Mirror Worlds, LLC v. Apple, Inc.
Doc. 389 Att. 3

Exhibit 2
Part 1 of 2

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IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
TYLER DIVISION

MIRROR WORLDS, LLC, Plaintiff, v. APPLE INC., Defendant.	Civil Action No. 6:08–CV–88 LED JURY TRIAL DEMANDED
APPLE INC., Counterclaim Plaintiff, v. MIRROR WORLDS LLC, MIRROR WORLDS TECHNOLOGIES, INC., Counterclaim Defendants	

EXPERT REPORT OF STEVEN K. FEINER, Ph.D.
RE: INVALIDITY OF
U.S. PATENT NO. 6,006,227, U.S. PATENT NO. 6,638,313, U.S. PATENT NO. 6,725,427 AND U.S. PATENT NO. 6,768,999

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I. INTRODUCTION

I have been retained by the law firm of Paul Hastings Janofsky & Walker, LLP, on behalf of defendants Apple Inc., as an expert witness in this litigation between Mirror Worlds, LLC and Mirror Worlds Technology, Inc. (collectively, "Mirror Worlds"), and Apple Inc. ("Apple").

In this report, I provide my opinions regarding the invalidity of the claims of U.S. Patent No. 6,006,227 ("'227 patent"), U.S. Patent No. 6,638,313 ("'313 patent"), U.S. Patent No. 6,725,427 ("'427 patent") and U.S. Patent No. 6,768,999 ("'999 Patent") that have been asserted against Apple by Mirror Worlds (collectively referred to the "Mirror Worlds patents").

Attached to this report as Attachment 1 is a copy of my curriculum vitae, which includes my contact information and describes my prior employment and work history in detail. A list of the consulting and litigation matters in which I have been involved over the last four years is attached to this report as Attachment 2. This list also identifies all of the cases in which I have testified as an expert witness in deposition and/or at trial.

A list of the documents, tangible things, reports, models and/or data compilations that I have been provided, reviewed, considered, and/or relied upon in the preparation of this report is attached as Attachment 3.

I am being compensated in this matter at a rate of $600/hour. My compensation is in no way affected by the outcome of this litigation.

II. QUALIFICATIONS

I am a Professor of Computer Science at Columbia University in New York, New York. I earned a Ph.D. in Computer Science from Brown University in 1987. As mentioned above, a copy of my curriculum vitae describing my qualifications, responsibilities, employment

history, honors, awards, and appointments, and a listing of the papers, articles, books, videos, presentations, tutorials, and other material I have authored, is attached to this report as Attachment 1.

I direct the Computer Graphics and User Interfaces Laboratory at Columbia University and, as set forth in my curriculum vitae, I have been involved in research in a variety of technical areas related to the Mirror Worlds patents for over 30 years. I am also the co–author of *Computer Graphics: Principles and Practice* (Addison–Wesley, 1990) and *Introduction to Computer Graphics* (Addison–Wesley, 1993), which are used as textbooks in computer science curricula in a number of universities. As part of my testimony, I plan to discuss technology covered in my textbooks, both of which are hereby incorporated into this report by reference in their entirety.

III. SUMMARY OF OPINIONS

As set forth in more detail in the other sections of this report, it is my opinion that:

Claims 13–17, 20 and 22 of the ’227 patent are anticipated and/or rendered obvious in view of the prior art, as discussed below;

Claims 1–4, and 9–11 of the ’313 patent are anticipated and/or rendered obvious in view of the prior art, as discussed below;

Claims 1, 2, 5, 7–10, 13, 15–19, 22, 24–26, 29, 31–34, 37 and 39 of the ’427 patent are anticipated and/or rendered obvious in view of the prior art, as discussed below; and

Claim 1 of the ’999 patent is anticipated and/or rendered obvious in view of the prior art, as discussed below.

It is also my opinion that claims 9, 10, 13, 15, 17, 18, 19, 22, 24, 29, 31, 37, and 39 of the ’427 patent are indefinite for lack of proper antecedent basis.

It is also my opinion that certain prior art and information discussed in this report would have been material to the prosecution history of the ’227 patent and are non–cumulative of the art and information actually disclosed to the United States Patent and Trademark Office (“USPTO”).

In addition to explaining the opinions presented in this report at trial, I may also provide a tutorial that discusses the technology relating to the Mirror Worlds patents and the prior art. My tutorial may also discuss the history of the technologies implicated by the Mirror Worlds patents, to provide an understanding of the background technologies and state of the art at the time the Mirror Worlds patents were filed.

I reserve the right to supplement this report for any reason, including any modifications or revisions to the Court’s Claim Construction Order, arguments made by Mirror Worlds or its experts regarding the validity or materiality of the Mirror Worlds patents, and/or additional information or facts that I become aware of or are brought to my attention.

IV. MATERIALS CONSIDERED

As previously mentioned, Attachment 3 sets forth the materials I have considered for the opinions expressed in this report. I reserve the right to reference these materials in addition to the materials expressly identified in my report to supplement and/or explain any of the opinions and analyses contained in this report. In addition, I hereby expressly incorporate by reference into this report Apple’s Second Amended Invalidity Contentions dated June 18, 2010, Apple’s (First) Amended Invalidity Contentions dated May 11, 2009 and Apple’s Invalidity Contentions dated November 3, 2008, including the cited references and accompanying attachments and claim charts. In addition, Attachment 5 contains a list of the materials and

references cited in this report and in the claim charts accompanying or incorporated by reference into this chart.

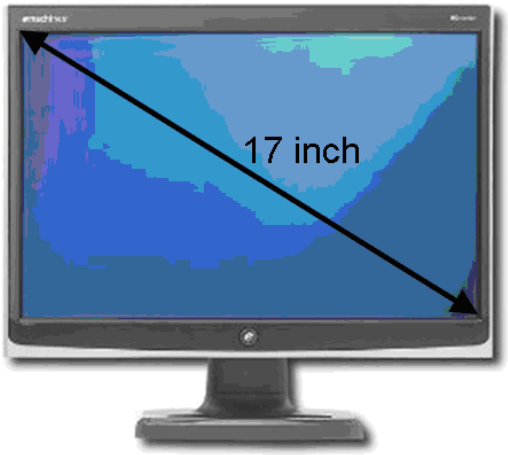
V. TECHNOLOGY BACKGROUND

When space is limited, most people are naturally inclined to search for or devise ways to more efficiently store items that they must store in that space. In this pursuit, one quickly recognizes that there can be tradeoffs between storing items efficiently and making them easily accessible. Managers of supermarkets continually deal with this as they look to offer more and more products in a way that will be noticed and accessible by customers. Employees in physicians' offices do this as the number of patient records grows. In fact, everyone, at one time or another, looks for ways to make more efficient use of their space, while still enabling items occupying that spacing to be readily accessible. Almost any type of item could be the subject of organization and retrieval, including documents such as, for example, reports, memoranda, bills, records, pictures, and letters.

To illustrate the conundrum often faced when addressing document storage, consider an office desktop. People often keep items on their desktop for easy access. When the number of documents being accessed becomes large, the desktop can become cluttered. In this situation, accessing the documents becomes difficult. This is just one example of how limited physical space affects storage and access. Other examples involve space on walls, floors, or other places in which information can be stored.

Desk image from web.tradekorea.com.

This problem not only applies to physical spaces, such as office desktops, but also applies to computer system monitors. Just as the sizes of physical spaces are limited, a computer monitor's display area is limited as well.



Computer monitor image from www.amazon.com.

In fact, the space available on a typical computer monitor at the time at which the Mirror Worlds patents were filed was only a small fraction of that available on a physical desktop, as the following figure from 1986 schematically shows.

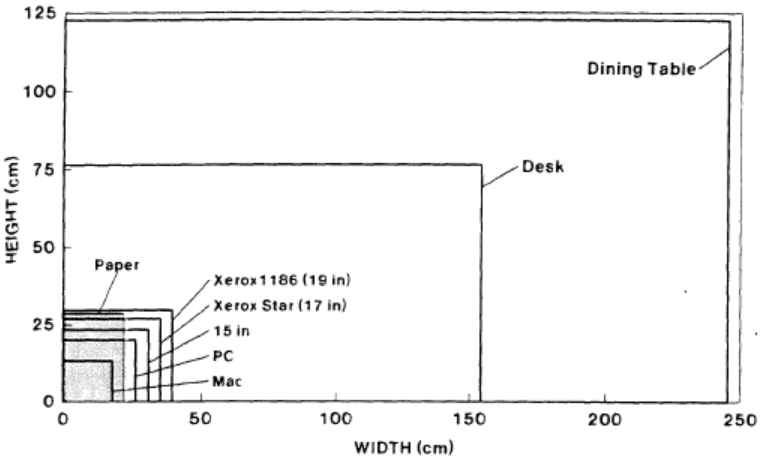


Fig. 2. Superimposed outlines of different workspaces. The crosshatched area shows the size of an 8½-by-11-inch page. Desks and dining tables are very much larger than even large displays. If display resolution were taken into account, the comparisons would be much more extreme.

[Henderson, at p. 213. (APMW0074226)]

Therefore, just as there can be difficulties in efficiently organizing information in physical space, there can be even greater difficulties in efficiently organizing information on a computer display monitor. In the discussion that follows, I will show that many of the techniques used to efficiently organize documents in physical space have been used to efficiently display information on a computer monitor.

As mentioned in U.S. Patent 6,249,724 by Richard Mander et al. ("Mander '724"), computer systems for organizing information in the mid–1990s typically fell into two types of file systems: flat file systems and hierarchical file systems. These file systems were often implemented as part of the operating system of the computer system and were intended to allow the user to organize information in a manner desired by the user.

In a flat file system, the computer stores all files (e.g., documents) at the same level, such that the user when examining these files sees all files at this level. Thus, a flat file system is similar to a desk where all documents on the desk are spread out, with none in any

folders or other containers. Such a file system becomes increasingly cumbersome as the number of documents grows.

Hierarchical filing systems on computers attempt to improve on flat file systems by providing a hierarchy of folders or subdirectories within which the user may store documents. In a hierarchical file system, the user can file a document into a folder that may itself be within another folder, or, more generally, within a hierarchically nested set of folders. One way of looking for any documents within a first folder involves opening the first folder after opening the second folder that contains the first folder (and, similarly, opening in sequence any folders within which the second folder was nested). In this manner, the user is not presented with a bewildering number of documents at the same level, as in the flat file system, and the user's files are maintained in an orderly and systematic way within the hierarchy specified by the user. According to Mander '724, versions of Finder on Apple's Macintosh used hierarchical file systems with graphical user interfaces.

As Mander '724 points out (see Mander '724 at 1:18–2:58), this hierarchical structure forces a computer user to be as organized as possible in filing information. If the user has difficulty in filing documents because of the difficulty in deciding the proper categories for the documents, then the user may store the documents in the highest directory of the hierarchy. As more and more documents are stored in the highest directory, a bewildering clutter of documents may appear in that highest directory, which then makes the system more like a flat file system. Mander '724 notes several problems caused by the use of hierarchical file systems and their user interfaces, and highlights how these problems can be particularly troublesome for email.

With these challenges presented to computer developers in the 1990s in mind, the following technical overview is provided. See Attachment 4 for a list of the references cited in the technical background of this report.

A. Pre–Computer Organization

The industrialization of printing systems and methods in the 18th and 19th centuries resulted in an information deluge. With all of this new information, there became an ever pressing need to devise ways to efficiently store and organize this information so that it was accessible to those interested in it.

A common method used to store documents efficiently involves stacking them directly on top of each other or directly side by side. This technique has been used in many environments, including in libraries where books are arranged in "stacks;" and in offices where documents are "stacked" on desks or in filing cabinets. While this method is efficient in terms of making use of storage space, it leaves something to be desired when it comes to enabling a user to easily access specific documents in the stack. As I will show, a number of methods and systems have been devised to improve the accessibility of documents in a stack.

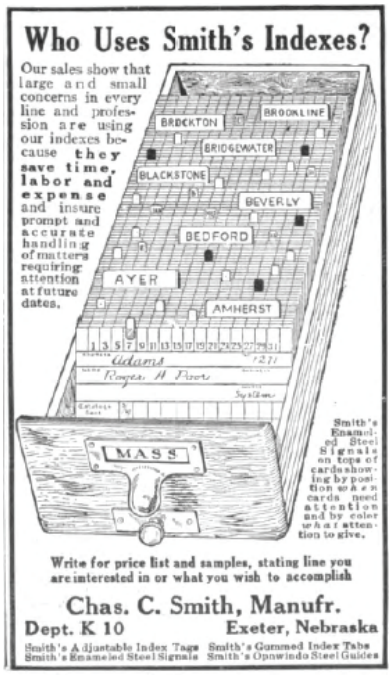
1. Stacks of information

a. File cabinets

File cabinets (see http://en.wikipedia.org/wiki/Filing_cabinet), also known as filing cabinets, date to the late 19th century and contain a set of drawers in which documents are stored side–by–side or back–to–back. Before file cabinets existed, businesses organized papers in envelopes, which they stored in arrays of pigeonholes often lining a wall or the interior of a desk. Finding and opening envelopes, and unfolding papers, proved to be inefficient, prompting the development of file cabinets.

File cabinets can be used to efficiently organize and store a wide range of documents. A typical file cabinet could be used to hold 8.5"×11" paper documents. Also popular were file cabinets or bureaus that hold 3"×5" index cards. While these index card bureaus have been used in many different locations, including homes and offices, they were most often found in libraries. Libraries utilize such bureaus to hold cards, each of which lists information such as the call number, title, author, and publication date, for an item in the library's collection. The cards are ordered and thus could be used by library users to locate and retrieve items from the library's collection. Examples of a typical file cabinet and index card bureau drawer of the 1920s are shown below.

"System: The Magazine of Business" at p. 378 (September 1921). (APMW0073702)



"System: The Magazine of Business" at p. 112 (July 1921). (APMW0073496)

b. File Folders

A file folder (see http://en.wikipedia.org/wiki/File_folder) is a folder that holds loose paper documents together for organization. File folders usually consist of a sheet of heavy

paper stock, plastic, or similar material, which is used to keep related documents together. File folders are often used in conjunction with a file cabinet to further organize paper documents. The following figures, taken from magazine advertisements dating to 1921, lament a problem with common file cabinets and demonstrate that by using file folders to further organize documents in a file cabinet, specific documents are more easily accessible to the user.

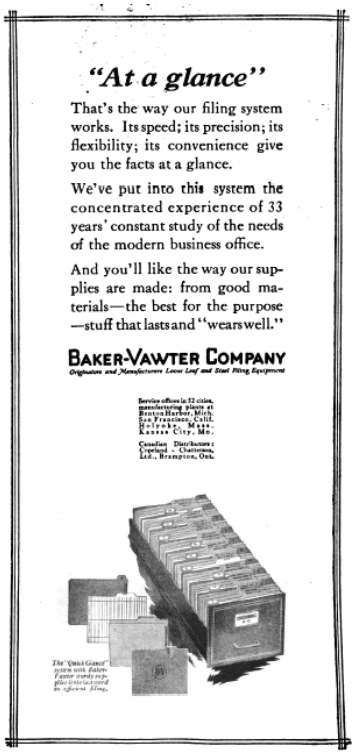
"System: The Magazine of Business" at p. 450 (October 1921). (APMW0073758)

"System: The Magazine of Business" at p. 70 (July 1921). (APMW0073464)

c. Limitations of file cabinets and file folders

While file cabinets and file folders are extremely useful for organizing documents in a space efficient manner, it was widely recognized at least eighty years ago that there was

room for improvement in terms of allowing users easier access to individual documents. The following figures, taken from a 1921 periodical, advertise products that were aimed at enabling users to glance at specific individual documents stacked in the file cabinets or file folders. By enabling this glance view, a user's accessibility to specific documents was improved.



"System: The Magazine of Business," p. 190, Aug. 1921. (APMW0073556)

"System: The Magazine of Business," p. 178, Aug. 1921. (APMW0073550)

"System: The Magazine of Business," p. 459, Oct. 1921. (APMW0073763)

2. Partial overlapping of documents for greater accessibility

It was readily apparent, even as far back as the 1920s, that by partially overlapping documents in a stack instead of directly or fully overlapping documents in a stack, accessibility to individual documents in the stack could be improved. This idea of partially overlapping documents in a stack was commonly known, as is shown in the following figures.

Elliott Index Cards print their own Addresses. They come in eight different colors and fulfill any desired card-index scheme. One piece. No metal. You can write or print on their fibre frames. Each card good for 10,000 impressions.

"System: The Magazine of Business" at p. 739 (December 1921). (APMW0073981)

"System: The Magazine of Business" at p. 55 (July 1921). (APMW0073455)

The "Universal Displayor" product described in the following figures could be used to organize a wide variety of information in a partially overlapping stack. The advertisement lists maps, charts, posters, pictures, bulletins, drawings, exhibitions, routing charts, advertising copy, directors' meetings, traveling exhibits, health records, merchandise, blue prints, specimens, statistics, samples, and surveys as information that could be organized and displayed using this product. As the advertisement further shows, users could just use their hands to flip between different items of information.

Display! Display! Display!

The nerve center of the modern business structure lies in the executive's office and consists of the most vital information he must keep available for instant use.

Whether it be sales data—plans—methods—organization—or other of the many factors that determine policies, prompt visibility and accessibility are absolutely essential.

Universal Displayors serve the executives in every purpose in just that way. With wings swinging like the pages of a big book, and readily accessible, whether on the floor or on the wall, *Universal Displayors* are becoming more and more to be recognized as an office necessity.

The following officials find them of great value:

Exhibitions		Maps
Statisticians		Charts
Health Officials		Posters
Office Managers		Pictures
Advertising Managers		Bulletins
		Drawings
Government Officials		Exhibitions
Factory Superintendents	**For**	Routing Charts
		Advertising Copy
Purchasing Managers		Directors' Meetings
Employment Managers		Traveling Exhibits
		Health Records
Welfare Managers		Merchandise
Comptrollers		Blue Prints
Secretaries		Specimens
Architects		Statistics
Engineers		Samples
Schools		Surveys

"System: The Magazine of Business" at p. 472 (October 1921). (APMW0073772)

The Nerve Center of a Warship

lies where the fire and signal controls are found. Similarly, in any modern business organization its nerve center will be found where the vital information of executives is kept available for ready reference and use. Whether it be sales information, plans, policies, organization or any one of the many determining factors of business organization, prompt visibility and accessibility is an essential.

