# Metaphor Design in User Interfaces

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Successful user interfaces consist of partially general and partially unique solutions to the design of metaphors, the fundamental concepts communicated through words and images, as well as through sound and interaction. By controlling the user's expectation of familiar structures and processes and surprise at novel approaches, the user-interface designer can achieve compelling forms that enable the user to be more productive.

## Introduction

In 1997, the U.S. Justice Department asked a Federal judge to fine Microsoft Corporation $1 million per day relating to the inclusion of Microsoft's Internet browser with the Windows 95 operating system. A contemporary article in the *New York Times* [Johnson, 1997] commenting on the fracas described this landmark antitrust case in cyberspace as essentially a fight about the power of metaphors. The author compared the situation to a company controlling almost all office desk manufacturing that added a free built-in phone to the desk and declared that the concept of the desk now includes the concept of the phone, and by the way, all other phone manufacturers, which charged for phones, might be out of business. Metaphors, it seems, have become big business.

What exactly are metaphors, and why are they so important? Metaphors figure prominently in user interfaces. User interfaces, a mixture of function and form, are the physical display of informational, aesthetic, and persuasive content affording the means for interacting with that content. For specific users (defined by their demographics, experience, education, and roles in organizations of work or play) and their tasks, user interfaces provide metaphors, mental models, navigation, appearance (including sound, for example), and interaction. These components may be defined in this way [Marcus, 1995; Marcus, 1992]:

*Metaphors:* essential similarity conveyed visually through words and images, or through acoustic or tactile means

*Mental Models:* organization of data, functions, tasks, roles, and people in groups at work or play

*Navigation:* movement through mental models afforded by windows, menus, dialogue areas, control panels, etc.

*Appearance:* verbal, visual, and acoustic and tactile perceptual characteristics of the displays

*Interaction:* the means by which users input changes to the system and the feedback supplied by the system.

Note that an application, its data, the graphical user interface (GUI) environment, and the hardware all contribute to the functional and formal attributes of the user interface, in particular to its metaphors. An advanced text editor working within the Microsoft Windows 95 GUI environment on a mouse- and keyboard-driven Intel Pentium processor-based PC presents one set of metaphors. The LCD displays and buttons on the front panel of a paper copier or the colorful displays and fighter-pilot-like joysticks for a children's video game on a Sega game machine present alternative metaphors.

This article will introduce fundamental distinctions of metaphors, review their history in computer systems, and demonstrate why they are so vital to the success of computer-based communication products.

## Types of Metaphors

Centuries ago, almost all university students learned how to use metaphors in effective communication as they studied rhetoric, which comprises over 1000 rhetorical techniques [Lanham, 1969]. Rhetoric, in turn, is a component of semantics, one of four dimensions of semiotics, the science of signs [Eco, 1976]. The semiotic dimensions are these:

Lexical: how we produce signs, e.g., how to make lines on a CRT

Syntactic: how signs are arranged in time and space, e.g., bigger or bluer

Semantic: to what signs refer, e.g., denoting structures or processes

Pragmatics: how we consume signs, e.g., their legibility and readability.

The term *metaphor*, derived from the Greek words for "carrying across," is specifically the technique of substituting one sign for another in order to make communication more effective. To describe the incoming fog as "creeping silently into the bay," is to describe its movement as though it were a cat, thereby clarifying and intensifying the listener's experience. We use metaphors in our daily speech, e.g., when we say "do you get the picture" to mean "do you understand what I am saying?" Linguists have analyzed and categorized how we use metaphors in daily speech [Lakoff and Johnson, 1980] and find metaphors often to be fundamentally spatial. For example, we say "why are you looking so down," "things are looking up," " that idea is too far out for me," and "I'm getting into organic foods." In general, metaphors help in these ways:

- Represent (denote) people, objects, structures, and processes, e.g., in a GUI, dropping a file in a desktop trash can is equivalent to deleting the file.
- Describe a structure or process: e.g., in a GUI, an outline file/folder list refers to a hierarchical structure.
- Explain causes and effects of a structure or process, e.g., in a GUI, a progress bar "explains" the delay in downloading a file.
- Express (imply or connote) concepts or values, e.g., in a GUI, a recycling arrow instead of a trash can suggests re-use or ecology.

There are standard kinds of metaphors:

- Structural: These substitute parts of one system for another, e.g., in GUIs, an outline structure for nested folder/file structure.
- Operational: These substitute behavior of one system for another, e.g., in GUIs, dragging-and-dropping a file to the trash can for deleting the file.
- Pragmatic: These enable a user to absorb or understand more , e.g., in GUIs, concrete desktop objects and processes represent more abstract components of operating systems such as DOS and UNIX.

In considering metaphors, it is important to make some further distinctions.

- *Metaphors* are limited in the scope of the substitutions; they are not complete exchanges. For example, one might use a limited number of military terms in business discussions. If someone got carried away and took the metaphor too far, listeners would think they were being too literal, or obsessive.
- *Models* are detailed representations of structures or processes either smaller in scale or

more abstract, in which the substitution is more complete. For example, one would praise a model airplane that included a complete engine in miniature.

- *Analogies* are point-by-point similar in function with a different structure or source. For example, in linguistics, one can find analogous terms such as these: energy, energize; apology, apologize.
- *Similes* are directly stated comparisons in which the listener or viewer is aware of the comparison, e.g., "Marriage is like a job; you have to work at it." Metaphors, on the other hand, are often more subtle, unconscious, or "invisible." Metaphors help people think and, in some ways, may constrain what they can think about, much like language in general.

