Managing Metaphors for Advanced User Interfaces

Aaron Marcus, President, Aaron Marcus and Associates, Inc.
1144 65th Street, Suite F, Emeryville, California 94608-1109 USA
Tel: 510-601-0994, Fax: 510-547-6125, Internet Email: marcus.1@applelink.apple.com

Abstract

User interface design includes designing metaphors, the essential terms, concepts, and images representing data, functions, tasks, roles, organizations, and people. Advanced user interfaces require consideration of new metaphors and repurposing of older ones. Awareness of semiotics principles can assist researchers in developing more efficient and effective ways to communicate to more diverse user groups.

Introduction

In an earlier era, a computer was a human being skilled in performing business calculations. At its inception, the modern computer, a data processing device, was thought of as an electronic "brain" located first in special rooms and later on typical office desktops.

Recent technology is altering the computer and its location. The use of graphical user interfaces (GUIs), the incorporation of multimedia, and the combination of computation with communication functions, e.g., fax, telephone, television, pagers, and CD-audio are enabling computer-based communication to occur in a wider array of environments beyond the office.

Consequently, the essential concepts, terms, and images of computers are being enlarged to include not only those associated with the business-office, productivity-oriented, desktop work-device for clerical, managerial, or engineering staff, but also for hand-held consumer communication devices used in leisure-time as well as work-time activities.

There is a resultant need for effective user interface design to communicate clearly the content being portrayed for an ever more diverse range of viewers or users of computer-based displays.

User Interface Design

The user interface embodies the data and functions of computer-based products and provides a basis for the product's usability and commercial success. One of the important challenges to user interface design is how to help the novice user become quickly proficient and eventually become an expert user without the encumbrance of the training aids that were useful for the novice. Systematic, information-oriented visual communication, or the graphic design of the user interface, is an important part of technologically sophisticated computer-based products as they spread into consumer and wider business markets internationally.

No matter what the technology, to achieve improvements in their performance and pleasure, future user interfaces designs must optimize the following components to meet users needs and preferences: mental models, navigation, presentation, interaction, and metaphors. These terms are explained below.

Mental model: The mental model is the appropriate organization and representation of data, functions, work tasks/play activities, and roles that people inhabit within social organizations of work or play.

Navigation of the model: Navigation refers to movement among data, functions, tasks/activities, and roles depicted in the model that provide speedy access and facilitate comprehension. This movement is usually facilitated by the use of menus, dialogue boxes, and control panels with or without icons.

Presentation: Presentation refers to the "look" or appearance characteristics that efficiently convey information to the user in an appealing manner. These characteristics include all aspects of visible language, such as typography, color, symbolism, imagery, animation, and sequencing of content, which may take the perceptual form of text, tables, charts, maps, diagrams, and figurative images. Presentation characteristics also include the acoustic realm: speech, sound cues, and music.

Interaction: Interaction, sometimes called "feel," refers to stimulus and feedback techniques and devices that operate efficiently and provide appealing perceptual (haptic and kinesthetic) experiences.

Metaphors: Metaphors are the fundamental concepts, terms, and images by which and through which information is easily recognized, understood, and remembered. Metaphors include the essential means by which choices for command/control are communicated and the status of all data and functions is depicted. Because electronic displays can be transformed...
relatively easily and quickly, these metaphorical techniques can vary widely across systems and change over time. Metaphors may achieve their effectiveness through associations of organization (structures, classes, objects, attributes, i.e., nouns) or operation (processes, algorithms, recipes, i.e., verbs).

Collections of data or objects are the nouns of visual-verbal communication. Typical examples of metaphorical contexts and associated familiar physical objects used to communicate the computer, applications, documents, and data include the following:

- Desk: Drawers, files, folders, papers, paper clips, sticky note sheets
- Document: Books, chapters, bookmarks, figures; newspapers, sections; magazines, articles; newsletters; forms
- Photography: Albums, photos, photo brackets/holders
- Television: Programs, channels, networks, commercials, viewer guides
- Compact disk, cassette, record, tracks, jukeboxes
- Games, game rules, game pieces, game boards
- Film: Rolls, slide trays, shows, reels, movies, theaters
- Containers: Shelves, boxes, compartments
- Tree: Roots, trunk, branches, leaves
- Network, diagram, map: nodes, links, landmarks, regions, labels, base (background), legend
- Cities: Regions, landmarks, pathways, buildings, rooms, windows, desks

Sets of functions are the verbs of visual-verbal communication. Typical examples of action concepts and their embodiment include these:

- Move (purposeful traversal): navigate, drive, fly
- Browse (low goal-oriented review of options): Rapid replacement, scanning text lines, window shopping, thumbing through books,
- Scan (very rapid browsing): fast review of scrollable items, fast review of buildings, objects, people, billboards on highway at high speed
- Locate: point, touch, encircle item(s)
- Select: touch item, poke item, grab item, lasso item, place finger on item and slide
- Create: add (new), copy
- Delete: throw away, destroy, lose, recycle, shred. Delete (temporary or permanent) sometimes consists of dragging a file icon to a trash can, garbage can, refuse truck, black hole, or a goat.
- Evaluate: Rotate knob, slide pointer, twist, spin
- Pour, flow: water (pipelines, rivers), electricity

The desktop metaphor popularized by Xerox, then Apple contains office references (desk top, documents, folders) mixed with building references (windows, trash cans). New metaphorical references and enrichments of the existing references are occurring all of the time. One of the most fundamental metaphorical changes will occur if we find ourselves calling computers communicators because their most important functions are communicative, not computational.

Visual Semiotics

To understand metaphors, their role in computer systems, and how to manage them, it is useful to recognize that using metaphors is one of many communication techniques collectively referred to as rhetoric, [Baker] [Lanham], the skillful use of language to describe, explain, and convince. Originally applied to verbal communication, studied by the Greeks and Romans, and once a fundamental part of university education, rhetoric can also be applied to visual communication [Bonsiepe].

Rhetoric, in turn, is one aspect of the semantic dimension of semiotics [ECO], the science of signs, the discipline that grew out of linguistics (de Saussure's semiologie) and philosophy (Peirce's semiotic) [Buchler]. In semiotics, one way of distinguishing signs is to distinguish them as icons (representational), symbols (abstract), or indices (connected by cause-and-effect).

The dimensions of semiotics refers to relationships among signs: to their referents, other signs, and the people who use them. The dimensions can be described briefly as follows:

Lexical: the relationships to the people and devices for producing signs
Syntactic: the relationships among signs
Semantic: the relationships to the ideas, objects, processes, laws, etc. referred to by the signs
Pragmatic: the relationships to the users or consumers of signs.

Within the dimension of semantics, there exist more than one thousand rhetorical terms [Lanham]. The following are examples of essential techniques:

Synonomy: Synonym repetition for emphasis
Erotesis: Questioning the viewer
Hyperbole: Exaggeration
Antithesis: Strong, contrasted ideas
Comparison: Extended, balanced, matching
Anaphora: Successive repetition of symbols Metaphor: Substitution of one for another.
Metonymy: Use of an associated symbol Synecdoche: Part for a whole; vice-versa
The last three techniques, including metaphor (literally, carrying across), use substitution to achieve their effectiveness. For example, the use of a magnifying glass pointer to indicate the area of a document to be shown at a larger scale can be considered the use of metonymy. Further examples of the application of these techniques to visible language appear in [Marcus, 1983] and to user interfaces appear summarized in [Marcus, August 1993]. These techniques provide a basis for experimenting with new approaches to depicting facts, concepts, and emotional values within the constraints of the display media available for human-computer communication. The user of metaphor has gained the most wide-spread attention in professional and popular media; however, the full range of rhetorical techniques are available to the designer of user interfaces to make communication of information more effective.

Metaphors certainly deserve immediate consideration; they are a fundamental basis for all human communication. Linguists [Lakoff and Johnson] comment that the "way we think, what we experience, and what we do every day is very much a matter of metaphor." In a similar vein, scientist Brian Arthur comments in Waldrop's [Waldrop] analysis of complexity theory, "science works mainly by metaphor. And what's happening is that the kinds of metaphor people have in mind are changing."

An appropriate metaphor balances delicately expectation and surprise on the part of the user/viewer. If the substitution is too alien to the user's culture or too far-fetched, the user will become confused, disinterested, distracted, bored, or antagonistic to the message carried by the metaphor.

Achieving the right mixture of metaphorical references in a complex user interface is a design task. In designing metaphors, one can adopt principles that have proven effective generally for visual communication [Marcus, 1994b]: organization, economy, and communication. The following are some essential guidelines.

**Organization:** Provide the user with simple, clear, and consistent metaphors. Consistency should be established internally within one user interface, externally across several, and in relation to real-world experience. (On the other hand, inconsistency may have value in establishing product recognition and memorability). Establish conventionalized, clear relationships among metaphor parts. Provide an understandable hierarchy with a clear primary and secondary focus for the user's attention.

**Economize:** Maximize the effectiveness of a minimal set of metaphors. Stress simplicity and clarity, i.e., include only essential elements and avoid ambiguity. Make the metaphors distinctive by distinguishing essential elements and establish a strong emphasis by ensuring that the important features of the metaphors are salient, i.e., easily perceived.

**Communicate:** Match the metaphors to the capabilities of users, i.e., their psycho-social needs, desires, education, and habits. Ensure ergonomic design by establishing legibility, readability, and multiplicity of references (aliases).

