Researching the History of Software: Mining Internet Resources in the "Old World," "New World," and the "Wild West"

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Sanity is a madness put to good uses.

So wrote the great philosopher and poet Jorge Augustín Nicolás Ruiz de Santayana in his essay "The Elements and Function of Poetry."[1] Without doubt, the advent of the early Web unleashed a mania, an unreasonable recklessness that to this day resists being swept back under the rug. How can we tease "sanity" out of the Web? Can the historian put this madness to good use?

When the World Wide Web made its debut in the early 1990s, it resembled a pageant that only a parent could love. The Internet Movie Database, the WebCrawler search engine, the Web cam of an isolated unbent spoon and its associated challenge to the telekinetic Uri Geller—those were "reliable" sites. Indeed, the most useful sites looked suspiciously like they had been ripped from Internet Gopher menus. Even Jerry's Guide to the World Wide Web (later rechristened "Yahoo!") could not be judged an entirely trustworthy directory in those days.

Already it is difficult to remember a time when banner advertising could be used as a legitimate navigational tool, when sessions running a Mosaic browser with its (usually slowly) pulsing upper right-hand image of Earth and two orbiting plan-etoids seemed interminable, and where alternatives to the hand-coding of new Web pages did not exist.

The Web is still widely criticized as an unreliable source of information, but epithets like "Weird Wide Web" and "Cyberia" are hurled at it with much less frequency today. We manage our (dwindling) portfolios online today, stock our libraries with the help of Amazon.com, and download crucial virus updates to keep the whole system working properly. The Web today gives as good as it takes with its skewering online parodies of presidential aspirations, ICANN battles, and Microsoft heavies. In part, this change of heart reflects the increasing acceptability of the Internet as a communications medium. In equal measure, the thawing of opinion precipitates from our reevaluation of the Web as a promising marketing tool. After all, people get serious where money is at stake.

Even the scholarly community has reevaluated the Web's potential. Professors distribute course assignments and drafts of their latest papers and presentations from personal home pages. Online editions of *The New York Times, The Washington Post,* and the OED have wormed their way into the daily ritual alongside the morning cup of coffee and the afternoon walk to seminar. Email is checked with more regularity than the mailbox down the hall.

Today, an array of online bibliographic databases like RLG-Eureka's History of Science and Technology, OCLC-FirstSearch's EconLit, America: History and Life and others have supplanted traditional journal indices. Catalogs such as OCLC-FirstSearch's WorldCat and Chadwyck-Healey Inc.'s ArchivesUSA allow researchers more options in accessing resources in libraries and archives. While sources like these have long been available "pre-Web," the Web has made them much easier to use. Recently the bibliographic power of the Web has increased immeasurably with the growth in "full-text" databases, which reproduce articles from many journals, and university faculty and staff rave about the speedy new services for electronic document delivery of their interlibrary loan requests. Certainly, the Web has become more than a matter of convenience for scholars— it is an indispensable tool for teaching and research.[2]

But the Web is becoming even more than a tool for finding book and article citations and tracking down archival collections—it is also becoming a *source* for digitized versions of a wide array of materials valuable to historians. In this review we explore the New World of sources in the history of software available on the Web, and attempt to provide a map, or at least a series of guideposts, for this digital landscape. In the first part we will look at sources that parallel or bear a strong resemblance to the kinds of sources traditionally available in the "Old World" of archives and libraries. In the second part we will discuss sources from the more obscure corners of the Web, with little resemblance to traditional sources, and no traditional mechanisms for use by historians. All of the sources cited here are freely available on the Web, with the exception of some important resources available at the Association of Computing Machinery (ACM) Web site.[3]

Old World and New

Archives, libraries, and many other institutions are readily finding a place on the Internet, publishing a cornucopia of documents on the Web, and providing easy access for researchers. The Library of Congress provides a model for other institutions to emulate with its American Memory Web site, which makes available online over seven million printed texts, manuscripts, maps, moving and still images, and sound recordings from its historical collections. Other institutions are following suit, and researchers willing to blaze a path through the digital world in search of source material will find a wealth of company profiles, oral histories interviews, archival material, computer- and computer-related institutions, computer science history conferences, and various other important documents. For historians, this is familiar territory—most of these documents parallel the kinds of sources found in the old "Paper World," the traditional realm for historical research.

Corporate Web sites

Corporate reports are an easy-to-find resource on the Web. The Yahoo Finance Research Center includes links to a number of companies' annual reports, financial statements, historical stock prices, and corporate profiles.[4] Many companies include corporate reports and financial information on their Web sites, but often such material covers only the past few years. Corporate sites are worth a check, though, because they sometimes contain useful information. For example, Computer Associates International has included a financial history page with information on stock splits, dividend payout and financial performance since the inception of the company. Perhaps, with their historic record of financial success,[5] CAI's decision-makers are more comfortable making the company's long-term financial track record easily accessible to all who might be interested.

Company profiles should be approached with the most incredulity, as professional standards for objectivity do not usually apply. Corporate sites often include company histories or timelines, and while they may be helpful, they are often directed at potential shareholders or schoolchildren, and not professional historians. The Adobe Corporate Backgrounder is typical of the kind of company history available from software firms.[6] The site craftily makes mention of current revenues ("exceeding $1 billion") and its NASDAQ ticker symbol (ADBE) in nearly the same breath. But the site is more interesting in its presentation of corporate "mission, values, and beliefs." From the promotional copy it is clear that Adobe is interested in maximizing earnings per share, thrives on cost-effectiveness, treats its employees well and pampers the best of them, and flourishes under the banner of truth because "life is too short to be ashamed of anything we do." No doubt there is subtext to be mined here.

One of the most unabashed company history sites is the so-called "Microsoft Museum." This Museum is dedicated to promoting and extending the unwritten

Microsoft myth: "We *are* the software industry." Microsoft marked its twenty-fifth anniversary in 2000, and the Museum site still includes information regarding that event. The site includes a multimedia Microsoft timeline, access to the PressPass portal for Microsoft news releases, and teaser copy from *Inside Out: Microsoft—In Our Own Words* (2002).[7] It also includes a downloadable "student packet." Perhaps the most heartfelt memento here is Bill Gates' admonition to students to stay in school, even though he himself left school prematurely:

> It's true that I dropped out of college to start Microsoft, but I was at Harvard for three years before dropping out—and I'd love to have the time to go back. . . . Nobody should drop out of college unless they believe they face the opportunity of a lifetime. And even then they should reconsider.[8]

One valuable collection is the online cache of archival materials supplied by the IBM Archives.[9] While the proportion of available documents and multimedia files to extant material in the private IBM vaults is extraordinarily small, the collection is growing quickly. IBM has done a great service to historians by making these primary documents easily available, allowing scholars to penetrate beyond the PR façade that most corporate histories present.

A few high-tech companies, including the microprocessor manufacturer Intel, have seen value in carefully recording the experiences of their prized employees, both past and present. In software history, Sun Microsystems has collected the reminiscences of critical employees who helped develop Java.[10] The finished product, an early history by freelance writer Jon Byous, recounts the false start of the top-secret "Green Team," the prototype "WebRunner" browser competitor to NCSA Mosaic, as well as early Java code development. The most amusing aspect of this site is that Java's history is handled with more retrospection on its third anniversary than most technologies get on their thirtieth. It is impossible to miss just how transfixed society and business were by the software business revolution when this site appeared. But then, measured in Internet time, three years is a veritable geological epoch.

For some time Evans & Sutherland, a pioneering computer graphics firm, hosted an extensive company history site that challenged the traditional one-page plus timeline model. This site ran to fifteen single-spaced pages and included discussion and streaming video presentations of the professional lives of the cofounders David Evans and Ivan Sutherland, product development, marketing, collaborations, and reorganizations. It was a surprisingly frank, open accounting of a private, then public, firm. But it is gone now. The original text is not difficult to find on unauthorized sites elsewhere. We recovered the page complete with original HTML formatting from a university site in the People's Republic of China.[11]

Online Archives and Libraries

A number of professionally administered oral histories are available on the Web. Several software specific oral histories—with Edward Feigenbaum, Donald Chamberlin, and Fernando Corbató, for example—may be found on the Charles Babbage Institute's Web site.[12] CBI holds one of the world's largest collections of research-grade oral history interviews relating to the history of computers, software, and networking. Most of the 300-plus oral histories have been developed in conjunction with grant-funded research projects on topics such as the development of software and the software industry, Defense Advanced Research Projects Agency (DARPA) funded computer research, and the early history of computer science departments. Approximately 270 of the total CBI oral history collection housed at the Institute are available in full-text form online. Finding aids to many more oral histories are found on a Smithsonian site: The Jerome and Dorothy Lemelson Center for the Study of Invention and Innovation hosts the complete finding aid to its Computer Oral History Collection in the National Museum of American History.[13] A number of transcribed interviews conducted with software's pioneers form a subset of these public efforts to enrich our understanding of American acumen and ingenuity in the computer world.