Two other rhetorical techniques of substitution related to metaphor are more specific:

- *Metonomy* is substitution of an associated sign. For example, when reporters say, "The White House announced a new executive decree" they mean the President of the United States, but they use the building to refer to the person who works in it.
- *Synecdoche* is substitution of a part for a whole, or vice-versa. For example, when a farm-owner describes a worker as a really good "hand," a part of the worker stands for the whole person.

The verbal communication techniques that have served written literature well for thousands of years have also served visual communication. Now that computers are such intense multimedia experiences, employing icons, pictures, video, and sound, designing effective metaphors is essential to the success of innovation in computer technology.

## The History of Metaphors in Computing

Computer research, development, marketing, and sales personnel, as well as the general public, have employed many picturesque terms to refer to computers. In fact, the term "computer" originally referred to a human being, a person who calculates or computes. The word came to be applied to a machine, and the concept transformed itself from a mechanical calculating "engine" to an electronic "brain." As input devices and output displays became more sophisticated, further metaphors developed to enable people to learn, use, remember, and enjoy computers more quickly and completely. The user interface emerged as a collection of metaphorical references embodying the controls and data displays by which the user interacts with the central processing unit and the stored programs, i.e., with both the hardware and the software. Over a half-century of development, these metaphors changed dramatically:

- Character-based user interfaces used references to teletypewriters, clerical files, and word-processing.
- Graphical user interfaces (GUIs) used the concept of the desktop to organize representations of peripheral equipment as icons, the contents of files inside windows, and the trashcan for deleting files.
- Pen-based user interfaces introduced written character gestures and marks, such as circling an item to delete it.
- Virtual-reality-based user interfaces introduced marks and gestures associated with flying (such as yaw, pitch, and roll) and new techniques of object selection and manipulation, such as pinching and 3D-twisting.
- Web-based browser user interfaces introduced new or transformed concepts such as browsing, chatting, and linking.

Metaphors in user interfaces can be classified in many ways. Hutchins [1989], as cited in Neale and Carroll [1997, p. 444] provides a comprehensive, general classification of metaphors:

- "*Activity metaphors* are determined by the users' highest level goals. For example, is the user controlling a process, communicating, or playing a game?
- *Mode of interaction metaphors* organize the fundamental nature in which the user thinks about interacting with the computer. These metaphors are task independent and determine how the user views what the computer is.
- *Task domain metaphors* provide an understanding for how tasks are structured."

Another way to classify user interface metaphors is by level. Generally, two levels of metaphors contribute to the complete set used in a user interface: systemic, or over-arching, metaphors and individual metaphors. Over-arching metaphors provide a complete basis for understanding a system; individual metaphors provide references for specific controls or data displays.

An example of over-arching metaphor is the desktop metaphor popularized originally by Apple Computer in its Macintosh products. An example of a specific control metaphorical reference is the "radio button" that represents exclusive selection of functions and/or data attributes. In any user interface, many specific terms used in conjunction with the application domain, together with its functions and data, provide additional metaphorical references. For example, an architectural program might include a "punch list" to refer to unresolved issues of a building's form or function.

Developers have employed many different metaphorical substitutions in the past half-century. Examples of overarching metaphors include the following:

- Physical places: rooms, buildings, cities, landscapes, planets
- Specific places: libraries, storehouses, banks, malls, chatrooms
- Activities: travel, fly, browse, search,
- Objects: desktops, books, Rolodexes, television sets

For objects and actions, the user interface must determine specific ways to depict essential nouns and verbs. For each kind of noun, specific secondary objects become relevant: e.g., a book might have a bookmark, a desk might have a drawer or a wastebasket nearby. Noun metaphors of collection and some associated objects include the following.

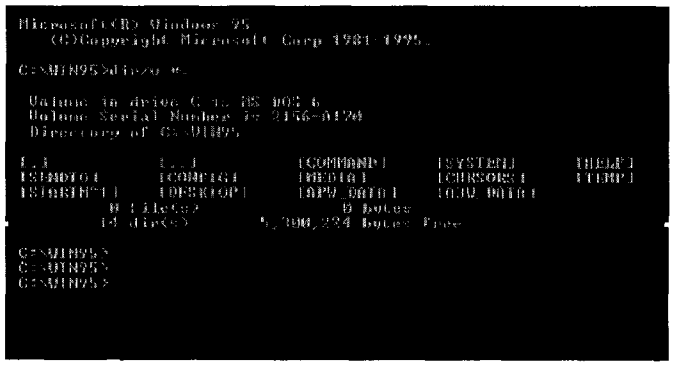
- Desk: folders, documents, drawers, paper
- Books, newspapers: pages, sections, bookmarks, indexes
- Photographs: albums, photos
- Television: programs, channels, remote control devices
- Slides, phonograph record: tracks, sorting devices
- Cards, boxes: shelves, containers
- Photography: rolls, trays, reels
- Trees: branches, leaves
- Theater: programs, actors, scripts

Verb metaphors of action (some of which were first discussed in [Foley and Wallace, 1974]) and their visualizations in GUIs include the following:

- Locate: move pointer to an object
- Select: single or double-click on a located object
- Add: select object from a repertoire and drag-and-drop it into a place
- Delete: drag-and-drop object in trash can or wastebasket
- Save: drag-and-drop object into a place
- Quit: select button or switch
- Cancel: make "X" or circular movement with pointer
- Acknowledge: make "check-off" movement with pointer
- Valuate: slide/ rotate control along metric of values
- Move left/right, forward/backward, up/down, in/out, to/from: drag control
- Stop: select button or switch

Examples of some of the basic kinds of user interfaces and their metaphors appear in the accompanying Figures 1-6.