The following is a summary of a typical design process for discovering and refining metaphors:

**Identify possible metaphors**
- Interview users: Needs, wants, tasks, nouns, verbs, terms, images
- Analyze users' work context
- Consider similar real-world paradigms
- Utilize upper levels of the mental model
- Consider similar and/or competitive products

**Identify user/software matches and their implications**
- Identify user/software mismatches and implications
- Look for links to related nouns and verbs
- Consider explicit vs. implicit references
- Consider scientific, societal, cultural paradigms and shifts

**Review prototypes with users**
- Review designs

**Matches and Mismatches: Expectations and Surprises**

In addition to providing familiar references, designing metaphors for advanced user interfaces invariably leads to the introduction of some new concepts, terms, and images. These novel items will surprise users and may lead to confusion, alienation, or even rejection. For example, in the early days of graphical user interfaces, scroll bars at the side of windows were not a familiar experience. Significant debate arose over which direction the text should move when pressing an arrow key. Eventually, industry convention confirmed the current paradigm as the "correct" one.

Establishing metaphors within a large community of users is an iterative process over a period of several years, even a decade. Some "bugs" in the metaphor design may be put in place at an early date and can later be changed only with significant effort to overcome users' habits. For example, the Apple Macintosh "trash can" is more precisely a (probably dirty, smelly) fluted, galvanized steel "garbage can and lid" more suitable for a restaurant's kitchen or home's garage than for the open-topped "waste basket" or "trash bin" of a clerical office. The use of the particular image undoubtedly was influenced by a programmer's culture that spoke of "garbage in, garbage out."
Another oddity remaining in the Macintosh repertoire of metaphorical references is the term Finder, which sometimes appears in pull-down menus and is referred to documents, but which never appears as a named entity (window, icon, etc.) on the screen.

New Metaphor Designs

New metaphor designs are emerging in several commercial fields: personal communication products, interactive television, and multimedia CDs.

Personal Communication Products

Several companies have announced developments of personal information products. For example, Apple has developed the Newton, which it calls a personal digital assistant (PDA). Within the metaphor of the assistant are six essential concepts that introduce a redesigned mental model of an operating system pictured in an orderly, pen-oriented, forms-like display:

- Names: Who, Rolodex
- Dates: When, Calendar
- Extras: Application and document files
- Undo: Reverse previous actions
- Find: Find related text, information
- Assist: Check related information and do what seems best

General Magic has proposed another set of concepts for its Magic Cap operating environment that are pictured in a different way. An essential metaphor is the urban environment: suites of functions and data are housed in buildings along a main street; the trash can becomes the refuse truck. The street scene is depicted as a frontal view of buildings on one side of the street. Apple’s E-World online communication/publishing environment also presents a series of choices depicted in an urban landscape viewed from above.

As other major companies enter the marketplace, they will try to differentiate the functions, the kinds of data, and the user interface itself from competing products. Thus far, the user interfaces seem somewhat modest in their attempt to provide a professional-level design of the look and feel and contain unrefined elements within their metaphors; a little ambiguity in the metaphors, mental model, and navigation remains.

For example, General Magic’s metaphors present a desk within an office room along a corridor within a building along a street, but the concept of the office room is minimized and sometimes seems to be missing in navigation steps in favor of the desk. Some of the prototypes seem still too-much driven by engineering concerns and not sufficiently by marketplace sensitivity.

Interactive Television

Interactive television test trials are, or will soon be, under way in a half-dozen US cities, e.g., the Time-Warner trial service in Orlando, Florida, and the US West trial service in Omaha, Nebraska.

These user interfaces will test new approaches to user interface design that meet the constraints of the medium: lower resolution than desktop displays, consumer demographics that include less educated, less productivity-motivated, and more culturally diverse users, alternative input devices (e.g., remote control devices), and television influences on command-control, status, and content display.

Interactive television test trials offer valuable opportunities to pursue new metaphors, e.g., personalities as agents, like the program announcer or the quiz-show host; new mental models and navigation techniques, e.g., news- and quiz-program content formats, and look-and-feel styles, e.g., non-recallinear bounded fields for information display and three-dimensional environments for user interface components.

One example of a well-designed, innovative approach to interactive television already being demonstrated is that of Eon, which has demonstrated a “transparent” user interface, in which all backgrounds of user interface components are transparent, so the viewer can simultaneously view a full-screen background video image, e.g., a football game in progress while making decisions about another layer of content in front of that plane.

Multimedia

Multimedia display (i.e., CRT or LCD display with mixture of graphics, text, video, and sound from CD-ROM or hypermedia documents on the Internet) also provides an impetus to innovation in user interface design. Multimedia has gained particular momentum recently in CD-ROM products (titles: documents or applications including reference, entertainment, education, and productivity tools) for consumer and business markets. The user interfaces of these products are typically driven, especially for the consumer market, by a need to establish a unique approach to content and to the user interface often focusing on elaborate graphics: photography, illustration, video, etc.

