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Before the web there was Gopher

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The World Wide Web, universally well known today, was preceded by an efficient software tool that was fondly named Gopher. The Internet Gopher, much like the Web, enabled users to obtain information quickly and easily. Why, then, did it disappear but the Web did not? Gopher faded into obscurity for two main reasons: hypertext and commerce.

Before the Web there was Gopher, a nearly defunct Internet application protocol and associated client and server software.[1] In the early 1990s, Gopher burrowed a crucial path through a perceived bottleneck on the Information Superhighway. Internet Gopher passed away as a technological and social phenomenon quickly: Its inventors released Gopher in 1991. Within three years, the World Wide Web had bypassed it. Most people who surf the Web today have no idea what Gopher is, but in the 1990s it helped usher in a new age of user-friendly access to a rapidly growing universe of online information.

The name Gopher, unlike so many other computer-related mnemonics and acronyms, really does convey something about what the application does. In the vernacular, a "go-fer" is someone who fetches things, like coffee. Gopher retrieved data placed on servers connected to the Internet and served as a gateway to other Internet services. Gophers are also burrowing mammals, mirroring the way users tunneled through a vast digital landscape with Internet Gopher. Gopher addicts spent countless sleepless hours burrowing through the information repository known as Gopherspace.[2] Finally, the Golden Gopher is the mascot of the University of Minnesota, birthplace of Internet Gopher.

Professional information managers are quick to point out that data has little value unless organized in a meaningful way. Internet Gopher's inventors demonstrated one way to add value to the mass of data available on the Internet. They developed software to systematize, arrange, and contextualize data like documents, audio files, and images.[3] Other software developers contributed to the effort, creating even more software for searching and delivering "gopherized" content quickly, easily, and cheaply.

But Gopher as a technology is rarely used anymore, despite the efforts of a handful of individuals to revitalize the protocol. Why did Gopher fail? Many Gopher aficionados have a ready answer: pretty pictures. For them, the Web won and Gopher lost because the Web could display vibrant images of, for example, hand-woven Turkish rugs, animated glyphs of mice stuffing email into virtual mailboxes, and blinking advertising banners. Clearly, the "Gopher faithful"—as they are often called—are right about the importance of pictures. People get serious when money is at stake, and in the early 1990s lots of people came to accept the premise that large amounts of money could be made buying and selling goods on the Web. And commerce is usually greatly facilitated by being able to see the goods.

But the extant primary literature on Gopher—much of it available only in digital form—provides tantalizing clues, indicating that this answer does not go far enough. For instance, Gopher in its many client incarnations did not prevent or discourage the display of images found in cyberspace—quite the opposite. It just gave access to them in a way no longer appreciated. On the other hand, many early Web browser users turned the graphics capabilities off so that pages loaded more quickly.[4] And concomitant activity for a privatized national information infrastructure—which facilitated the growth of a visually rich commercial presence on the Internet—seems more staging than chief protagonist in Gopher's decline.

Most important, I believe, was the threat posed to Gopher by hypertext. The motivations of Gopher's primary architects and developers led to the creation of a particular type of browsable information system that—on the surface at least—appeared incompatible with the model embodied by the World Wide Web. Where the Web's principal developers, most notably Tim Berners-Lee, emphasized distrib-

uted processes that linked data in a nonlinear or decentered fashion with hypertext, Gopher's principal developers stressed and heavily valued their clients' library-like hierarchical interface. The Web epitomized the fluid and opaque postmodernist ethos. Gopher, by contrast, cleaved to the classical-modernist aesthetic of technology as one-dimensional, systematic, and transparent, with "depths that can be plumbed and understood."[5]

In this article, I argue that interest in Gopher waned because its least distributed, most hierarchical quality—cascading file menus—failed to hold the interest of a growing number of software developers, administrators, and inexpert users introduced to an iconographic, hypertextual online environment.

Origins of Gopher

Internet Gopher was conceived in the Microcomputer, Workstation, and Networks Center on the Twin Cities campus of the University of Minnesota. The Gopher team's leader, Mark McCahill, had his first brush with computing in eighth grade, writing Basic programs on his school's time-sharing terminal. Later, as a University of Minnesota undergraduate, McCahill found computers to be a turnoff. "There was a Fortran course that you had to take [where] you had to do punch cards," McCahill remembers. "I hated it because sitting and typing stuff on those keypunches and then submitting a deck to the operator … it just wasn't interactive."[6]

Instead, McCahill became infatuated with chemistry. Later, working as a summer intern on a federal grant studying water and sewage treatment plants, he met a group using an Apple II computer to analyze effluent. "It was interactive enough that it was fun," he remembers. McCahill began considering a career change, taking more computer science classes at the university, and looking for a job doing microcomputer support in the computer center.

McCahill quickly made a name for himself as a gifted application programmer within the university's computer center, working his way up to manager of the microcomputer and workstations systems group. He also did battle with the notorious Internet Worm in 1988.[7]

By the late 1980s McCahill, like many of his fellow "PC and workstation radicals," began butting heads with the administrators of mainframe computers, the then-workhorses of campus computing. "We had the distributed computing religion in a big way," recalls McCahill. One of his group's first distributed computing projects was the writing of

Macintosh computer software to replace Elm, a popular 1980s email system.[8] The team's answer was the PC-friendly POPMail (POP stands for post office protocol).

McCahill considered Elm an acceptable mail delivery system but one that was too difficult for "secretaries and nontechnical people."[9] Ease of operation for the uninitiated computer user was of great importance to McCahill, but POPMail also steeped his group in new ideas about distributed computing and client-server Internet applications. Some Gopher code came straight from the team's finished email client. Work on the email software provided both an ideology and the relevant expertise to ultimately develop Internet Gopher.

A widespread movement for campuswide information systems (CWIS, pronounced "kwiss") in the late 1980s and early 1990s exacerbated ongoing conflicts between the proponents of mainframe and PC environments. The CWIS was envisioned as a complex information space where students, faculty, and staff could engage in electronic self-publishing, retrieve course information, and have access to email, the online library catalog, campus phone book, and other remote facilities.[10] University administrators across the country had to make a choice: side with the mainframe establishment or side with the PC radicals in building their CWISes.

University of Minnesota officials first proposed a mainframe CWIS in late 1990. At this point, some of the earliest CWISes had already been running for several years at Cornell University (CUinfo), Iowa State (Cynet), Princeton (PNN), and elsewhere.[11] The first attempt to design a CWIS on the University of Minnesota campus, however, quickly degenerated into what microcomputer and workstation programmer Farhad Anklesaria later called "a classic design-by-committee monstrosity."[12] The fight over the CWIS between mainframe and personal computing proponents briefly turned ugly.[13] McCahill, for his part, called the university's mainframe CWIS proposal "crazy" and proceeded to ignore it entirely.[14]

The Internet Gopher Team learned much from the experience, as participants and bystanders. They grew firmer in their dislike of design by committee, preferring instead a freer exchange of ideas. They confirmed their suspicions that the proposed information system ought to follow the distributed model, with content published directly from anyone's personal computer, not just from central administration computers. "We got the idea that maybe we should let the people who create the

information publish it under their own computers," McCahill later explained.[9]

McCahill and Anklesaria soon submitted their own PC-oriented proposal. They recommended building a Gopher system composed of three unique parts: clients, servers, and the Gopher protocol. The client would become the user interface; the server would control document indexing and retrieval; and the protocol would govern communications between clients and servers. Any client that could translate the user's specific query into the protocol language, and any server answering the request coded using the Gopher protocol, could be incorporated into the system.

The proposal was at first coolly received by the administration. But given great latitude to follow up on their idea of creating a standard protocol as a basis for a CWIS, McCahill began assembling an "Internet Gopher Team." In April 1991 they released their Gopher CWIS to the world.[15]

The members of the original Internet Gopher Team at the University of Minnesota—particularly McCahill, Paul Lindner, Farhad Anklesaria, Dave Johnson, Daniel Torrey, and Bob Alberti—presented their Gopher, like their email software, as a way to make navigating an online information space easier. McCahill and Anklesaria both attribute libraries as the main inspiration for Gopher's basic design. "We both like libraries a lot," notes McCahill.

> My idea of a good time is to just go wander around where there is a big collection of books on the shelf next to each other and I find the one I was looking for and then I look at some others really close to it. … Browsing.[6]

Another source of inspiration for Minnesota's Gopher was Nextstep, the operating system of the now-defunct Next computer company.[16] McCahill's group had several of these machines. Users of Nextstep's file browser could scroll through columns of file titles on their computer's desktop. Titles were selected by a mouse click, and repeated mouse clicking and movement brought up the files represented by the titles or else more "child directories," new columns of titles from which to choose.[17] The Nextstep file viewer became a prototype for Gopher's ranked or graded menu-driven interface. Nextstep also supported full-text searches. Notes McCahill,

> I was in love with full-text searches, but I didn't want to write a full-text search engine because that would have taken a long time. … One of the

things NeXT was flogging with [their] machine was, "Hey, there's a digital library." In other words, full-text searches over a body of work. … I said, "Great, if we could weave full-text searches onto a hierarchical structure"—the hierarchy gives you a way to browse and organize the information and do the shelf browsing. … The full-text search engine lets you find things that you wouldn't find by shelf browsing.[6]

Constraints imposed by current technology also played an important role in the development of Gopher. Gopher, in its original incarnation, had none of the multimedia qualities associated with today's browsers. Gopher's inventors deliberately minimized CPU and bandwidth requirements. Speed instead was of paramount importance. A stark, menu-based system appeared to fit the bill perfectly.[18] The University of Minnesota "Mother Gopher" system itself relied on minimal hardware, initially completing 5,000 client-server transactions each day with two mirrored Macintosh IIci's.[19]

On the Information Superhighway

Gopher helped overcome what at the time was considered a critical lapse in the developing national information infrastructure, both on campus and off. In particular, as George Gilder of the Discovery Institute has noted, "There was a monstrous incongruity at the heart of the Internet. Its access software was at least 10 years behind."[20] The Internet, by the late 1980s, had become an exponentially growing mass of poorly classified data available mainly by using nonintuitive software. In 1984, the Internet had about 1,000 hosts serving up information to users. In 1987, there were 10,000. By 1990, the number of hosts stood at more than 100,000. Clearly, the access problem was growing.[21]

As computer historians Martin Campbell-Kelly and William Aspray wrote in *Computer: A History of the Information Machine* (1996), by the early 1990s "there were millions of documents, but no catalog and no way of finding what was useful."[21] Marc Andreessen, principal developer of the Mosaic Web browser at the National Center for Supercomputing Applications (NCSA), saw that

> PC Windows had penetrated all the desktops, the Mac was a huge success, and point-and-click interfaces had become part of everyday life. But to use the 'Net you still had to understand Unix. You had to type FTP [file transfer protocol] commands by hand and you had to be able to do address-mapping in your head between IP

addresses and host names and you had to know where all the FTP archives were. … And the current users had little interest in making it easier. In fact, there was a definite element of not wanting to make it easier, of actually wanting to keep the riffraff out.[20]

Andreessen was not alone in seeing this problem and working on a solution. "What was cool about that time was that nobody knew what was the right thing at all," remembers McCahill.