Universal Displayors serve executives in every conceivable way for just that purpose. With wings swinging like the pages of a big book, and readily accessible, whether on the floor or on the wall, Universal Displayors are becoming more and more to be recognized as a necessary office device. The following executives use them to a large extent:

Factory Superintendents
Employment Managers
Advertising Managers
Purchasing Managers
Government Officials
Welfare Managers
Office Managers
Health Officials
Comptrollers
Statisticians
Exhibitions
Executives
Secretaries
Architects
Engineers
Schools

FOR

Maps
Charts
Posters
Surveys
Pictures
Samples
Bulletins
Statistics
Drawings
Specimens
Exhibitions
Blue Prints
Merchandise
Health Records
Routing Charts
Advertising Copy
Traveling Exhibits
Directors' Meetings

Circular 32C Tells You More About Visualization. Write for it today.

Universal Fixture Corp.
133 West 23d St. New York

"System: The Magazine of Business" at p. 576 (November 1921). (APMW0073858)

This concept of organizing documents in partially overlapping stacks has been well–known and widely used for many years. I will now show several examples where this partially overlapping document concept has been used for organizing magazines and periodicals, timecards, maps and sales information, game cards, posters, music records, compact discs, and jukebox song selections. Some of these examples date to the 19th century, although it is likely these concepts may have been considered obvious even earlier.

a. Magazines or Periodicals

Displays for magazines and periodicals are commonplace in newspaper stands, convenience stores, and physicians' offices. These displays typically orient the magazines and periodicals such that they partially overlap. Doing this makes it possible for the magazines and

periodicals to be efficiently stored in a small space, while at the same time providing users with easy access to individual items. An example of this sort of rack is shown in the following picture from an article dating to the 1920s.

OUT IN PLAIN SIGHT

The rack holds magazines supplied by this bank to officers and employees. The display keeps the magazines circulating

"System: The Magazine of Business" at p. 30 (July 1921). (APMW0073432)

b. Timecard holders

Another example of how people have determined that it makes sense to display documents in a partially overlapping stack is a common timecard holder that holds the timesheets of many employees.

There are several options for storing and arranging these timecards. One option would be to stack all of these timecards in a fully overlapped manner. While this may be efficient in terms of space storage, it would be problematic for accessibility in cases in which each of tens or even hundreds of employees in a line needs to find their timecard so they could clock in to work. Another option would be to lay out all the timecards in a non–overlapped manner. While one would be able to see the entire timecard of every individual, this method would take up a lot

of unnecessary storage space, since the employee would need to see only a portion of the full timecard to identify it quickly.

A third option is to arrange the timecards in a partially overlapping stack. This method has been commonly adopted in practice, likely because it is effective in its use of storage space and because it offers workers easy accessibility to their individual timecard.

Holders like this for storing timecards in this partially overlapped manner have been common for some time as the following picture from an article dating to the 1920s demonstrates.

"System: The Magazine of Business" at p. 680 (December 1921). (APMW0073930)

c. Sales information holders

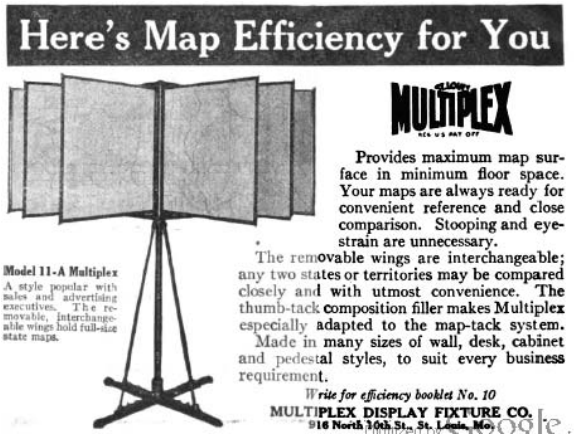
Another example where people have chosen to display documents in a partially overlapped manner is in the field of sales. In this field, the ability to display items in a format that allows for easily accessibility for display, while at the same time not consuming too much space, is highly valued. The Multiplex automatic Window Display (shown below) is an example of a product that has these desired attributes.

This product was hailed as being a "way of advertising goods by window display." It displayed a significant amount of information in a smaller area than was typically

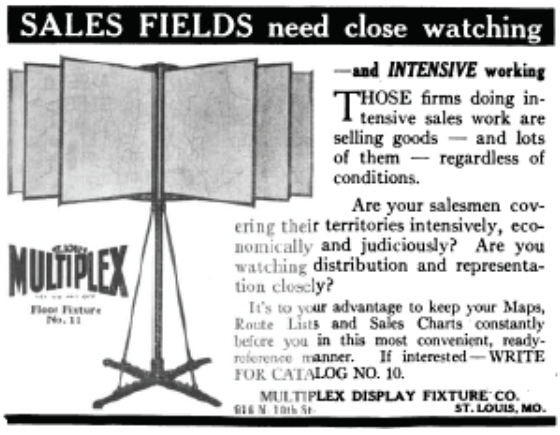
required: The advertisement mentions "that on the five wings of the fixture there can be displayed as many samples or as many advertising announcements as could be gotten on a table three feet wide and thirty feet long, yet the fixture occupies only about four square feet of display space." ["Commercial America," p. 35, July 1911. (APMW0072258)]

["Commercial America" at p. 35 (July 1911). (APMW0072258)]

Another Multiplex product is shown below in advertisements from a periodical from 1921. These advertisements clearly show the multiplex product as displaying partially overlapped documents that appear to the user as a receding foreshortened stack.

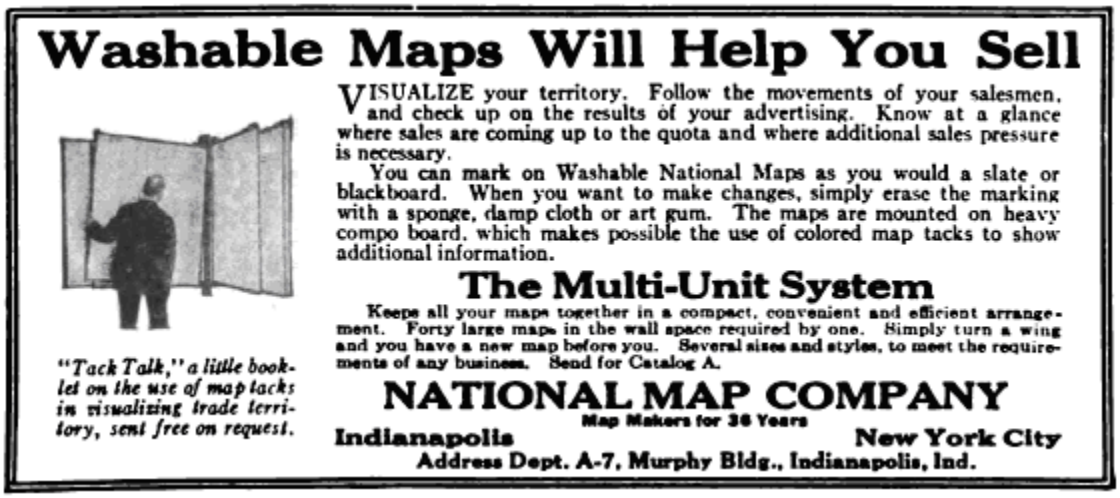


["System: The Magazine of Business," p. 217, August 1921. (APMW0073575)]



["System: The Magazine of Business" at p. 92 (July 1921). (APMW0073482)]

Yet another example of a system for displaying multiple documents in a stack is shown in the following advertisement from the same magazine.



Washable Maps Will Help You Sell

VISUALIZE your territory. Follow the movements of your salesmen, and check up on the results of your advertising. Know at a glance where sales are coming up to the quota and where additional sales pressure is necessary.

You can mark on Washable National Maps as you would a slate or blackboard. When you want to make changes, simply erase the marking with a sponge, damp cloth or art gum. The maps are mounted on heavy compo board, which makes possible the use of colored map tacks to show additional information.

The Multi-Unit System

Keeps all your maps together in a compact, convenient and efficient arrangement. Forty large maps in the wall space required by one. Simply turn a wing and you have a new map before you. Several sizes and styles, to meet the requirements of any business. Send for Catalog A.

"Tack Talk," a little booklet on the use of map tacks in visualizing trade territory, sent free on request.

NATIONAL MAP COMPANY

Map Makers for 36 Years

Indianapolis **New York City**

Address Dept. A-7, Murphy Bldg., Indianapolis, Ind.

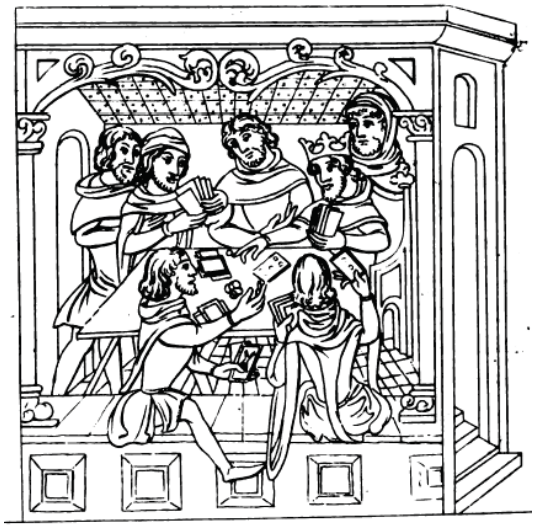
["System: The Magazine of Business" at p. 118 (July 1921). (APMW0073502)]

d. Holding multiple documents by hand

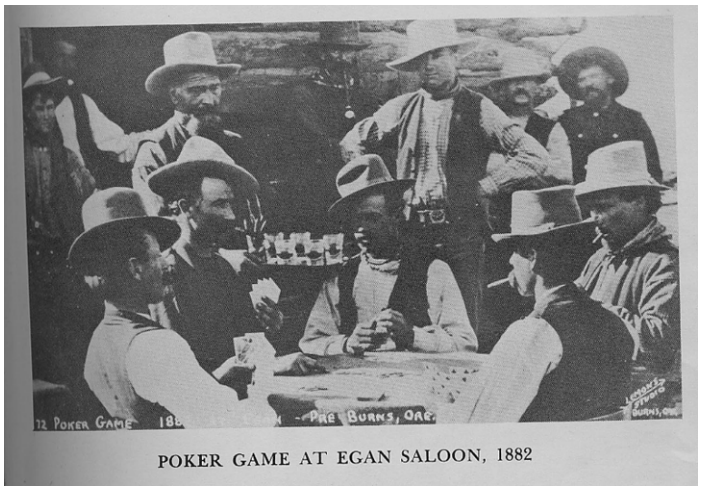
When an individual holds in his or her hand multiple documents and would like to display or view them, it is natural for that person to partially overlap the documents so that a portion of each document is visible. This method of holding and displaying multiple documents has been practiced for over one hundred years. Consider the following common example in which individuals have thought it natural to display multiple documents in this partially overlapped manner.

e. Card players holding hands of cards

Players of card games have long held their cards in a convenient manner in which card are overlapped and easily accessible. This common configuration corresponds to a partially overlapped stack. Below are an engraving (ca. 1816, after a medieval illustration), a photograph (ca. 1882), and a painting (ca. 1903) of card players holding their cards in this partially overlapped stack configuration.



[Singer at p. 68 (1816) (APMW0071873)].



[Poker1882 (APMW0072222)].

[Dogs Playing Poker (His Station and Four Aces) by C. M. Coolidge, 1903]

f. Music record album organizers

The picture shown below, which was taken in 1969 at the Music Millennium store in Portland, Oregon, shows a typical way in which music record albums were organized. The albums are arranged in a partially overlapped stack. To access a specific album, a customer could

easily scan the rack for the desired album and once located, just pull out the album by hand to take a closer view. As shown below, similar approaches have been used for compact disks.

[Calamar at p. 88 (c. 1969) (APMW0074633).]

g. Compact disc organizers

["Billboard Magazine" at p. 52 (July 4, 1992] (APMW0075696)]

h. Jukeboxes

The jukebox (see http://en.wikipedia.org/wiki/Jukebox), which is a music–playing device that can play specially selected songs from self–contained media, was popularized over

70 years ago. Early jukeboxes were rather large decorative devices, often constructed of fine wood, with colored lighting on the front of the machine and on its vertical sides.

The classic jukebox has buttons with letters and numbers on them that, when combined, are used to indicate a specific song whose name or other identifying characteristic is displayed on the machine. An example of such a jukebox is shown below, in which the record being played is displayed at the center, surrounded by the other records in the stack.

[Adams at p. 86 (1955). (APMW0074350)]

Early jukeboxes displayed song information, such as the song name, for every song they stored. When small, wall–mounted, jukeboxes had the capability of playing twenty songs or less, displaying each song name on a single display menu was feasible. However, when the number of songs stored on the jukebox became substantial, displaying each song name or identifying characteristic on a single menu was problematic.

As was quickly realized, a way to overcome this problem was to replace the single song selection menu with several smaller menus. Each new menu listed a subset of the songs that could be played by the jukebox. These menus were situated in a partially overlapped

fashion. A user could flip from menu to menu by using controls provided on the jukebox. Two examples of jukeboxes that utilized the flip–through menu structure to provide the user with the capability to select from hundreds of songs, are shown below.

Wurlitzer 5250 (1961)

Wurlitzer 5250 jukebox (ca. 1961) [Adams at page 105 (APMW0074353)] and Wall–Ette WRC jukebox (ca. 1968) [Wallette (APMW0076432)]

With the development of compact discs in the 1980s, the media used in modern jukeboxes moved from vinyl records to compact discs. These CD jukeboxes, for the most part, continued to use the flip through overlapping menu structure that earlier record jukeboxes had used. In addition, the available songs identified on these CD jukeboxes were not only identifiable by the song name. Graphical representations corresponding to the song's album cover were also added to the flip through menu to identify and distinguish songs. An example of a CD jukebox, the Rowe Laser Star 100B CD Jukebox (1990), which utilized the flip through overlapping menu structure with individual song album cover images, is shown below.

Image of Rowe Laser Star 100B CD Jukebox (circa 1990) from www.belamny.com/images/rowecd100b.jpg

3. Document ordering

There are many ways in which physical documents can and have been ordered for access and retrieval. A number of obvious ways to organize documents have been known for well over half a century, including ordering them numerically, alphabetically, and chronologically, as shown below.

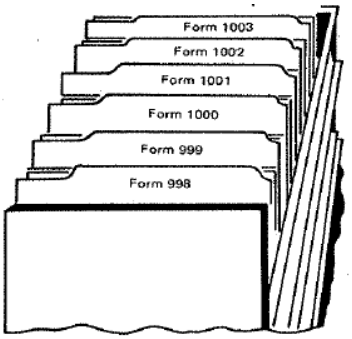


Figure 8–1 Straight Numeric Arrangement

[Robek at p. 160 (1987). (APMW0074261)]

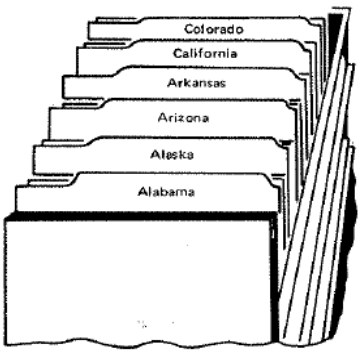


Figure 8–4 Alphabetic Arrangement

[Robek at p. 163 (1987). (APMW0074264)]

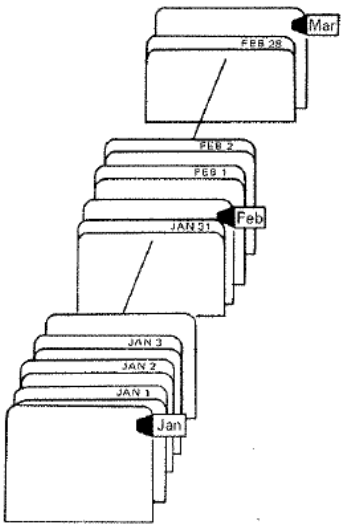


Figure 8–5 Chronological Arrangement

[Robek at p. 179 (1987). (APMW0074265)]

These ways of ordering documents have been around for over eighty five years as the following advertisement from 1921 demonstrates. This product being advertised is said to be capable of organizing documents "alphabetically, numerically, or by states, months, or days."

A box that makes the day's work easy

Ever turn your desk topsy-turvy looking for a letter that wasn't two feet away? Of course you have.

We have something that prevents such annoying delays—the Sorting Box.

It's an attractive steel container for keeping all "active" data at your finger tips; keeps it neatly, compactly, and arranged alphabetically, numerically, or by states, months, or days; an ideal follow-up file on "live" stuff.

This is just one of many uses.

Put one on your desk and see how much easier it makes your work.

BAKER-VAWTER COMPANY

[“System: The Magazine of Business” at p. 478 (October 1921). (APMW0073776)]

The following are additional examples in which documents have been ordered by number, by alphabet, by color, and by time.

a. Ordered by number

There are many instances where documents are organized numerically. For example, checks, invoices, vouchers, licenses, purchase orders, warranties, and insurance policies are just a few of many examples where people have chosen to order a set of documents by number. Consider the following two systems by which many libraries order their collections by number.

b. Library collections ordered according to the Dewey Decimal Classification System

Most libraries utilize a system, referred to as the Dewey Decimal Classification (DDC) system (see http://en.wikipedia.org/wiki/Dewey_Decimal_Classification), to organize their collections. This system was first designed by Melvil Dewey in 1876. The DDC is comprised of ten main classes. Each class is divided into ten divisions and each division is divided into ten sections. The DDC represents these categories using decimals. Items in a library's collection are organized in increasing numerical order of the decimal number. An item can be any information entity (e.g., book, computer file, graphic, or map), that is considered library material.