***Figure1: A text-based user interface uses metaphorical references to typewriter-like controls.***



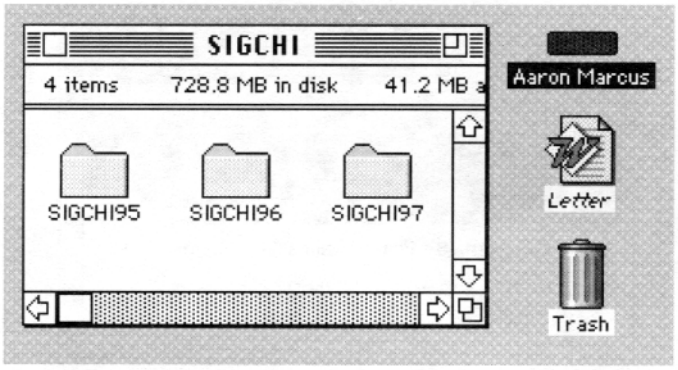



*Figure 2: A graphical user interface (GUI) uses metaphorical references such as folders, windows, and the trash can.*

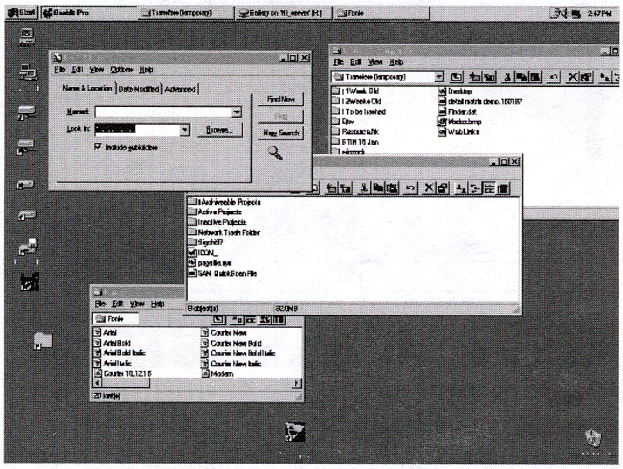


*Figure 3: Multi-window user interfaces add additional complexity but generally employ metaphors similar to the basic GUI metaphors.*

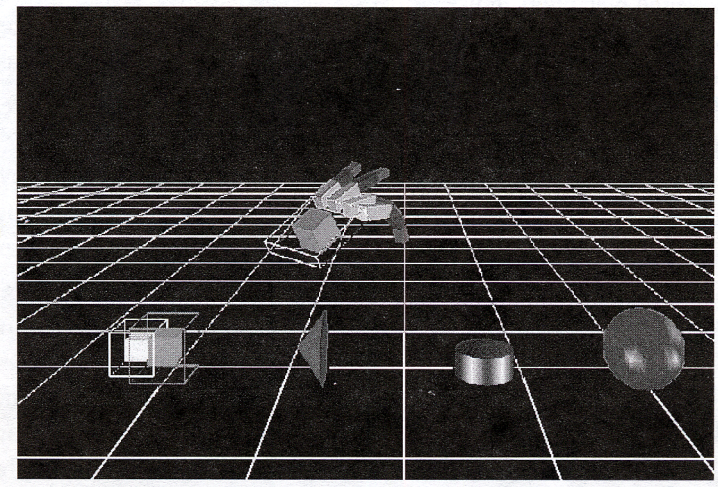


*Figure 4: Virtual Reality user interfaces use three-dimensional movement metaphors and three-dimensional objects metaphors.*

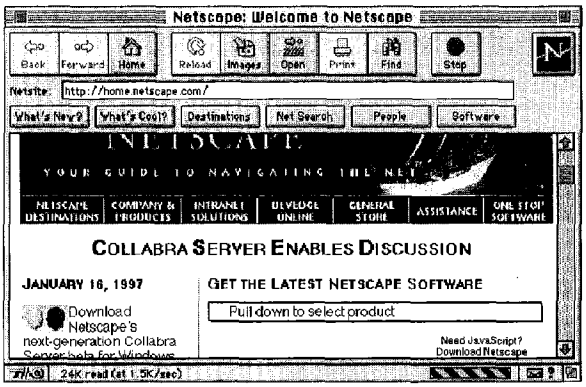



*Figure 5: Web-based user interfaces introduce metaphors associated with connectivity and browsing.*

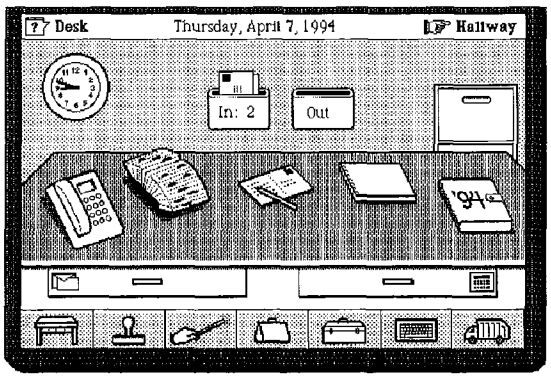



*Figure 6: General Magic's Magic Cap User Interface [Gibbs, 1994; Hill and Carleton, 1995] places a desk in a room. The room is along a hallway, in a building, on a street, in a user-interface metaphor with an urban scale. Note that the garbage can has become a garbage truck in keeping with the urban reference.*