A number of less formal "interview" sites may also be accessed. ACM's relatively new online magazine *Ubiquity* houses interviews with Peter Denning, Gordon Bell, Bill Joy, and William Wulf.[14] *Wired* also archives its collection of stories and interviews with the so-called "Wired 52."[15] Marc Andreessen, member of the Wired 52, is honored with "The Marc Andreessen Interview Page" which includes the transcript of a session with independent journalist Thom Stark.[16] More traditional oral history accounts supplemented by streaming video are available at Silicon Genesis, part of the Stanford Silicon Valley project directed by Henry Lowood, curator of History of Science and Technology Collections at Stanford.[17] Most of the oral histories are with early semiconductor developers, but the site also hosts an oral history taken with Shawn and Kim Hailey of Meta Software.

Traditional archival material relevant to the study of software's past is also available online. Here, the bounty is truly astonishing. Several caches of papers relate to the lives of individual computer scientists. The Allen Newell and Herbert Simon collections found at the Carnegie Mellon University Libraries Web site include thousands of digitized pages drawn from the papers of these two artificial intelligence pioneers. [18] (A review by Corinna Schlombs of the Allen Newell archive site is found in this issue of *Iterations*.) The EWD Archive accompanies a Festschrift site dedicated to Edsger W. Dijkstra of the University of Texas, Austin, and contains digitized versions of over one thousand manuscripts written by this programmer and software engineer.[19] The Joshua Lederberg Papers online repository at the National Library of Medicine contains work done not only in molecular biology, but also in service to his interest in informatics. [20] The Turing

Digital Archive maintained by King's College Cambridge is likewise of research value.[21]

A number of more specialized archival collections are also available to software history researchers. The Computer Security Resource Center at the National Institute of Standards and Technology hosts an extensive archive of early computer security papers, which may be read as portable document files (pdf).[22] Perhaps no archival site, however, is as quirky as the video game documentation in the Stephen M. Cabrinety Collection in the History of Microcomputing at Stanford University.[23] Where else can you read the complete text of the documentation accompanying the *Alien* videogame for the Commodore computer? Other documents from the Cabrinety collection, along with student papers on gaming history, are available through the How They Got Game Web site, a project led by Henry Lowood and funded by the Stanford Humanities Laboratory.[24]

A phenomenon made possible by the Web is the creation of "virtual archives"— digitized collections bringing together documents from archival repositories throughout the world. One such archive is the Turing Archive for the History of Computing, maintained by two philosophy professors at the University of Canterbury, New Zealand.[25] The site includes a catalogued collection of documents related to Turing and his work and a number of reference articles by one of the site's proprietors, Jack Copland. This collection makes clear both the promise and the problems inherent with this kind of venue. Creators of virtual archives have the freedom to create handpicked online collections that focus on any topic, though in principle they should select only items that are free of copyright or for which proper permission has been obtained from the archives holding the original items.

Freeing scholars from the need to travel hundreds or thousands of miles only to deal with limited hours and gaps in materials, the potential rewards to be derived from virtual archives is an exciting development indeed. But the very personal and selective nature of these collections is a drawback. Researchers have always needed a certain amount of trust in archivists' familiarity with their collections, but the virtual archive raises this to a new level: without having on hand an entire box of correspondence available to sift, for example, a researcher has no way of knowing whether all relevant items from a collection have been included at the virtual archive site. At this point in their development, "virtual archives" might be more appropriately used by students learning to work with archival materials or by professional historians as a supplement to work in traditional archives. They may also prove useful by providing access to materials from institutions or companies with only a small collection of documents, or for those without the resources or facilities to make them easily available to historians in their original format.

Digitized libraries of published material are also finding their way onto the Web. No search for relevant Internet sources would be complete without a search of past and present Association of Computing Machinery publications in the ACM Digital Library.[26] The online Library by its own reckoning contains 54,000 articles from thirty journals and nine hundred separate proceedings of the Association for Computing Machinery. The Digital Library, which entered service during the summer of 1997, is meant to substitute for subscriptions to online ACM publications. ACM, along with NCSTRL (the Networked Computer Science Technical Reference Library), the AAAI (American Association for Artificial Intelligence), and the arXiv.org e-Print archive sponsors the Computing Research Repository (CoRR).[27] CoRR is one of several "automated archives for electronic communication of research information" that has derived considerable support from the Los Alamos National Laboratory, Cornell University, and National Science Foundation grants. Many more computer science papers distributed across the Internet are found on the main NCSTRAL (pronounced "ancestral") site.[28]

Researchers should not discount the potential of the Web as a continuous document delivery service. A large number of documents relevant to an understanding of the software industry are now finding their way online. Documents of interest to the enterprising historian include 1963 memos concerning TJ-2, an early word processing program (born on a Digital PDP-1 at the Massachusetts Institute of Technology);[29] the original proposal for the World Wide Web by Tim Berners-Lee, then of CERN;[30] and the IIT Research Institute's Draft Report of the Carnivore System presented to the U.S. Department of Justice.[31]

Organizations

A number of computer-related institutions are also building resources for historical study. These may be roughly divided into two groups: institutions primarily motivated to service the computer science and computer business communities, and those with a direct interest in preserving and extending the history of those communities. Of the former are the ACM special interest groups (SIGs), which have many features that are of value to historians, including bibliographic search tools. Among SIGs of particular interest in studying the history of software are SIGACT (algorithms and computation theory), SIGGRAPH (computer graphics and interactive techniques), SIGMOD (management of data), SIGOPS (operating systems), and SIGPLAN (programming languages).[32] One bibliography that deserves special acknowledgement is SIGGRAPH's Computer Science (formerly DBLP, for Database Systems and Logic Programming) Bibliography maintained by Michael Ley at the University of Trier.[33] The presentation of references in reverse chronological order, divided by author is useful. Also helpful is the utility that collects and presents current information on the whereabouts of the home pages of 38,000 computer scientists.

Many other special interest groups engage specifically in the history of software and networking. For example the Unix Heritage Society archives many documents related to the development and use of this operating system.[34] Here one can link to varying interpretations of Dennis Ritchie's famous comment nestled within the Unix source code:

```
/*
 * Switch to stack of the new process and set up
 * his segmentation registers.
 */
retu(rp->p_addr);
sureg();
/*
 * If the new process paused because it was
 * swapped out, set the stack level to the last call
 * to savu(u_ssav). This means that the return
 * which is executed immediately after the call to aretu
 * actually returns from the last routine which did
 * the savu.
 *
 * You are not expected to understand this.
 */
```

The Society also provides access to the old versions of Unix code through the Unix Tree and maintains a Unix Heritage Society mailing list. The Internet Society (ISOC), by contrast, is a hybrid concerned with both the past and future of the Internet. ISOC supports some of the most detailed timelines of the history of computer networking, and presents several narratives on the birth of the Internet from the perspective of Vinton Cerf, Robert Kahn, Jon Postel, Lawrence Roberts, and Tim Berners-Lee.[35]

Computer science history conferences give insights into the kinds and currency of papers presented by historians and computer scientists. Several online conference sites are still available for viewing, even many years after the meetings convened. The Dagstuhl Conference on the History of Software Engineering is one such example.[36] In August 1996 historians and computer scientists met at Schloß Dagstuhl, Germany, to examine the history of software engineering, structured analysis, structured programming, and systems analysis. The outcome remains available as a set of twenty-two papers relevant to the history of this important movement by scholars such as William Aspray, Tim Bergin, Martin Campbell-Kelly, Paul Ceruzzi, Donald Mackenzie, Michael Mahoney, David Parnas, Mary Shaw, and James Tomayko. Other conferences of interest include the Vannevar Bush Symposium sponsored by the MIT Department of Electrical Engineering and Computer Science in October 1995,[37] and From Sumer to Spreadsheets held by the British Society for the History of Mathematics at Kellogg College Oxford, in September 2001.[38]

Computer science departments themselves are making concerted efforts to record their history. One of the most extensive such efforts is being taken by the MIT Laboratory of Computer Science (formerly Project MAC). The history of the department is admirably documented in a linked timeline of milestones with references to important papers on CTSS, Eliza, Logo, Macsyma, RSA, and several computer graphics projects. The site also includes the complete copy from chapter one of Simson Garfinkel's *Architects of the Information Society: Thirty-Five Years of the Laboratory for Computer Science at MIT* (MIT Press, 1999).[39] Another fine site documents the history of scientific computing at Lawrence Livermore National Laboratory. Most compelling are the oral histories collected by insider George A. Michael and others documenting the development of the Computation Department at LLNL between 1950 and 1975.[40] No less than forty histories are available at Michael's site.

A different but no less gainful approach to collecting an institutional history of computer science is taken by the National Science Foundation. The NSF has established a site devoted to documenting projects it supported in the past. The site takes the form of a searchable database of ten thousand descriptions of projects that relied at least in part on NSF supercomputing center resources. The reports themselves, notes the introductory copy, "range from astronomy to zoology, and include scientific breakthroughs on black holes, how the heart works, pollution control, and modeling the oceans."[41]

Bibliographies and Reference Works

One Old World transplant spreading rapidly in the New World of cyberspace that was not disseminated as widely as it should have been in the Old World is the syllabus. Traditionally, teachers (and administrators) have thought of syllabi as proprietary tools. Students got the syllabus only after they had enrolled in the class. While students may focus primarily on the grading section, syllabi represent an extraordinary amount of work on the part of the instructor, and ideally reflect acquired skills and deep education costing tens-of-thousands of dollars and countless hours of study and practice.