Libraries order their collection on shelves in increasing numerical order of the decimal number, (e.g., 050, 210, 350, 350.973, 351) corresponding to the DDC. When two items in the collection have the same classification number, the conflicting items are placed according to the second line of the call number (usually the first letter or letters of the author's last name, or the title if there is no identifiable author) in alphabetical order.

c. Universal Decimal Classification

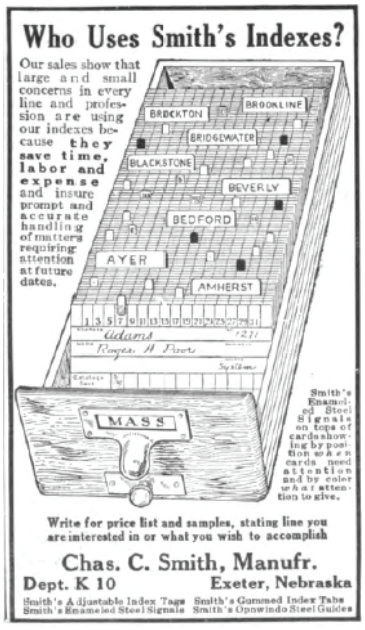
Another system that is used by many libraries to organize and order their collections by number is the Universal Decimal Classification (UDC) system (see http://en.wikipedia.org/wiki/Universal_Decimal_Classification). The UDC was developed by the Belgian bibliographers Paul Otlet and Henri La Fontaine at the end of the 19th century. It is based on the Dewey Decimal Classification, but allows for the assignment of multiple classifications to an item, enabling multiple orderings.

d. Ordered by alphabet

The use of alphabetical ordering to order items or documents is well–known and has been utilized for many years. Examples of items that are typically ordered alphabetically are dictionaries, encyclopedias, book indexes, telephone books, and address books.

Many document file systems are geared to be ordered alphabetically. This has been done for a long time, as substantiated in the following figures from a 1920s periodical.

["System: The Magazine of Business" at p. 82 (July 1921). (APMW0073472)]



["System: The Magazine of Business" at p. 112 (July 1921). (APMW0073496)]

["System: The Magazine of Business" at p. 471 (October 1921). (APMW0073771)]

e. Ordered by number and alphabet

There are many examples where documents are organized by combination of numerical ordering and alphabetical ordering. One such example is now described.

1. Library collections ordered according to the Library of Congress Classification

Some libraries, including the United States Library of Congress utilize an alphanumeric classification and ordering system. The Library of Congress Classification (LCC) system (see http://en.wikipedia.org/wiki/Library_of_Congress_Classification and http://www.loc.gov/catdir/cpso/lcc.html) was first developed in the late nineteenth and early twentieth centuries to organize and arrange the collections at the Library of Congress.

The system is comprised of twenty–one main classes, each identified by a single letter of the alphabet. Most of these alphabetical classes are further divided into more specific subclasses, identified by two–letter, or occasionally three–letter, combinations. Examples of these representations include class N (Art) with subclasses NA (Architecture); NB (Sculpture), ND (Painting); as well as several additional subclasses. Each subclass includes topics relevant to the subclass. Each topic is assigned a single number or a span of numbers. Whole numbers used in LCC may range from one to four digits in length, and may be further extended by the use of decimal numbers. Some subtopics appear in alphabetical, rather than hierarchical, lists and are represented by decimal numbers that combine a letter of the alphabet with a numeral, e.g. .B72 or .K535. Relationships among topics in LCC are shown not by the numbers that are assigned to them, but by indenting subtopics under the larger topics that they are a part of, much like an outline [http://www.loc.gov/catdir/cpso/lcc.html].

The items in a library organized by the LCC are ordered by taking into account both alphabetical and numerical elements of the call number, as the following figure shows.

[Library 2 (APMW0074601)]

f. Ordered by color

There are even examples where documents are ordered by color, as is shown in the following advertisement circa 1921.

["System: The Magazine of Business" at p. 576 (November 1921). (APMW0073858)]

g. Ordered by time

Calendars are the simplest example in which a number of items, including, for example, appointments, and meetings, are ordered by time. Two examples of such calendars are shown below.

["System: The Magazine of Business" at p. 482 (October 1921). (APMW0073780)]

["System: The Magazine of Business" at p. 114 (July 1921). (APMW0073498)]

There are many other examples where documents are ordered by time. These examples include a person's medical record folder, a museum's collection, a credit card statement, a bank statement, and the list goes on and on.

B. Speculative Methods for Organizing and Accessing Documents

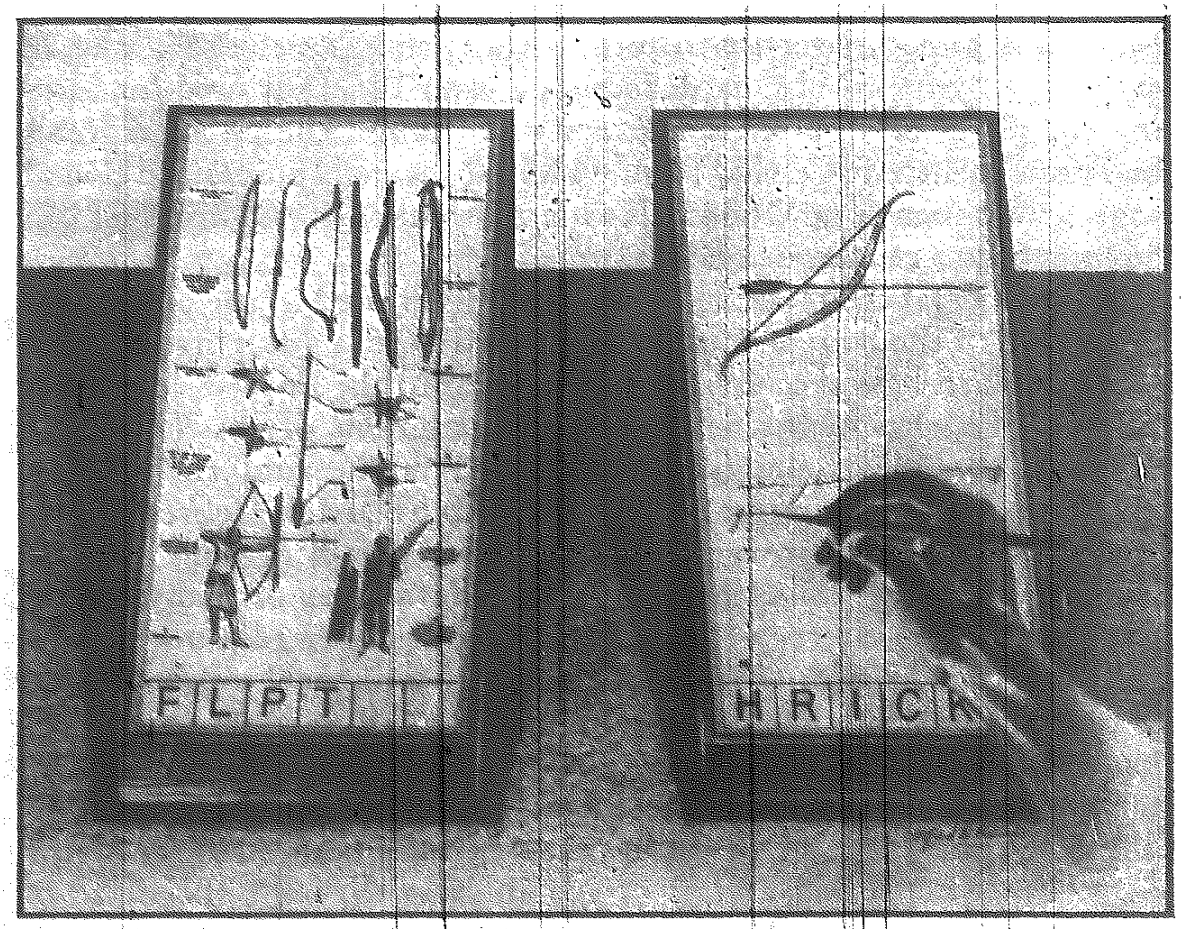
In July 1945, Vannevar Bush published an article entitled "As We May Think" in *The Atlantic Monthly*.[1] In this article, Bush communicates his concern that the immense volume of information becoming available to scientists would overwhelm traditional methods of acquisition, storage, organization, and analysis. He suggests that scientists need to create new methods for dealing with this information. See, for example, the Vannevar Bush article at APMW0055075.

[1] A version of this article also appeared in the September 10, 1945 issue of Life Magazine (APMW0080776– APMW0080785) which is hereby incorporated by reference.

Bush argues that "[a] record if it is to be useful to science, must be continually extended, it must be stored, and above all it must be consulted." See, for example, the Vannevar Bush article at APMW0055076. Bush then goes on to describe a system that was suited to the task of extending, storing, and enabling a user to access the record (i.e., information). In this system, records are stored as a miniaturized representation so that these records occupy little space. Bush looked for advances in microfilm to allow pictures to be stored in a small amount of space. At the time the Vannevar Bush article was published, microfilm already existed with a factor of 20 linear reduction. Bush noted that, with 100 times linear reduction, the entire "Encyclopaedia Britannica could be reduced to the volume of a matchbox." With such an efficient storage medium, improved distribution of information could be realized. See, for example, the Vannevar Bush article at APMW0055077.

Bush recognized the problems with traditional methods of providing access to information: "Our ineptitude in getting at the record is largely caused by the artificiality of systems of indexing." To enable the information to be utilized by an end–user, Bush describes a proposed system that incorporates "slanting translucent screens, on which material can be projected for convenient reading." See, for example, the Vannevar Bush article at APMW0055082. This system could display the equivalent of quick glance views of desired records or pages. See, for example, the Vannevar Bush article at APMW0055083. Bush further describes how the system enables the user to easily access a specific record: "If the user wishes to consult a certain book, he taps its code on the keyboard, and the title page of the book promptly appears before him, projected onto one of his viewing positions." See, for example, the Vannevar Bush article at APMW0055082.

Bush's proposed system enabled the organization and management of many different types of information: "A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory." See, for example, the Vannevar Bush article at APMW0055082 and the speculative image below from the Life Magazine version (APMW0080785) showing the use of the memex:



MEMEX IN USE is shown here. On one transparent screen the operator of the future writes notes and commentary dealing with reference material which is projected on the screen at left. Insertion of the proper code symbols at the bottom of right-hand screen will tie the new item to the earlier one after notes are photographed on supermicrofilm.

Bush also described how records in a system could be organized according to time: "Time is automatically recorded to tie the two records together." See, for example, the Vannevar Bush article at APMW0055078.

Bush described a system that could store and provide access to an immense amount of information from one's life experience:

> "The lawyer has at his touch the associated opinions and decisions of his whole experience, and of the experience of friends and authorities. The patent attorney has on call the millions of issued patents, with familiar trails to every point of his client's interest. The physician, puzzled by a patient's reactions, strikes the trail established in studying an earlier similar case, and runs rapidly through analogous case histories, with side references to the classics for the pertinent anatomy and histology. The chemist, struggling with the synthesis of an organic compound, has all the chemical literature before him in his laboratory, with trails following the analogies of compounds, and side trails to their physical and chemical behavior. The historian, with a vast chronological account of a people, parallels it with a skip trail which stops only on the salient items, and can follow at any time contemporary trails which lead him all over civilization at a particular epoch. There is a new profession of trail blazers, those who find delight in the task of establishing useful trails through the enormous mass of the common record. The inheritance from the master becomes, not only his additions to the world's record, but for his disciples the entire scaffolding by which they were erected." Vannevar Bush article at APMW0055084.

C. Computer–Based Methods for Organizing and Accessing Documents

1. File cabinets and folders

Just as filing cabinets and folders are used in peoples' homes and offices to organize and store paper documents, electronic folders are used on computer systems to organize and store electronic documents. An electronic folder operates just like a physical folder, in that it can be used to hold multiple documents. In the case of an electronic folder, the documents are

also electronic. Electronic documents, like paper documents, can correspond to any number of file types, such as digital pictures, spreadsheets, letters, and video clips.

The metaphor of a filing cabinet or folder works well here. If your file cabinet or folder is stuffed with paper documents and they are not in any given order, you will have a hard time finding a specific desired document. If all the documents stored on your computer (i.e., in your computer filing cabinet) or in individual computer file folders become poorly organized and disorderly, it will likewise be difficult to easily locate specific documents.

a. Folder and document representations on text–based user interfaces

Early personal computer operating systems, such as MS–DOS, have textual user interfaces. To interact with a computer having a textual user interface, a user types commands into the command–line interface. For MS–DOS, users type commands at the so–called MS–DOS prompt "C:\Temp>", where "C:" identifies the default disk drive and "\Temp" identifies the default path. The top level directory, identified by a single "\", as in "C:\", is called the root directory.

b. Document represented by a characteristic such as its name

All documents or files in an MS–DOS operated computer system are specified by a four-part naming convention. The four required parts are (1) drive, (2) path or folder, (3) filename, and (4) filename extension. As an example, a file specified by "C:\cars\.ford.txt" is specified as being located on the "C:" drive in the "cars" folder, has the name "ford," and is a text document.

A user can see the names of all the files and folders in a given directory by typing the command "dir" at the command prompt. The dir command typed by itself, displays the disk's volume label and serial number; one directory or filename per line, including the filename

extension, the file size in bytes, and the date and time the file was last modified; and the total number of files listed, their cumulative size, and the free space (in bytes) remaining on the disk. To display the file or folder attributes of the files or folders contained in a specific folder, the user can type the command "dir [drive:][path][filename] [parameters]". For instance, to list all the files and folders in the "cars" folder on the C: drive, as mentioned above, the user would type "dir C:\cars\". By adding the proper parameter to the command line statement, a user can have the files and folders sorted or ordered according to alphabet (i.e., name), size of the file or folder, type of file (i.e., extension), date and time, and last access date.

c. Folders and document representations on direct manipulation user interfaces

For over fifty years, scientists and engineers have researched systems and methods aimed at what was later termed "direct manipulation user interfaces" [Myers at p. 46]. This research and development is embodied in graphical user interfaces (GUIs), comprised of windows, icons, and widgets (e.g., buttons, menus, and scroll bars), which can be directly manipulated by techniques that mimic in part human interaction with physical objects.

These computer systems require a way for users to specify the operations that they would like the computer to perform. Direct manipulation interfaces allow a user to directly manipulate visible objects on a display, typically with a pointing device. In the 1950s, 1960s, and 1970s, many different pointing devices were developed to specify desired operations. These pointing devices included the light pen, the trackball, the joystick, cursor keys, the digitizing tablet, the touch screen, and the computer mouse.

The concept of a direct manipulation interface was first demonstrated in 1963 by MIT graduate student Ivan Sutherland in his Ph.D. dissertation, entitled "Sketchpad: A Man–Machine Graphical Communication System." Sketchpad interprets information specified

directly on a computer display with a light pen. A Sketchpad user could use the light pen to draw new objects, and select, move, and modify existing ones. Sutherland described his system as one that "opens up a new area of man–machine communication", since systems prior to Sketchpad required most communication to be typed and Sketchpad "eliminat[ed] typed statement (except for legends) in favor of line drawings" [Cambridge at p. 17].

Figure 1.2: TX-2 OPERATING AREA — SKETCHPAD IN USE. On the display can be seen part of a bridge similar to that of Figure 9.6. The Author is holding the Light pen. The push buttons used to control specific drawing functions are on the box in front of the Author. Part of the bank of toggle switches can be seen behind the Author. The size and position of the part of the total picture seen on the display is obtained through the four black knobs just above the table. *(Originally on page 11.)*

[Cambridge at p. 20. (APMW0074438)]

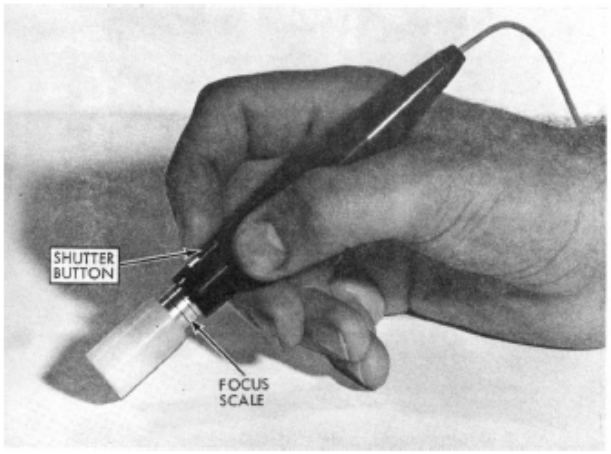


Figure 4.1: LIGHT PEN. Courtesy of MIT Electronic Systems Laboratory. *(Originally on page 56.)*

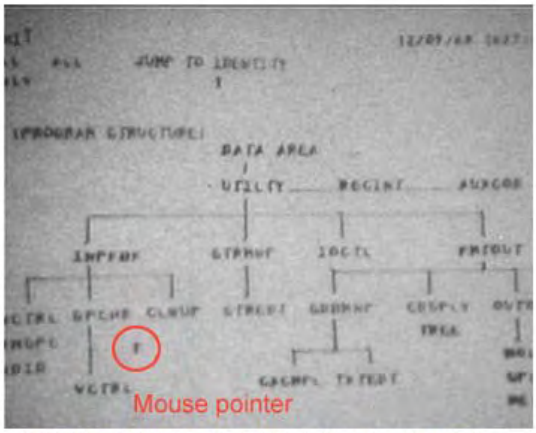
[Cambridge at p. 54. (APMW0074472]

In 1967, William Newman demonstrated the "Reaction Handler," which supported direct manipulation of graphics, and featured "Light Handles," a kind of graphical potentiometer [Myers at p.47].

In the 1960s, Doug Engelbart and his colleagues at the Stanford Research Institute developed a computer system called the oNLine System (NLS), whose user interface is shown below. This system utilized a new pointing device, called a mouse, to manipulate graphics on a computer monitor. The mouse was intended to be a lower cost replacement for the light pen that was used in Sketchpad and earlier systems. In 1968, Engelbart and his colleagues gave an historic demonstration of NLS at the Fall Joint Computer Conference.

The oN-Line System display, keyboard and mouse

[Reimer at p. 3. (APMW0074575)]



A screen from the NLS demo. The red circle indicates the mouse pointer.