## Advantages and Disadvantages of Metaphors

Used correctly, well-designed metaphors in user interfaces offer numerous advantages for successful, effective communication:

- Using concepts familiar to users may require less training time, because users can intuit primary attributes of structure or processing. Domain knowledge of one area may be transferable to another. In addition, the metaphors prepare the user for transferring the content domain model or role-task model into the user's mental model. For example, most office workers, knowing the hierarchy of files and folders stored in file cabinets, find the desktop metaphor's representation of these entities intuitively clear.
- Familiar concepts in an unfamiliar environment can add appeal. When users are new to a topic or application domain, seeing familiar references can reduce tension, stress, boredom, confusion, anxiety, and alienation, while increasing their self-assurance, calm, interest, engagement, and dependence upon the user interface.
- Because the metaphor's representation may not be complete (as noted earlier, it is not a model), the very incompleteness may invite "filling" in of details from the user's experience, providing there is a basic sufficiency of familiarity. McLuhan [1964] called this an attribute of "cool" media.
- Metaphors can increase ease of learning, memorization, and use. Simple, clear, and consistent conceptual "monuments" in a cognitive landscape enable users to focus on and retain a limited number of primary attributes of a complex system [Carroll and Mack, 1985; Laurel, 1993; Anderson, 1983]. By reducing operational com-

plexity, users may be able to achieve greater initial productivity.

- Metaphors selected for particular user communities can assist in making communication more direct and effective. For example, in US consumer products, terms and images oriented to particular target markets such as children, seniors, Hispanic/Latino, Asian, African-American, or other groups are routinely used to facilitate communication.
- Besides making communication more effective, metaphors are also used to appeal to the aesthetic taste, self-image, or cultural associations of user communities. Examples include the "hip," "cool," or "hot" terms and images of Wired.com's Website, the graphic-design-oriented treatment of contents in magazines such as *Wired* or *ID*, an industrial/graphic design publication, or the treatment of contents in television or magazines for electronic products.

Designing metaphors is a powerful technique of communication. Used well, metaphors can stimulate users' interest in products, facilitate understanding of complex content, and promote a positive attitude toward products and their use. Designed inappropriately, however, metaphors can promote misunderstanding and alienation on the part of users and impede their performance:

- One source of confusion among users as well as designers is the distinction between metaphors and mental models. Metaphors are simple, limited relationships, either at a global or local scale. Models, on the other hand, are intended to have thorough, systematic similarities to the original, in other words to be a "miniature." Note that the upper layers of mental models may contain many primary words, icons, or images that represent fundamental metaphorical concepts of the user interface.
- Other "costs" of designing metaphors are these: While diverse markets may benefit from diverse metaphors targeted for their communities, the cost of developing these variations may be considerable, requiring study of particular cultures or communities and their terminology. Maintaining metaphors also has a cost: Metaphorical references vary over time, especially with changes in technology or cultural/aesthetic shifts, and users eventually may not understand or appreciate the references.

For example, the telephone concept and image has changed markedly in the last century. The speaking tube of early telephones has disappeared, and the circular dial of the telephone has evolved into push-buttons. Consequently these earlier images, in general, have been phased out as icon/symbol references. The blended functionality of the typical desktop phone, fax, pager, cellular phone, Internet-PC phone, and other devices make the reference to "telephone" somewhat fuzzy as a concept. The telephone handset has survived in many pictographic icon/symbol references, however, the availability of telephones as accessories pinned to clothing, tucked into pockets, hanging from cords around the neck, or attached to the wrist like a wristwatch, signal the gradual disappearance and eventual unreadability of the traditional telephone metaphorical references.

Note that new metaphorical items may themselves become a metaphorical basis for further technology developments. For example, the interactive spreadsheet on the personal computer is quite different from the previous historical, static object, the ledger page. The interactive spreadsheet, in turn, becomes a tool to use in other contexts, turning the spreadsheet display and functionality into a basis for understanding programming languages or database queries.

Given the significant costs and benefits of metaphors, the design process should be considered carefully when planning user interface development.

## Metaphor Design Process

The user-interface development process may be summarized as follows:

- Plan: Define the problems or opportunities; establish objectives and tactics; determine budget, schedule, tasks, and development-team and other resources
- Research: Investigate dimensions and techniques for all subsequent steps, e.g., techniques for analysis, criteria for evaluation, media for documentation, etc.

- Analyze: Examine results of research, e.g., problem or opportunity (conduct market research), refine criteria for success in solving problem or exploiting opportunity (write marketing or technical requirements), determine key usability criteria; and define the design brief, or primary statement of the design's goals
- Design: Visualize alternative ways to satisfy criteria using alternative prototypes; based on prior or current evaluations, select the design that best satisfies criteria; prepare documents that enable consistent, efficient, precise, accurate implementation.
- Implement: Build or carry out the design to complete the final product, e.g., write code using appropriate tools.
- Evaluate: Test results at any stage in the marketplace against defined criteria for success, e.g., conduct focus groups, test usability on specific functions, gather sales and user feedback.
- Document: Record development history, issues, and decisions in specifications, guidelines, and recommendation documents.
- *Note:* User-interface development is cyclical and partially or completely repetitive. For example, evaluation may be carried out prior to, during, or after the design step.