Brewster Kahle [founder of Wide Area Information Servers (WAIS) Inc.] was pushing full-text search solves all problems; just do it all in WAIS. . . . You [also] had the old standby-anonymous FTP-supplanted with an index so you could actually find the stuff: the Archie thing.[6]

FTP and WAIS (pronounced "ways") are protocols for sending and receiving files over a transmission control protocol/Internet protocol (TCP/IP) network like the Internet. These protocols, like Gopher and hypertext transfer protocol (HTTP) for the Web, start with the assumption that not all software for computer network communication need be stored in the same place. Instead, pieces of software (called modules or objects) are stored in multiple locations and executed from a distance. A *client* is a program that communicates messages to a server program, which in turn reads the message and carries out whatever order might be enclosed. A *server* is simply a program running on a computer that performs some service to various clients over a network. Clients and servers manipulate and combine data and procedures, but not all clients and servers necessarily speak the same language or have identical syntax in their communications. In a sense, the FTP, Gopher, and HTTP protocols allow "transparent" communication between otherwise incompatible programs and processes, regardless of location.

Client-server relationships have become the standard model for network applications today. A typical process for client-server computing begins with server software running on a computer (the server). The server is initialized, and then goes into stand-by mode waiting for a client on the network to request service. The client contact is initiated when the user enters a command to perform some work. The client transforms the command into a request directed to the server. The client may ask the server any number of things, from printing a document on an attached printer, retrieving a file,

or even returning the correct time. The client-server configuration is today generally considered efficient, reliable, flexible, and multiply redundant—an important feature for networks relied upon to carry critical traffic like bank account information and hospital records.

FTP, available since 1971, is a protocol for sharing files remotely.[22] Many institutions have FTP servers that act as repositories for documents, images, programs, and other data files. The servers are often specialized, favoring certain kinds of information and services. Anonymous FTP allows public users to access and download files in a designated directory for that purpose. Usually, the anonymous FTP directory is separated from the directories used by local users. Retrieval of a file with anonymous FTP required prior knowledge of textual commands and location identifiers.

It was often cumbersome for FTP users to keep track of the remote servers' location and content, which is why public Archie servers became important.[23] Archie was an application for finding specific anonymous FTP servers with data files of particular interest to the user. Archie automatically trolled the Internet for anonymous FTP information, presenting the user with a telnet-based client with a text-based indexed directory of filenames.[24]

WAIS software allowed Internet users to conduct more user-friendly text searches and retrieve documents. WAIS servers carried the databases of text to be searched and retrieved. WAIS client programs ran on the user's local machine, communicating with the server using the Z39.50 protocol. WAIS users first located a "source" or server with a relevant database, and then submitted words, which the client transformed into server requests for documents. The server returned lists of documents sorted by the number of "hits" recorded for each document. Users selected documents from the list for viewing on their own monitors.[25]

Another information system was based on the network news transmission protocol (NNTP),[26] a protocol used to send and selectively retrieve Usenet News. It supported a discussion list system for distributing information to and from network servers and reader's client software.[27] When the Gopher team set to work on their protocol and client-server software, they made sure to include gateways in their clients that let users retrieve information via FTP, WAIS, and NNTP.

Gopher at Minnesota combined both a lean client-server communication protocol and sleek software tools for using it. The Gopher client accessed a server list, or directory, of

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Internet Gopher Information Client v1.03

                    UIUC Gopher Information Service

  --> 1.  Welcome to the U of Illinois Gopher.
      2.  Campus Announcements (5/06/93)/
      3.  What's New?  (last update: 4/20/93)/
      4.  Information about Gopher/
      5.  Keyword Search of Gopher Menus <?>
      6.  U of Illinois Campus Information/
      7.  Champaign-Urbana & Regional Information/
      8.  Computer Documentation, Software, and Information/
      9.  Libraries and Reference Information/
     10.  Newspapers, Newsletters, and Weather/
     11.  Other Gopher and Information Servers/
     12.  Phone Books (ph)/
     13.  Internet File Server (ftp) Sites/



Press ? for Help, q to Quit, u to go up a menu          Page: 1/1
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Figure 1. Home Gopher menu and top-level selectors available from the University of Illinois, Urbana-Champaign, in 1993.

numbered choices, which McCahill later likened to Web homepages. In fact, McCahill called the first directory that appeared on the user's screen the "Home Gopher." Successive selections from this Home Gopher took users deeper and deeper into a hierarchy of subdirectories, eventually routing them to specific locations with detailed content, documents, or data files. Menus, more forgiving of faulty memories of locations or filenames, were a distinct advantage. Menus could also be "bookmarked," an idea predating the Web.[28]

The directory items (see Figure 1) that appeared, called selectors in Gopherspace, resided on the server. Information encoded in gopherized selectors gave clients the server's domain name, the type of selector (that is, whether it was a directory, a file, or a search engine), and the unique location string necessary to retrieve the item. Servers could be linked together by Gopher server administrators (so-called Gophermeisters) so the user could surf seamlessly.

Praise for Gopher was general and pervasive—and not simply from technical people. Wrote Peter Havholm in the Department of English at Wooster College, for example: "From my perspective, the Internet with anonymous FTP but without Gopher is like the ancient world before the Library in Alexandria."[29]

Gopher's spread in the community

Early CWIS development usually overlooked the possibility of online connections between universities. Internet Gopher, too, initially served only the humble ambitions of University of Minnesota students, staff, and faculty who wanted to rapidly and easily find answers to their questions about campus com-

puting facilities. This situation did not last long. The University of Minnesota Gopher team deliberately facilitated growth in the number and variety of Gopher utilities by freely distributing software from its FTP server at boombox.micro.umn.edu and posting a notice to a campuswide information systems mailing list on Usenet.

News of Gopher spread rapidly in academic computing circles as a potential solution to the seemingly intractable CWIS problem. Dennis Boone at Michigan State University recalls that his group set up its first "semi-official" server during the winter of 1991–1992. The story has familiar echoes:

It was becoming clear that general computing on the mainframe was not going to last much longer. Lab management noticed the unofficial gopher server and combined the realization that they should work towards an official Campus Wide Information System with the understanding that our group needed to be redirected. ... Rich [Wiggins, the group's leader] and I also spent a fair amount of time talking to various librarians about schemes for topical categorizations. ... It seemed foolish to reinvent the wheel. We struggled with the fact that different people approached search problems in different ways, that all existing classification schemes provided inconsistent coverage, and that most schemes were either too shallow or too deep. Our Vice Provost weighed in with the desire for the Gopherspace structure to resemble the administrative structure of the University. (We shot that one down on the basis that the campus arena where basketball and touring performers play is lost in some arcane part of the U bureaucracy.) In the end we wound up with a monstrosity designed by committee, and several relatively good conclusions, which appear in the design rules: lots of help, navigational aids which address the varying search habits problem, adaptive depth and splitting of content.[30]

The decision to implement Gopher as a solution to CWIS rarely came from high-level administrators.

A number of early conferences put together by interested information systems and digital library groups also cemented new respect for Gopher. People like Clifford Lynch,[31] director of the Division of Library Automation at the University of California, Peter Deutsch of Archie fame, McCahill, and Berners-Lee were adept at conveying a spirit of urgency and endless possibility opened up by distributed computing and electronic publishing.

The Internet Gopher Team also nurtured their protocol and software by starting their own conference. Between 1992 and 1995, CICNet[32] and the University of Minnesota hosted four "GopherCons," invitation-only workshops for Gopher developers. The workshops were divided into technical development and practical applications sessions. Participants at GopherCon '92, for instance, heard McCahill and Anklesaria playfully describe Gopher as "Internet duct tape"[33] for splicing together a fractured networking world. Librarians at the same meeting spoke about the necessity to index Gopherspace to aid in "resource discovery and navigation" or in more traditional lingo: "collections development, cataloging, and filing."[34]

Boone, who attended and helped organize the first GopherCon, remembers the meeting well. "Mark and his staff brought a handful of small signs, which he intended to hold up as people made suggestions," he notes.

> One of them said 'Hairball,' and the page was mostly full of what could only be a drawing of one. It was clear that while they wanted to listen to suggestions and share the development effort, they felt that they had an internal UMN responsibility as well as the one that grew from open distribution of the software.[30]

More than 250 people attended the second Gopher conference in 1993. Among them were representatives from Apple, the Center for Networked Information Discovery and Retrieval, the *Chronicle of Higher Education*, IBM, Microsoft, Motorola, the National Aeronautics and Space Administration's Goddard Space Flight Center, the *New York Times*, the Northwestern Online Total Integrated System (NOTIS), the World Bank, Xerox Palo Alto Research Center (PARC), and many universities from around the world in 1993.[35]

By nearly all accounts, Gopher in 1993 was as least as cool among the geek glitterati as the Web would soon become. MTV veejay Adam Curry set up an MTV.com gopher and wore his Internet Gopher World Tour T-shirt on the air. With much pomp and circumstance the White House unveiled its first public Gopher on *Good Morning America*. In 2000, I myself heard Rosie O'Donnell wistfully recall on her TV show how Richard Dreyfuss had introduced her to Gopher on the set of *Another Stakeout* (1993).[36] Gopher clients quickly became available for most operating systems and were rapidly disseminated to places as far away as France, China, and Japan. These developments were

especially astonishing because the only content one could gopher to at first was cookbook recipes and tech support documents for keeping Gopher running.[37]

Gopher represented one of the first attempts to introduce the power of the Internet to ordinary folk, even if few regular Joes ever used it.[38] McCahill on several occasions called Gopher "the first Internet application that my mom and dad could use." Almost unfathomable today, just the idea that laypeople might want to use Internet resources—and that software developers and support people would encourage them to do so—was not assumed in the early days.

Ease of use was of paramount importance.[39] Gopher had several advantages over other client-server software in the early 1990s. Gopher was easy to set up and required little maintenance. Documents already existing in cyberspace as well as newly created ones required little or no special formatting. The small file sizes one encountered or created with Gopher rarely overwhelmed the at-home modem connection. The protocol, in fact, could run on many last-generation machines because it favored lowest common denominators like plain text—the Gopher team disparagingly labeled amenities like tabs and form feeds froufrou. The menu-based interface also simplified indexing.[40]

"Gopher was a big deal because it was easy to install," noted McCahill. "A lot of people could run it. And the more people who installed the software, the more information was available on servers."[9] Former *Rolling Stone* journalist Stewart Brand's description of the buoyant philosophy of Silicon Valley's offbeat computer jocks of the 1970s—"putting maximum computer power in the hands of every individual who wants it"—echoes McCahill's aim in the 1990s.[41] Ordinary people, McCahill argued, could and should have exceptional power at their fingertips.