In this context, the decision by MIT last year to make freely available all course syllabi under the OpenCourseWare project may be interpreted as a remarkable sea-change in attitude towards the dissemination of education resources. MIT expects no less a goal than to "provide the content that supports an MIT education."[42] But well before this decision was rendered, the Web had become an easy medium for the surprisingly free exchange of syllabi. Perhaps in part this reflects a new attitude toward syllabi as a negotiation between mentors and students rather than as a script writ in stone.

In the history of software, a number of syllabi are available online. Princeton University historian of science Michael Mahoney, for instance, makes available his syllabi on the university Web site, including lists of course readings, short

synopses of lectures, and descriptions of purposes and goals. One graduate course of especial interest available on Mahoney' site is "The Sciences of the Artificial," which includes many topics of interest to students of software, including cybernetics, information theory, bioinformatics, and artificial intelligence.[43] Ohio State University computer scientist Wayne Carlson has made available the syllabus for his course, "A Critical History of Computer Graphics and Animation."[44] This syllabus includes links to a timeline of Computer Graphics and a "CGI Family Tree," which shows the relationships among the individuals and institutions involved in the development of computer generated images.

University of Wisconsin, Madison computer science doctoral student Jim Gast in his course "Introduction to Artificial Intelligence" includes a slide show presentation on the History of AI.[45] Economic and social historian Richard Griffiths' course site "History of the Internet, Internet for Historians" at the University of Leyden surveys the history of ARPANET and the World Wide Web, the history of electronic mail, and Veronica and search engine technology.[46]

Rob Latham's University of Iowa honors proseminar "Postmodern Technocultures" moves the debate over software's past from the scientific to the cultural implications of cybernetics and simulation, and explores the manifestation of a cyberpunk ethos.[47] Computer science professor Jim Mooney's "Advanced Operating Systems" syllabus at West Virginia University offers not only a course overview and assigned readings, but also a classified list of computer operating systems and extensive bibliography of operating systems literature.[48] Perhaps the best starting place is the Web site of University of Warwick computer historian Martin Campbell-Kelly. Campbell-Kelly has compiled a list of courses on the history of computing taught at more than two-dozen institutions around the world.[49]

Reference works are one type of Paper World resource that may soon migrate entirely to the Internet. Already numerous reference resources abound on the Web, allowing historians to obtain a quick overview of an unfamiliar subject or to check some of the more mundane details of research without leaving the computer for a dash to the library. Of course, most historians are familiar with the professionally-run general reference sites, perhaps the most widely used of which is Britannica. Many such sites require a fee for use, and most universities have subscriptions that provide access for faculty, staff and students. A for-profit service such as Britannica has an obligation to provide accurate information to its subscribers, allowing the researcher to place reasonable trust in the source. Xrefer, another general reference site, draws its content from published reference sources and sells subscriptions to Xreferplus, its full-service reference resource. But the site also contains a free reference library with access to information from 43 of the 101 reference works available with the subscription, the most relevant of which are *The Compact American Dictionary of Computer Words*, *A Dictionary of Science*, and *The New Penguin Dictionary of Science*.[50]

General reference sources such as Britannica and xrefer typically do not supply the kind of specialty information sought after by the software historian. A number of free dictionaries, timelines, and glossaries focused on computer-related topics have been placed on the Web by both individuals and institutions. Even if a site is free to use, the institution that supports it has a reputation to maintain, and thus, a stake in supplying accurate information to its visitors. Sites that are free to use but supported through advertising need to develop a reputation for easy-to-find, sound information to increase traffic, and thus advertising revenue. For those who do not mind pages flashing ads for nanotechnology and computer conferences, Webopedia has an extensive dictionary of computer-related terms.[51] Definitions are brief and the historical scope is thin, though, making it of limited use for the historian.

Scholars researching software history will find the Web abounds with online bibliographies, and the potential consequence of erroneous information in these works is small—an incorrect citation will likely only lead to a frustrating or fruitless trip to the library. Historians looking for a primer in computer history might look to the bibliography maintained by the IEEE History Center, which includes most of the significant secondary sources in the history of computing.[52] Currently the bibliography covers works published through early 2000, but the site's proprietors indicate it is a work in progress. The Software History Bibliography, maintained by CBI, contains approximately 1,500 references to primary and secondary sources in software history.[53] The Web is also rich in bibliographies aimed primarily at computer scientists rather than historians. While a number of excellent bibliographies exist, only one will be mentioned here because of its scope, The Collection of Computer Science Bibliographies. This ambitious site includes over 1,400 bibliographies encompassing over 1.2 million individual references.[54] Although many of the bibliographies address recent topics in computer science, some focus on long-standing subjects, while others explicitly focus on historical events. The site continues to grow as Alf-Christian Achilles, the developer of the site, maintains it in his spare time, and the site receives almost 10,000 requests per day. According to Achilles, plans are in place to acquire funding that would allow the site to become more than a spare-time project.

The Wild West

If cyberspace can be called the New World for historical research, the online libraries, archives and corporate Web sites discussed in the first part of this review are akin to the mid-19th century New England of this New World. Venturing beyond these staid pages into the farther reaches of cyberspace, intrepid software history researchers can find a vast number of eclectic sites and other online resources produced by a mixed bag of software insiders and enthusiasts. The quality of this material and its value to researchers varies immensely from site to site. But with many of the significant figures in software history feeling at home in cyberspace, some of these sources might be available only on the Web, with no

paper versions in existence. These sites are a virtually untapped resource awaiting exploration.

Personal Homepages

Some sites maintained by individuals contain resources that appear similar in kind to those in the "Old World" of libraries and archives, and the people who maintain these sites are quite serious about the resources they have collected or the articles they have written and published on their sites. These sites have been categorized within the realm of the Wild West, however, because these resources are not assembled and maintained by the traditional institutional purveyors of research sources. Examples of this nature include otherwise-unpublished articles placed on personal Web sites, such as the history of LISP Web site[55] written and maintained by Dr. Herbert Stoyan (Chair of Artificial Intelligence at the Institute of Computer Science of the University of Erlangen-Nürnberg) or the history of Prolog, written by a computer scientist as part of his degree program at the Technischen Universität Berlin.[56] While these two sites contain unpublished secondary sources, the REXX History archive is representative of the kinds of valuable primary sources that may be found in obscure corners of the Web. This site, compiled by an IBM UK Fellow, contains links to a number of documents related to IBM's development of the REXX language and associated programs.[57]

Many "players" in the history of computing maintain Web sites where they present their own take on historical events. A number of these sites tell the story of the development of technologies in which the authors were involved, and may also include links to relevant primary sources. Some also serve as platforms for the promotion of site creators' views on the future of software. With oral historians unable to interview more than a fraction of the thousands of computer and software practitioners alive today, the personal reflections of a number of early leaders in software might only be found in these self-published Web manifestos.

Advocates of the Free Software movement have established two sites that tell of the history and philosophy behind the development of GNU, an operating system planned as a free replacement for UNIX.[58] Eric Raymond, author of the *New Hacker's Dictionary* (MIT Press, 1996 3rd ed.) and a strong proponent of open source software development, has placed several articles on his homepage, including a "Brief History of Hackerdom," and "The Cathedral and the Bazaar," an essay on the development of Linux.[59]

Not all personal sites have been established as an exercise in advocacy—some sites appear to be less a soapbox than a memoir. Such sites may contain quirky remembrances of software history, but they often go beyond the anecdotal to record an insider's view of events. These narratives, which abound on personal Web sites and elsewhere, need to be greeted with some degree of skepticism. Of

course, using "personal history" represents a new take on the problem of sources long faced by historians—reading a history of a failed operating system written by its inventor, for instance, takes us into problematic territory different from the traditional "history written by the victor" quandary.

Still, many are surprisingly forthright. In addition to personal history, these sites may also contain non-historical writings, published and unpublished, that may be of interest as primary sources, and other documents, graphics, links and files that represent the site's proprietor. Bob Bemer, "grandfather" of COBOL and father of ASCII, has created a chatty and eclectic site that includes, among other things, copies of some of his published papers and a link to "Interesting Computer History as seen (and sometimes made) by" Bob Bemer himself.[60]

One pioneer who has taken a great deal of interest in disseminating material about his own early work is Dennis Ritchie of Bell Laboratories. Ritchie, co-inventor of the Unix time-sharing system, has posted a number of accounts of his work, as well as primary material, to his public Web site.[61] The collection includes published reminiscences, a limited amount of scanned material, and a salvaged 1976 memo on the potential for porting Unix to new machines.

This memo and some other documents on Ritchie's site are transcribed rather than scanned. Historians, however, appreciate working with original documents or at least scans of materials for the sensory experience, and in some cases the senses may uncover information not contained by the words on the page.[62] Using originals or images of originals also ensures researchers are using an accurate rendition of the text.

The creators of VisiCalc, an early and successful spreadsheet program, have also established a Web site dedicated to the history of this program, a forerunner of today's commercial spreadsheet applications.[63] The site, hosted by co-inventor Dan Bricklin with the assistance of business partner Bob Frankston, includes photos, Dan Bricklin's personal narrative on the development of VisiCalc, screenshots, software for the original IBM PC version of the spreadsheet utility, a retrospective on why VisiCalc was not patented, and a transcript of a Software Arts (creators of VisiCalc) meeting on August 12, 1981, documenting the staff's reaction to the formal announcement of the IBM Personal Computer.