Within the overall user-interface development process, the metaphor design process may be defined in this way:

- Identify items among data and functions that should be targets
- Identify sources of metaphorical reference
- Generate many possible metaphors
- Identify and evaluate matches and mismatches
- Revise metaphors to strengthen effective matches and reduce harmful mismatches

Metaphors are mappings from one domain to another. The designer first must identify targets, i.e., those objects, structures, or processes, that seem confusing, unrelated, or inappropriate.

For example, a set of functions in an application may seem likely to be useful together. How might they be thought of or perceived as an integrated group? The designer must then identify possible sources, or metaphorical references, which enable the user to understand or perceive this grouping in a "natural" and forceful manner. Or, as another example, a particular collection of data seems likely to benefit from a memorable name that is associated with some aspects of the function that acts upon the data. What terms or images might enhance the clarity and memorability of this relationship between functions and data?

The sources may arise from the user's context, i.e., from daily use of existing tools and documents and subject matter in a typical work or play environment. They also may arise from other relevant subject-matter domains or work/play contexts, or they may arise from ordinary everyday experience.

By making matches, and attempting to optimize them, the designer can also observe the mismatches: terms that seem too inappropriate, overly forced, inappropriately comical, or dysfunctional. By evaluating them among designers, clients, and users, then revising them, just as for all other components of user interfaces, the disruptive mismatches will lessen, and a well designed management of the user's expectation and surprise will emerge.

Mismatches in metaphors may occur for several reasons. One is that the target domain cannot provide a match for a primary attribute in the source domain, especially if the source is real-world objects, structures, or processes. Consider the confusion that has arisen among novice users of text-editing software who use a *typewriting* metaphor to understand their activities. Users may become confused by the change of visual representation of the real-world object (e.g., there is no moving carriage or type-element) or the difference of operations (e.g., operations required to delete a mis-typed character). In such cases, the users' confusion may lead to performance degradation or errors.

Because metaphors inevitably are limited, designers may need to add unique functions to the context of a given metaphor that go beyond it or real-world experience. Smith [1987] has referred to this kind of mismatch as a tension between *literalism* and *magic*. For example, with a space metaphor for a hypertext document, there may be links that jump to other spaces quite unlike anything in everyday real-world experience. Another example is in the *pile* metaphor, a representation of a stack of

documents on the screen that, among other things, can be re-organized automatically at the selection of an appropriate command, quite unlike piles of documents in the real world.

The result is often, especially in rich, multimedia applications, that metaphorical references sometimes are quite inconsistent as a group. These contradictions may not necessarily be harmful. As Neale and Carroll point out [1997], "mismatches raise new questions that require examining existing assumptions about the source domain based on the metaphor. When these questions are answered, dissimilarities result in further development of the user's [understanding]."

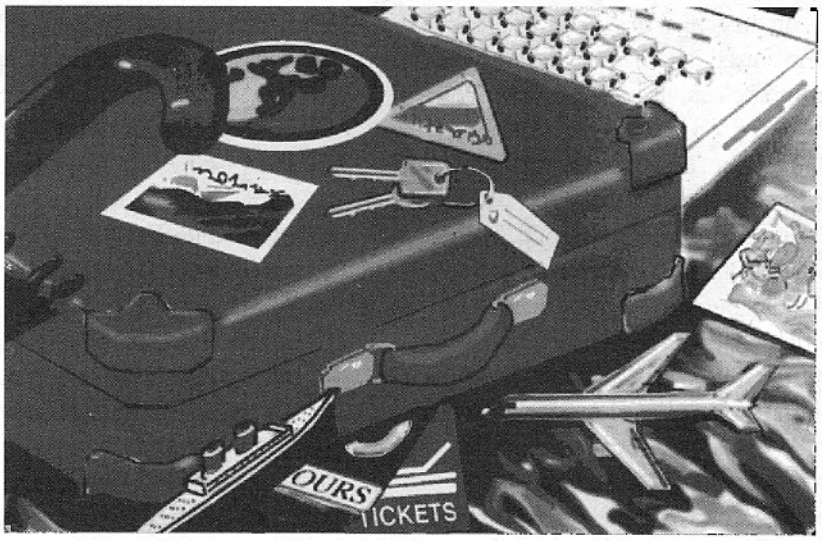
The primary success criteria for metaphors are the extent to which they can facilitate understanding, diminish misinterpretation, and promote positive, desired associations with the product, its use, or the self-image of the user. In theory, these characteristics can be evaluated comparatively in focus groups or tested among users. Managing expectation and surprise through the selection of appropriate metaphors remains a complex discipline, mixing art, science, and professional experience. In a word, it is a *design* activity.