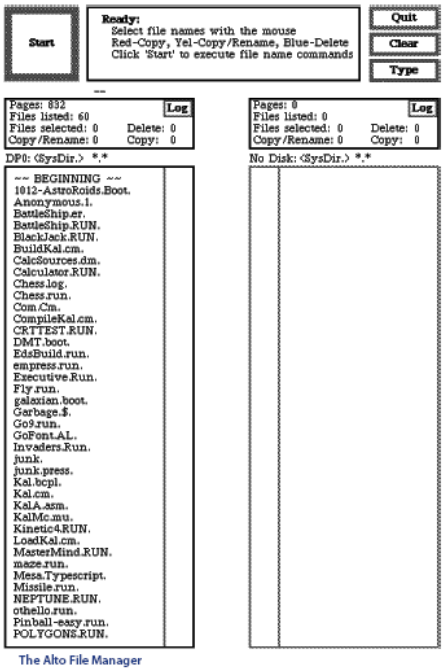
[Reimer at p. 5. (APMW0074577)]

Also in 1968, the AMBIT/G system for the manipulation of directed graphs was demonstrated at MIT Lincoln Labs. This system included interface elements such as iconic representations, gesture recognition, dynamic menus with items selected using a pointing device, and selection of icons by pointing [Meyers at p. 47. (APMW0074367)].

Researchers at the Xerox Palo Alto Research Center (PARC) extensively explored GUIs in the 1970s. They developed what was in effect the first personal computer, the Alto, offering a GUI in 1973. This system was not a commercial product, but several thousand units were built and were heavily used at Xerox and at several universities for a number of years. The Alto (shown below) used a mouse to manipulate graphical elements such as windows, menus, radio buttons, check boxes, and icons on a bitmapped screen.

The Xerox Alto

[Reimer at p. 6. (APMW0074578)]



The Alto File Manager

[Reimer at p. 7. (APMW0074579)]

In addition, Xerox PARC researcher Alan Kay published an article in 1977 on the "Dynabook," a speculative hand–held networked computer, in which the idea of direct manipulation interfaces for everyone was outlined. Many of the user interfaces developed at Xerox PARC exemplify what has been referred to as "WYSIWYG" (what you see is what you get) in that they allow users to view and edit information on the computer in a form that is intended to look as much as possible like the end result. Early examples of WYSIWYG interfaces were the Xerox PARC "Bravo" text editor and "Draw" drawing program [Meyers at p. 47. (APMW0074367)]. A modern day example of a WYSIWYG interface is Microsoft Word, which allows a user to view and edit a document in a form that is very similar to the end product.

A 1976 Xerox PARC internal memo showing a schematic of the plan for a GUI using a "desktop metaphor" [Bardini at pp.158–159 (APMW0074395–6)] is displayed below. Notice the iconic representations of computer items and the receding stack of documents.

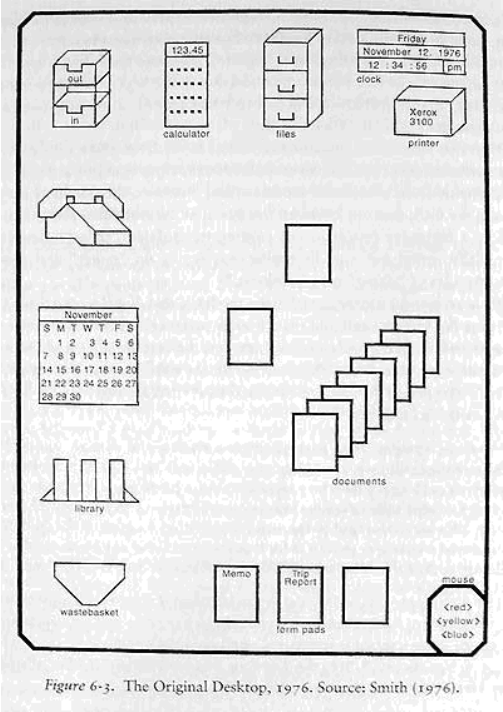


Figure 6-3. The Original Desktop, 1976. Source: Smith (1976).

[Bardini at p. 164. (APMW0074401)]

In the 1970s, Alan Kay worked with a team to develop a programming language and integrated development environment called Smalltalk, which would turn out to be the first commercial product to employ overlapping windows. A number of iterations of this Smalltalk environment were developed: Smalltalk–72, Smalltalk–74, Smalltalk–76 and Smalltalk–80.

In the early 1980s, several commercial systems that employed GUIs were produced. These include the Xerox Star (1981), the Apple Lisa (1983), and the Apple Macintosh (1984), and the Atari ST and Commodore Amiga in 1985. The GUIs on these commercial systems provided visual iconic representations of folders, documents, and other computer items.

d. Iconic representations of documents and folders

In 1975, David Canfield Smith, in his Ph.D. thesis at Stanford, was the first to use the term “icon” to refer to a GUI element. Icons typically refer to “any nontextual symbol on the display” [Johnson at p. 16 (APMW0076284)]. Smith worked at Xerox PARC, and contributed to the development of icon–based file management system GUIs there. It was widely recognized,

during Smith's time at Xerox PARC, that the textual user interfaces used in operating systems were limited in terms of organizing and maintaining files or documents. In the article "The Xerox Star: A Retrospective," published in *IEEE Computer* in September 1989, the authors lamented the difficulty with these textual user interfaces:

> "[A colleague] complained that she couldn't keep track of the files on her disk. An inspection of her system revealed files named memo, memo1, memo071479, letter, etc. Naming things to keep track of them is bothersome enough for programmers, but completely unnatural for most people."

[Johnson, at pp. 15–16. (APMW0076283–4)]

e. Xerox Star

To improve the accessibility for organizing and maintaining files, companies such as Xerox PARC implemented icon–based document management in systems that employed graphical user interfaces. An example of the icon–based document management system employed in the Xerox Star computer (1981) is shown below.

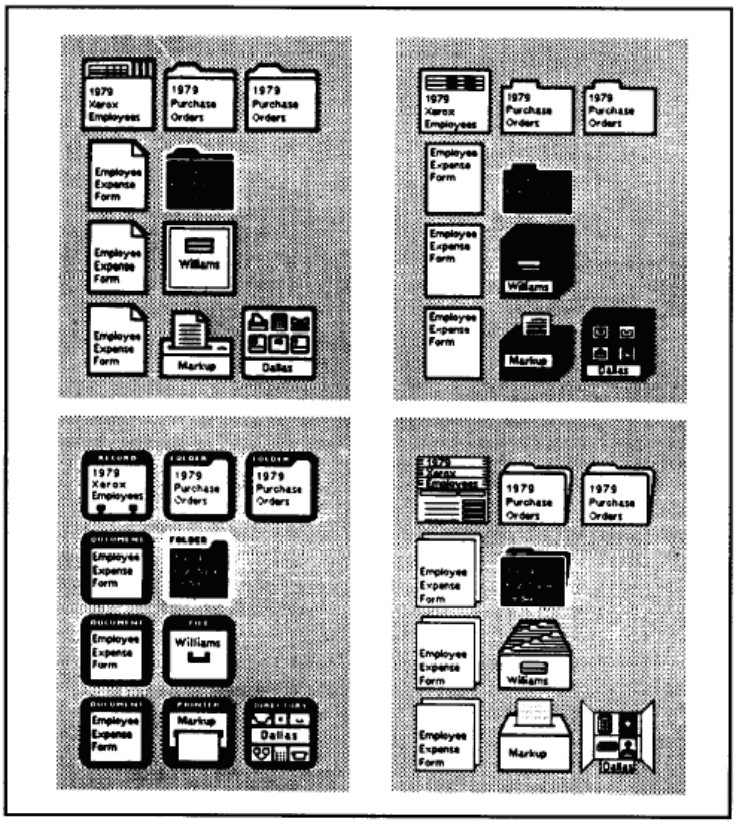


Figure 4. Visual order and user focus. Four candidate sets of icons were designed and tested for Star. A representative sample from each set is shown here. In Star, the icon selected by the user is indicated by inverting its image. Candidate icon sets in which the images are mostly white allow icons to stand out when selected. The set that best satisfies this criterion, the one on the upper left, was chosen.

[Johnson at p. 18 (APMW0076286)]

As the figure shows, a document in Xerox Star's icon–based file management system is distinguishable by more than just its visible document name. It is also distinguishable by the icon on which its name is shown. Different types of documents are represented by different icons. For instance, all folders have the same distinctive icon and all printers have the same distinctive icon.

The Xerox Star system was designed for casual computer system users. Because of this assumption about Star's target customer base, the designers sought to create a simple to learn and easy to remember system that would allow users to focus on their work instead of having to worry about concepts such as operating systems, software, applications, and programs.

Star provided users with documents, business graphics, tables, personal databases, and electronic mail. Star included features such as windows, a mouse–driven interface, and icons.

f. Apple Lisa

The Apple Lisa personal computer (shown below) was designed and sold by Apple in the early 1980s. It offered a GUI that could be manipulated with a mouse:

Photo 1: *The Lisa computer system.*

[Williams1 at p. 33 (1983). (APMW0074156)]

[Williams1 at p. 37 (1983). (APMW0074160)]

"With graphics of sufficient quality and a mouse, the Lisa lets you get what you want by pointing at it. Because the video cursor moves in direct response to the way the hand moves the mouse, you feel as if you're actually pointing at something on the screen." [Williams1 at p. 36. (APMW0074160)] Lisa used a "desktop metaphor": "The Lisa computer depends on the metaphor that the video display is a desktop, while the icons are objects on the desktop." [Williams1 at p. 36. (APMW0074160)] Similar to the Xerox Star computer, Lisa displayed icons that were visual representations of computer files folders, printers, floppy disks, and hard disks.

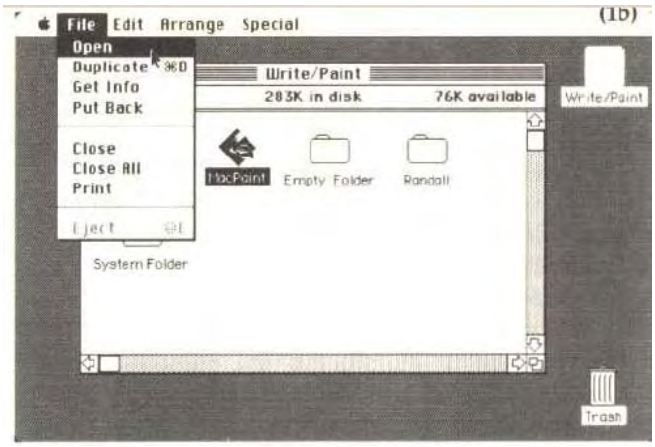
Special documents or programs could be opened by the user by pointing the cursor to the icon representing the document and then double clicking the button on the mouse. The Apple Lisa offered greater capabilities than the Xerox Star in that it allowed a user to drag

and drop icons, and offered a fixed drop–down menu bar. A good reference describing the development of the Lisa user interface is Roderick Perkins, Dan Smith Keller, and Frank Ludolph, "Inventing the Lisa User Interface" *Interactions*, 4(1), Jan./Feb. 1997, pp. 40–53.

g. Apple Macintosh

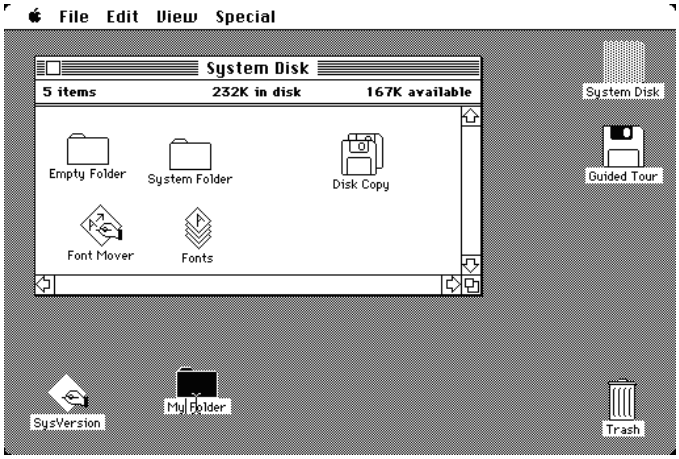
Apple first released the original Macintosh computer (shown below) in 1984. The Macintosh was priced from $1995 to $2495, compared to the $9995 Lisa. The Macintosh was the first commercially successful product to use a GUI [Williams1, Williams2].

[Williams2 at p. 30 (1984). (APMW0074185)]



[Williams2 at p. 33 (1984). (APMW0074188)]

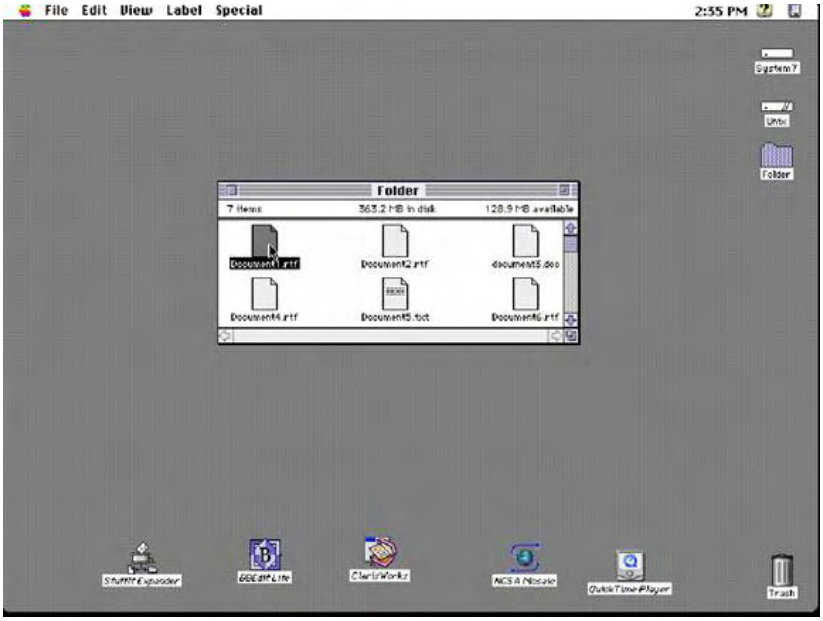
On the Macintosh desktop metaphor GUI, files looked like pieces of paper and directories looked like file folders. In addition, there were desk accessories, such as a calculator, notepad, and alarm clock.



[Mac (APMW0074710)]

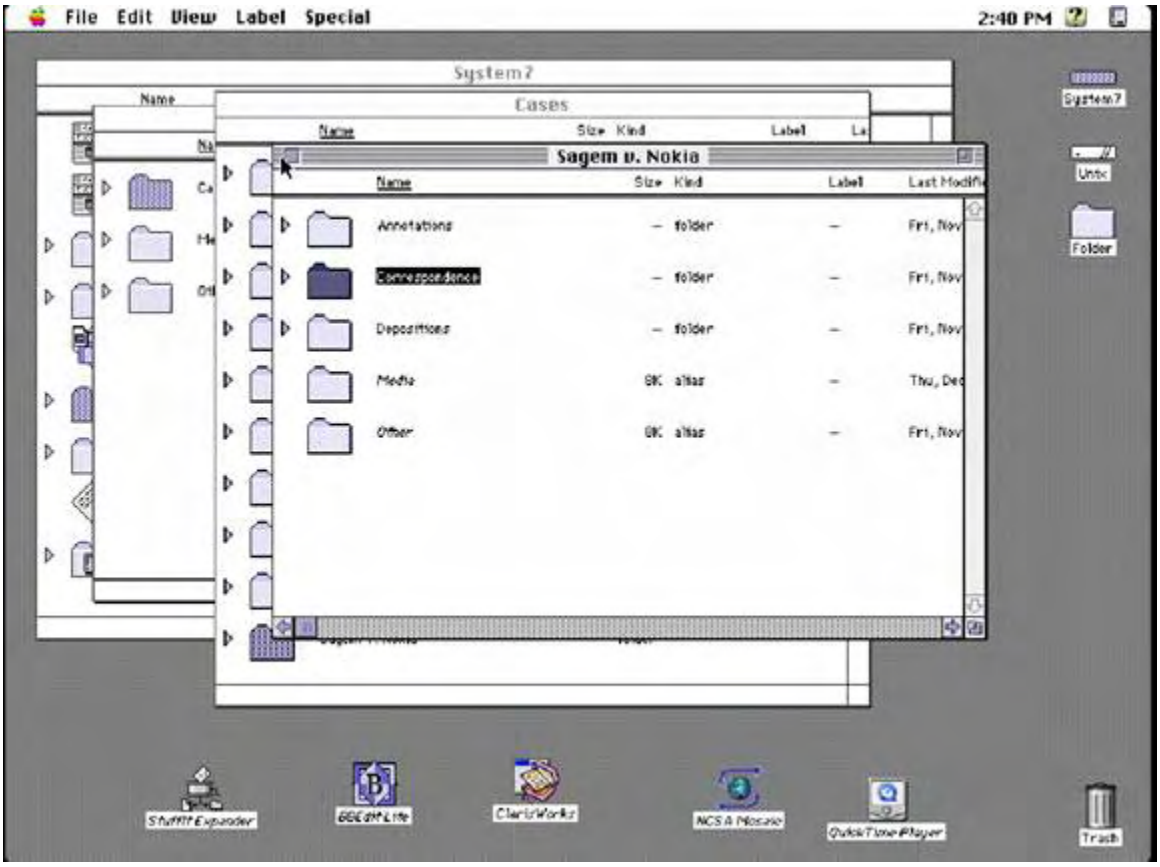
The Macintosh allowed the user to move these icons around the screen as desired (i.e., using "drag and drop"). In addition, the user could delete files and folders by dragging them to a trash can on the screen.

h. Macintosh System 7 OS and Finder



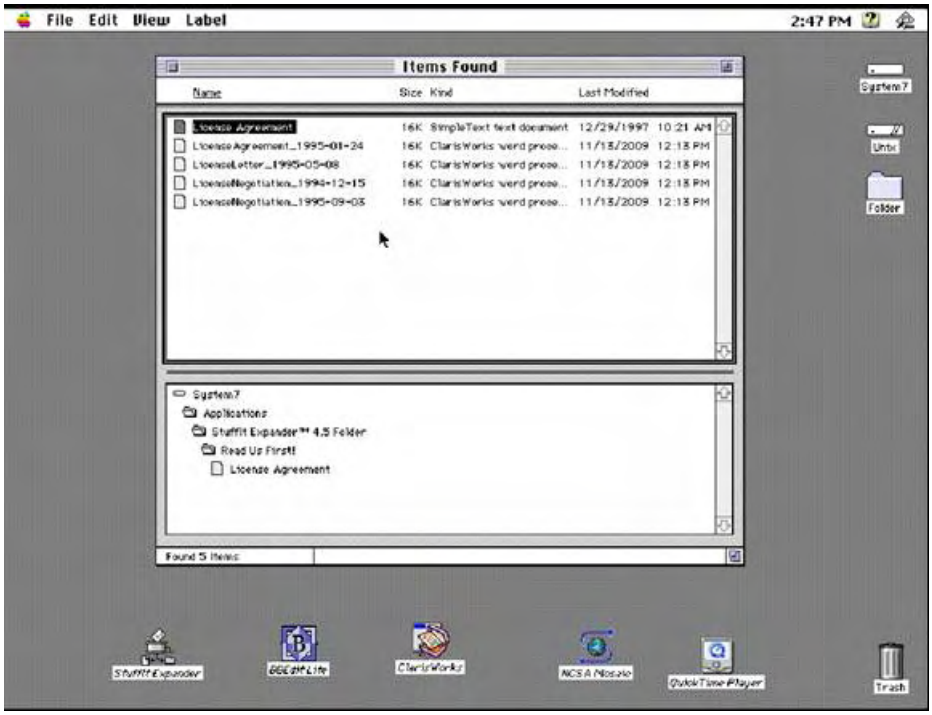
The Apple System 7 Operating System was released in 1991. The System 7 GUI also implements a desktop metaphor, and represents documents as pieces of paper that are put into folders. System 7 is a "hierarchical" system in which one folder of documents might be placed in another folder, which may be nested in yet another folder, and so on, to form a

hierarchy of folders. This concept is illustrated in the figure below, which shows windows stacked on top of one another, such that the window in the foreground of the display represents the folder at the bottom of its hierarchy.