Bricklin is also a dedicated "blogger"[64] (Web-logger) who has taken up the task of publicly chronicling his daily activities, mostly in computer industry circles, in an online diary or "blog." Blogs from individuals and groups are potentially rich and valuable resources for historians and will be readily accessible beyond the walls of jealous archives—as long as you have the right plug-ins. A brief history of blogs may be found at Rebecca's Pocket, a site maintained by Rebecca Blood.[65] Blood notes that blogs have changed over the last five or six years from commentaries on interesting Web links (the obscure, the overlooked, the important, the weird) to short entries on "something noticed on the way to work,

notes about the weekend, a quick reflection on some subject or another." How historians will bring order to this cacophony is an enticing question.

An example of blogging demonstrating the potential of the medium for research in software history is "Joel on Software," a site by developer Joel Spolsky. The intimate view afforded by this blog is breathtaking. On February 8, 2002, for example, Spolsky informs us that "Now that ArsDigita is gone, I think we can officially declare the Internet Exuberance era, which opened with Travels with Samantha, officially closed. Even though the tendency is to blame it on the VCs, who replaced an exciting, charismatic and visionary founder with grey, grey, grey, the truth is that the Internet consulting market was totally wiped out more than a year ago and there's no reason for AD to have been exempted." These two sentences alone are hyperlinked to material in five other blogs or Web sites.[66] Other notable blogs issue from Wired Magazine's senior editor Paul Boutin[67] and Linux kernel designer Alan Cox[68] (as well as "the other side of the story" presented by his wife, Telsa[69]).

Personal pages also may not contain the self-conscious reflection of "personal history" or create the diary-like intimacy of the weblog, but they can still provide incidental material to enrich the portrait of a subject, and they can provide access to unpublished papers, informal musings, and unedited ideas available nowhere else. Donald Knuth, author of the canonical series in computer science, *The Art of Computer Programming*, maintains a site that includes news about his family alongside previews of parts of volume four of this important series.[70] Visitors can also check out lists of errata in his publications and pictures of the impressive pipe organ installed in his home. Any historian writing about John McCarthy would do well to visit McCarthy's personal site, which includes numerous papers from the past four decades of his career. He also posts occasional comments on an array of issues in science and public affairs, several of which address what appear to be two of his pet peeves, the anti-genetic engineering movement and organic foods.[71]

Whether they have an intentional focus on historical events or not, these sites allow the historian a new kind of access to his or her subject—one that is unparalleled in the Paper World. The creator of a personal Web page is creating a public image of himself, in a medium that allows for play and experimentation. The gravity of print is not here—the ease and low cost of Web publishing allows for spontaneity and capriciousness on the part of the publisher. If the site proprietor has an idea, it can be easily announced on the Web; it can just as easily be removed on a whim. By exploring the small part of cyberspace shaped by his or her subjects, the historian can discover what is important to them. And although the representation provided by a personal page might not be unguarded, it is often far less formal and much more quirky than other presentations of the self—it is a lot like meeting the person. And it is new territory for the historian to explore.

Enthusiasts' Sites

Web publishing also provides an inexpensive forum for enthusiasts of all kinds, and those with a passion for anything computer-related are naturally inclined to pay tribute to the objects of their zeal on the Web. Like personal pages, enthusiasts' sites cover a wide array of subjects, use the unique properties of the Web with differing degrees of success, and vary in the quality and extent of their information. Some are produced by ambitious individuals, while others are the products of real-world organizations or Web-based collectives.

A prime example of the individually maintained page is the Alan Turing Homepage, an enormous Web site created by Andrew Hodges, author of the well-received biography, *Alan Turing: The Enigma*[72] and a British mathematician self-described as having an "academic non-career."[73] Hodges has created a kind of advanced academic blog with his impressive Alan Turing Scrapbook, which contains an assortment of writings, photos, notes, and links on topics relevant to Turing's life and work. Also included is a short biography and complete bibliography of Turing's writings, and notes on archival holdings of Alan Turing's papers and photographs.

Devotees of the mainframe timesharing operating system (OS) Multics (1965-2000) have maintained their connections with one another through the development of a site with an extensive record of the history and features of this OS, the Multiplexed Information and Computing Service.[74] The site includes a list of almost 1,500 people who have contributed to Multics, with some mail and email addresses, a history and bibliography, and a selection of technical papers and other documents. Like the primary resources at Dennis Ritchie's site (mentioned above) these documents were transcribed, and are not available as images replicating their (original) paper forms. The site also includes a page with links to personal stories and pictures from engineers who worked on the development of Multics. (This installment of *Iterations* includes an in-depth review of the site by Thomas Haigh.)

Friends and colleagues of the late John W. Tukey have developed a site devoted to collecting memories of him.[75] Tukey, a pioneering Princeton statistician who, among other accomplishments, co-authored (with J.W. Cooley) the first paper on the fast Fourier transform algorithm. Tukey is credited with coining the term "software," a discovery made through the use of the online journal collection J-STOR. (Atsushi Akera reviews the "Memories of John W. Tukey" Web site in this installment of *Iterations*.)

Despite the popular image of the Web as the territory of the future, it has also been settled by enthusiasts devoted to resurrecting the past. The Software History Center, a project run by software industry pioneers Luanne Johnson and Burt

Grad, sponsors events like the 2002 ADAPSO reunion, collects anecdotes from software's past, and serves as a conduit for the preservation of records.[76]

Members of the "retrocomputing" movement have established a number of sites devoted to the preservation and dissemination of old programs and operating systems. At Martin Campbell-Kelly's site—dedicated to one of the first stored-program computers, the EDSAC (1949)—the technically-oriented scholar can download a simulation of this computer in versions ready for Windows or a Mac.[77] The Computer History Simulation Project, led by Bob Supnik, allows visitors to download a package of OS simulators and software kits that emulate a variety of early computers, including the pervasive DEC PDP series (1960-late1970s), the early small-business computer IBM 1401 (1960), and the MITS Altair 8800 (1975), originally sold as a $397 computer kit.[78] The Online Software Museum maintains historical sketches on several systems and anyone with a VT-100 terminal emulator can log on and try their hand at Altair BASIC, CP/M or RDOS.[79] Such simulators may be a fun and challenging diversion for the software historian, but they also provide historians with first-hand experience with the tools and technologies addressed by their work. But can "preserved" software find a critical place as part of serious historical research? With historians of technology generally concerned with social and institutional history and less with narratives focused primarily on technical development, the place for this material in the scholarly research of the history of software remains to be seen.

One area of software that is primarily in the hands of amateur enthusiasts is gaming history. The history of software should extend beyond the merely trivial, but it is hard to classify computer and video gaming—which has carved out a formidable niche in Western and Eastern culture—as trivial. Computer and video gaming today is a six-billion-dollar industry in America alone, and the shock wave accompanying the advertising blitz it generates elicits significant reactions from educators, parents, and the cultural elite, as well as the target audience.

The history of gaming is rich terrain for the study of software communities. The subgenre of interactive fiction, for instance, is one area where historians of computing might find opportunities to fashion more humanistic studies of technology.[80] The Colossal Cave Adventure game,[81] produced in the 1970s, is usually credited as the first interactive fiction game to depict a virtual world that could be navigated with pidginized English. The game was based on the dimensions of a real cave in the Mammoth Cave complex in Kentucky, and is filled with real caver ("spelunker") jargon. The history of MUD, the Multi-User Dungeon or Multi-User Dimension, a form of interactive fiction that includes the Colossal Cave Adventure game, is documented in many places including the personal page of Richard Bartle, who co-wrote the first MUD for the DEC-10 in 1979.[82]

A more general resource is The GameArchive. The GameArchive is a volunteer site managed by a group of video game and pinball machine collectors.[83] The site

includes everything from blueprints for Bally pinball machines to collections of Atari lapel pins, press photos, and an archive of articles about the genre. Unfortunately, gaming history sites are often awash with nostalgia, a form of homesickness for the past that often overemphasizes the novelty of the past while denigrating the present. The How They Got Game Site discussed in the first part of this essay is a notable exception.