Gopher remained surprisingly true to McCahill's vision. Gopher clients were "fun" to use and required minimal training. Gophermeisters exhorted new users to just "play with it" and "keep making choices to see what pops up."[42] The Internet Gopher Team with their protocol conscientiously reinforced and magnified the ideal of personalized exploration of cyberspace.

Users often did not know how Internet Gopher worked, but that did not prevent them from logging long hours looking for answers. Students at the University of Georgia used Gopher to virtually browse the shelves of the

> **Faculty and students at the University of Utah accessed Gopher to get timely reports on avalanche dangers … , announce the date of the faculty-staff pig roast tailgate party, and post information on the Bellydance Festival.**

university's science library, to find out what was for lunch in the cafeteria, or to see how the day's weather might affect their plans. Faculty and students at the University of Utah accessed Gopher to get timely reports on avalanche dangers in backpacking country, download the governor's speeches on educational technology, announce the date of the faculty-staff pig roast tailgate party, and post information on the Bellydance Festival. Seemingly everywhere, campus users formed a first generation of Internet addicts, mesmerized by streaming video demonstrating basic chemical reactions, electronic editions of *Moby Dick,* and online campus crime statistics.

Some Gopher services were truly pioneering public Internet experiments. Ed Stawick designed LegiSlate, a prototype Gopher developed by the University of Minnesota and the *Washington Post* to electronically publish government proceedings recorded in the Federal Register and the full text of bills laid before Congress.[43] Massachusetts' *Middlesex News* provided its users with a gopher to give them access to a selection of the next day's articles, restaurant reviews, and editorial columns, much as the *New York Times* does today. Elizabeth Miller and others built the federal government's sprawling Library of Congress Machine-Assisted Realization of the Virtual Electronic Library (LC Marvel) gopher, which offered "easy and well-organized access to government information and to library information, online catalogs, and library gophers."[44]

During the years of rapidly growing GopherCon crowds, gophers themselves mul-

tiplied. Said Albert DeSimone Jr. of University Computing and Networking Services at the University of Georgia, "If ubiquity is a virtue, then Gopher is a candidate for sainthood."[45] Soon there was standard gopher software for Unix, VMS-based DECs and MVS-enabled IBMs, and for personal computers running DOS, Windows 3.0, and OS/2.[46] Perhaps because it blossomed in university educational settings where students soaked up freely available computer lab time, the most popular client was TurboGopher for the Apple Macintosh.[47]

Gopher also benefited from its own Archie-like indexing software. Archie had helped people find documents on FTP servers, but the Internet Gopher Team had initially implemented no similar service beyond the modified Next Digital Librarian, which served up directory indexes. Then, late in 1992, Fred Barrie and Steve Foster at the University of Nevada at Reno introduced Veronica (for "Very Easy Rodent-Oriented Netwide Index to Computerized Archives," a pun on the Archie comic book series[48]) making it easy to search large numbers of gopher servers rapidly.[49]

Barrie remembers that in the summer of 1992 Gopher was the "hottest new thing on the Internet." Together, Barrie and Foster set up a gopher server and began encouraging other departments on campus to install their own gopher servers. However, one thing was missing, a Gopherspace-wide index. But, as Barrie remembers, "The hierarchical nature of the protocol lent to a[n] easy recursive algorithm to push directories on a stack to search an entire gopher server."[50] Thus Veronica was born.

Veronica was both a software agent searching the Internet for gopher files and a powerful search engine. Veronica collected and indexed directory information and filenames across known Gopherspace, which could then be searched with Boolean queries. "We used the NeXT Digital Librarian as the first search engine," remembers Barrie,

> but I did not like the results that we were getting, so I rewrote the search engine in Perl. … The Veronica server was almost a direct copy of the 'Simple Sample Server' in the Perl book [*Programming Perl* by Larry Wall], with a few changes for the Gopher protocol.[50]

Barrie and Foster called what the Veronica server did in combing Gopherspace for new material "harvesting." It took 30 or more hours for Veronica to harvest the entire collection of 10 to 15 million gopher selectors found online. Frequent harvesting was crucial because up to

10 percent of the locations and content on Gopher changed every week.[51] By the spring of 1993, Veronica was responding to 150,000 requests placed at its search engine per month, and by early 1994, it was handling more than one million requests per month.[52]

In the quest to index Gopher items, an important adjunct to Veronica, and which continued the name play based on the Archie comics, was Jughead. Rhett "Jonzy" Jones in the University of Utah Computer Center crafted Jughead (an acronym for the unwieldy "Jonzy's Universal Gopher Hierarchy Excavation And Display") in 1993. Gophermeisters and digital library staff liked Jughead because it allowed them to limit the number of file hierarchies to be searched, thereby returning relevant results far more quickly. In general, the maximum number of hits returned via Jughead was 1,024—a large number but small in comparison to the number returned by a Veronica search.[53]

How the Web won and Gopher lost

Work on Internet Gopher accelerated between 1991 and 1993 as development teams at the University of Minnesota, Michigan State, and elsewhere began implementing the protocol, server, and client as a general-purpose CWIS. But of course we now know that the Web won and Gopher lost. Why and how— and when—did this happen?

Certainly the Web's stalking-horse was afoot almost immediately after Gopher's debut. The World Wide Web was the brainchild of Berners-Lee, a researcher at the Centre Européene des Recherche Nucléaire (CERN), a pan-European high-energy particle physics institute in Geneva, Switzerland. At CERN, in response to a proposal floated in 1990, Berners-Lee's group developed a protocol (HTTP), a server (informally called a "Web server"), and client software (a "Web browser"), as well as a language in which to author new Web pages called HTML (HyperText Markup Language). The new technology also included something called hypertext, partially inspired by Ted Nelson's ideas for Xanadu, an electronic publishing tool for automating the "deep connection" of documents.[54] Berners-Lee developed his information system for use by CERN researchers and other physicists working with high energy. He hoped that hypertext-linked documents and other material would better facilitate collaboration and resource sharing in scientific communities.

The Web became fully functional at CERN in May 1991, but in August 1991 Berners-Lee released details of HTTP to the Usenet news-group alt.hypertext and shortly thereafter made the browser software generally available. Both of the original CERN browsers left much to be desired. The first browser was for use exclusively on Next computers. The second was a simple VT100 line-mode browser that could run on almost any platform but only by sacrificing user friendliness. Still, by the end of 1992, more than 50 Web servers were operating across the globe.[55]

The breakout years for the Web were 1993 and 1994. In 1993, a team led by Andreessen and Eric Bina at NCSA developed the Mosaic browser, which included hypertext and an easy-to-use point-and-click graphical user interface. In 1994, Andreessen joined entrepreneur Jim Clark to found Netscape Communications Corp. and commercialize their browser.

Speculation about the Web infiltrated the Gopher community almost from the start, but so-called Gopher flight was not appreciable— at first. Ed Vielmetti of CICNet graced the first GopherCon in 1992 with a paper on "what we would be gathering to discuss if the University of Minnesota had never developed Gopher," namely the World Wide Web. Vielmetti in his presentation described the Web as a model of what Gopher might become, and speculated on the possibility of having Gopher pointers to Web content.[56]

Other attendees, however, found little to appreciate in Berners-Lee's software. "During the first GopherCon, the Web was this crypt[ic] thing," remembers Billy Barron, a VAX/Unix systems manager at the University of North Texas.

> The installation document was written in HTML, which was 'Greek' back then. The only major client was the CERN Line Browser, which was just horrible. The Web was this thing that looked like it could be interesting, but was poor on implementation.[57]

Michigan State's Wiggins, at a May 1993 meeting of the Internet Engineering Task Force in Columbus, Ohio, summarized the community's mood: "Gopher is 'winning,'" he wrote, for six major reasons:

1. Client software is available on popular platforms (PC, Mac).
2. Good VT100 support via 'curses' [a Unix routine, which controls cursor actions on text-based terminals] client.
3. The perception that hypertext is inherently complicated … (this perception is of course not shared by WWW adherents).
4. The relative ease of setting up a server. Some
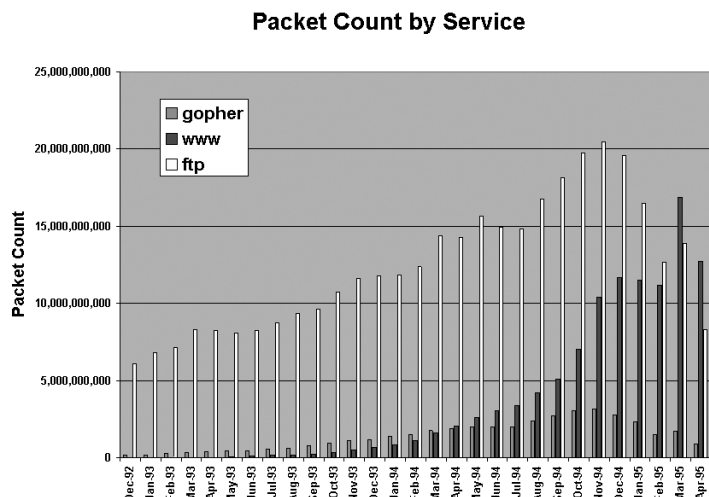
Packet Count by Service

Figure 2. Estimated NSFnet backbone packet traffic for Gopher, World Wide Web, and file transfer protocol, December 1992–April 1995. (Courtesy Merit NIC Services and Georgia Tech's Graphics, Visualization, and Usability Center.)

folks have a Gopher server running within an hour or two of downloading the package. … (one attendee reported that the installation documentation [for Web server software] came in HTML … creating an interesting bootstrap problem.

5. U Minn as a central registry in the US, providing visible 'home page' for all Gophers.

6. Gopher is very strong at linking to various document types. You can point a Gopher server at a Unix mail file, a WAIS server, or an FTP site, and <boom> you've got an instant gateway.[58]

Many technical people remained unconvinced of the Web's potential late into 1993. Lou Rosenfeld, founder and president of Argus Associates, remembers that in October 1993,

I invite[d] Rich Wiggins, Internet god of Michigan State University and author of *The Internet for Everyone*, to speak to my class at UM. [Wiggins said] 'I know you're all very involved with Gopher right now, so prepare yourselves: very soon, the Web will take off. This new graphical thing called Mosaic is going to change everything.' Yeah, right, Rich.[59]

Gopher's fall and the Web's rise

Statistics are also available documenting Gopher's rise and fall. One of the most common Internet measurements is packet traffic. A packet is a piece of data, usually partitioned from a longer message, to which is attached

information like sender and destination addresses as well as check bits. A typical packet size is 1,000 to 1,500 bytes.