System 7 also allows the user to search for files. From the desktop, the Find command opens a search window. The user can then specify a search request, as shown below:

In the image above, the search is for the word "license" within the name of an item. The items that satisfy this search are displayed, as shown below, with the folder hierarchy for a selected item shown in a panel below the search results:



The search results can be sorted by name, size, kind, and date modified. For example, the user can click on the "Last Modified" column header to sort the entries by date. These search capabilities, along with the desktop metaphor and hierarchical file system, are typical of operating systems from the mid–1990s.

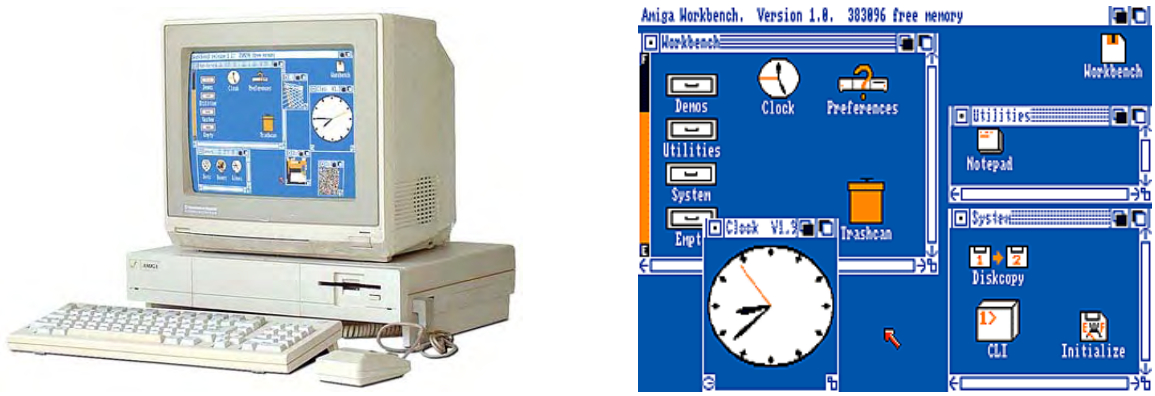
i. Atari 520ST

Atari released the 520ST computer (shown below) in 1985. The 520ST was the first personal computer to come with a fully bit–mapped color GUI. This GUI was Digital Research's GEM interface. Like the Macintosh, Lisa, and Star computer GUIs, GEM used icons to represent certain elements on the computer, such as documents, folders, and applications. Unlike the Macintosh, the GEM interface did not allow the icons to be moved freely, although they could be copied or deleted. The 520ST offered a two–button mouse, which could be used to manipulate icons on the GUI [Anderson (APMW0074206–10)].

[Atari 520ST (APMW0075772)]

j. Commodore Amiga

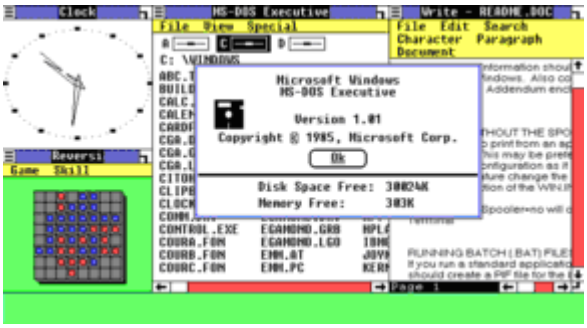
Commodore released the Amiga computer (shown below) in 1985. The Amiga also had a GUI that was manipulated using a mouse.



[Amiga (APMW0075770)]

k. Microsoft Windows 1.0

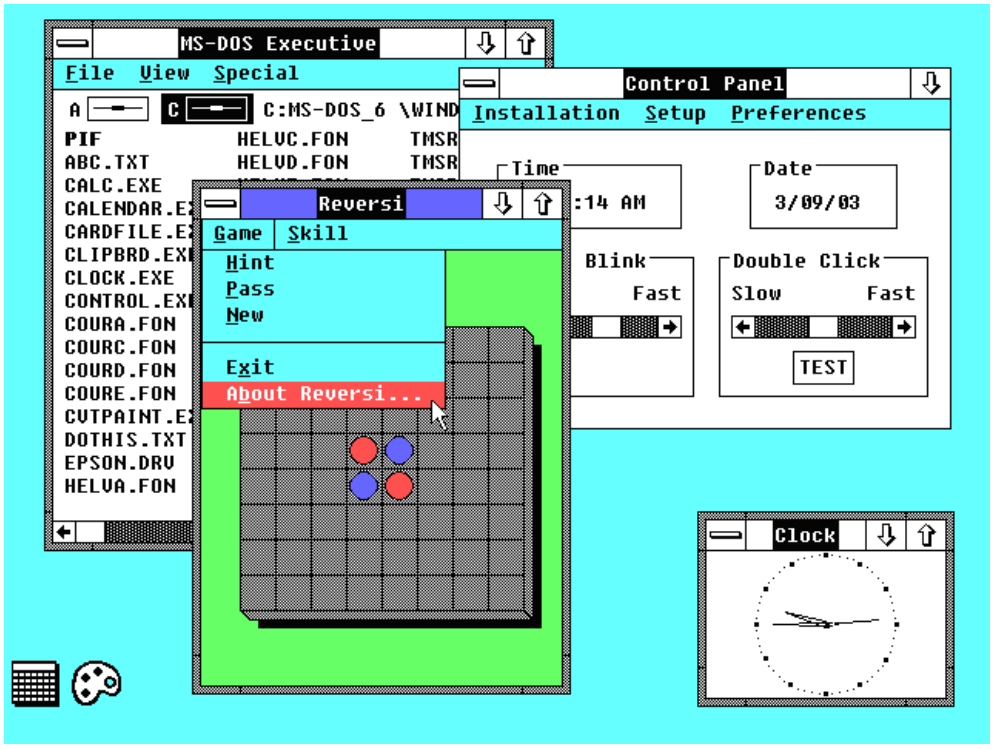
Microsoft Windows 1.0 (shown below) is an operating system with a GUI that was released in 1985. Windows 1.0 runs a shell program known as MS–DOS Executive. Supplied programs include Calculator, Calendar, Cardfile, Clipboard viewer, Clock, Control Panel, Notepad, Paint, Reversi, Terminal, and Write. Windows 1.0 worked with a bitmap display and a mouse. It allowed only tiled (nonoverlapping) windows. Only dialog boxes could overlap other windows.



[Windows 1.0 (APMW0076437)]

l. Microsoft Windows 2.0

Microsoft Windows 2.0 (shown below) is an operating system with a GUI that was released in 1987. Unlike its Microsoft predecessors, Windows 2.0 allowed application windows to overlap each other.



[Windows 2.0 (APMW0076438)]

m. Apple and Microsoft lawsuit concerning Windows 2.0

On March 17, 1988, Apple sued Microsoft and Hewlett–Packard in the Northern District Court of California, accusing them of violating copyrights Apple held on the Macintosh system software. In particular, Apple claimed that Microsoft Windows 2.03 and the HP New–Wave software infringed seven copyrights held by Apple. The copyrights were said to protect audiovisual work on the Apple Macintosh GUI, including the following features: overlapping windows, iconic representation, object opening and closing, menus, and icon manipulation. On April 7, 1989, Apple submitted to the court a list of alleged similarities between its works and the works of Microsoft and HP. The list contained 189 alleged similarities between the Apple audiovisual works and Windows 2.03 [Apple Computer, Inc. v. Microsoft Corp., 717 F.Supp. 1428 (N.D.Cal.1989)].

The court determined that under a 1985 agreement, in which Apple granted to Microsoft a non–exclusive license of the audiovisual displays in Windows 1.0, 179 of the

similarities claimed to be in Windows 2.03 were licensed [Apple Computer, Inc. v. Microsoft Corp., 717 F.Supp. 1428 (N.D.Cal.1989)].

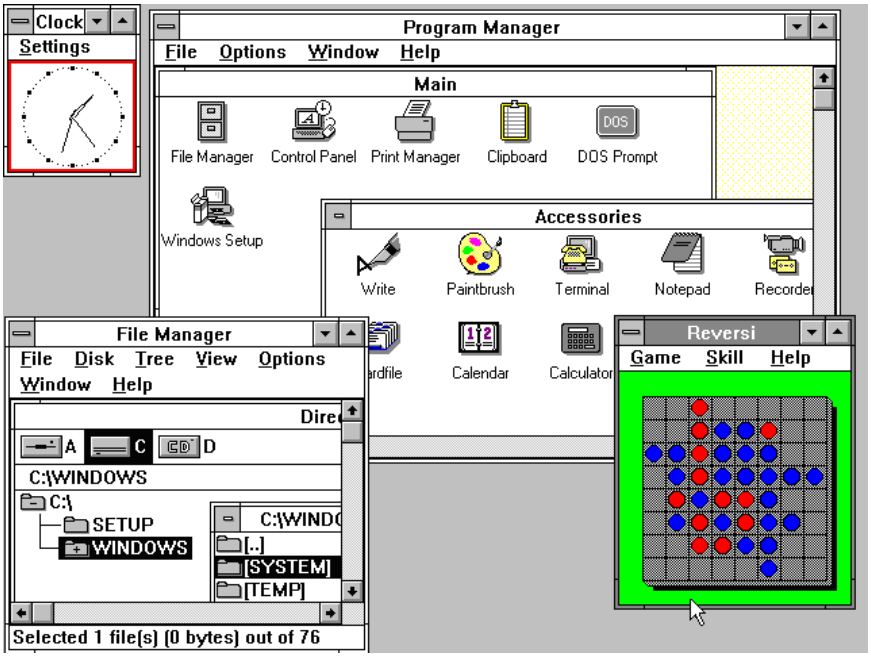
Microsoft moved for partial summary judgment that copyright protection did not extend to any of the remaining alleged similarities on the first list that had not yet been deemed to be covered by the 1985 agreement. The Court granted the motion [Apple Computer, Inc. v. Microsoft Corp., 799 F. Supp. 1006 (N.D. Cal. 1992)].

Apple filed its motion for reconsideration. After granting this motion, the court on May 12, 1992 heard argument from counsel for Microsoft and Apple on Microsoft's "Motion for Partial Summary Judgment Dismissing Apple's Claim Against Windows 3.0." The Court determined that not one of the identifiable alleged "additional similarities" came close to being an identical copy of the corresponding features in the Apple works. Therefore, with every similarity subject to at least one limiting doctrine, none of the similarities could by itself be the basis of an infringement determination [Apple Computer, Inc. v. Microsoft Corp., 799 F. Supp. 1006 (N.D. Cal. 1992)].

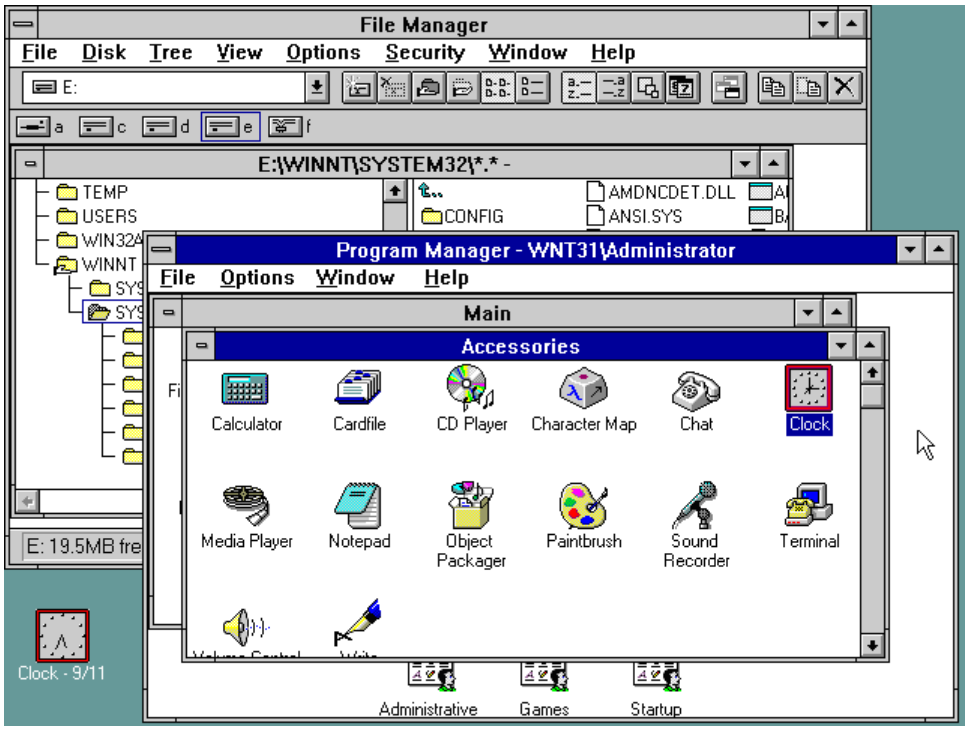
The decision was affirmed on appeal in 1994 [Apple Computer, Inc. v. Microsoft Corp., 35 F. 3d 1435 – (9th Cir.)], and Apple's appeal to the U.S. Supreme Court was denied [Microsoft Litigation].

n. Microsoft Windows 3.0

Microsoft Windows 3.0 (shown below) was released in 1990. It incorporated a new Program Manager, File Manager, and Print Manager, a completely rewritten application development environment, and improved Windows icons [http://www.microsoft.com/windows/winhistorydesktop.mspx].



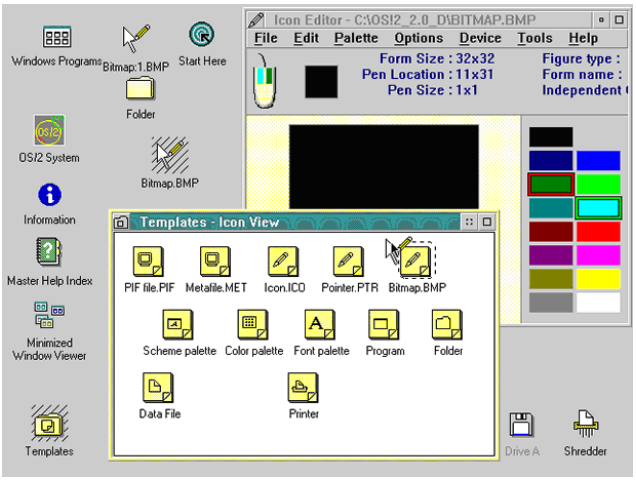
[Windows 3.0 (APMW0076439)]



[WindowsNT3.1 (APMW0076441)]

o. IBM OS/2 2.0

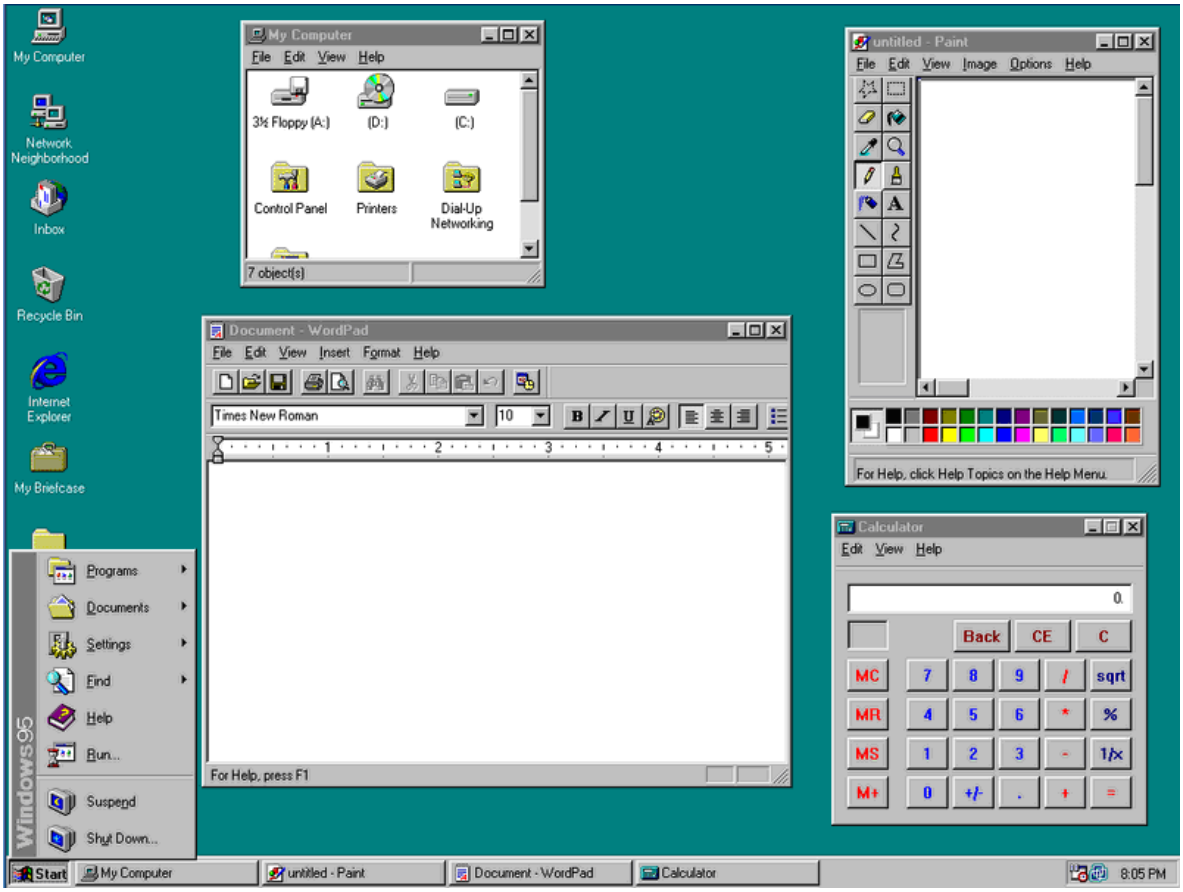
IBM OS/2 2.0 (shown below) is an operating system with a GUI (the Workplace Shell) that was released in 1992. This was the first version of OS/2 to be produced by IBM without the involvement of Microsoft.



