software agents prepare to sift the riches of cyberspace. Science. Vol. 265, 12 Aug.
- Winograd, Shmuel and Richard N. Zare. 1995. "Wired" science or whither the printed page? Science. Vol. 269, 4 Aug.
- Zakon, Robert Hobbes. Hobbes' Internet Timeline, v2.2. WWW distribution address: <http://info.isoc.org/guest/zakon/Internet/History/HIT.html>. E-mail: timeline@hobbes.mitre.org.