"Indigenous" Sites

Some developers have taken advantage of the unique capabilities of Web publishing, intentionally or unintentionally tailoring their material to this format to present information in a way no other media can. Many of these "indigenous" sites defy categorization, even in a discussion that takes as its starting point the idiosyncratic nature of much Web-based material. A good example of such a site is CyberGeography Research. Martin Dodge, proprietor of the site, defines the scope of it in this way:

> CyberGeography is the study of the spatial nature of computer communications networks, particularly the Internet, the World-Wide Web and other electronic "places" that exist behind our computer screens, popularly referred to as *cyberspace*. Cybergeography encompasses a wide range of geographical phenomena from the study of the physical infrastructure, traffic flows, the demographics of the new cyberspace communities, to the perception and visualisation of these new digital spaces.[84]

Dodge, a researcher with the Centre for Advanced Spatial Analysis at University College, London, has included an "Atlas of Cyberspaces," with a number of maps and other graphic representations that he calls "cybermaps." Among the collection is a set of historical maps drawn by the creators of the ARPANET, Usenet, and the Internet in the course of their development. Although this set is far from complete, a perusal of the collection may inspire historians to reconceptualize their own work by encouraging them to think about software development as a map or image rather than as a narrative.[85]

As the number of Web-indigenous documents grows, forward (and backward) thinking Netizens are collecting and maintaining them in archives, one of which, the Google (formerly Usenet) Groups Archive of newsgroup posts, is of ready value. Here, historians of computing can find messages posted to online discussion groups over the past twenty years.[86] A whopping 700 million messages are archived at this site. Google administrators/archaeologists have already combed through this material and uncovered the first notices about the "Y2K problem" (January 18, 1985), "search engines" (March 10, 1988), and "Internet Gopher" (September 10, 1991). First-person narratives and other memoranda concerning the early years of Usenet are being collected through the ECHO (Exploring and Collecting History Online) Science & Technology Memory Bank project funded by the Alfred P. Sloan Foundation.[87]

Other "born digital" archives include collections of streaming video, anecdotes, and "frequently asked questions" or FAQs. Streaming media sites are among the

most novel approaches to software's history to be found on the Web today. Video and audio interviews with software pioneers can be found as occasional segments at Dr. Dobb's TechNetCast.[88] Footage and sound archived here includes an interview with Peter Salus on the history of Unix recorded at the 2001 Usenix Technical Conference, Danny Hillis' keynote address at the 2000 Game Developer Conference on the "magic of software" as storytelling and play, and Dick Shoup and Alvy Ray Smith's path-breaking work on the computer graphics paint programs SuperPaint and BigPaint.

The "frequently asked question" sheet, or FAQ, is a curious mechanism for transmitting information in the form of an "orientation guide" or "noise-reduction tool" for users of online resources. Many FAQs were born out of the frustrations of Usenet discussion groups. Established members of these groups disliked imparting basic instructions and repeating tired conversations with "newbies." FAQs became a mechanism for educating and informing new users before they hopped onto discussion threads. As such, they may be of especial interest to historians interested in online social networks or communities. An exhaustive archive of Usenet FAQs is found in the searchable Internet FAQ Archives, which periodically catalogues nearly 4,000 individual FAQ pages authored by approximately 1,500 individuals.[89] Other born-digital archives of note include the collection of Internet RFCs[90] and a collection of ARPANET manuscript material placed on the Web by journalist Katie Hafner, located at the Internet Archive.[91]

A number of other electronic resources are intended to keep historians of software apprised of their own community's efforts and the latest news in computer science and software business generally. A good example of this is the newsgroup list. One such list, operated by Internet pioneer Dave Farber, professor of telecommunication systems and business and public policy at the University of Pennsylvania, is called the Interesting People List.[92] The archive of this list is updated in real-time as new messages arrive from list members—which include journalists, computer scientists, industry leaders, and users—and catalogues a remarkable array of opinions stretching back to April 1993.

For the computer historian two lists are available. Paul Ceruzzi, Curator of Aerospace Electronics and Computing at the Smithsonian's National Air and Space Museum, personally maintains a list inaugurated last year that is only beginning in its service as a useful tool for computer historians.[93] Another is the Red Rock Eater News Service hosted by Philip Agre of the Department of Information Studies at UCLA.[94] The names comes from the *Book of Riddles* by Bennett Cerf:

> Q: What is big and red and eats rocks?
> A: A big red rock eater.

Neither Ceruzzi's nor Agre's list is designed for direct discussion activity. Instead, both serve as information clearinghouses.

Treasures and Tribulations

Many humanists have been reluctant to embrace the Web as a research source, and for good reason.[95] Godwin's Law ("As an online discussion grows longer, the probability of a comparison involving Nazis or Hitler approaches one")[96] and the easy descent into impassioned silliness it lampoons characterize huge swaths of cyberspace. Although mere fear or loathing may keep some historians from employing the Web in their work, there are also substantial barriers to carrying out solid historical research using Internet-based sources.[97]

Many of the sites discussed in this review—the first part in particular—are sponsored by well-known institutions, and many of the materials they make available on the Web are the kinds of sources recognized and typically used by historians. But today, more than ever, large parts of the Web remain a crying wilderness of bewildering sights, sounds, and thoughts. How can we know we are looking at high quality material when the usual flags of quality are not there? No librarian has sifted through the Web, selecting only the best for a library collection; no archivist chose to collect these materials, believing they should be preserved for future generations. Sites generally are not reviewed in our professional journals. We know the good publishers, and if a book came from a university press we can assume it went through peer review. The mere fact that a book or article has been published—an expensive endeavor—usually suggests someone believed the author's work worthy of substantial investment. That we may lose our bearings on the Web is a common concern. But we *are* equipped to evaluate Web-based sources, even without the usual filters. After all, we can distinguish the *New Yorker* from *People* even when the two lie side by side at the dentist's office. Many of the Web sites discussed in this review are maintained by people widely known in the fields of computing or history of technology. And perhaps the more unusual sites—those representing what historian Roy Rosenzweig calls "grass-roots history," with their quirky quality that would be red-flagged by a professional publication or archive—might become the basis for interesting and innovative historical research.[98]

But even if we can conquer our fear of accidentally relying on poor-quality source material, how do we find relevant sources on the Web? No one knows just how vast the Web is, and no search engine has indexed all of its corners. Google, the search engine with the highest number of indexed sites, claims to have roughly 1.5 billion fully-indexed pages in its database.[99] Some organizations have tried to tame the Web and make it useful for academic researchers by developing subject-specific "portals" that collect and organize content, providing links to relevant sites. (An up-and-coming portal of portals is the InvisibleWeb)[100] Portals may also include a search engine whose search domain is preset, limiting a search to relevant sites. But for those who wish to find material not indexed by portals, no real solution yet exists. Sifting through the results of any Web search performed with one of the general search engines such as Altavista or Infoseek can quickly turn into an exercise in futility, or at least seem like a terribly inefficient way to

spend research time. The search engine Google, which has a built-in bias for selecting sites in the .edu and .gov domains, might be a scholar's best bet (or at least first resort) when searching the Web.[101]

A final problem of note is that which Jeffrey Barlow calls the "volatility of the Web."[102] If scholars employ Web-based sources in their work, how can they cite them with confidence, knowing that individual Web pages and even whole sites can quickly disappear? One solution for the time being is the Internet Archive Wayback Machine, which holds "snapshots" of the Web that extend back to 1996.[103] As of October, 2001, this non-profit site included 10 billion pages, and a copy of the entire Web is added to the collection every two months. However, because the site essentially republishes Web pages, it poses a challenge to copyright law, and Internet Archive representatives have submitted an amicus brief to the Supreme Court regarding *Eldred v. Ashcroft*, a case that challenges the 1998 law extending copyright terms for twenty more years. While the legal status of the Wayback Machine remains in question, Web developers can thwart the archiving of their sites by the Internet Archive by requiring a password to view pages or by excluding the robots that index Web pages.[104]

Even with the potential problems noted here, the Web houses a vast and ever-growing pool of material, and sooner or later historians will have to grapple with it. And who better to test the potential of the Web as a source for scholarly research than historians of software? The Internet is a natural forum for those engaged in inventing, developing, marketing and working with software—this is their "home turf," so to speak. If the world of bits and silicon is the computer scientist's laboratory, then the Internet is their break room, and historians who take the opportunity to visit will have the chance to act as ethnographers, participating in their subjects' culture as they observe it.

Juliet Burba and Philip L. Frana, "Researching the History of Software: Mining Internet Resources in the 'Old World,' 'New World,' and the 'Wild West,'" *Iterations: An Interdisciplinary Journal of Software History* 1 (September 13, 2002): 1-35.

Appendix

All links active as of August 15, 2002.