[OS2 (APMW0075067)]

p. Microsoft Windows 95

Microsoft Windows 95 (shown below) is an operating system with a GUI that was released in 1995.



[Windows95 (APMW0076440)]

2. Windows for displaying multiple documents or programs simultaneously

Computer systems utilize the concept of windows to allow several programs or documents to be displayed on a monitor at the same time. Some window systems allow individual windows to overlap other windows; whereas other systems do not. Nonoverlapping windows systems typically offer the ability to tile windows. In this case, the computer system adjusts the size and position of opened windows to prevent overlap. Tiled windows were included in SRI's NLS (1968), in Stanford's COPILOT (1974) and in MIT's EMACS text editor (1974). An example of tiled windows in EMACS is shown below.

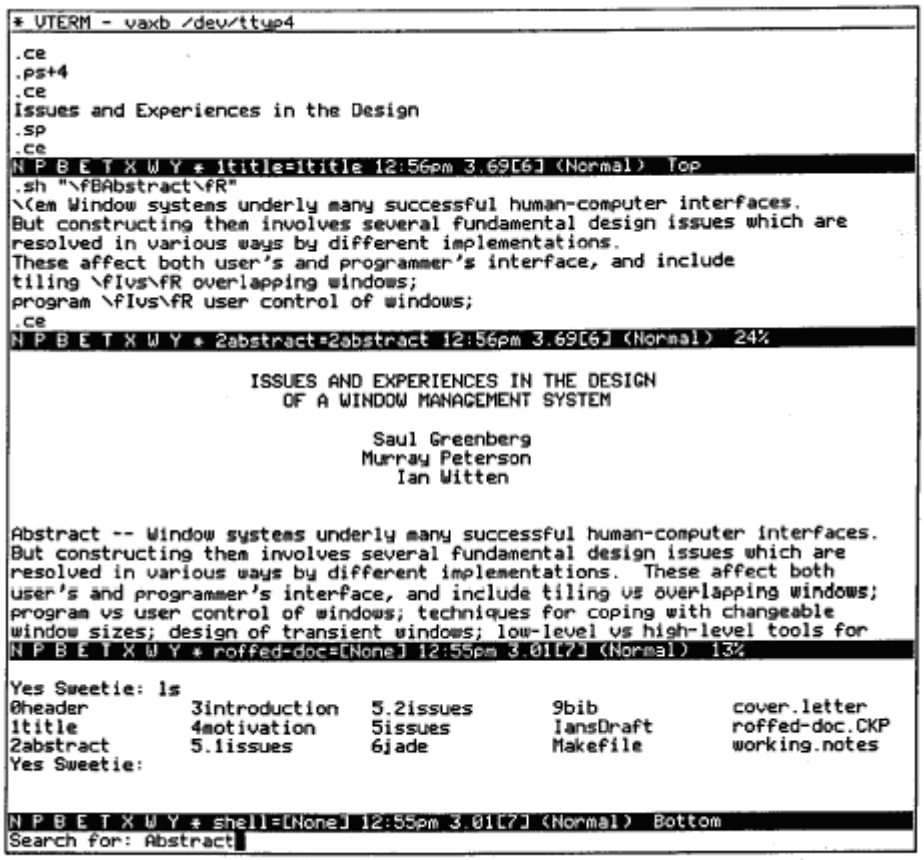
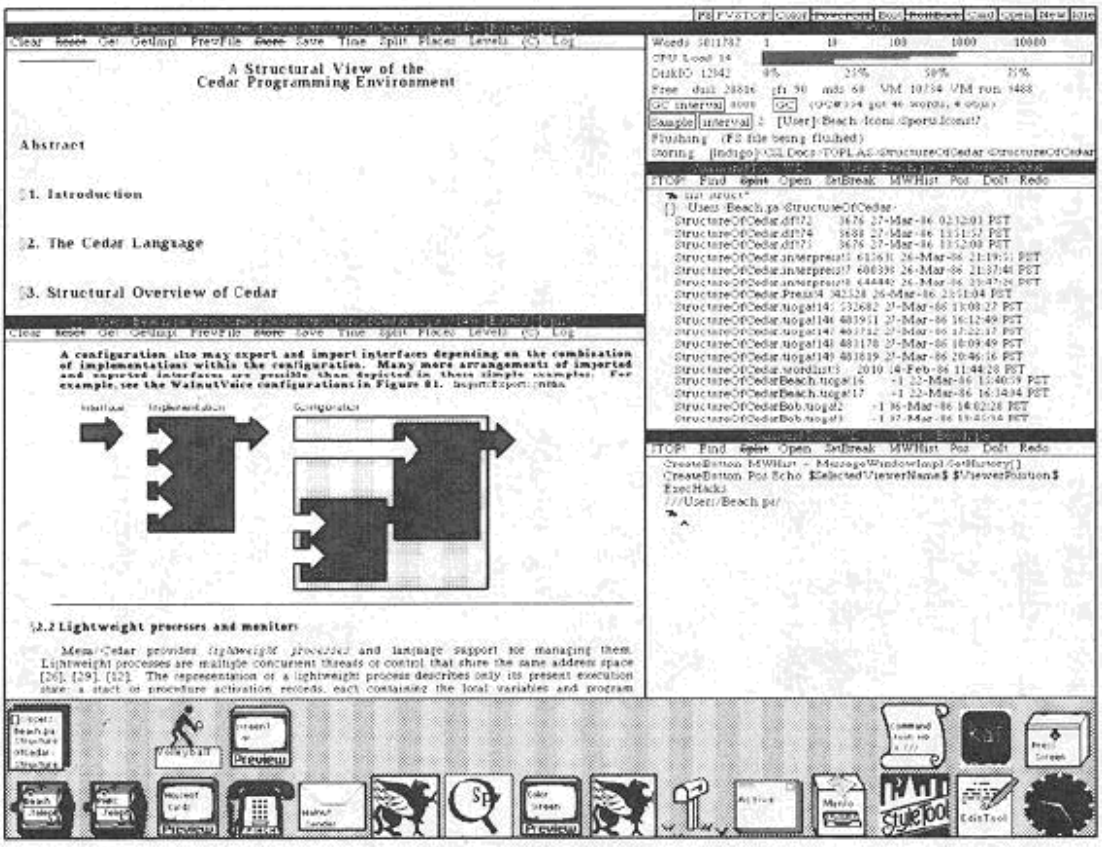


Figure 2: Tiled Windows — The Emacs Editor
[Greenberg (1986). (APMW0074214)]

In the late 1970s and early 1980s, several commercial systems that employed windows were produced. These include efforts by Lisp Machines Inc. (LMI) and Symbolics Lisp Machines (1979) [Myers at p. 47.]. The first major tiled window manager was the Xerox PARC "Cedar Window Manager" (1981), which is shown below.



[Cedar at p. 452. (APMW0075731)]

Shortly after the Cedar system was introduced, other window managers were demonstrated, such as the "Andrew window manager" produced by Carnegie Mellon University's Information Technology Center (1983). In the early 1980s, several commercial systems that employed windows were introduced, such as the Xerox Star (1981), the Apple Lisa (1982), and the Apple Macintosh (1984).

3. Partially overlapping windows

The idea of (opaque) overlapping windows was first proposed by Alan Kay in his 1969 Ph.D. thesis, and implemented in the 1970s in Smalltalk on the Alto computer at Xerox PARC.

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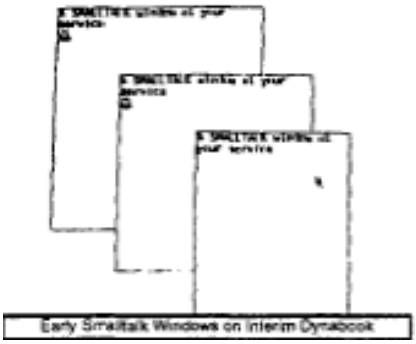
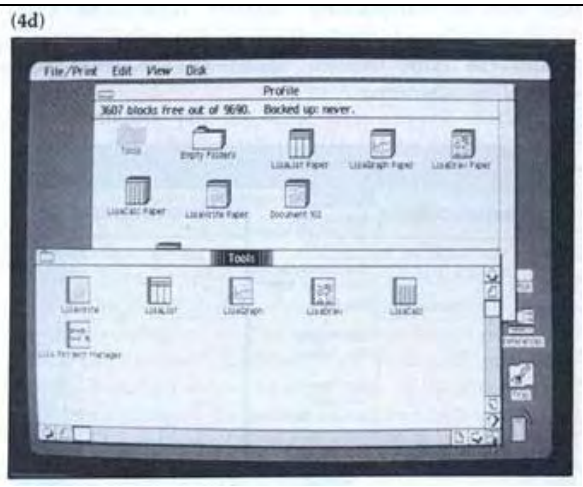
Smalltalk running on a Xerox PARC Alto computer [Smalltalk_Alto (APMW0074786)]



Three overlapping windows from the Xerox PARC Smalltalk system [Kay at p. 21 (1993). (APMW0074328)]

The Apple Lisa (1983) and Macintosh (1984) were two early commercial systems that employed overlapping windows.



Apple Lisa [Williams1 at p. 37 (1983). (APMW0074160)]

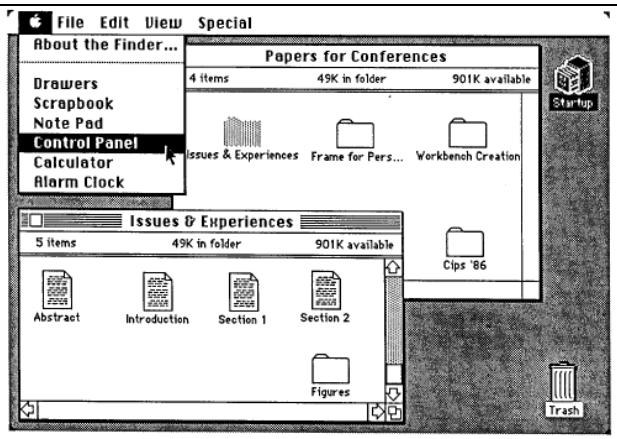


Figure 1: Overlapped Windows and a Pull-Down Menu — The Apple Macintosh

[Apple Macintosh [Greenberg (1986). (APMW0074214)]

Early versions of Xerox Star (1981) and Microsoft Windows used only tiled windows, but soon after supported overlapping windows.

Overlapping windows provided improved capabilities to the end–user by decoupling the amount of screen space associated with a given program or document from the number of programs and documents that were concurrently open. However, with the ability to determine the locations and sizes of a set of overlapping windows came the need to spend time

and effort maintaining the layout of the windows on the monitor. The term “window thrashing” has been applied to the situation in which a user has to spend significant effort to keep desired windows visible [Henderson at p. 211. (APMW0074224)].

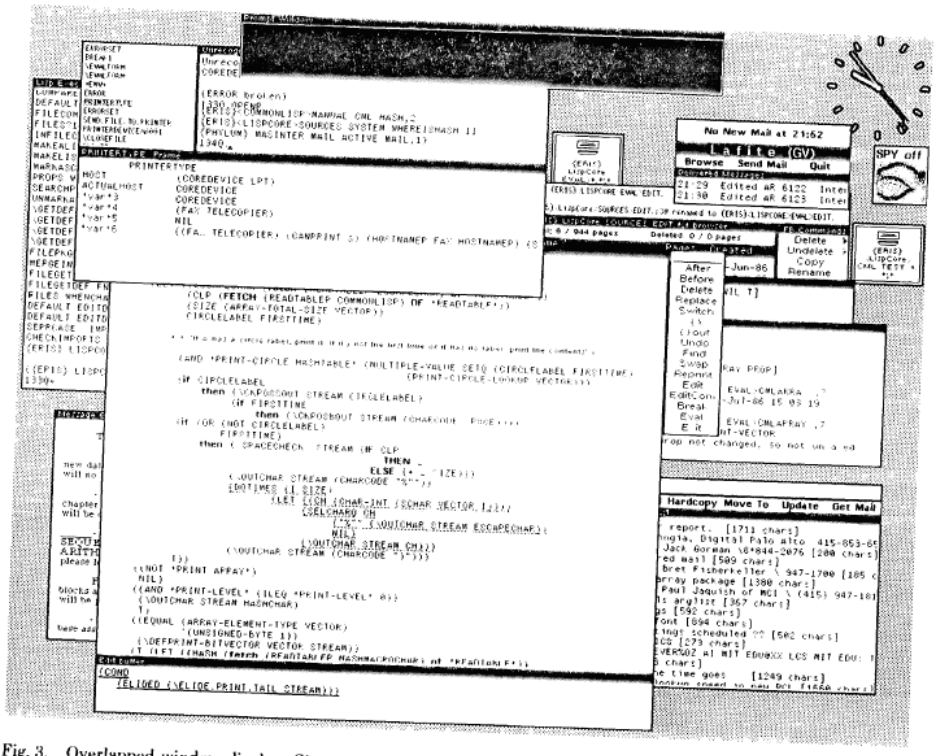
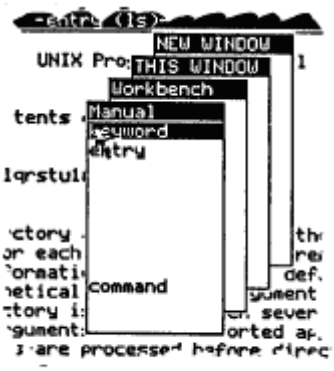


Fig. 3. Overlapped window display. Since the workspace is small, it is easily overloaded and becomes a cluttered desk.

[Henderson at p. 214. (APMW0074227)]

The Jade Window Manager developed at the University of Calgary (Canada) included overlapping menu windows that could be arranged in a receding stack, as shown below. A user can select specific windows in the stack by pointing at them using a computer mouse.



3a: Stacked Menu

3a: JADE's stacked menu is raised by pressing a dedicated menu button. Moving the mouse to a hidden menu brings it immediately to the surface.

[Greenberg (1986). (APMW0074216)]

4. Representation of 3D objects in 2D systems

The concept of representing three–dimensional (3D) objects on a two–dimensional (2D) surface, such as in a painting or drawing, has been widely researched and developed for hundreds of years [Carlbom at pp. 465–472 (APMW0074043–50]. One well known approach for representing 3D objects on a 2D surface is through *planar geometric projections*, in which linear *projectors* pass from each point on a 3D object through a corresponding point on a 2D *projection plane*. In particular, there are two main planar geometric projection methods for performing this dimension–reducing transformation: perspective projection and parallel projection.

In a *perspective projection*, the projectors meet at a common point known as the *center of projection* at a finite distance from the projection plane. Perspective projection produces a view of an object similar to what would be seen by the human eye. In a *parallel projection*, the projectors are parallel to each other (i.e., meet at an infinite distance from the projection plane). Parallel projection yields a view of an object that can better represent the object's metric properties, since any set of lines that are parallel in the original object will project

to a set of lines that are parallel on the projection plane, and the length of any line's projection is independent of its distance from the projection plane.

Any line in an object whose projection on the projection plane is a different length than the true length of the line in the object is said to be *foreshortened*. In parallel projection, all lines that are parallel in the object are foreshortened with the same *foreshortening ratio* (the projected length of the line divided by the true length of the line) and are said to be *uniformly foreshortened*. I reserve the right to elaborate on the discussion of projections in the Carlbom article and in my books.

According to ancient folklore, Agatharchus in the 5th century B.C. was said to be the first painter to use perspective on a large scale. Vases dating to the 6th century B.C. demonstrate the use of perspective. The first artist to utilize drawings in construction was Vitruvius, an architect and engineer in Rome. Around 14 B.C., Vitruvius wrote "De Architectura" in which he defined a perspective as a drawing in which "the lines all meet at the center of a circle."

In the early 14th century, the artist Duccio di Buoninsegna utilized perspective in his painting, *The Last Supper*. As shown below, Duccio used receding walls and ceiling lines to suggest depth [Carlbom at p. 468 (APMW0074046)].

FIGURE 1-2. Duccio di Buoninsegna, *The Last Supper,* Opera del Duomo, Siena, fresco, c. 1308, (Alinari/ Editorial Photocolor Archives).

[Carlbom at Fig. 1–2. (APMW0074046)]

In the 15th century, perspective was further developed by artists such as Leonardo da Vinci. His painting, *The Last Supper,* shown below, uses perspective more consistently than Duccio's work.