In December 1992, the Gopher protocol stood at 13th on the list of applications moving packets on the NSFnet backbone. The HTTP (Web) protocol stood at 186th. By June 1993, Gopher ranked 11th and the Web 21st. By December 1993, Gopher ranked 9th and the Web 11th. In April 1994, the Web surpassed Gopher for the first time in terms of number of packets traversing the NSFnet backbone; their positions had reversed (the Web stood at 9th and Gopher in 11th place). By December 1994, the Web had climbed to 3rd and Gopher rose to 9th. In the spring of 1995, the Web surpassed all other applications in terms of NSFnet packet traffic; Gopher slipped to 10th.[60] The NSFnet packet count for FTP, Gopher, and the World Wide Web are summarized in Figure 2.

Packet traffic, however, can be a misleading way of measuring the popularity of various protocols. First, graphics-heavy applications like the Web generate more packets than a text-based application like Gopher. Packet measurements also indicate nothing about who uses which protocols and for what purposes. For instance, in 1993 FTP—ranked number one—alone handled more than 20 percent of all packet traffic. One should certainly not construe from this that FTP was easier for the novice to use. Many other factors also cloud the picture: The Web was more popular in Europe, and earlier, but this is not reflected in NSFnet packet statistics; packet traffic counts are complicated by servers using unassigned ports; much data on WAIS was served up by Gopher without appropriate attribution; moreover, packet traffic counts are usually based on sampling.

Another way of measuring the success of each system is achieved by counting the number of servers running Gopher and Web software. In November 1992 with the debut of Veronica, there were 258 known Gopher servers. In May 1993, about 400 registered Gopher servers (and 1,100 unregistered Veronica-harvested ones) were connected to the Internet against only 50 HTTP (Web) servers.[61]

This information is summarized in Table 1.

This type of data also has problems. For instance, only about 40 percent of Gopher servers in the world used the "well-known" Internet Assigned Numbers Authority (IANA) port,[62] making identification of server hardware and software more difficult. Knowing the number of servers is also not necessarily the best

indicator of the number of actual users. Still, from these two data sets it appears that although interest in Gopher may or may not have flagged in late 1994, the Web nevertheless overtook it in terms of raw packet traffic on the NSFnet and in server numbers.

Interest in the Web also began outpacing interest in Gopher. Most quantitatively, in December 1993, Northwestern University mathematics professor John Franks noted that the volume of posts to the Usenet group comp.infosystems.www was double that of comp.infosystems.gopher. Wrote Franks, "A few months ago it was the reverse. I will leave it to you to decide if this means WWW is winning or losing :)"[63]

Commercializing Gopher

Gopher emerged and disappeared at a vulnerable moment in the national growth of computer networking. When the Gopher team first released their protocol and client-server software to the world, they labored under a special "acceptable use policy" prohibiting use of the federally sponsored NSFnet backbone services for commercial purposes.[64]

Already by 1988, however, the National Research Council and the National Science Foundation started a remarkable series of dialogues and issued a report, "Towards a National Research Network," which famously attracted the attention of then-Senator Al Gore.[65] The Clinton-Gore administration promoted the building of this national network—an "information superhighway"—as social and economic policy.[66] The cause was embodied by debate over the shape of a vast new National Information Infrastructure (NII), which included plans to privatize the NSFnet backbone. The Internet's privatization was not fully realized until the decommissioning of the backbone on 30 April 1995, but it had already captured the imaginations of many who saw endless possibility and perhaps personal fortune in NII proposals and legislation.

McCahill also realized that the ongoing debate about the Internet's future was blurring the line between university research and commerce. "In the early days I had to explain to the networking guys around here that it was okay to be doing some of this stuff because we can use it for the students," he remembers. Still, moving from a position where commercialization was a goal to actually supporting commercial content represented a significant shift in direction. For instance, McCahill made "no provisions for advertising" with Gopher because you simply "couldn't do that."

Table 1. The number of Gopher and Web servers installed at different times during the years 1992, 1993, 1994, and 1995.

Date	No. of Gopher Servers Installed	No. of Web Servers Installed
Nov. 1992	258	
May 1993	1,100	50
June 1993		130
July 1993	2,018	
Nov. 1993		270
Dec. 1993		623
Apr. 1994	6,958	
June 1994		2,738
Sept. 1994	4,488	
Dec. 1994		10,022
Jan. 1995	5,057	
June 1995		23,500
July 1995	9,046	

Given this changing environment, the commercialization of competing information systems was not particularly unusual. Archie left its university base at McGill University and became a commercial product marketed by Bunyip Information Systems. Netscape Communications took Mosaic and turned it into a $2.6 billion initial public offering. WAIS, a project supported by Thinking Machines, had always been proprietary technology. McCahill, for his part, did not seriously consider leaving the University of Minnesota to found a Gopher startup because the venture capital necessary just "wasn't there."

The Internet Gopher Team had no great marketing plan for Gopher technology when they released it into the wild in 1991 and were just as surprised as everyone else by Gopher's quick adoption. The team thought nothing of freely giving away Gopher software, and members derived their reward mainly in terms of acclaim for their "hack." Despite this, however, Berners-Lee and others have argued that—at least in part—money eventually got in the way of Gopher's success. The culprit in Gopher's demise, Berners-Lee has said, was licensing.[67]

Gopher's rapid success put tremendous pressure on the Gopher team. Maintaining old Gopher clients and servers and developing new ones for other platforms consumed a large and growing share of resources in McCahill's group. Within months of Gopher's release, it became apparent that supporting Gopher would become an acute problem unless some other way of funding the project could be found.

The university's computing facilities at the time faced extraordinary budget problems, potential layoffs, and possible outsourcing of

the entire operation to a private company. Noted McCahill, "We [didn't] have much choice but to say, 'You know, budgets are super-tight here and we are putting a ton of effort into this.'"[6] In the context of Internet-wide commercialization the question became, as CICNet's Vielmetti explained at the time, "How are we going to fund development of tools that tend to get used for free?"[68]

Gopher licensing rumors first began swirling in February 1993 in response to an article in *Network World* announcing the University of Minnesota's intention to commercialize Gopher.[69] On 24 February McCahill mapped out his university's position:

> While lots of information wants to be free (look at all the stuff currently available via anonymous ftp and gopher), some information isn't going to be available unless there are some mechanisms for charging. We want gopher to be a tool that allows you to get at both flavors of information … and we have this funny feeling that if our software is being used for commercially [sic], we ought to get something in return. We have been able to justify making gopher freely available to the higher education community based on the idea that it makes more information available to us (and everyone else) on the Internet. However, when someone starts making money from our work, it makes sen[s]e for the University to get a piece of the action. In fact, we have already done some deals already with the commercial world for use of our software, and hope to do more deals in the future. … Our plan is to continue to make gopher freely available to the education community because this gets more free information available online for us and everyone else on the Internet. In the case of commercial use of our software we are very interested in doing licensing deals because this gets us the resources to do more development and support.[70]

The reaction of the Gopher development community was swift and critical. Two days after McCahill made his case, J.Q. Johnson, director of network services at the University of Oregon, outlined his concerns:

> Although I understand and even endorse the goals of U Minn's development group in recouping its costs by taxing commercial use, I'm concerned that the policies as stated are sufficiently vague to scare off lots of people. . . . Is it U Minn's position that the protocol itself is protected? How about independently developed clients and servers? . . . If the University of Minnesota planned to try to make the gopher protocol pro-

prietary, then I for one would start looking for an alternative, and would stop contributing to the gopher development effort.[71]

Later in the day, Gopher team member Paul Lindner responded to Johnson's critique:

> True, the vagueness does cause unnecessary confusion. We really haven't had any lawyers really look at it. We've taken the common sense approach. If you use gopher to make money, then the U of Minn wants something in return. … I know that the UofMN will take a moderate stance on these matters. … Greed would kill gopher, believe me … [72]

The next day Johnson appeared mollified after a private talk with McCahill. Wrote Johnson in a follow-up posting:

> U Minn has not made what I would consider a definitive formal statement on that yet, but the outline of their intent seems to me to be: essentially unlimited internal use by universities (presumably even if such use is restricted or makes the university money through tuition, or charging for CPU time on timesharing systems, or whatever); essentially unlimited use of server software obtained from U Minn by anyone else as long as the information is freely available to the Internet; essentially unlimited use of the client software as long as you don't charge for the use.[73]

Others continued to voice concerns. Wrote Vielmetti in a 28 February 1993 post:

> It would be nice to be clear on which of the vast assemblage of code that has gone into the Gopher project has a U Minnesota copyright on it, which is effectively uncopyrighted, and which is available under a GNU or similar license. … Can I even use the code that I contributed to the project without having to buy it back? … Mark, I hope you have really and truly sat down with your University lawyers and that they know and understand what it [sic] going on here. When I look at the code base as of (say) 1.03 there was no hint, no clue that there were any commercial restrictions on the code, no notices of anything except that you borrowed code from nntp and from elm and from the Stevens[74] book.[75]

Minnesota fortified its position in mid-April 1993 with a formal licensing announcement made at GopherCon by Shih-Pau Yen, Minnesota's director of computer and information services. Yen outlined a three-tier program to offer different Gopher server licenses

to institutions of higher education, small businesses, and larger corporations. Licensing took the form of an annual fee based on the size of the firm using Gopher software. All the software would remain free to non-profits, educational institutions, and individuals. Yen also announced that all software created by Minnesota's Internet Gopher Team before the April meeting would be considered freeware.[76]

Despite the controversy, most software developers inside and outside academe were willing to submit to some sort of fee to pay for future Gopher development. How the fee should be paid was another matter. Many thought that although software developers at minor institutions and small companies might balk at a hefty development price tag, most major universities and corporations would not bat an eye. One attendee suggested that donations be solicited to pay for Gopher. Another suggested that licensing clients made more sense than licensing servers. Some favored giving clients and servers away for free but charging for training and documentation.[77] Several members of the Gopher community liked Wiggins's idea of establishing an independent "Internet Gopher Consortium," if only to break the de facto lock that the University of Minnesota had on server software development.[78]

Wiggins thought that companies, universities, and individuals should contribute to the effort by paying licensing fees to the consortium, which would take on the task of Gopher development coordination. The Internet Gopher Consortium might operate something like the X Consortium for X Window System development at the Massachusetts Institute of Technology (MIT), or the yet-to-be established World Wide Web Consortium, W3C, founded in October 1994. The University of Minnesota's Lindner liked the idea, but it went nowhere.[79]

The proposed consortium might have alleviated many of the concerns of Gopher developers who felt that Minnesota was not responsive enough to the community's needs. Over the next several years, developers and users vented their frustrations over Minnesota's sluggish response to requests for bug fixes, updates, and new clients.[80] Licensing only slowed the process further as the Gopher team became reluctant to share source code.