Institutions and organizations

Association of Computing Machinery
http://www.acm.org

ACM Special Interest Groups Guide
http://www.acm.org/sigs/guide98.html

Charles Babbage Institute
http://www.cbi.umn.edu

Community Memory Project
http://www.well.com/~szpak/cm/

Internet Society: History of the Internet
http://www.isoc.org/internet/history

Matrix NetSystems
http://www.matrixnetsystems.com/company/research/index.jsp

SGML Users' Group History
http://www-ipg.umds.ac.uk/d.hill/teaching/rsc0/internetIntro/sgmlhist0.html

SHARE
http://www.share.org

Software History Center
http://www.softwarehistory.org/

Software Patent Institute
http://www.spi.org/

Unix Heritage Society
http://minnie.tuhs.org/TUHS/index.html

Archival collections

ACM Digital Library
http://www.acm.org/dl/

Allen Newell Collection
http://heinz1.library.cmu.edu/Newell/

The Computing Research Repository
http://arxiv.org/archive/cs/intro.html

Early Computer Security Papers
http://csrc.nist.gov/publications/history/

EWD Archive
http://www.cs.utexas.edu/users/EWD/

Herbert Simon Collection
http://heinz1.library.cmu.edu/Simon/

IBM Archives
http://www-1.ibm.com/ibm/history/index.html

The Joshua Lederberg Papers
http:// http://profiles.nlm.nih.gov/BB/

Networked Computer Science Technical Reference Library (NCSTRL)
http://cs-tr.cs.cornell.edu/

The Stephen M. Cabrinety Collection in the History of
Microcomputing:Videogames
http://www-sul.Stanford.edu/depts/hasrg/histsci/index.htm

The Stony Brook Algorithm Repository
http://www.cs.sunysb.edu./%7Ealgorith/

Turing Archive for the History of Computing
http://www.alanturing.net/

The Turing Digital Archive
http://www.turingarchive.org

Oral histories and interviews

CBI Oral History Collection
http://www.cbi.umn.edu/collections/oralhistories.html

Lemelson Center Computer Oral History Collection
http://www.si.edu/lemelson/dig/computeroralhistory.html

Marc Andreesen Interview Page
http://www.dnai.com/~thomst/marca.html

Silicon Genesis
http://www-sul.Stanford.edu/depts/hasrg/histsci/silicon%20genesis/intro-ntb.html

Ubiquity Interviews
http://www.acm.org/ubiquity/interviews.html

Wired Magazine Archive of People
http://www.wired.com/wired/archive/people/

Conference sites

1995 SQL Reunion
http://www.mcjones.org/System_R/SQL_Reunion_95/

25th Anniversary of Computer Science at Cal Tech
http://www.eas.caltech.edu/cs25/

Dagstuhl Conference on the History of Software Engineering
http://www.dagstuhl.de/DATA/Reports/9635/report.9635.html

From Sumer to Spreadsheets
http://www.dcs.warwick.ac.uk/~hoc/BSHM2001/

Vannevar Bush Symposium
http://www.eecs.mit.edu/AY95-96/events/bush/

Resource sites-professional historical

Building a Future for Software History
http://www.cbi.umn.edu/shp/index.html

The History of Bioinformatics
http://hrst.mit.edu/hrs/bioinformatics/public/index.htm

How They Got Game
http://poweredge.stanford.edu/videogames/

Computer science departments and Federal programs

Computing at Columbia Timeline
http://www.columbia.edu/acis/history/

Early Days of Computer Engineering and Computer Science at UCLA
http://www.cs.ucla.edu/csd/overview/history.html

Early History of Computing in Turku
http://www.abo.fi/~atorn/History/Contents.html

Forty Years of Computing at Newcastle
http://www.cs.ncl.ac.uk/events/anniversaries/40th/webbook/contents.html

A History of Scientific Computing at Lawrence Livermore National Laboratory
http://www.nersc.gov/~deboni/Computer.history/

History of Supercomputing at Florida State University

http://ed-thelen.org/comp-hist/super-users-view.html

History of the Department of Computer Sciences at Purdue University
http://www.cs.purdue.edu/history/history.html

History of the Medical Informatics Section of the Medical Library Association
http://www.medinfo.mlanet.org/history.html

History of the University of Utah School of Computing
http://www.medinfo.mlanet.org/history.html

Internetin historiaa
http://www.funet.fi/index/FUNET/history/internet/

MIT LCS Timeline
http://www.lcs.mit.edu/about/about.html

NSF Computational Science Highlights
http://www.sdsc.edu/MetaScience/welcome.html

Penn Computing
http://www.isc-net.upenn.edu/networking/pennnet-history.html#1940s

A Personal History of Computer Science at UNC-Chapel Hill
http://www.cs.unc.edu/History/

SLAC Archives and History Office
http://www.slac.stanford.edu/history/earlyweb/

SRI Computer Science Laboratory History
http://www.csl.sri.com/history/index.shtml

Timeline of Computing Services at the University of Alberta
http://www.ualberta.ca/CNS/PUBS/hyperDispatch/hyperDispatch19/timeline.htm
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Company profiles

Adobe Company Profile
http://www.adobe.com/aboutadobe/pressroom/companyprofile.html

Evans & Sutherland Historical Page
http://www.es.com/about_eands/history/index.asp

Evans and Sutherland History

http://ai.zju.edu.cn/~yzhuang/cad/Evans.htm

Java Technology: An Early History
http://Java.sun.com/features/1998/05/birthday.html

Microsoft Museum
http://www.microsoft.com/mscorp/museum/home.asp

Official Intellivision Classic Videogame Website
http://www.intellivisionlives.com/

SIMULA History
http://java.sun.com/people/jag/SimulaHistory.html

Dictionaries, glossaries, encyclopedias

Babel: A Glossary of Computer Oriented Abbreviations and Acronyms
http://www.neurophys.wisc.edu/www/comp/babel.html

IBM Glossary of Computing Terms
http://www.networking.ibm.com/nsg/nsgmain.htm

NIST Dictionary of Algorithms and Data Structures
http://www.nist.gov/dads/

Web Dictionary of Cybernetics and Systems
http://pespmc1.vub.ac.be:80/ASC/INDEXASC.html

Webopedia
http://www.pcwebopedia.com

Xrefer
http://www.xrefer.com

Bibliographies

Annotated Bibliography of Artificial Intelligence
http://www.u.arizona.edu/~chalmers/biblio/4.html

CBI Software History Bibliography
http://www.cbi.umn.edu/shp/bibliography.html

The Collection of Computer Science Bibliographies
http://liinwww.ira.uka.de/bibliography/index.html

DBLP Computer Science Bibliography
http://www.informatik.uni-trier.de/~ley/db/welcome.html

Human-Computer Interaction Bibliography
http://www.hcibib.org/

IEEE History Center Computer History Bibliography
http://www.ieee.org/organizations/history_center/Bibliography/computer_history
_biblio.html

A Serious Beginner's Guide to Hypertext Research
http://ilex.cc.kcl.ac.uk/wlm/essays/diy/hyperbib.html

Syllabi, course descriptions, course notes

Brief History of Operating Systems (Jim Mooney site)
http://www.cs.wvu.edu/~jdm/classes/cs258/cs258.html

Introduction to Artificial Intelligence (Jim Gast)
http://www.cs.wisc.edu/~jgast/cs540/slides/01Intro/

History of the Internet, Internet for Historians (Richard T. Griffiths)
http://www.let.leidenuniv.nl/history/ivh/frame_theorie.html

Postmodern Technocultures (Rob Latham)
http://www.uiowa.edu/~c008171/robspage/pomotechno.html

The Sciences of the Artificial (Michael Mahoney)
 http://www.princeton.edu/~hos/h593/593f00.htm

Courses in the History of Computing (Martin Campbell-Kelly)
http://www.dcs.warwick.ac.uk/~mck/HoC_Courses.html

Journals, newsletters and other publications

IEEE Annals of the History of Computing
http://www.computer.org/annals/

Iterations: An Interdisciplinary Journal of Software History
http://www.cbi.umn.edu/iterations/

Publications in the RAND "On Distributed Communications" Series
http://www.rand.org/publications/RM/baran.list.html

Timelines, flowcharts

Canadian Internet Timeline
http://www.reseau-medias.ca/eng/indus/internet/timeline.htm

A Chronology of Artificial Intelligence
http://www.shai.com/ai_general/history.html

Unix, Microsoft Windows, and Computer Languages History
http://perso.wanadoo.fr/levenez/

Evolution of Computer Animation
http://www.bergen.org/AAST/ComputerAnimation/CompAn_Evolution.html

History of Medical Informatics
http://www.veranda.com.ph/hermant/History.htm

History of Programming Languages
http://www.cs.iastate.edu/~leavens/ComS541Fall97/hw-pages/history/

History of Video Games
http://www.videogames.com/features/universal/hov/hov01.html

Hobbes' Internet Timeline
http://www.zakon.org/robert/internet/timeline/

Kerlow's Art of 3D Computer Animation
http://www.artof3d.com/timelines.htm

Open Source Software History
http://eu.conecta.it/paper/Some_dates_open_source.html

PBS Internet Timeline
http://www.pbs.org/internet/timeline/

Documents

Draft Report of the Carnivore System
http://www.usdoj.gov/jmd/publications/carniv_entry.htm

Original Proposal for the World Wide Web
http://www.w3.org/History/1989/proposal.html

Thomas Penfield Jackson's Findings of Fact in the Microsoft Antitrust Suit
http://news.cnet.com/News/Pages/Special/Microsoft/findingoffacts.html

TJ-2: A Very Early Word Processor
http://world.std.com/~dpbsmith/tj2.html

Personal pages: Historical essays and secondary material

Lisp History
http://www8.informatik.uni-erlangen.de/html/lisp-enter.html

Doug Jones' Punched Card Index
http://www.cs.uiowa.edu/~jones/cards/

Emergence of the Programming Language Prolog (in German)
http://www.dietmar-schmitt.de/essays/SGI/Prolog/index.html

Eric Steven Raymond's Home Page (A Brief History of Hackerdom)
http://www.tuxedo.org/~esr/

History of CALL
http://historyofcall.tay.ac.uk/poster02/poster2-1.htm

History of "The" Teapot
http://www.sjbaker.org/teapot/index.html

Personal history and homepages

Bemer's Computer History Vignettes
http://www.bobbemer.com

Dave Winer's Homepage
Outliners and Programming
http://davewiner.userland.com/outlinersProgramming