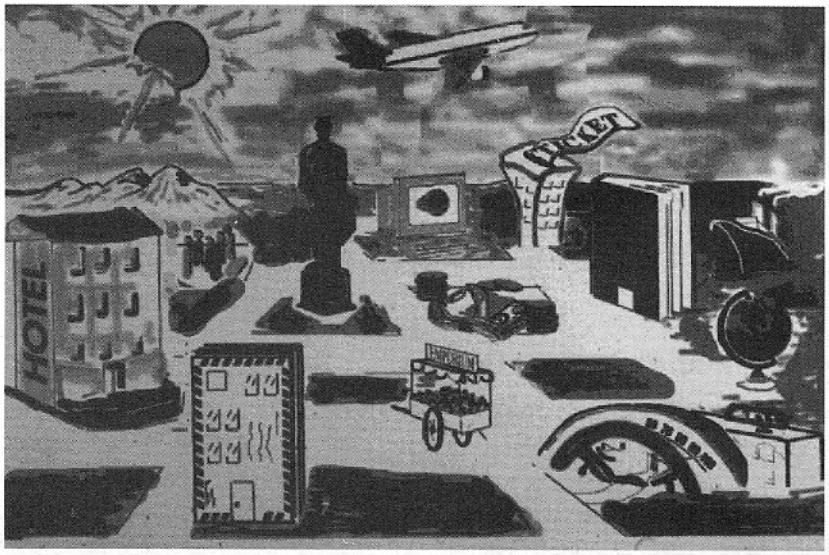
## A Case Study of Metaphor Design

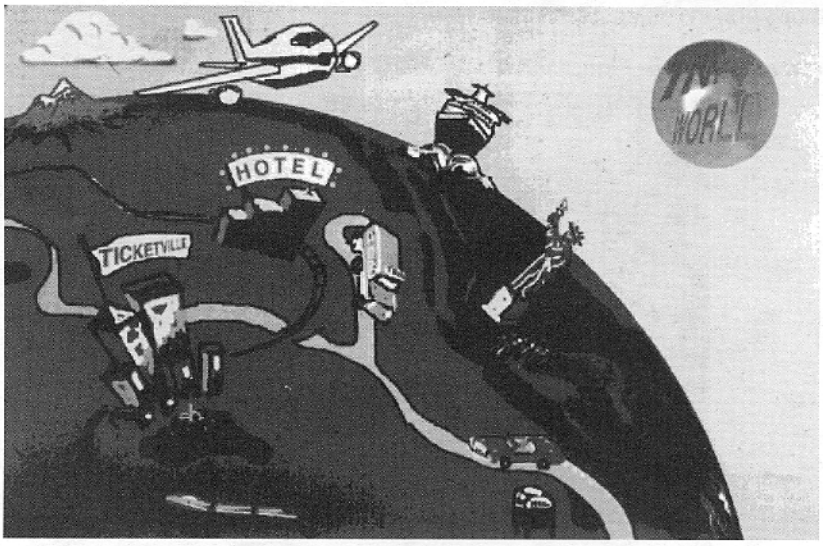
To illustrate metaphor design practice in user interfaces, consider Figures 7-16, which illustrate the design of the opening, or launch, screen of Planet SABRE, a new design for the SABRE Travel Information Network (STIN). The metaphor was developed by the author's firm in conjunction with the staff of STIN during 1994-1996. SABRE is one of the world's largest private on-line networks serving approximately one-third of all travel agents worldwide to enable bookings of flights, rental cars, and hotels. The existing legacy mainframe database query-and-retrieval system with a textual user interface offers users hundreds of arcane alphanumeric commands to access fixed frames of alphanumeric data. The new system offers a Microsoft-Windows graphical user interface for a client-server network. This new technology offered an opportunity to change radically how users understood the SABRE software.

The development team considered for some time how better to represent the core applications and associated data. During a three-day think-tank series of discussions, they explored both abstract and pictorial approaches to visualizing the upper levels of the mental model and communicating the novel qualities of the new graphical approach to formulating queries and retrieving information. In addition to abstract representations of the system, several different physical scenes emerged that seemed more likely to be memorable and appealing to the user group (see Figures 7-10). Each of the scenes showed physical, spatial metaphors: an airport terminal, a view of a traveler's suitcase with travel gear, an urban scene, etc. One approach in particular seemed promising, as judged by initial interviews with a limited number of travel agents: the functional modules depicted as three-dimensional objects on the surface of a planet viewed from outer space.

***Figures 7-10: Initial sketches of four alternative metaphorical scenes for the Planet SABRE user interface.***


OURS
TICKETS


HOTEL


HOTEL
TICKETVILLE

Note that the airplane representing air reservation booking is flying in outer space, a patently impossible situation. This is typical of metaphors, as noted by Black [1979]: "...such 'absurdity' and 'falsity' are of the essence: in their absence, we should have no metaphor but merely a literal utterance."

The large land-mass or planet metaphor has been used in other products and is one of several spatial or *geographic* metaphors typically useful for depicting elements of an operating system or a suite of applications. In a sense, this image is a very large extension of the concept of the desktop, which is in a room, in a building, in a city, in a country, on a continent, on a world, somewhat like a larger-scaled version of General Magic's Magic Cap user interface (see Figure 6).

Once any metaphor is determined, the context of the metaphor may influence strongly certain appearance and interaction issues such as spatial organization, size, image style, means of highlighting, etc. The designer's task is not finished merely with metaphor selection: the metaphors must be detailed correctly to be successful.

In spatial metaphors, especially at the scale of urban form, Lynch [1960] has identified organizing attributes of paths, edges, landmarks, nodes, and districts. On Planet SABRE, these elements presented themselves in the image at a global scale. The user-interface development team tried many variations of locating the elements of the display: both application modules, such as those for booking air, car, and hotel reservations, as well as ornamental characteristics of the planet, such as its land masses and seas. They also tried many variations of images depicting these application modules, such as using a building, a vehicle, or a landscape object for a particular application. The planet was meant to be connote generic land masses and not to denote specific countries.