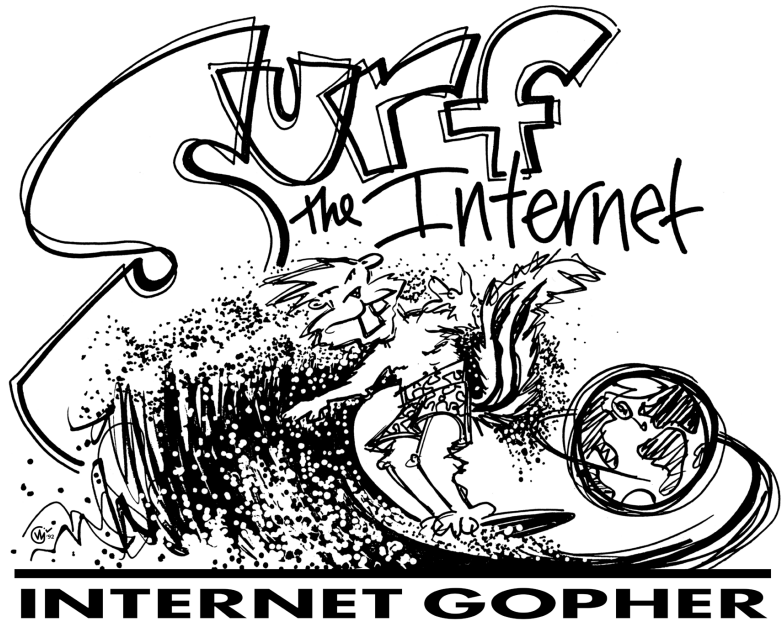Potential licensees also fretted about poor

Figure 3. Surfer Dude T-shirt design. Mark McCahill, a windsurfing enthusiast, pioneered use of the phrase "surfing the Internet" in a 24 February 1992 Usenet post. (Copyright 1992 and 1994 W. Jedlicka.)

channels of communication with Minnesota. "I set up a server here with one entry for our commercial stuff, and the rest, hopefully, information of value to the 'Net at large," reported Bill Middleton of Texas Metronet.

> I sent off a letter to the Gopher development folks at UMN, asking them to render a decision as to our exemptability, or at least, our discount :) A few days later I got back a letter from someone there saying that we would not have to pay, provided we continued to make available the other stuff for free. I was also told that the Boss Man at UMN would get back with me to confirm this. But that never happened.[81]

Minnesota's indiscriminate policies alienated some. Shortly after MTV's Curry wore his Internet Gopher T-shirt on television (see Figure 3), the University of Minnesota sent him an unexpected letter requesting $5,000 for a Gopher license. It was, as Curry put it, "The first dot-com valuation!"[82]

Still, Gopher continued to enjoy growing popularity in the summer of 1993 despite the licensing controversy, and the claim that commercial licensing caused Gopher users to quit using it is easily overstated. All of Gopher's main competitors at the time also pursued licensing with varying degrees of success: The startup WAIS, Inc. began licensing commercial versions

> # All along, McCahill accepted Gopher mainly as a content-rich document delivery system, not as a "frilly" advertising medium.

of its software the same month as Gopher.[83] The NCSA released the source code for its Mosaic server and placed no restrictions on its non-commercial use but still required companies to get a license.[84]

More importantly, an overwhelming number of individual Gopher users had no commercial aspirations and therefore remained unaffected by the licensing requirements. The Gopher faithful tended to be professors, students, and staff at major universities and colleges, as well as tech-savvy early adopters who were as interested in the programming feat as in any potential for profit. Barron, for one, remembers the licensing dispute as only "one of the final nails in the coffin."[85]

"Pretty pictures"

The "pretty pictures" argument, a corollary of Internet commercialization, is insufficient for many of the same reasons. McCahill and others have concluded that advertising more than licensing made the Web a more attractive browser. Advertising, McCahill has said, "made for a perfect environment for WWW, because with the graphic-heavy pages, there is a great place to put your ads." Multimedia capabilities made the Web visually exciting if not necessarily more informative. As Mike Franks put it in the *Internet Publishing Handbook*, "The biggest drawback to Gopher is that it just isn't as sexy (or impressive in appearance) as WWW can be."[86]

McCahill has since defended his decision to favor plain text documents over those with embedded graphics and other add-ons:

> Widespread use of inline graphics to create visually rich pages make sense as an advertising vehicle since the aim is not to create a quickly traversable information hierarchy. Gopher directories make it possible to locate pertinent information relatively quickly.[87]

As late as 1996 he asserted: "I think I'm in the library business, not the billboard and ad business." All along, McCahill accepted Gopher

mainly as a content-rich document delivery system, not as a "frilly" advertising medium.[37]

Gopher did have multimedia capabilities. Gopher was extensible to 255 different data types. Images or graphics could be uncovered simply by running Veronica searches with a preference selected for these types of files. HyperGopher (introduced in 1993) enhanced the protocol's ability to display images. The developer community was well aware of the need to develop and publicize Gopher's ability to handle both graphics and sound. Lindner, for instance, rigged up the first Gopher that played music in real time after becoming frustrated with the positioning of the Minnesota group's shared boom box,[88] and large audio files from the 1992 presidential debate on the Michigan State campus were also archived on Gopher.[89]

Gopher just did not permit inline graphics or access to audio and video right on the page. "Although [Gopher] can make picture files available for download," Franks noted, "it can't mix the pictures and text together in a glossy brochure-like presentation as WWW can."[86] The Gopher team, for its part, did not like the Web's handling of multimedia. McCahill preferred links to graphics-enriched document files as an alternative to the limited Web design permitted with early HTML editors. "The idea of HTML, which said, 'Well, I'll give you some rough hints about kind of the size and you kind of figure out how it gets laid out on the page,' was a little bit offensive to the graphics designers' sensibilities," says McCahill.

> If you really care about pretty graphics, HTML is the wrong place to do this. At least early incarnations were completely wrong. We really liked [Adobe] PDF because you got absolute control over layout, location, and all that stuff.[6]

Limited bandwidth initially conspired against browsers like Mosaic too. Graphics-laden Web pages in 1993 could easily take 30 seconds to several minutes to download. So slow was Mosaic in retrieving pages that people had the option of mouse clicking on the client's animated graphic of two rotating orbs to stop a data transfer. Users often simply turned off the display of images in early browsers so that the text part of pages loaded more rapidly.[90] Several prominent members of the wired community objected to all the "callipygian naked-lady bitmaps" circulating on a sluggish Web. Most prominent was Berners-Lee himself who strenuously objected to Web pages that existed for the sole purpose of delivering streaming video and images.[20]

"Pretty text"

The most profound difference between the Web and Gopher was to be found in the user interface. The Web adopted a distributed metaphor for displaying and linking together information. Gopher instead adopted the relatively inflexible display of hierarchically structured data.[91] That decision had serious ramifications, for it was "pretty text"[92]—hypertext—that did more damage to Gopher's standing as a user-friendly information system than did growing pains related to commercialization.

Many critics have described our time as the twilight of the Age of the Book where, as historian John Lukacs has recently written, "moving pictures and … television led to a condition in which the routine imagination of large masses of people became pictorial rather than verbal."[93] The derogation of the printed word did more than replace the alphabet with iconography. Indeed, the culture of electronic media trivialized the serial nature of reading for the masses, replacing it with a multidirectional distributed form.[94] As University of California at Los Angeles (UCLA) professor emeritus Richard Lanham has commented, "The 'Great Book,' the authoritative text, was built on the fixity of print technology. That fixity no longer operates."[95]

Eroding cultural assumptions about the way information, among other things, ought to be ordered placed Internet Gopher at a severe disadvantage. It called into question the need for an underlying structure—like a library of carefully ordered books traceable to a similarly ordered card catalog. Many computer information systems experts mercilessly attacked traditional library science. Typical was the following comment:

> Libraries have card catalogs by subject, by author, by title, etc. I'm unconvinced that this is sufficient or th[at] even librarians have all the answers. It's much easier to change a computer menu than a card catalog. Let's be creative here. What other ways are there to categorize information that real users can use?[96]

And, as McCahill now admits, "Libraries are not that big a part of everyday life. They are a nice thing to have around, but that's not where the bulk of the action is in the world. Probably it never will be."

The devaluing of serial order represented an attack on the very root of Gopher: the hierarchical file menu system. Gopher's menus were organized hierarchically because that is what the Internet Gopher Team assumed users would intuitively, or by habituation, expect

from such an application. Gopher would thrive on its straightforward layout, building on computer users' familiarity with the hierarchical file systems common to the many computer operating systems invented since Fernando Corbató and a team of MIT researchers developed the first "hierarchical" file system for the pioneering Compatible Time-Sharing System (CTSS) in the mid-1960s.[97] As the Gopher team pointed out in their first position paper issued in March 1993:

> While documents (and services) reside on many servers, Gopher client software presents users with a hierarchy of items and directories much like a file system. The Gopher interface is designed to resemble a file system since a file system is a good model for organizing documents and services.[98]

Yet, historian Janet Abbate has argued that the World Wide Web, unlike Gopher, "put a human and more democratic face" on the infrastructure of the Internet.[99] Berners-Lee also did not admit the superiority of hierarchical ordering of information. In the autobiographical *Weaving the Web* (1999), Berners-Lee argued that the Web was instead more amenable to, and indeed much like, human cognition. "A computer typically keeps information in rigid hierarchies and matrices, whereas the human mind has the special ability to link random bits of data," he wrote.[100]

The not-so-secret weapon for accomplishing this was hypertext, text embedded with clickable pointers to more text.[101] The Web's architects gave fluidity to file structure by encouraging the arrangement of information in terms of an "egalitarian" mesh where each piece of information is potentially referable to any other. Berners-Lee, Andreessen, and many others since have deliberately advanced this "intertwingled"[102] online experience. Hypertext gave precedence to the distributed rather than hierarchical layout of information.

The perception of fixed hierarchy became Gopher's greatest liability. Internet Gopher emphasized the orderly arrangement of information according to a predetermined yardstick or rule. But determining the "one best way" was a subject of intense debate. "Menu design is indeed a tough nut to crack," wrote Wiggins.