Don Knuth's Homepage
http://Sunburn.Stanford.EDU/~knuth/

The History of the GPL
http://www.free-soft.org/gpl_history/

GNU project
http://www.gnu.org/gnu/thegnuproject.html

Joel on Software
http://www.joelonsoftware.com/index.html

John McCarthy's Homepage
http://www-formal.Stanford.EDU/jmc/

The Linux Portaloo (Alan Cox Weblog)
http://www.linux.org.uk/diary

Paul Boutin Weblog
http://paulboutin.weblogger.com

Spreadsheet History
http://www.j-walk.com/ss/history/index.htm

The Story of Frontier
http://davewiner.userland.com/historyOfFrontier

Telsa Gwynne (the "more accurate" version of Alan Cox's life)
http://www.linux.org.uk/~telsa/Diary/diary.html

VisiCalc Information: History and Commentary
http://www.bricklin.com/visicalc.htm

Enthusiasts' groups

Ada Home
http://www.adahome.com/

Alan Turing Homepage
http://www.turing.org.uk/turing/

Multics Home
http://www.multicians.org

Memories of John W. Tukey
http://cm.bell-labs.com/cm/ms/departments/sia/tukey/

Software History Center
http://www.softwarehistory.org/

Gaming and recreation

Classic Gaming

http://www.classicgaming.com

The Dot Eaters
http://www.emuunlim.com/doteaters/

The Colossal Cave Adventure Page
http://www.rickadams.org/adventure/index.html

Early MUD History
http://www.mud.co.uk/richard/

GameArchive
http://www.gamearchive.com/

A Short History of Interactive Fiction
http://www.gnelson.demon.co.uk/inform/short.html

Interactive Fiction Page
http://www.cs.cmu.edu/afs/cs.cmu.edu/user/wsr/Web/IF/homepage.html

Interactive Fiction Archive
http://www.ifarchive.org/

The Origin of Spacewar
http://www.enteract.com/~enf/lore/spacewar/spacewar.html

Retrocomputing

Computer History Simulation Project
http://simh.trailing-edge.com

The Edsac Simulator
http://www.dcs.warwick.ac.uk/~edsac/

The History of Emulation
http://www.zophar.net/articles/art_14-1.html

The Online Software Museum
http://museum.sysun.com/museum/index.html

Internet archives and other digital document collections

REXX History
http://www2.hursley.ibm.com/rexx/rexxhann.htm

Dennis Ritchie Homepage (Primeval C and other materials)
http://cm.bell-labs.com/cm/cs/who/dmr

Internet Archive Wayback Machine
http://www.archive.org

Internet Archive: Arpanet Collection
http://www.archive.org/arpanet/index.html

Internet FAQ Archives
http://www.faqs.org/faqs

Internet RFCs
http://www.faqs.org/rfcs

30 Years of RFCs by Robert Braden, et al.
http://www.faqs.org/rfcs/rfc2555.html

The Living Internet
http://www.livinginternet.com/

Google Groups
http://www.google.com/grphp

Miscellaneous sites

An Atlas of Cyberspaces
http://www.cybergeography.com

Cybercinema
http://128.174.194.59/cybercinema/

Dr. Dobb's TechNetCast
http://technetcast.ddj.com/

Newsgroups and mail lists

Internet History Mail List
http://www.postel.org/internet-history/

Interesting People List
http://www.interesting-people.org/archives/interesting-people/

Paul Ceruzzi's Mail List

Email paul.ceruzzi@nasm.si.edu

Red Rock Eaters
http://dlis.gseis.ucla.edu/people/pagre/rre.html

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[1] See Santayana on America: Essays, Notes, and Letters on American Life, Literature, and Philosophy, ed. Richard Colton Lyon (New York: Harcourt, Brace & World, 1968).

[2] See Michael O'Malley and Roy Rosenzweig, "Brave New World or Blind Alley?: American History on the World Wide Web," Journal of American History (June 1997): 132-155. Republished at http://chnm.gmu.edu/chnm/

[3] http://www.acm.org
Because the sources maintained by the ACM are indispensable to the software historian and are available to all ACM member-subscribers, they have been included in this review.

[4] http://biz.yahoo.com/r/

[5] http://www.cai.com/invest/history.htm

[6] http://www.adobe.com/aboutadobe/pressroom/companyprofile.html

[7] http://www.microsoft.com/mscorp/museum/home.asp

[8] http://www.microsoft.com/mscorp/museum/Myadvicetostudent.doc
Link to document available as "My Advice to Students" at http://www.microsoft.com/mscorp/museum/musStudent.asp

[9] http://www-1.ibm.com/ibm/history/index.html (Available only by written request.)

[10] http://java.sun.com/features/1998/05/birthday.html

[11] The present Evans & Sutherland history page is available at http://www.es.com/about_eands/history/index.asp
For a cached version of the earlier and much more extensive E & S history see http://ai.zju.edu.cn/~yzhuang/cad/Evans.htm

[12] http://www.cbi.umn.edu/collections/oralhistories.html

[13] http://www.si.edu/lemelson/dig/computeroralhistory.html

[14] http://www.acm.org/ubiquity/interviews.html

[15] http://www.wired.com/wired/archive/people

[16] http://www.dnai.com/~thomst/marca.html

[17] http://www.stanford.edu/group/mmdd/SiliconValley/SiliconGenesis/

[18] See http://heinz1.library.cmu.edu/Newell/ and http://heinz1.library.cmu.edu/Simon/

[19] http://www.cs.utexas.edu/users/EWD/

[20] http://profiles.nlm.nih.gov/BB/Views/Exhibit/narrative/ai.html

[21] http://www.turingarchive.org/

[22] http://csrc.nist.gov/publications/history/

[23] http://www-sul.stanford.edu/depts/hasrg/histsci/index.htm

[24] Archive at http://poweredge.stanford.edu/videogames/Archive/ parent site at http://poweredge.stanford.edu/videogames/main.swf

[25] http://www.alanturing.net

[26] http://www.acm.org/dl/

[27] http://arxiv.org/archive/cs/intro.html

[28] http://www.ncstrl.org/

[29] http://world.std.com/~dpbsmith/tj2.html

[30] http://www.w3.org/History/1989/proposal.html

[31] http://www.usdoj.gov/jmd/publications/carniv_entry.htm

[32] http://www.acm.org/sigs/guide98.html

[33] http://www.acm.org/sigmod/dblp/db/welcome.html

[34] http://minnie.tuhs.org/TUHS.index.html

[35] http://www.isoc.org/internet/history/

[36] http://www.dagstuhl.de/DATA/Reports/9635/report.9635.html

[37] http://www.eecs.mit.edu/AY95-96/events/bush/

[38] http://www.dcs.warwick.ac.uk/~hoc/BSHM2001/

[39] http://www.lcs.mit.edu/about/about.html

[40] http://www.nersc.gov/~deboni/Computer.history/

[41] http://www.sdsc.edu/MetaScience/welcome.html

[42] Phillip D. Long, "OpenCourseWare: Simple Idea, Profound Implications," Syllabus Magazine, January 2002. On the OpenCourseWare project see http://web.mit.edu/ocw/

[43] http://www.princeton.edu/~hos/h593/593f00.htm

[44] http://www.accad.ohio-state.edu/~waynec/history/ID797.html

[45] http://www.cs.wisc.edu/~jgast/cs540/slides/01Intro/

[46] http://www.let.leidenuniv.nl/history/ivh/frame_theorie.html

[47] http://www.uiowa.edu/~c008171/robspage/pomotechno.html

[48] http://www.cs.wvu.edu/~jdm/classes/cs258/cs258.html

[49] http://www.dcs.warwick.ac.uk/~mck/HoC_Courses.html

[50] http://www.xrefer.com; The Compact American Dictionary of Computer Words, ed. American Heritage Dictionaries (Houghton Mifflin Company, 1998); A Dictionary of Science, eds. Alan Isaacs, John Daintith and Elizabeth Martin (Oxford University Press, 1999); and The New Penguin Dictionary of Science, ed. Michael J. Clugston (Penguin, 1998).

[51] http://www.pcwebopedia.com

[52] http://www.ieee.org/organizations/history_center/Bibliography/computer_history_biblio.html

[53] http://www.cbi.umn.edu/shp/bibliography.html

[54] http://liinwww.ira.uka.de/bibliography/index.html

[55] http://www8.informatik.uni-erlangen.de/html/lisp-enter.html

[56] http://www.dietmar-schmitt.de/essays/SGI/Prolog/index.html

[57] http://www2.hursley.ibm.com/rexx/rexxhann.htm

[58] http://www.free-soft.org/gpl_history/ and http://gnu.org/gnu/thegnuproject.html

[59] http://www.tuxedo.org/~esr/

[60] http://www.bobbemer.com

[61] http://www.cs.bell-labs.com/who/dmr/

[62] For many years an apocryphal story has circulated among historians about an unnamed European historian who had been tracking the spread of cholera in the eighteenth century by smelling the envelopes of old letters. Letters mailed from

cholera-infested regions were sometimes sprinkled with vinegar, which was believed to be a disinfectant. With no original letters, the historian would have had no way to track the cholera, and thus no research study. Paul Duguid, according to his testimony on National Public Radio and elsewhere, witnessed the vinegar-sniffing firsthand. The story is retold in The Social Life of Information (2000) by Duguid and coauthor John Seely Brown.