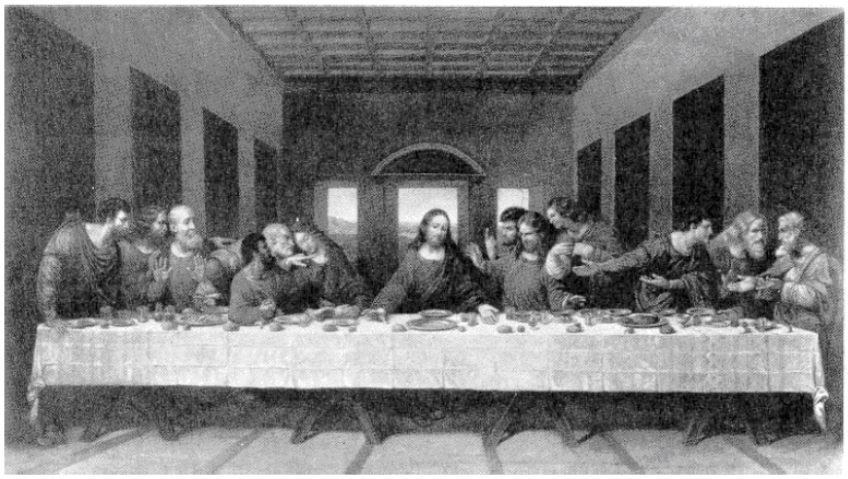


FIGURE 1-4. Engraving of Leonardo da Vinci's fresco, *The Last Supper,* Santa Maria delle Grazie, Milan, c. 1495–1498, (The Bettmann Archive).

[Carlbom at Figure 1–4. (APMW0074048)]

Around the same time, Albrecht Durer, in *Unterweysung der Messung mit dem Zyrkel und Rychtscheyd,* discussed perspective incorporating both mathematical and mechanical

methods. An example of a mechanical method for achieving perspective is shown in his woodcut below. Later work developed principles for applying perspective to engineering drawing.

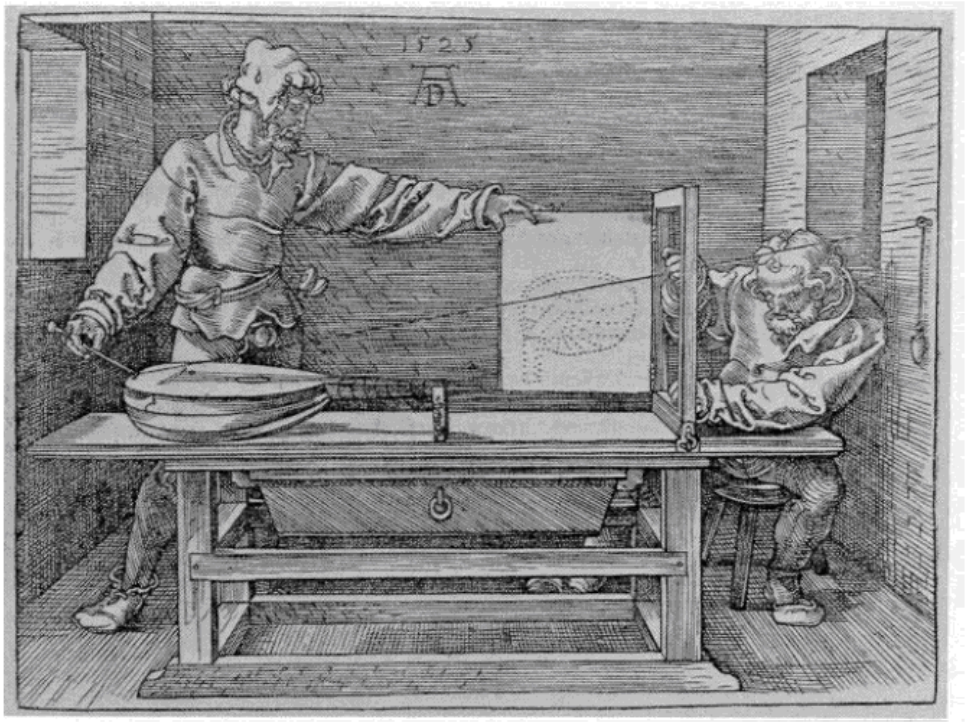
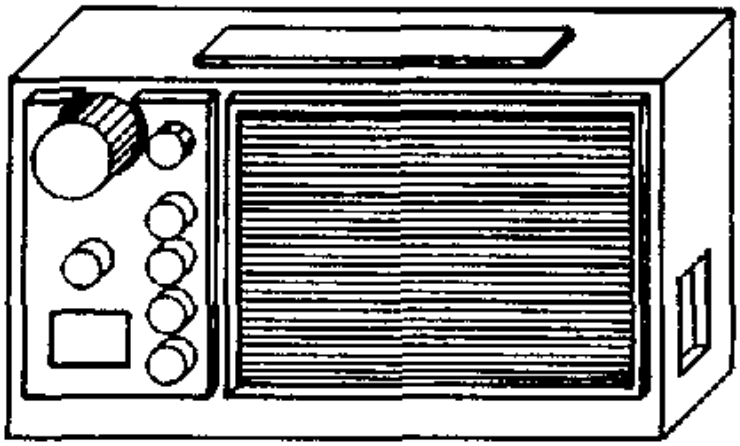


FIGURE 1-5. Albrecht Dürer, *Artist Drawing a Lute,* woodcut from *Unterweysung der Messung mit dem Zyrkel und Rychtscheyd,* 1525, (The Metropolitan Museum of Art, Harris Brisbane Dick Fund, 1941).

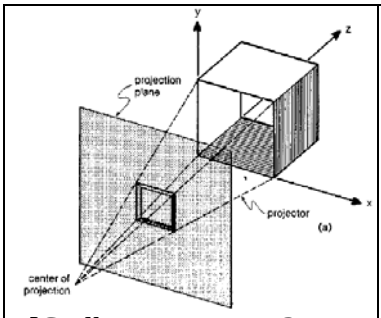
[Carlbom at Figure 1–5. (APMW0074048)]

The following figure shows an example of a parallel projection that demonstrates uniform foreshortening.



[Carlbom at Figure 2–4 (APMW0074052)]

In contrast to a parallel projection, a perspective projection characteristically results in a view in which objects farther from the center of projection appear smaller than objects nearer to the center of projection. In a perspective projection, lines undergo *perspective foreshortening* (*nonuniform foreshortening*) such that given a pair of parallel lines of equal length; the closer of the two lines will project as longer than the other. Furthermore, a set of lines that are parallel will project as parallel only if they are parallel to the projection plane; otherwise they will project to lines that, if extended, meet at a point. Examples of how to create perspective projections are shown below.



[Carlbom at Figure 3–21. (APMW0074064)]

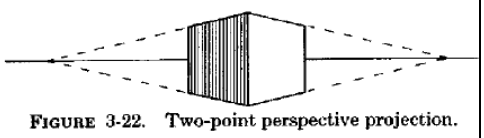


FIGURE 3-22. Two-point perspective projection.

[Carlbom at Figure 3–22. (APMW0074064)]

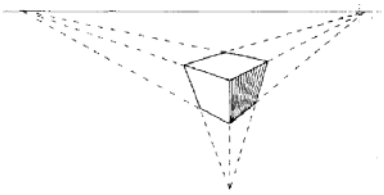


FIGURE 3-23. Three-point perspective projection.

[Carlbom at Figure 3–23. (APMW0074065)]

5. 3D representations in 2D computer graphics systems

In the field of computer graphics, the topic of representing 3D objects on a 2D surface, such as a computer monitor, has also been widely researched and developed, building on the work described above. Computer graphics systems also use perspective projection and parallel projection, as described above.

6. GUIs for displaying 3D representations in 2D systems

Researchers at Xerox PARC worked extensively in the 1990s to develop graphical user interfaces that provided 3D visualizations of hierarchical file and document directories. By producing GUIs that represented items in 3D, Xerox researchers tried to make more efficient use of the computer monitor, which has limited 2D area.

One example of this 3D work was the "Cone Trees" project, which produced an environment for visualizing hierarchical information, such as for a file browser application. Using this 3D GUI environment, Xerox was able to "visualize an entire UNIX directory hierarchy, which contained about 600 directories and 10,000 files." The figure below shows one user's directory in the "Cone Trees" system.

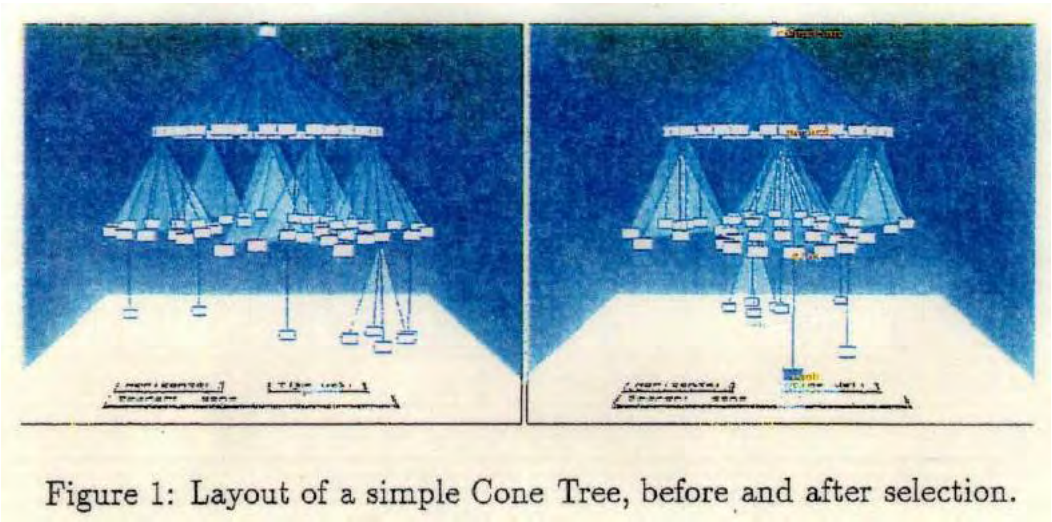
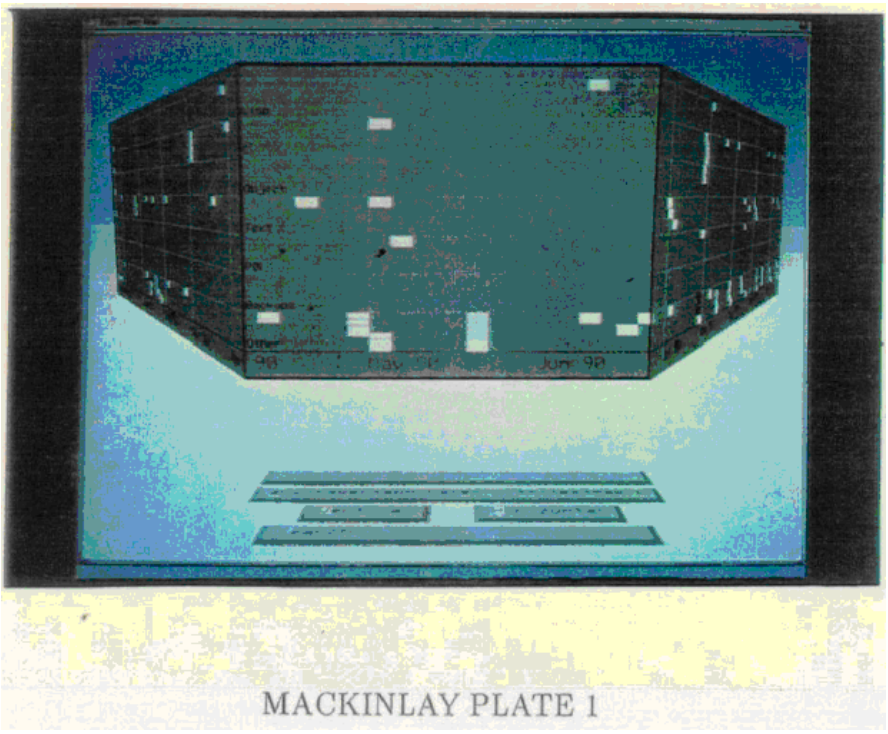


Figure 1: Layout of a simple Cone Tree, before and after selection.

[Robertson at Figure 1. (APMW0074290)]

Xerox also had a related research project called the "Perspective Wall." In this project, Xerox developed a GUI that employed perspective projection with perspective foreshortening. As 3D objects receded into the screen, they were foreshortened more. Thus, objects that receded into the screen were foreshortened (had smaller projections) than otherwise identical elements that were nearer to screen. "The Perspective Wall in Mackinlay Plate 1 holds cards that represent files in a computer system that are structured by modification date

(horizontally) and file type (vertically). The perspective view has the further advantage that it makes the neighborhood of the detailed view larger than more distant parts of the contextual view." [Mackinlay at p. 4. (APMW0074301)]



[Mackinlay at Plate 1. (APMW0074304)]

7. Documents displayed in a receding foreshortened stack

The Xerox researchers, in their WebBook and Web Forager projects, later extended their work to the organization, search, and visual display of information from the internet. The Xerox WebForager environment allows a user to group and organize related web pages into what they called a WebBook. The WebBook is displayed by the GUI as a 3D document space. Using a mouse, a user could flip through the distinct pages of the web book. When a desired page is located, the page is selected and can be viewed as shown below.

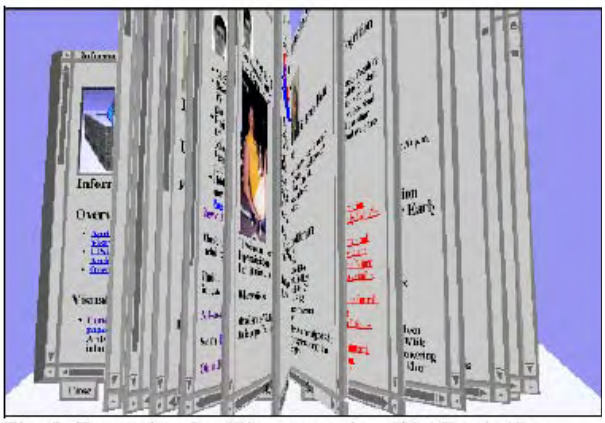


Fig. 3. Example of ruffling pages in a WebBook (See Color Plate 3)

Fig. 2: Example of a WebBook (See Color Plate 2).

[Card2 at Figs. 2, 3. (APMW0074356)]

Documents can be stored in the Web Forager workspace at different spatial depths relative to the projection plane, which was parallel to the screen of the computer monitor, as shown below. Documents displayed farther back from the screen (i.e., receding from the screen) are foreshortened more than the documents displayed nearer to the screen.

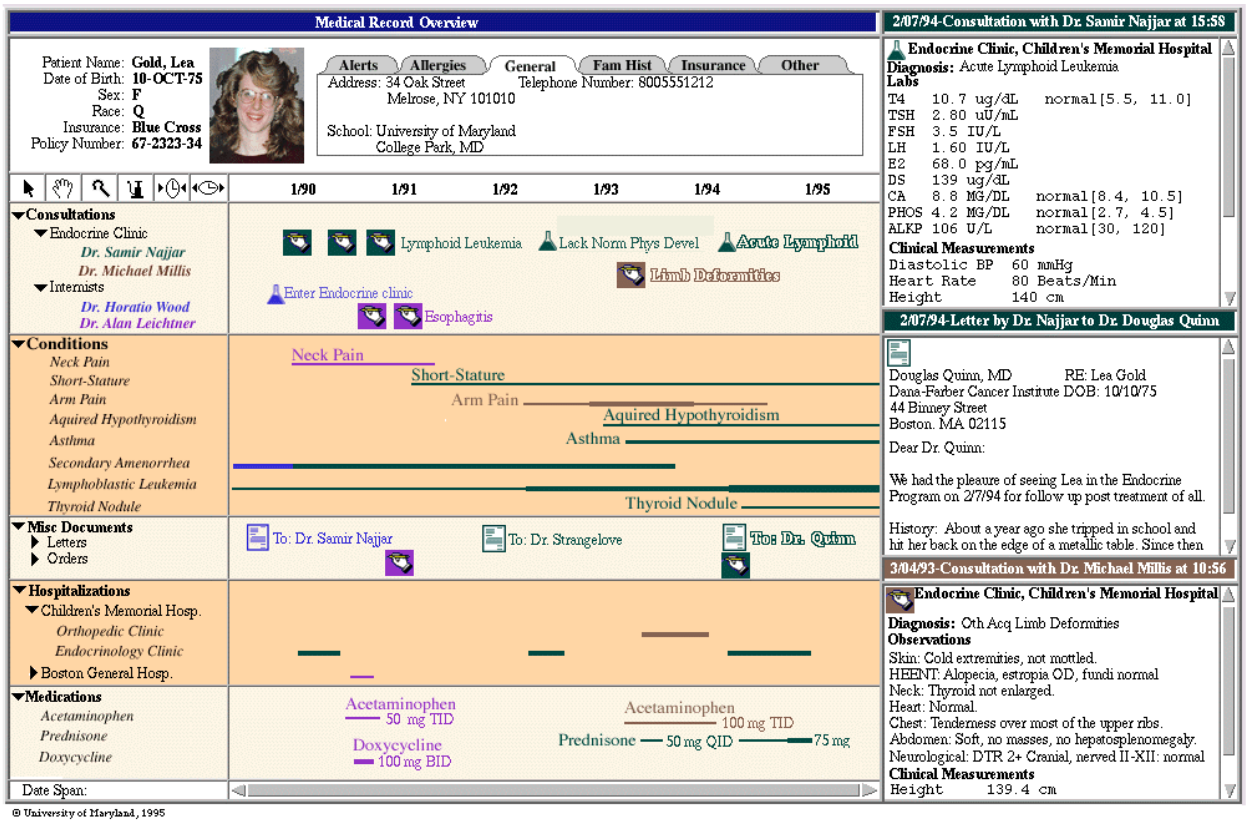
Fig. 5: The Web Forager. (See Color Plate 1)