> No matter how the menu is designed—well or poorly, depth—first versus breadth-first, long titles versus short-the user's way of organizing the world is not necessarily going to match the thinking of the menu design committee.[103]

Librarians also complained about the arrangement of information under Gopher. "There are a few honourable exceptions to the rule," explained Giles Martin of the University of Newcastle (Australia) Libraries,

> but most Gopher menus seem to have been constructed by amateurs wh[o] have given little or no thought to how their Gopher provides coherent access to the materials within it, or how their little fragment of the universe of knowledge fits into the rest of the universe.[104]

Following the trunks of Gopher menus down to the ends of their branches and back again posed a particularly vexing problem. Many users drilling down deep into the hierarchical chains of poorly designed Gopher menus found that they could no longer easily return to particular nodes where other interesting limbs branched off.[105]

The Web prescribed no one best way. It allowed both hierarchy and hypertext. Cascading file menus could easily be reproduced with fidelity on a Web browser like Mosaic, the major difference being that the backslash (/) indicating more information within a selector had been replaced by underlined hypertext. "Gopher allows searches AND menus. WWW allows searches AND menus AND hypertext [emphases in original]," noted Berners-Lee in a Usenet post. "Hypertext turns out to be a neat idea BECAUSE it can represent menus to start with. When you really get into it, you often find that you need a little more."[106]

The joy of discovery with a hypertext browser could be intense. After reciting a litany of problems and irritants in Mosaic software, Paul Chamberlain of IBM in Austin, Texas, still raved, "It's the best thing since sliced bread."[107] Typical was the statement of Ricardo Parodi of the UCLA Office of Residential Life who stated flatly, "The next generation is here and it is MOSAIC. Hopefully enough people will start publishing and hyperlinking in this media that it will make gopher obsolete."[108] Even steadfast Gopher developers like Wiggins were impressed by the achievement. Wrote Wiggins after his first session with Mosaic at an IETF meeting in 1993:

> We've been running a Gopher service since early 1992, and we're very active in the community. But after seeing Mosaic and WWW, it is very hard to deny the benefits of networked hypertext. Via Mosaic I showed Berners-Lee our Gopher at Michigan State. The first document we opened says 'Look in the xxx folder for more information.' B-L said, 'Now with WWW that

would be an embedded pointer.' In Mosaic, the hypertext links appear in color within the document. Links you've clicked on appear in a different color—a nice touch. An example of a lovely use of WWW is an experiment at Ohio State, where they made a cross-referenced set of Unix 'man' pages. You see a reference to another page; the title is in red on the screen; click on it if it is of interest <boom> it's on your screen.[109]

Admittedly, some Gopher developers and users objected to the "twisty maze" implicit in the Web, built up by cross-referencing documents with hypertext links. At GopherCon '93, systems programmer Boone upbraided participants looking at alternatives to the familiar "files and menus" strategy for accessing information on computer hard drives and on the Internet. Information systems, he argued, should have "no 'hunt the wumpus games.' Hierarchy is preferable to a maze."[110]

For the most part, however, these objections were cast aside in favor of the hypertext browser. In part, says Boone, Web portal sites like Yahoo replaced Gopher menus with encyclopedic directories of their own[111] and search engines like WebCrawler, and later Google, took over the role formerly played by Veronica.

Additionally, pretty text, whatever its drawbacks, usually appealed to people on an emotional or subjective level more than on a technical or cognitive one. It was not simply a matter of technological progress. Hypertext was mesmerizing, part and parcel to the underlying pattern of contemporary life; Gopher, by contrast, retired to the back highways of the information revolution, becoming a traveled route only when the preferred one was unavailable.

In fact, Gopher designers themselves sacrificed some measure of hierarchy on the altar of the distributed user interface. Veronica offered one shortcut to particular data files. Gopherspace as a whole, moreover, was never hierarchical. Regardless of its popularity, the Mother Gopher at the University of Minnesota did not represent the apex of "all gophers everywhere"—there was no top-level server. Gopher menus extracted from the underlying structure of the file systems also could be reorganized or manipulated to meet the needs of users. Menus were not necessarily mapped directly. And Gopher allowed "side links" between items in remote directories, similar if not identical to the Web's cross linking. Gopher developers also experimented with cutting-edge hypermedia Gopher browsers, including fluid three-dimensional fly-by simulations of information "terrain."[112]

Figure 4. Cartoon strip from 1995 showing basics of Gopher information retrieval. File-menu design is depicted on paper tacked to wall. Information selected for retrieval is represented in the cartoon as a bound library book. (Courtesy K. Ackerman.)

Because of these features, Gopher had some of the same problems as the Web. Users of both Gopher and Mosaic, for instance, were prone to feeling "lost in space," especially when trying to recover particular information in a poorly remembered corner of cyberspace.[113] Both were subject to broken links—links to pages that no longer existed or had been moved. And both Gopher and the Web—products of an infinite number of individual decisions—had no formal mechanisms for propagating "mirrors" of popular information closer to home to better distribute the load. Again, the decision to abandon Gopher in favor of the Web was as emotional as it was rational. It was like an argument for metaphysics, impossible ultimately to prove or deny.

Coexistence actually could have been an option. Indeed, the Web's developers used Gopher content as a crutch in the Web's own debut. From the start, browsers like NCSA Mosaic could retrieve information from gopher servers. The idea that the Web might fetch both hypertext and gopherized content was not lost on many. In the summer of 1993, Franks wrote and disseminated GN, a combined Gopher/HTTP server.[72] In 1994, Mike Potter of Los Alamos National Laboratory announced a hybrid Web-Gopher server he had developed called "gopherhttpd."[114] At the 1995 GopherCon, Lindner made a major concession to the Web, unveiling modifications that allowed users to read and publish HTML documents directly on Gopher.[115]

Vielmetti remembers spending a lot of time "stitching the various systems together," for example

making a WAIS database show up as a search item on a Gopher menu, or using FTP to mirror a collection of network addresses from MIT, indexing to WAIS, and then relaying the results through Gopher.[116]

Others thought of the Internet as a whole as a "large book" with various information systems working together to index it (WAIS), list the table of contents (Gopher), and show its pages (WWW).[117] Tim Berners-Lee went so far as to incorporate the "gopher://" prefix into his Uniform Resource Identifiers, which meant that Gopher content and the Gopher protocol could still be accessed using a Web browser. Even the authors of Mosaic initially thought of their browser as the "next Gopher."[118]

The Gopher ideal

Romantic attachments die hard, and this has been no less true for Gopher. Nostalgia for Gopher remains palpable (see Figure 4). As database programmer Cameron Kaiser of Point Loma, California, Nazarene University put it recently, "Mosaic came out barely a year or so [after Gopher's release] and plunged the world into darkness and all seemed lost under the choking strands of the World Wide Web."[119]

Tinged with resignation, Lawrence Rhodes of the Bring Back Gopher Campaign has written,

In retrospect, I suppose if I had thought about the common man's infatigable [sic] hunger for porn and nonstop commerce and the myriad

> ## Gopher-like interfaces, unwittingly, have invaded handheld PDAs and wireless telecommunications devices.

other forms of bad taste, I would have seen the dangers of the banal.[120]

Gopher fans now use the Usenet newsgroup comp.infosystems.gopher to post tributes. The lament of one participant in this dialogue echoes the spirit of many others:

> There is not much left on Gopher. I can only remember with a tear the hours I could spend on Gopher, searching for anything I could think of and always finding thousands of great documents about it, when I was new to the Internet.[121]

Despite massive Gopher flight over the years, many people are still gamely trying to resuscitate the protocol. Kaiser has cobbled together a Gopher search engine he calls Veronica-2. He argues that Veronica-2 has uncovered 2.5 million still-working selectors. Using Veronica-2, I discovered that the UCLA Physics & Astronomy Calendar of Events was up-to-date on the Physics Department Gopher in 2000; that the African National Congress still relied on Gopher in issuing press releases, promotional material, publications, and speeches; and that several undisturbed Gopher servers still contained the complete works of William Shakespeare.[122]

But Kaiser sadly admits that most of the selectors uncovered by Veronica-2 are dead or contain no information. Today, it is difficult to find Gopher sites and the information they once contained. Instead, the Internet is sparsely populated with the skeletons of dead Gopher menus. The University of Delaware Home Gopher, for example, still operated in 2000 but contained only two documents, one reading:

> Nearly all of the files and directories which used to be part of the 'Gopher' data hierarchy were removed on Sunday, February 8, 1998, by Dan Grim. If anything needs to be recovered from what was here, it should be accessible on the

most recent full dump of the /www file system.

The other document reiterates this announcement as if in haiku.

Still, the idea of Gopher—if not exactly Gopher itself—lives on in a number of newer low-bandwidth applications. Before it expired as a user-friendly way of exploring the wired world, Gopher had begun tunneling its way into the wireless one. In August 1993, McCahill announced that his group at Minnesota was working on a Gopher client for the pioneering Apple Newton personal digital assistant.[123]

That project of course ended in disappointment, but the ideal of the original Gopher as a smart, lean, and intuitive information-handling application remained surprisingly strong. Gopher-like interfaces, unwittingly, have invaded handheld PDAs and wireless telecommunications devices. Advertising copy for the Samsung SCH-8500 cell phone, for instance, vaunts its embedded "mini-browser," which allows the user to surf the Web for "news, information, and all you need to know." But the mini-browser looks nothing like the media-rich interface of Netscape Navigator or Microsoft Internet Explorer. Instead, it displays a numbered, hierarchical, menu-driven set of files. It is an exceptional case of Gopher mimicry. In this way, perhaps, Internet Gopher has partially ducked Andreessen's emphatic epitaph: "Gopher is dead."

Looking beyond Gopher and WWW

This survey ties together the ideologies of two competing computer information systems—Gopher and the World Wide Web—in making the claim that "pretty text" more than "pretty pictures" explains the rise of one and the demise of the other. Looking beyond these two technologies, however, many intriguing questions remain. Some are quite specific, and demand closer attention: How did TCP/IP, protocols used to connect disparate networks in forming the Internet, promote the development of protocols like FTP, Gopher, and HTTP?[124] Would it have helped to transfer control of the Gopher protocol to an external body like the X Consortium? What was the role of Lynx, a briefly popular text browser for the World Wide Web?

Other questions are more far-reaching: Which segments of the population were attracted to the Internet by particular browsers, and why? How does the level of administrative control affect protocol development, implementation, and usability? And of course there is the holy grail: What is the optimal way of finding

things indefinitely given a transitory online environment? Questions like these will continue to draw close scrutiny in future adaptations of the Internet as a public communications medium, as well as in interpreting its origins.

Acknowledgments

References and notes

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2. Gopherspace is that part of the Internet accessible to the Gopher protocol in the form of hierarchically structured data. See M. Vedris, "The Art of Computer Gopherring," *ITI '94: Proc. 16th Int'l Conf. Information Technology Interfaces*, Univ. Computing Centre, Zagreb, Croatia, 1994, pp. 209-214.

3. L. Ward, "Exploring the Power of the Internet Gopher," UIUCnet, vol. 6, Jan. 1993, not printed; available in the Software History Project Archives, CBI; and J. Gordon, "Cruising the Web Was Made Possible by the First Internet Connection," Ten Ways U Research Affects You series, Minnesota Public Radio News, Feb. 2001. Mark McCahill called Gopher "a printing press for information in the Internet." See also J. Rittenour, "Information

Superbus Working Fine, U Says," *Minnesota Daily*, 4 Apr. 1994.

4. In 1994 a typical TurboGopher protocol could retrieve one megabyte of information in about 13 seconds. Mosaic for the Macintosh took 30 minutes to complete the same task. See M. McCahill's appraisal in "GopherCon '94 State of the Gopher Address," unpublished.