Many of the current products have been strongly influenced by Apple’s Hypercard™, video games, magazine publishing, movies, and MTV, not only traditional graphical user interfaces like the Apple Macintosh™, Microsoft Windows™, OSF Motif™, etc. The varieties of approaches in content and visual style have not developed industry paradigms familiar to the marketplace, but as multimedia title publishing achieves
greater market penetration, popular conventions will arise.

As more products are released, especially in a series, some drawbacks of current products will become increasingly evident:

- Chaotic mixture of metaphorical references
- Incomprehensible mental models
- Illegible and/or unreadable typography, especially lists, tables, and forms
- Over-use of color
- Incomprehensible input control areas: command buttons, hypertext hot-spots, etc.
- Lack of product series user interface standards

With the immense content of data available on CD-ROMs and increasingly sophisticated functionality of search and retrieval, CD-ROM's, as interactive storytelling, require careful attention to their own user interfaces in which playful, individualistic approaches to attracting viewers, training them, and enabling informal browsing combine with more business-like activities of forming queries and engaging in complicated dialogue.

Other Possibilities

New computer/communication contexts and their metaphor possibilities include the following:

- Personal assistants, communicators: agents, guides, servants, colleagues, societies; conversations, broadcasts
- Collaborative environments: group discussions, bulletin boards, whiteboards, group work
- Accessories: cloth, clothing, glasses, helmets, wallets
- Writing instruments: pens, pads, wands, gloves
- Economies: marketplaces, monetary media
- ITV: channels, providers, distributors
- Networks, online information services: clouds, clusters, webs, globs, who-what-why-when-how
- Games: combat, cooperation, trading, personal chemisty
- IVHS Navigation: Where, what, how, when
- Virtual reality: 3D widgets
- Knowledge/data visualization (organization, hierarchy, multi-dimensionality): N-Vision [Feiner and Beshers], Parallel Coordinates [Inselberg and Dimsdale], Tree-Maps [Johnson and Shneiderman], Cone-trees, Cam-trees, Information Wall [Card et al]

Conclusions

Older communication media have used a series of metaphors drawn from the circumstances of the past. Waldrop [Waldrop] argues that the metaphorical basis was that of Apollo, i.e., related to archery, medicine, and music. Earlier metaphors are mechanical and oriented to nineteenth century physics, with an emphasis on equilibrium, stability, determinism, quantities, and prices. The communication media have focused essentially on one-way distribution from headquarters outward to a mass audience of undifferentiated, identical recipients. The content was a manageable amount of data and functions, symbols, and tools, with a manageable change of metaphorical paradigms.

Waldrop goes on to argue that in the modern age (an age of unprecedented complexity requiring complexity theory to understand the nature of change), the appropriate metaphorical basis is Dionysus/Bacchus, i.e., related to vegetation and wine. Future displays of systems will emphasize a biological reference to self-organization, patterns, structures, cycles, qualities, values. Future communication environments will emphasize networked two-way communication with multiple centers of distribution and micro-audiences of differentiated, individual recipients who will receive "teradose's" of data and functions, symbols, documents, and tools. The paradigm shift, or change of metaphors will be constant and swift as paradigms evolve from prototypes, become typed, evolve to archetypes, and eventually become stereotyped or obsolete.

Future research needs to explore further the cultural diversity of metaphors and its impact on communication, means of evaluating their effectiveness, and the process of designing them. These metaphors are likely to be a mixture of both Apollo and Dionysus, not solely one or the other. In a fully networked, hypermedia society, there will be a metaphor marketplace in which, to borrow from the artist Andy Warhol, every metaphor will be famous worldwide for 15 minutes.

The anthropologist Claude Levi-Strauss called human beings tool-makers and sign-makers. Computers combine both aspects in intriguing new ways. If designers optimize metaphors, users can gain more rapid access to complex information content, and, at the same time, not lose their comprehension as they speed through data and functions. As designers contemplate the future of user interfaces, they need to remember lessons learned from the history of rhetoric, particularly metaphor, to achieve successful communication simple, clear, consistent solutions that will continue to benefit increasingly diverse information products for increasingly diverse international users.

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References


Marcus, Aaron, "An Introduction to the Visual Syntax of Concrete Poetry, Visible Language, Vol. 8, No. 4, 1974, pp. 333-360. The article lists several dozen variants of visual syntax and shows their application to complex typographic forms.


Morris, Charles, Signs, Language, and Behavior, George Braziller, New York, 1946. In this classic work the author introduces the terminology and principles of semantics and his definition of semiotics.