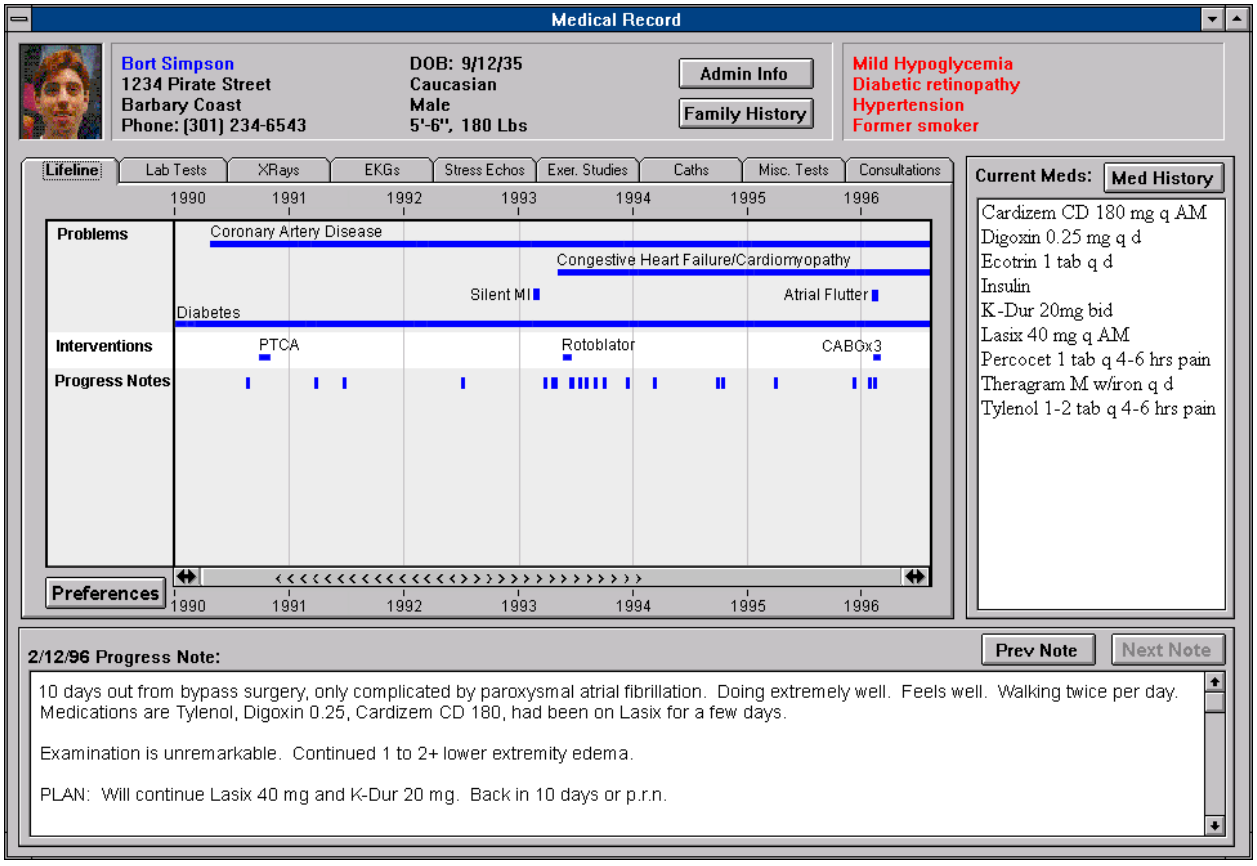
[Card2 at Fig. 5. (APMW0074358)]

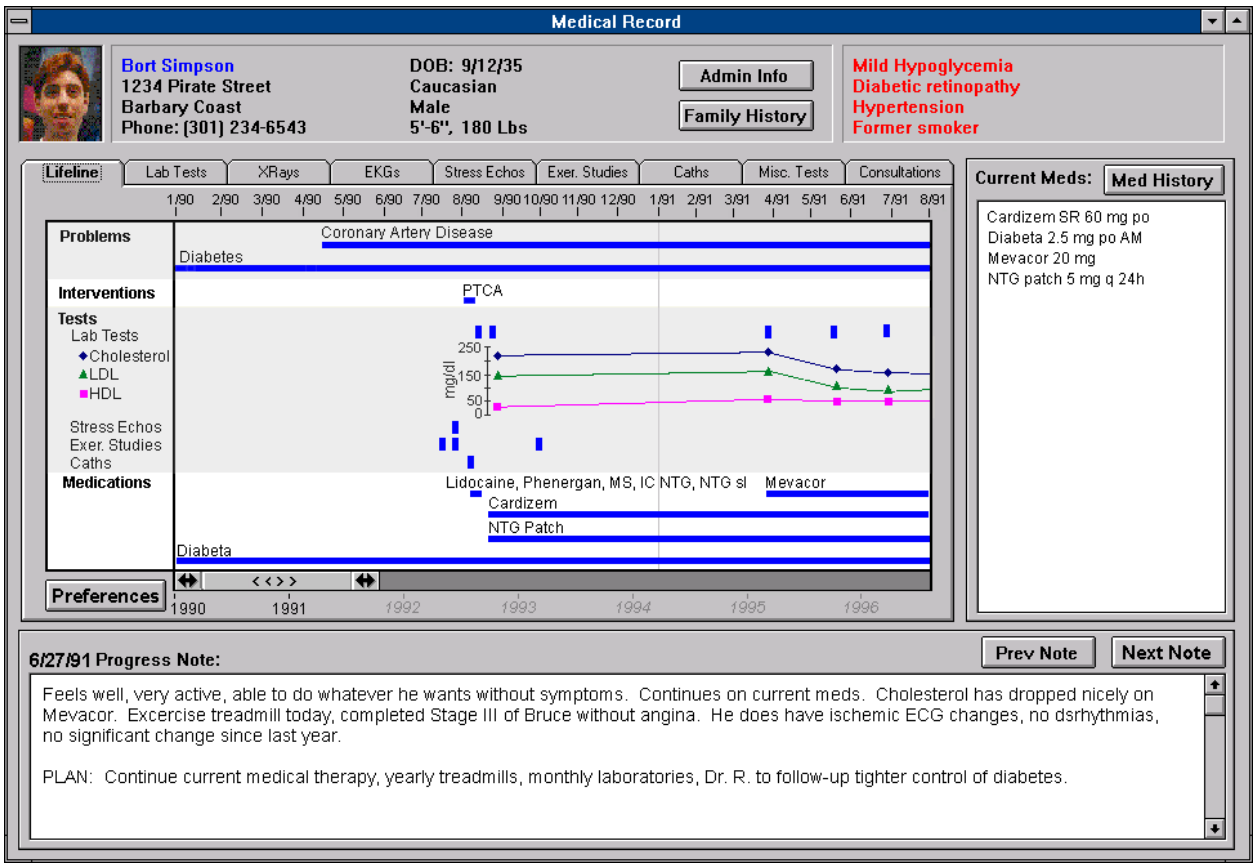
8. Timelines

In the 1990s, Catherine Plaisant and Ben Shneiderman at the University of Maryland were investigating techniques to summarize, filter and present large amounts of information. One of their projects, LifeLines, was developed for visualizing personal history records for the Maryland Department of Juvenile Services. A paper on LifeLines was submitted in September 1995 for publication in the ACM CHI '96 Conference Proceedings: Plaisant, C., Milash, B., Rose, A., Widoff, S., and Shneiderman, B. (Sept. 1995), "LifeLines: Visualizing personal histories," ACM CHI '96 Proceedings of the Conference on Human Factors in Computing Systems (Vancouver, BC, Canada, April 13–18, 1996), pp. 221–227 (the "LifeLines CHI'96" article). Further details about the LifeLines project are available on the website for the Human–Computer Interaction Lab at the University of Maryland (http://www.cs.umd.edu/hcil/lifelines/).

As explained on the LifeLines website, LifeLines provides a temporal visualization environment for personal histories, including medical histories. A one–screen overview of the record using timelines provides direct access to the data. For a patient record, medical problems, hospitalization and medications can be represented as horizontal lines, while icons represent discrete events, such as physician consultations, progress notes, or tests. Line color and thickness can illustrate relationships or significance. Rescaling tools and filters allow users to focus on part of the information, revealing more details. Examples screen images are shown below (images obtained from http://www.cs.umd.edu/hcil/lifelines/medprints.shtml).


Medical Record Overview
Patient Name: Gold, Lea
Date of Birth: 10-OCT-75
Sex: F
Race: Q
Insurance: Blue Cross
Policy Number: 67-2323-34
Alerts
Allergies
General
Fam Hist
Insurance
Other
Address: 34 Oak Street
Melrose, NY 101010
Telephone Number: 8005551212
School: University of Maryland
College Park, MD
1/90
1/91
1/92
1/93
1/94
1/95
Consultations
Endocrine Clinic
Dr. Samir Najjar
Dr. Michael Millis
Internists
Dr. Horatio Wood
Dr. Alan Leichtner
Lymphoid Leukemia
Lack Norm Phys Devel
Acute Lymphoid
Limb Deformities
Enter Endocrine clinic
Esophagitis
Conditions
Neck Pain
Short-Stature
Arm Pain
Aquired Hypothyroidism
Asthma
Secondary Amenorrhea
Lymphoblastic Leukemia
Thyroid Nodule
Misc Documents
Letters
Orders
To: Dr. Samir Najjar
To: Dr. Strangelove
Tos Dr. Quinn
Hospitalizations
Children's Memorial Hosp.
Orthopedic Clinic
Endocrinology Clinic
Boston General Hosp.
Medications
Acetaminophen
Prednisone
Doxycycline
Acetaminophen
50 mg TID
Doxycycline
100 mg BID
Acetaminophen
100 mg TID
Prednisone
50 mg QID
75 mg
Date Span:
© University of Maryland, 1995
2/07/94-Consultation with Dr. Samir Najjar at 15:58
Endocrine Clinic, Children's Memorial Hospital
Diagnosis: Acute Lymphoid Leukemia
Labs
T4 10.7 ug/dL normal[5.5, 11.0]
TSH 2.80 uU/mL
FSH 3.5 IU/L
LH 1.60 IU/L
E2 68.0 pg/mL
DS 139 ug/dL
CA 8.8 MG/DL normal[8.4, 10.5]
PHOS 4.2 MG/DL normal[2.7, 4.5]
ALKP 106 U/L normal[30, 120]
Clinical Measurements
Diastolic BP 60 mmHg
Heart Rate 80 Beats/Min
Height 140 cm
2/07/94-Letter by Dr. Najjar to Dr. Douglas Quinn
Douglas Quinn, MD RE: Lea Gold
Dana-Farber Cancer Institute DOB: 10/10/75
44 Binney Street
Boston, MA 02115
Dear Dr. Quinn:
We had the pleaure of seeing Lea in the Endocrine Program on 2/7/94 for follow up post treatment of all.
History: About a year ago she tripped in school and hit her back on the edge of a metallic table. Since then
3/04/93-Consultation with Dr. Michael Millis at 10:56
Endocrine Clinic, Children's Memorial Hospital
Diagnosis: Oth Acq Limb Deformities
Observations
Skin: Cold extremities, not mottled.
HEENT: Alopecia, estropia OD, fundi normal
Neck: Thyroid not enlarged.
Heart: Normal.
Chest: Tenderness over most of the upper ribs.
Abdomen: Soft, no masses, no hepatosplenomegaly.
Neurological: DTR 2+ Cranial, nerved II-XII: normal
Clinical Measurements
Height 139.4 cm


Medical Record
Bort Simpson
1234 Pirate Street
Barbary Coast
Phone: (301) 234-6543
DOB: 9/12/35
Caucasian
Male
5'-6", 180 Lbs
Admin Info
Family History
Mild Hypoglycemia
Diabetic retinopathy
Hypertension
Former smoker
Lifeline
Lab Tests
XRays
EKGs
Stress Echos
Exer. Studies
Caths
Misc. Tests
Consultations
1990
1991
1992
1993
1994
1995
1996
Problems
Coronary Artery Disease
Congestive Heart Failure/Cardiomyopathy
Silent MI
Atrial Flutter
Diabetes
Interventions
PTCA
Rotoblator
CABGx3
Progress Notes
Preferences
Current Meds:
Med History
Cardizem CD 180 mg q AM
Digoxin 0.25 mg q d
Ecotrin 1 tab q d
Insulin
K-Dur 20mg bid
Lasix 40 mg q AM
Percocet 1 tab q 4-6 hrs pain
Theragram M w/iron q d
Tylenol 1-2 tab q 4-6 hrs pain
2/12/96 Progress Note:
Prev Note
Next Note
10 days out from bypass surgery, only complicated by paroxysmal atrial fibrillation. Doing extremely well. Feels well. Walking twice per day. Medications are Tylenol, Digoxin 0.25, Cardizem CD 180, had been on Lasix for a few days.
Examination is unremarkable. Continued 1 to 2+ lower extremity edema.
PLAN: Will continue Lasix 40 mg and K-Dur 20 mg. Back in 10 days or p.r.n.



As explained on the website, LifeLines can: 1) reduce the chances of missing information, 2) facilitate the spotting of anomalies and trends, 3) streamline access to details (as LifeLines act as large menus), and 4) remain simple and tailorable to various applications.

9. Document indexing and searching

The oN–Line System (NLS) system offered the ability to search every element in the system. As Engelbart described:

> "Links were part of the oNLine System from day one. I had long thought that you would want to link to a document someone else had written. But I also realized that you might want to link directly to something deep in a particular file. Maybe you would want to go straight to a single word inside a paragraph or someday link from one email to another. That led to our making every element in the NLS addressable, so it could be linked to." [Wired magazine article]

In addition, as discussed above LifeLines also include document indexing and searching capabilities rescaling tools and filters allow users to focus on part of the information, revealing more details. (http://www.cs.umd.edu/hcil/lifelines.)

D. Metadata

As explained in Wikipedia, metadata is loosely defined as data about data. http://en.wikipedia.org/wiki/Metadata. Metadata provides information about data items, such as: means of creation, purpose of the data, time and date of creation, creator or author of data, placement on a network (electronic form) where the data was created, what standards used, and so on. http://en.wikipedia.org/wiki/Metadata. Several papers show that metadata was well known to one of ordinary skill in the art before 1996. See Warwick Cathro (1997) “Metadata: an overview” http://www.nla.gov.au/nla/staffpaper/cathro3.html, see also, Bretherton, F. P.; Singley, P.T. (1994). "Metadata: A User’s View, Proceedings of the International Conference on Very Large Data Bases (VLDB)". pp. 1091–1094 (available at http://www.osti.gov/bridge//product.biblio.jsp?query_id=0&page=0&osti_id=230637).

E. Apple’s Advanced Technology Group

Apple’s Advanced Technology Group (“ATG”) was in existence between 1986 and 1997. ATG, the individuals in ATG, and the research conducted by ATG were well known to practitioners in the art by 1996. Evidence of the widespread respect for ATG’s contributions to computer science is shown by the publication of a special issue of SIGCHI in April 1998 (“SIGCHI April 1998 Bulletin”) that contains a retrospective of the work at ATG during that period. See “A Farewell to the Apple Advance Technology Group,” SIGCHI Bulletin, Vol. 30, No. 2, April 1998, pp. 1, 46 151 (APMW0071661, APMW0071772).

This special retrospective gives a detailed picture of ATG's research contributions through 21 brief overviews and detailed survey papers, including:

1. An Introduction to the Special SIGCHI Bulletin Issue" by James R. Miller (APMW0071666–APMW0071667)
2. "The ATG Knowledge Management Technologies Laboratory" by Daniel M. Russell (APMW0071668–APMW71670)
3. "An Overview of the ATG Intelligent Systems Program" by James R. Miller (APMW0071671–APMW0071672)
4. "From Documents to Objects: An Overview of LiveDoc" by James R. Miller and Thomas Bonura (APMW0071673–APMW0071678)
5. "Drop Zones: An Extension to LiveDoc" by Thomas Bonura and James R. Miller (APMW0071679–APMW0071683)
6. "An Architecture for Content Analysis of Documents and Its Use in Information and Knowledge Management Tasks" by Branimir Boguraev, Christopher Kennedy, and Sascha Brawer (APMW0071684–APMW0071691)
7. "Dynamic Document Presentation" by Branimir Boguraev and Rachel Bellamy (APMW0071692–APMW0071697)
8. "An Online Digital Photography Course for High School Teachers" by Bonnie Nardi, Brian Reilly, and Reinhold Steinbeck (APMW0071698–APMW0071701)
9. "Hit Squads & Bug Meisters" by Shilpa V. Shukla (APMW0071702–APMW0071704)
10. "Beyond Search: The Information Access Research Group at Apple" by Daniel E. Rose (APMW0071705–APMW0071709)
11. "User Experience Research Group" by Daniel M. Russell (APMW0071710–APMW0071714)
12. "Rapid Prototyping of Awareness Services Using a Shared Information Server" by William F. Walker (APMW0071715–APMW0071721)
13. "Interaction–Driven Speech Input" by Jerome R. Bellegarda (APMW0071722–APMW0071725)
14. "The ATG Learning Communities Laboratory: An Overview" by N. Rao Machiraju (APMW0071726–APMW0071727)

15. “Learning Conversations” by Rachel Bellamy and Kristina Woolsey (APMW0071728–APMW0071732)
16. “In Search of Design Principles for tools and Practices to Support Communication Within a Learning Community by Stephanie Houde, Rachel Bellamy, and Laureen Leahy (APMW0071733–APMW0071738)
17. “Interface Issues in Text Based Chat Rooms” by Brian J. Roddy and Hernan Epelman–Wang (APMW0071739–APMW0071743)
18. “ATG Education Research: The Authoring Tools Thread” by Jim Spohrer (APMW0071744–APMW0071753)
19. “Unfamiliar Gound: Designing Technology to Support Rural Healthcare Workers in India”1998, April Mike Graves, Sally Grisedale, and Alexander Grünsteidl (APMW0071754–APMW0071763)
20. “A History of the Apple Human Interface Group” by S. Joy Mountford (APMW0071764–APMW0071767)
21. “Discourse Architecture” by Jed Harris and Austin Henderson (APMW0071768–APMW0071772).

The overviews (SIGCHI April 1998 Bulletin Nos. 1, 2, 10, 14, and 20) provide a good sense of the scope of the work discussed in the retrospective. Several of the articles describe ATG’s research in automatically figuring out what documents are about and mention semantic indexing, topic identification, content analysis, and document characterization. See SIGCHI April 1998 Bulletin Nos. 4–7. “Beyond Search: The Information Access Research Group at Apple” (SIGCHI April 1998 Bulletin No. 10) describes the Information Access Research Group from which the Piles-related papers and patents arose. “A History of the Apple Human Interface Group” SIGCHI April 1998 Bulletin No. 20) provides a good summary of Apple’s work on user interfaces during the life of ATG.

VI. MIRROR WORLDS PATENTS

The Mirror Worlds patents arise from the ’227 patent. The ’313 patent is a continuation of the ’227 patent, while the ’427 patent is a division of another continuation (U.S.