5. S. Turkle, *Life on the Screen: Identity in the Age of the Internet*, Touchstone Books, p. 17.

6. Unless otherwise cited, all quotations by McCahill come from M.P. McCahill, OH 328. Oral history interview by Philip L. Frana, 13 Sept. 2001, Minneapolis, Minnesota. Charles Babbage Inst., Univ. of Minnesota, Minneapolis; available online at http://www.cbi.umn.edu/oh.

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8. Elm was authored by D. Taylor of HP Laboratories; N. Randall, "Burrowing Towards Bethlehem: Gopher and the New Promise," in *The Soul of the Internet: Net Gods, Netizens, and The Wiring of the World*, Int'l Thomson Computer Press, 1997, pp. 163-75.

9. T. Yoshida, "An Interview with Mark P. McCahill," Minneapolis, Minn., 5 Mar. 1998, unpublished; available online at http://web.kyoto-inet.or.jp/people/tomoko-y/umn/kiji.html.

10. H. Strauss, "What, the CWIS is Dead?" Campus-Wide Information Systems, vol. 13, no. 2, 1996, pp. 13-16. See also R. Wiggins, "Building a Campus-Wide Information System," *Campus-Wide Information Systems* (CWIS), vol. 11, no. 1, 1994, pp. 57-66; idem., "Building a Campus-Wide Information System, Part II," *CWIS*, vol. 11, no. 3, 1994, 33-43; W. Dailey, "The Rutgers University Campus-Wide Information System," *CWIS*, vol. 11, no. 2, 1994, pp. 35-38; and A.C. D'Souza, "The University of Pennsylvania's PennInfo Campus-Wide Information System," *Public-Access Computer Systems Rev.*, vol. 4, 1993, pp. 5-12.

11. R.W. Wiggins, *The Internet for Everyone: A Guide for Users and Providers*, McGraw-Hill, 1994. Wiggins notes that when Steve Worona of Cornell Information Technologies began looking at designing a protocol for moving Cornell's mainframe-based CUinfo CWIS over to a PC and workstation-based service, Worona encountered Gopher and found it "exactly what we were looking for." See R. Wiggins, "The University of Minnesota's Internet Gopher System: A Tool for Accessing Network-Based Electronic Information," *Public-Access Computer Systems Rev.*, vol. 4, no. 2, 1993, p. 28. CUinfo is still available to students, staff, and faculty at Cornell

Univ.at http://cuinfo.cornell.edu. Note that the page remains text-rich with minimal graphics. My thanks to Edward Vielmetti for directing me to this site.

12. K.J. Henninger (camera operator), "Internet Gopher," an interview with M.P. McCahill and F. Anklesaria, QuickTime Movie, 2 Sept. 2000. Available at ftp://boombox.micro.umn.edu/pub/movie/.

13. Confirmed by P. Lindner, personal communication, 8 Nov. 2000; and F. Anklesaria, personal communication, 6 Nov. 2002. Anklesaria remembers three CWIS "factions going in three different directions."

14. "Internet Gopher," QuickTime Movie, 2 Sept. 2000. See the note in Ref. 13 above.

15. F. Anklesaria has said that their first meeting with the CWIS committee in December 1990 was a "total disaster." The acting chief information officer demanded that any work on Gopher cease, but backpedaled after hearing that most work on the project was occurring during nonwork hours. Gopher was first used internally in January and February 1991 to index help line material. Personal communication, 6 Nov. 2002.

16. On the Next computer, see R.E. Stross, *S. Jobs and the NeXT Big Thing,* Atheneum, 1993.

17. R. Khare, "Who Killed Gopher? An Extensible Murder Mystery," *IEEE Internet Computing,* vol. 3, Jan.-Feb. 1999, p. 81.

18. M.P. McCahill and F.X. Anklesaria, "Evolution of Internet Gopher," *J. Universal Computer Science,* vol. 1, no. 4, 1995, p. 237.

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21. M. Campbell-Kelly and W. Aspray, *Computer: A History of the Information Machine,* BasicBooks, 1996, pp. 297-298.

22. On FTP see also J. Postel and J.K. Reynolds, "File Transfer Protocol (FTP)," RFC 959, Network Working Group, Oct. 1985.

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24. A short reminiscence on Archie's development by P. Deutsch can be found in "Archie: A Darwinian Development Process," *IEEE Internet Computing,* vol. 4, no. 1, Jan.-Feb. 2000, pp. 69-71; http://www.computer.org/internet/v4n1/deutsch.htm.

25. B. Kahle et al., "Wide Area Information Servers: An Executive Information System for Unstructured Files," *Electronic Networking: Research, Applications, and Policy,* vol. 2, no. 1, 1992, pp. 59-68. For an overview of WAIS in the context of the CWIS debate, see B. Kahle's public draft of the paper "Roles of Electronic Publishing on Campus," in a Usenet newsgroup post to alt.wais on 1 Mar. 1992.

26. NNTP, or network news transmission protocol. NNTP replaced the UUCP utility.

27. P. Lapsley, B. Kantor, and others first implemented it at the Univ. of California, Berkeley and San Diego, in the mid-1980s. See B. Kantor and P. Lapsley, "Network News Transmission Protocol," RFC 977, Network Working Group, Feb. 1986.

28. A. Treloar, "Architectures for Networked Information: A Comparative Study of Gopher and the World-Wide Web," *J. Information Networking,* vol. 2, no. 1, 1994, p. 29.

29. Usenet post to bit.listserv.ipct-l, 23 Apr. 1994.

30. Personal communication, 19 Apr. 2002.

31. C.A. Lynch, "Information Retrieval as a Network Application*," Library Hi Tech,* vol. 8, no. 4, 1990, pp. 57-72.

32. CICNet was a regional NSFnet Internet service provider to the Big Ten universities based in Ann Arbor, Mich.

33. A phrase also used by computer book publisher O'Reilly & Associates in describing the Perl programming language, which was used in the original Unix implementation of Gopher.

34. P. Riddle, "Trip Report: 1992 GopherCon," Ann Arbor, Mich., 17 Aug. 1992, unpublished.

35. Trip notes from GopherCon '93 by T. Kambitsch of Butler Univ. Libraries, posted to comp.infosystems.gopher, 21 Apr. 1993.

36. J. Romenesko, "Down the Gopher Hole," St. Paul Pioneer Press, 4 Mar. 1996, pp. 1F-2F. Gophermeisters were tickled by the attention. Bubbled Rice Univ. systems programmer P. Riddle in a Usenet post to the Gopher community, "As I type this, I am taping a segment of MTV's Top 20 Video Countdown on which veejay Adam Curry is wearing an 'Internet Gopher' t-shirt! (Specifically, the black heavy-metal-style 'Internet Gopher World Tour '93' shirt from GopherCon '93.) . . . God, I can't believe I'm actually making a fuss about this!" Usenet post to comp.infosystems.gopher, 9 Oct. 1993.

37. J. Romenesko, "Down the Gopher Hole," p. 2F.

38. D. Ramirez, "Taking Another Look at Gopher," *Resource Sharing & Information Networks,* vol. 12, 1996, pp. 17-18.

39. A. Micek, "Programmers Pleased with Gopher's Simplicity," *Minnesota Daily,* 6 June 1993.

40. F. Anklesaria et al., "The Internet Gopher Protocol," RFC 1436, p. 10.

41. S. Brand, "Spacewar: Fanatic Life and Symbolic Death Among the Computer Bums," *Rolling Stone*, 7 Dec. 1972.

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45. A. DeSimone Jr., "About Gopher at the Univ. of Georgia," *UCNS Computer Rev.*, Fall 1993, not printed; available at ftp://boombox.micro.umn.edu and in the Software History Project Archives, CBI.

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47. L. Ward, "How Six Gopher Clients Stack Up," UIUCnet, vol. 6, Jan. 1993, not printed; available in the Software History Project Archives, CBI; and E.J. Valauskas, "TurboGopher: Internet Access with Ease on the Macintosh," *Online*, vol. 17, no. 2, Mar. 1993, pp. 87-89.

48. P. Deutsch has since argued that Archie was shorthand for "Archiver," and not named after the comic book character. See his Usenet post to alt.gopher, 7 Dec. 1992.

49. J.A. Polly and St. Cisler, "Travels with Veronica, Part 1," *Library J.*, vol. 120, Jan. 1995, pp. 32-34. See also S. Foster, "Common Questions and Answers about Veronica, a Title Search and Retrieval System for Use with the Internet Gopher," FAQ, 14 May 1993; and D.P. Dern, "'Archie-Like' Veronica Service Added to Gopher," *Internet World*, vol. 4, 1993, p. 3. Before Veronica there was the Road Map and TS/TB. Both tools were implemented by D. Boone of Michigan State Univ. in July 1992. Road Map allowed users to read the entire directory structure of a single Gopher server. TS/TB allowed title searching of the directory tree on a particular Gopher server. See R. Wiggins, "The University of Minnesota's Internet Gopher System: A Tool for Accessing Network-Based Electronic Information," *Public-Access Computer Systems Rev.*, vol. 4, no. 2, 1993, p. 36.

50. Personal communication, 20 May 2002.

51. G. McMurdo, "How the Internet was Indexed," *J. Information Science*, vol. 21, no. 6, 1995, pp. 479-489. Over its short lifetime, Reno's Veronica server was pounded by requests. The most popular search terms on Veronica in May 1995 were,

in order, "zip," "txt," "size," "hqx," and "gif." The search term "sex" ranked 1,245th, and "pornography" ranked 16,179th. Extracted from a list emailed to the Univ. of Minnesota Gopher administrator account by S. Foster, 30 June 1995.

52. G. McMurdo, "How the Internet was Indexed," pp. 479-489.

53. R. Jones, "Jughead: Jonzy's Universal Gopher Hierarchy Excavation And Display," 9 Apr. 1993, unpublished; idem., "The New/Improved Jughead," in *Proc. GopherCon '95*, Minneapolis, Minn., 9-10 June 1995, unpublished; H. Hahn and R. Stout, "The Gopher, Veronica, and Jughead," in *The Internet Complete Reference*, Osborne McGraw-Hill, 1994, pp. 429-457.

54. J. Conklin, "Hypertext: An Introduction and Survey," *Computer*, vol. 20, no. 9, Sept. 1987, pp. 17-41. For a contemporaneous appraisal of the virtues of hypertext, see T.H. Nelson, *Literary Machines,* Mindful Press, 1990.

55. T. Berners-Lee et al., "World-Wide Web: The Information Universe," *Electronic Networking: Research, Applications, and Policy*, vol. 2, no. 1, 1992, pp. 52-58; and Berners-Lee, "The World-Wide Web," *Comm. ACM*, vol. 37, no. 8, 1994, pp. 76-82. For a survey of essential details see Berners-Lee, "The World Wide Web: A Very Short Personal History," http://www.w3.org/People/Berners-Lee/ShortHistory.html.