[63] http://www.bricklin.com/visicalc.htm

[64] "Blogging" refers to on-demand, online personal weblogging or journaling. According to the Jargon File, the Bloggs Family is "an imaginary family consisting of Fred and Mary Bloggs and their children. Used as a standard example in knowledge representation to show the difference between extensional and intensional objects. For example, every occurrence of 'Fred Bloggs' is the same unique person, whereas occurrences of 'person' may refer to different people." However, in most cases "blog" is simply an abbreviation of "weblog."

[65] http://www.rebeccablood.net/essays/weblog_history.html
Rebecca Blood is author of The Weblog Handbook: Practical Advice on Creating and Maintaining Your Blog (Perseus Publishing). See also We've Got Blog: How Weblogs are Changing Our Culture, with an introduction by Rebecca Blood (Perseus Publishing, 2002).

[66] http://www.joelonsoftware.com/index.html

[67] http://paulboutin.weblogger.com/

[68] http://www.linux.org.uk/diary/

[69] http://www.linux.org.uk/~telsa/Diary/diary.html

[70] http://Sunburn.Stanford.EDU/~knuth/

[71] http://www-formal.stanford.edu/jmc

[72] Andrew Hodges, Alan Turing: The Enigma (New York: Simon and Schuster, 1983).

[73] http://www.turing.org.uk/turing/

[74] http://www.multicians.org

[75] http://cm.bell-labs.com/cm/ms/departments/sia/tukey/

[76] http://www.softwarehistory.org/

[77] http://www.dcs.warwick.ac.uk/~edsac/

[78] http://simh.trailing-edge.com

[79] http://museum.sysun.com/museum/index.html

[80] See the Interactive Fiction Page
http://www.cs.cmu.edu/afs/cs.cmu.edu/user/wsr/Web/ IF/homepage.html and the Interactive Fiction Archive http://www.ifarchive.org/

[81] http://www.rickadams.org/adventure/index.html

[82] http://mud.co.uk/richard/

[83] http://www.gamearchive.com/

[84] http://www.cybergeography.org/about.html

[85] http://www.cybergeography.org

[86] http://www.google.com/grphp

[87] http://echo.gmu.edu/usenet/index.html

[88] http://technetcast.ddj.com/

[89] http://www.faqs.org/faqs/

[90] http://www.faqs.org/rfcs/ See also the piece "30 Years of RFCs" (RFC #2555) by Robert Braden, et al. at http://www.faqs.org/rfcs/rfc2555.html

[91] http://www.archive.org/arpanet/index.html

[92] http://www.interesting-people.org/archives/interesting-people/

[93] Email paul.ceruzzi@nasm.si.edu

[94] http://dlis.gseis.ucla.edu/people/pagre/rre.html

[95] Suzanne Graham, "Historians and Electronic Resources: A Second Citation Analysis," Journal of the Association for History and Computing 4 (August 2001). At http://mcel.pacificu.edu/JAHC/ jahcindex.htm the author performs a citation analysis on articles published by members of randomly selected history departments. She found that only five percent of these historians cited online documents in their articles and concluded that "historians have yet to apply electronic resources as evidence in a significant way."

[96] See Mike Godwin, "Meme, Countermeme," at http://www.wired.com/wired/archive/2.10/ godwin.if.html

[97] While Barlow remarks on the irrational fear of the Web that keeps some scholars away and the stodgy contempt for the ease of Internet research that stops others ("real historians don't read bytes") he also discusses the substantial reasons why the Web is mistrusted as a source. See "Historical Research and Electronic Evidence: Problems and Promises," by Jeffrey G. Barlow in Writing, Teaching, and Researching History in the Electronic Age: Historians and Computers, ed. Dennis A. Trinkle (Armonk, N.Y.: M.E. Sharpe, 1998).

[98] Roy Rosenzweig, "The Road to Xanadu: Public and Private Pathways on the History Web," Journal of American History 88 (September 2001), republished at http://chnm.gmu.edu/chnm/xanadu.html

[99] According to an independent assessment Google's own estimate of the size of their database is somewhat too high—see http://www.searchengineshowdown.com/stats/sizeest.shtml

[100] The InvisibleWeb limits searches to sites that are "portals" to large archival collections, databases, reference works, etc. The tool works best by using the clickable menus rather than by keyword search. See http://www.invisibleweb.com

[101] Descriptions of the search heuristics of a number of popular search engines can be found at www.searchengineworld.com

[102] See Barlow pp. 218-220 for a discussion of the problem and some proposed solutions.

[103] http://www.archive.org

[104] Heather Green, "A Library as Big as the World," Business Week Online, Feb. 28, 2002, at http://biz.yahoo.com/bizwk/020228/svdbxsjyy3jmcjcxidlrsa_1.html ; and Katharine Mieszkowski, "Dumpster Diving on the Web," Salon.com, Nov. 2, 2001, at http://www.salon.com/tech/feature/2001/11/02/wayback/index.html

The Internet makes the world smaller. The ability to communicate and exchange information instantaneously and across vast distances has enabled more individuals and businesses to participate in the economy, regardless of their location. Whenever a new technology emerges with the potential to change the way people live and work, it sparks lively debate about its impact on our world and concern over how widely it should be adopted. Some people will view the technology with tremendous optimism, while others will view it as threatening and disruptive. In the coming years, people will increasingly rely on the Internet to share sensitive information with trusted parties about their finances, medical history, personal habits, and buying preferences. How can we tease" sanity" out of the Web? Can the historian put this madness to good use? Disciplines. Computer Sciences. Publication Date. September 13, 2002. Citation Information. Juliet Burba and Philip L Frana. "Researching the History of Software: Mining Internet Resources in the â€œOld World,â€â€œNew World,â€ and the â€œWild Westâ€" Iterations: A Journal of Software History Vol. 1 (2002) Available at: http://works.bepress.com/philip_frana/5/. Copyright 1999â€"2020 bepress.â„¢ All rights reserved. Contact Us. Terms of Service. Copyright. Privacy Policy. User Guide. The Wild West is the history, geography, people, and culture of life in the Western United States. Click for more facts. Throughout the extensive worksheet pack there are multiple lesson resources and quizzes for students to practice their knowledge which can be used within the classroom or homeschooling environment. Wild West Matching Type. Wild West Organizer. New posts New resources New profile posts Latest activity. Resources. Latest reviews Search resources. Members. KD was a great researcher. The volume of material produced reminded me of Miles Mathis quantity of work. KD said he had a full time job and the amount of work produced seemed to be that job although he said he worked in road engineering or something like that. There has been a realization that the volume of postings by Miles Mathis would have been more easily done wih a group rather than an individual. KDs Avatar had a listing of Mexico City on it at first then after a year or so switched to an American flag and Seattle as his location. He said he had a bet with his wife a 6 pack of beer that Software is a set of programmed instructions stored in the memory of stored-program digital computers for execution by the processor. Software is a recent development in human history, and it is fundamental to the Information Age. Ada Lovelace's programs for Charles Babbage's Analytical Engine in the 19th century is often considered the founder of the discipline, though the mathematician's efforts remained theoretical only, as the technology of Lovelace and Babbage's day proved insufficient to build

Mining in World History. January 2002. Authors The history of resource development is almost as old as human civilization and successful civilizations are always accompanied by a source and means of recovering natural resources (Lynch, 2004). By contrast though, because much of the research assumes that new discoveries will be of lower quality than currently mined deposits, only a minimal role for copper exploration in the 21 st century is anticipated, merely outlining further, ever lower quality copper resources. An alternate hypothesis is that the development problem is actually a discovery problem. The implication is that the exploration focus must change. But the world hasn't always been this way. Until 1999, the term "internet of things" didn't even exist. So, how exactly did the internet of things evolve so fast and become such a regular buzzword, and what milestones marked internet of things development globally? In order to answer these questions, let's dive into the roots of this incredible technology. The brief history of the internet of things. The concept of connected devices itself dates back to 1832 when the first electromagnetic telegraph was designed. The telegraph enabled direct communication between two machines through the transf... New areas are also appearing at the intersections between interconnected technologies and various industries: Internet of medical things. Industrial internet of things. View Mining History Research Papers on Academia.edu for free. The Austrian Alps are home to the world's oldest and extensively studied record of large-scale underground salt mining: the UNESCO World Heritage site Hallstatt-Dachstein/Salzkammergut. In this study, we focus for the first time on the impact that the salt extraction had on the vegetation and the environment throughout the millennia, presenting the first paleoecological data for the mining area, which have been obtained from a peat bog located near the mines. New approaches in the development of drainage in the Rammelsberg and initial insights into the three-dimensional recording of historical mining models as part of 'Altbergbau 3D: An interdisciplinary project exploring the history and more. This article will summarize a few milestones in computer networking history and Internet in particular. Special attention will be paid to: Uses in education. Uses that change people's lifestyle and work habits. Licklider (1960) wrote "Man-Computer Symbiosis": J.C.R. Licklider & W. Clark On-Line Man Computer Communication coined the Galactic Network concept encompassing distributed social interactions.