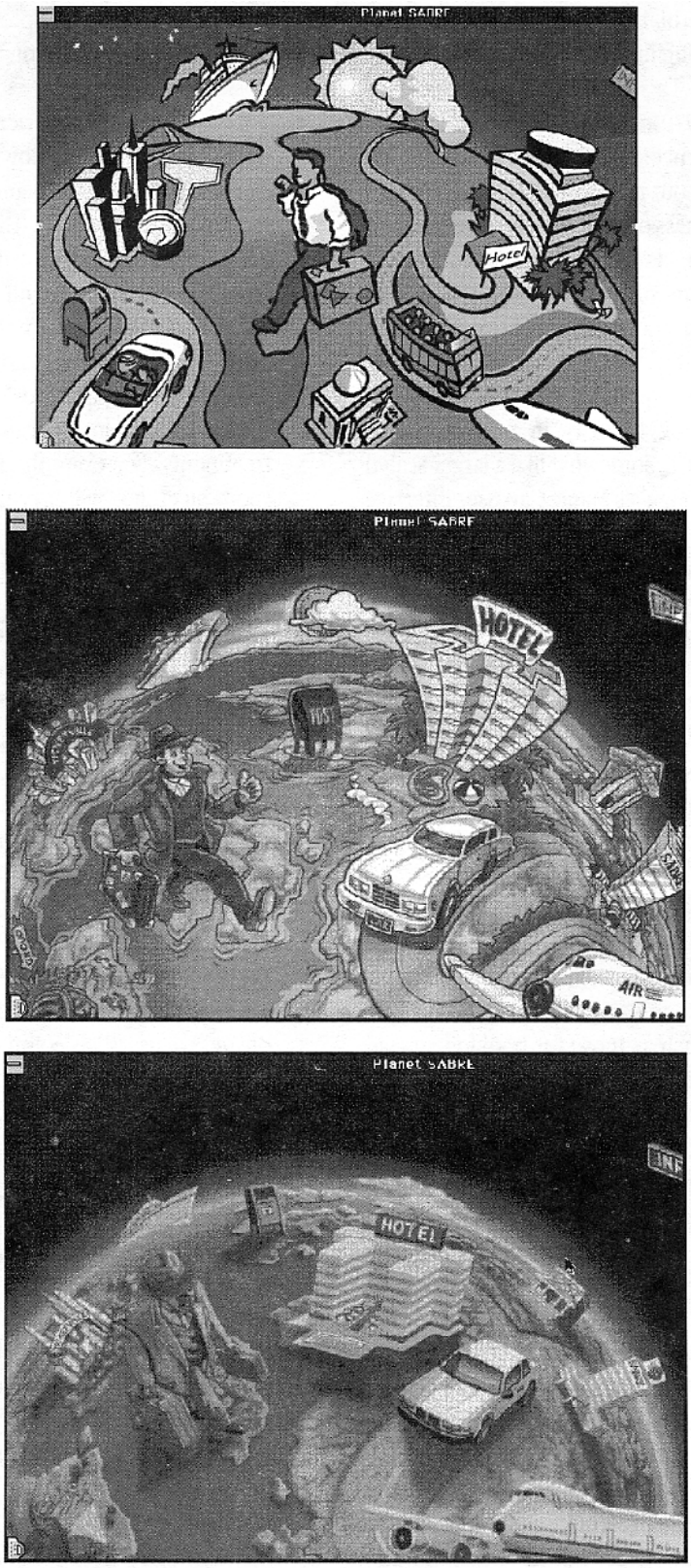
The team also considered the size of the icons representing applications. To keep the spatial perspective consistent, the icons needed to change size depending on how far away they were in the scene. Using the implications of the metaphor, the team decided to make the representation of the four most important applications central in the scene and closer to the viewer, therefore larger: passenger data, air bookings, car bookings, and hotel bookings. Other items were supplementary and therefore placed in a more distant, peripheral, and smaller position.

Considering spatial orientation, the icons would have to appear upside down if they appeared south of the equator of the planet to be consistent with the metaphorical image. This orientation of objects, for example, a tour bus with passengers, appeared strange, even absurd, and was abandoned. Therefore, the view had to emphasize a "front" half of a northern hemisphere in order to show objects in familiar, recognizable positions.

Metaphorical images can appear in many styles or treatments. For example, furniture appearing in a room metaphor will inevitably convey a certain epoch and aesthetic approach. Microsoft's Bob, a set of basic applications for first-time computer users, showed what might have been intended as a cartoon-like caricature of the den or library of Bill Gates, Microsoft's President. Although short-lived, the product was reported by a Microsoft user-interface design staff member to be popular with housewives in the Mid-West, who presumably found its style comfortable and unthreatening. An appropriate style needs to be determined for the user community.

The Planet SABRE development team designed three different styles of presentation: pictographic, cartoon, and realistic (see Figures 11-13). Representative travel agents stated that the cartoon style was undesirable because it seemed to diminish the seriousness of users' tasks and roles. This reaction demonstrated the importance of the user interface, and specifically metaphors, as a "mirror" depicting the user's self-image, not only a "window" looking into a world of content operated upon by special tools. Discussions among users and the client's product development managers eventually led to the realistic view as most appropriate.