56. E. Vielmetti email posted to W3C mailing list www-talk, 19 Aug. 1992.

57. Personal communication, 7 May 2002.

58. R. Wiggins posting to bit.listserv.cwis-l Usenet newsgroup, 2 May 1993.

59. Interview with L. Rosenfeld by S. Champeon for the online journal-weblog *a jaundiced eye*, 8 May 1997. See http://a.jaundicedeye.com/stuck/archive/050897/article.html.

60. Derived from data supplied by Merit NIC Services and accessible at http://www.cc.gatech.edu/gvu/stats/NSF/merit.html.

61. Collected from various sources, especially Usenet posts by S. Foster who recorded summary results of Veronica harvests, and M. Gray's Web Growth Summary based on data collected using the World Wide Web Wanderer, a special automated agent he developed in his student days at MIT.

62. In a TCP/IP network, a port identifies the end point of a logical connection. The port number identifies what type of port is involved. Port 70, for example, is used for Gopher traffic and port 80 for HTTP traffic. Port numbers are assigned by IANA.

63. Usenet post to comp.infosystems.www on 8 Dec. 1993.

64. The National Science Foundation did encourage the exploitation of regional academic networks for private uses. The text of the NSFnet acceptable use policy is available in many places online,

including http://www.creighton.edu/nsfnet-aup.html.

65. B. Kahn et al., "Towards a National Research Network," *Nat'l Research Council and Nat'l Science Foundation Report*, 1988.

66. In 1991, George Bush signed the High-Performance Computing Act that included language designed to foster private investment in high-speed networking. The original bill submitted by Gore included the proviso that federal support be "phased out when commercial networks can meet the networking needs of American researchers."

67. Interview with T. Berners-Lee on *The Charlie Rose Show*, 20 Oct. 1999.

68. Usenet post to comp.infosystems.gopher, 10 Mar. 1993.

69. E. Messmer, "Internet Retrieval Tools Go On Market; Gopher and WAIS To Go Commercial This Month; Other Information Retrieval Products Gaining Ground," *Network World*, 15 Feb. 1993, p. 29.

70. Usenet post to comp.infosystems.gopher, 24 Feb. 1993.

71. Usenet post to comp.infosystems.gopher, 25 Feb. 1993.

72. Usenet post to comp.infosystems.gopher, 25 Feb. 1993. Months later, Northwestern Univ. mathematician J. Franks, turned off by continuing ambiguity in the Gopher license, wrote and disseminated a freeware Unix Gopher server called GN which ducked the license requirements. Said Franks later that summer, "It was a bad decision on their part and hurt the use of Gopher." See "Gopher Licensing Fee Sparks Dispute," in the inaugural issue of *The Internet Letter*, vol. 1., no. 1, Oct. 1993, not printed; available as a bit.listserv.buslib-l Usenet post on 16 Aug. 1993, at ftp://boombox.micro.umn.edu, and also in the Software History Project Archives, CBI.

73. Usenet post to comp.infosystems.gopher, 26 Feb. 1993.

74. Referring to W.R. Stevens' *UNIX Network Programming*, Prentice Hall, 1990.

75. Usenet post to comp.infosystems.gopher, 28 Feb. 1993.

76. Reported in P. Riddle, "Trip Report: 1993 Gopher-Con," Minneapolis, Minn., 12-13 Apr. 1993, unpublished.

77. Usenet post to comp.infosystems.gopher by R. Wiggins, 14 Apr. 1993.

78. Noted S. Trier of Case Western Reserve, "I feel like some people still associate the gestalt of gopher too strongly with U. Minn.'s gopher code. That's bad in the long run, because that, associated with the licensing, makes 'gopher' more-or-less proprietary." Usenet post to comp.infosystems.gopher, 15 Apr. 1993.

79. See the Usenet exchange between R. Wiggins, S. Trier, P. Lindner, M. Macgivern, D. Collier-Brown, R. Atkinson, D. Herr-Hoyman, A. Lunde, M. Subramanya, and L. Viden posted to comp.infosystems.gopher, 14-22 Apr. 1993.

80. See in particular the remarkable Usenet posts to comp.infosystems.gopher by Gopher programmer N. Iacovou of the Univ. of Minnesota and S. Trier of Case Western Reserve Univ., 1-3 Apr. 1995.

81. Usenet post to comp.infosystems.gopher, 17 Sept. 1993.

82. Personal communication, 25 Apr. 2002.

83. Thinking Machines made the specification and source code for the WAIS protocol, as well as an implementation, available free of charge.

84. On the entry of Internet-based business ventures see S.M. Greenstein, "Commercialization of the Internet: The Interaction of Public Policy and Private Choices," *Innovation, Policy, and the Economy*, vol. 1, A.B. Jaffe et al., eds., MIT Press, 2000.

85. Personal communication, 7 May 2002.

86. M. Franks, "Gopher and Gopher+," *Internet Publishing Handbook*, Addison-Wesley, 1995.

87. M.P. McCahill, "Internet Information Systems, WWW, and Gopher," *Science & Technology Libraries*, vol. 15, no. 4, 1996, pp. 73-79.

88. Wiggins, *The Internet For Everyone*, pp. 220-221.

89. Announced to comp.infosystems.gopher by R. Wiggins, 26 Oct. 1992.

90. Early startups like Amazon.com, which began as an email store, focused on the text of their Web site over graphics for this very reason. See R. Spector, *Amazon.com: Get Big Fast*, HarperBusiness, 2002, p. 61.

91. See M. McCahill's commentary in "Gopher: The First Revolution," in *Hyper-G Now Hyperwave: The Next Generation Web Solution*, Addison-Wesley, 1996, pp. 55-64.

92. An idiom suggested to me by Paul Holbrook in a personal communication 2 June 2002.

93. J. Lukacs, "It's the End of the Modern Age," *The Chronicle of Higher Education*, 26 Apr. 2002, p. B7.

94. Literary theorist G.P. Landow in *Hypertext: The Convergence of Contemporary Critical Theory and Technology*, Johns Hopkins Univ. Press, 1992, has described hypertext as the textual equivalent of the distributed client-server network. See also J.D. Bolter, *Writing Space: The Computer, Hypertext, and the History of Writing*, Lawrence Erlbaum Assoc., 1991; and R.A. Lanham, *The Electronic Word: Democracy, Technology, and the Arts*, Univ. of Chicago Press, 1993. For more on early conceptions of hypertextual technology see T. Bardini, "Bridging the Gulfs: From Hypertext to Cyberspace," *J. Computer-Mediated Comm.*, vol. 3, Sept. 1997, http://www.ascusc.org/jcmc/index.html.

95. See R. Lanham, "The Implications of Electronic Information for the Sociology of Knowledge," *Leonardo*, vol. 27, no. 2, pp. 155-164.

96. Usenet post by C. Johnson to comp.infosystems.gopher, 10 Feb. 1993.

97. M.M. Waldrop, *The Dream Machine: J.C.R. Licklider and the Revolution that Made Computing Personal*, Viking, 2001, p. 230.

98. F. Anklesaria et al., RFC 1436.

99. J. Abbate, "The Electrical Century: Inventing the Web," *Proc. IEEE*, vol. 87, no. 11, Nov. 1999, p. 1999. See also her comments in *Inventing the Internet*, MIT Press, 1999, pp. 212-218.

100. T. Berners-Lee, *Weaving the Web: The Original Design and Ultimate Destiny of the World Wide Web*, HarperSanFrancisco, 1999, p. 3. Berners-Lee did not say that humans are incapable of hierarchical thinking, but only suggested that distributed cognition might be one place where humans differed from the machines they had created.

101. T. Berners-Lee got the idea from Ted Nelson who as a boy had read an essay by V. Bush where it was written: "The human mind . . . operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain." From Section 6 of Bush's "As We May Think," *Atlantic Monthly*, vol. 176, no. 1, July 1945, pp. 101-108. Available online at http://www.theatlantic.com/unbound/flashbks/computer/bushf.htm.

102. Ted Nelson's word, used in *Computer Lib/Dream Machines*, Mindful Press, 1974.

103. Usenet post to comp.infosystems.gopher, 9 Feb. 1993.

104. Usenet post to bit.listserv.ipct-l, 22 Apr. 1994.

105. J.E. Kosokoff, "Well-Constructed Gophers: Is Your Gopher Golden?" *Computer-Mediated Communication Magazine*, vol. 2, no. 3, 1 Mar. 1995, p. 40.

106. Usenet post to alt.gopher, 2 Oct. 1992.

107. Usenet post to comp.infosystems.www, 23 July 1994.

108. Usenet post to bit.listserv.ipct-l, 21 Apr. 1994.

109. Usenet post to bit.listserv.cwis-l, 30 Apr. 1993.

110. P. Riddle, "Trip Report: 1993 GopherCon," Minneapolis, Minn., 12-13 Apr. 1993, unpublished.

111. Yahoo is an acronym for "Yet Another *Hierarchical* Officious Oracle" [my emphasis].

112. See "Announcing Alpha-Test Releases of Internet GopherVR for Macintosh and Unix," Univ. of Minnesota, Minneapolis, 30 Mar. 1995, not printed; available in the Software History Project Archives, CBI; and P. Lindner Jr., "GopherCluster: Document Visualization in the Third Dimension," *Proc. GopherCon '95*, Univ. of Minnesota, 1995, not printed; available in the Software History Project Archives, CBI.

113. G. Gay and J. Mazur, "Navigating in Hypermedia," *Hypertext/ Hypermedia Handbook*, E. Berk and J. Devlin, eds., McGraw-Hill, 1991, pp. 271-283; and M. Bernstein, "The Navigation Problem Reconsidered," idem, pp. 285-297.

114. M. Potter, "Running WWW on Top of Gopher," *Proc. GopherCon '94*, Minneapolis, 1994, unpublished.

115. P. Lindner Jr., "Using Gopher with the World-Wide-Web," *Proc. GopherCon '95*, Minneapolis, 1995, unpublished. See also M. Potter, "Running WWW on Top of Gopher," *Proc. GopherCon '94*, Minneapolis, 1994, unpublished.

116. Personal communication, 24 Apr. 2002.

117. See, for example, the Usenet post by D. Brooks to comp.infosystems.www. providers, 1 July 1994.

118. R.H. Reid, *Architects of the Web: 1,000 Days that Built the Future of Business,* John Wiley & Sons, 1997, pp. 8-9. Direct collaboration between the Internet Gopher team and CERN was a missed opportunity.

119. C. Kaiser, "A Brief Introduction to Gopherspace," available at gopher://gopher.floodgap.com:70/0/gopher/welcome.

120. See the Gopher Manifesto posted at http://www.scn.org/~bkarger/gopher-manifesto.

121. V. Dufour posting to comp.infosystems.gopher, 27 Sept. 2000.

122. Results available as of Sept. 2000. Veronica-2 can be searched at gopher://gopher.ptloma.edu.70/1/v2.

123. Reported by K. Sandvik in a Usenet post to comp.sys.pen, 27 Aug. 1993.

124. This question is addressed for some protocols in Abbate's *Inventing the Internet.*

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