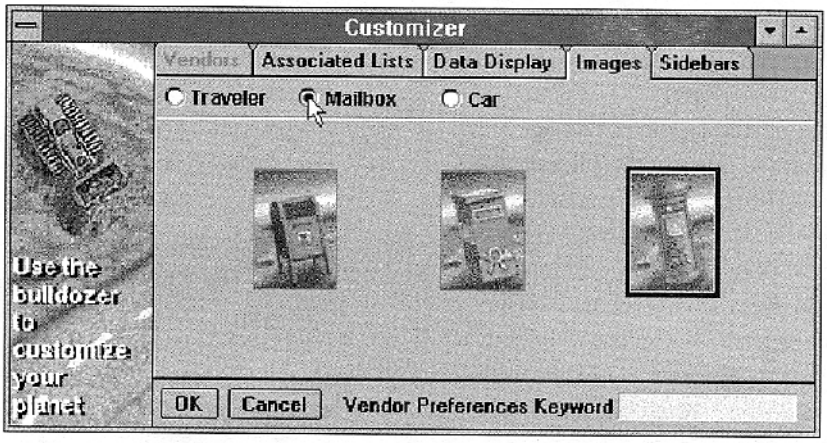
This final scene went through many refinements as the total image was "debugged" as a metaphor, including revisions of color and shape to make the scene and icons appear brighter and "happier" (see Figure 14), of icon image selection to account for different representations of objects, e.g., mail boxes, in different countries (see Figure 15), and of icon positioning to accommodate necessary sizes and shapes.




*Figures 11-13 : Examples of pictographic, cartoon, and realistic alternative versions of the Planet SABRE planet-metaphor image.*

*Figure 14 : The final version of the Planet SABRE launch screen featured a "happier" representation of the traveler/customer and brighter, "happier" colors in the vegetation of the planet.*

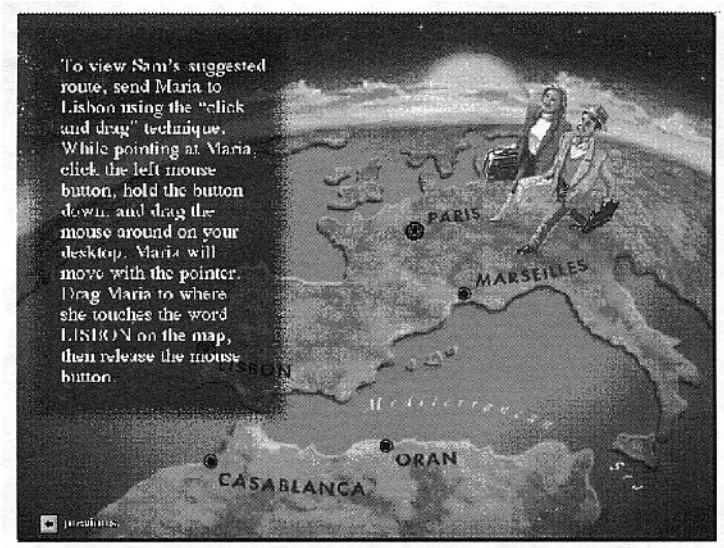

*Figure 15: A dialogue box enables users to change the image of a mailbox on the planet to represent better the object as known for a particular country or region.*




Note that the metaphor in this product development had primary importance for marketing and training, not performance by experts. The launch-screen metaphor was a significant marketing tool for the product. A marketing objective was to demonstrate dramatically to long-time users that a revolutionary change in the product was coming in the near future and to win purchasers' approval for and commitment to the new version. The Planet SABRE image was both surprising and potentially threatening to new users, but also exciting, and, once users' emotions calmed down, reassuring, and friendly.

The planet metaphor was also helpful in initial training and introductory use of the product to communicate the re-organized mental model of the system (see Figure 16). Once novice users were familiar with the product and understood the organization of applications, most of them would spend most of their time in specific primary applications such as air travel booking and not return to the initial launch screen, because the primary functions were available as a tool bar.

*Figure 16: A scene from a training game used to introduce the metaphors and controls of Microsoft Windows as well as those of Planet SABRE.*




## Conclusions

Metaphors have been and will continue to be a significant component of user-interface designs, at all levels of the mental model and its navigation, as well as intimately connected to the detailed appearance of and users' interaction with controls and status displays.

As products continue to increase the number and kinds of functions and to increase the amount and kinds of data available through computer-based communication media, the challenge of enabling more people and more kinds of people to use this content and these tools effectively will increasingly depend upon metaphorical embodiment of complexity. In addition, it is likely that metaphorical references will change more rapidly, requiring frequent updating of users' assumptions.

Future analysis of metaphors may address the following issues:

- How might metaphors be designed for different kinds of intelligence? Gardner has identified the following kinds of intelligence [Gardner, 1985]. They suggest users might have varying dimensions of conceptual competence with regard to using metaphors:

  Verbal/image comprehension
  Word/image fluency
  Numerical/graphical fluency
  Spatial visualization
  Associative memory
  Perceptual speed
  Reasoning
  Image

- How might metaphors be designed for different cultures that differ by such dimensions as age, gender, national or regional group, or profession? The author has posed this as a question before to the user-interface analysis/design community previously [Marcus, 1993]. The topic is discussed broadly in [DelGaldo and Nielsen, 1996].

The taxonomic analyses of metaphors for user interfaces, the theoretical basis for metaphor selection, the criteria for metaphor evaluation, and the design method are still emerging in the user-interface design discipline. Nevertheless, designers should be aware of the scope of the activity, know sources of insight, and incorporate professional techniques in their development process in order to improve the value and success of their products.

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The figures throughout the text depict an opening screen for Planet SABRE, a new means of presenting to travel agents the functions and data of the American Airlines SABRE Travel Information Network by means of PCs running Microsoft Windows 3.1 and eventually Microsoft Windows 95.

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