Chapter 3  Symbolism

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Signs, symbols, icons, cursors, and other specialized graphics are popular in paper documents, audio-visual presentations, and user interfaces. These graphics provide functional guidance, aesthetic charm, and corporate or product identity. In the past decade, developers gave relatively little attention to research, analysis, design, and evaluation of this component of visible language. Today, however, products often employ hundreds and even thousands of icons. The current decade will provide increasing commercial, cultural, technological, political, and educational incentives to make these pictographic and ideographic elements work well as a system of signs.

3.1 Clarity and Consistency in Icon Design

Nonverbal pictograms, glyphs, and symbols are finding their way into more workstations for office automation, CAD, CAM, CAE, computer-aided education and training, art and design, and even programming. These signs are used to represent options for actions, cursors locating points on a screen, and other structures or processes. People building and using these computer graphics systems often ask three questions: What exactly are icons and symbols? How can we best use them? What should they look like? This section attempts to answer these questions.
Visual Semiotics

One of the first matters that needs clarification is the terminology. What exactly is an icon? If we turn to the discipline of semiotics, the science of signs and their meaning, we will learn that there are three kinds of signs: icon, index, and symbol.

An icon is something that looks like what it means: it is representational and easy to understand. An example is a line of ink standing for a geometric line in a textbook illustration. An index is a sign that was "caused" by the thing or process to which it refers. The trail of muddy footprints in a front hallway is an index that the children have just entered. A symbol is a sign that may be completely arbitrary in appearance. We often must learn to make the association between a symbol and its meaning, and we must agree that such a symbol will mean a certain thing. An example is the American flag standing for the United States. As you may already realize, all of the letters you are now reading are symbols, the kind called phonograms. Because sounds are not visible to the eye, their appearance as letters in our phonetic alphabet is a matter of historical convention.

Strictly speaking, the so-called icons in iconic interfaces are a mixture of icons, indexes, and symbols. The spread of advertisements and literature about the Xerox Star, the Apple Lisa, and the more recent Apple Macintosh established the term "icon" in the lexicon of computer graphics during the 1980s. Here, I refer to these graphic forms loosely as icons, symbols, or generally as signs. There are four other, more technical terms from semiotics to keep in mind. These terms concern what signs mean: lexical qualities, syntactics, semantics, and pragmatics. In the next section we shall look at design issues for each of these four terms.

Lexical qualities concern how signs are produced. For example, what kinds of marks can a CRT device make? Do they appear as picture elements called pixels or as straight line segments called vectors? Each kind of visible mark influences the kind of signs that can be displayed.

Syntactics refers to the sign's appearance: are they circular, red, big, on the left, or moving? Such features of their appearance can be significant and can communicate a relationship that is important for a class of signs. For example, square icons of a single size can be easily assembled into an efficient, space-filling, regular pattern on the screen.

Semantics is often understood to be the meaning of the term "meaning": to what do these signs refer? These signs can stand for physical objects, people, actions, ideas, or sounds. A sign, for example, may denote the action of exiting from the system or deleting an object called a file.

Pragmatics concerns how signs are consumed. We may ask: will the CRT refresh rate cause disturbing flicker? Can a viewer 28 inches from the screen identify the sign? Part of a sign's total meaning or significance lies in the answers to such questions.

Advantages and Disadvantages

Why are icons and symbols becoming so popular in computer graphics systems? What advantages do they offer over words? Part of the answer lies in the realm of marketing: icons can be entertaining, clever, and visually appealing. Another advantage is that an individual sign may take up fewer pixels and less space than the equivalent in words. Therefore, more information can be packed into a given window or screen space. The space savings in menus, maps, and diagrams can be significant. Even more important, icons and symbols can replace written languages and contribute to interfaces that are international in design and comprehension.

If the signs are well conceived, systematically designed, and effectively displayed, the icons and symbols should be easier to recognize quickly than their verbal counterparts in a busy visual context. Within a
window filled by text, for example, a short phrase at the bottom of the window might explain that more text could be displayed if the user scrolls the window contents. This information could be symbolized with a simple arrow that effectively communicates the message and clearly distinguishes itself from alphanumeric text material.

Another primary advantage is the value of icons and symbols in reinforcing and aiding user comprehension of previously delivered verbal information. In tutorial and training materials, for example, a simple question mark inside a round circle can efficiently denote a source of help for the user or a source of confusion for the computer that the computer is bringing to the attention of the user. With just a few pixels, an entire situation and course of action can be implied.

However, icons and symbols are not a panacea for electronic publishing or user-interface design; they cannot completely replace words in some complex situations. There are clear disadvantages to the use of icons and symbols. An entire repertoire of new icons must be researched, designed, tested, and introduced into the marketplace. There is no system in existence that may be readily incorporated, unlike letterforms and typefaces. Some international sign languages like Blissymbolics and Ota’s LoCos (see Bibliography, Section 3.1) provide a starting point, but these new visible languages must be replanned and redesigned. This is a costly and time-consuming task if it is done well; the consequences of poor design are confusion and lower productivity for the user. As with typefaces, the signs often must appear in different sizes, weights, and styles. An entire “font” of symbols would have to be designed for each major size.

There are some examples of designing graphic symbol well in other fields. For example, the U.S. Department of Transportation commissioned a study that made recommendations for the use of symbols in mass-transit environments (see Bibliography, Section 3.1, Symbol Signs). Skilled graphic designers created conventions for symbols that have improved the quality of such signage throughout the country. Similar activities are necessary in the computer graphics field where signage systems for the mind are now being built into user interfaces.

Because of difficulties in designing, teaching, and comprehending icons and symbols, there is a practical limit to how many different local and global signs can be introduced into a system. Even the pictographic/ideographic Chinese system, with its large repertoire of signs, has a much smaller number of signs (approximately 3000) that most people use in practice. Ideally, icons and symbols should be used for what they can do best, to communicate concepts effectively within a small area of space. At the same time they should retain a clear, consistent approach. This leads us to consider some of the graphic design issues.

**Design Issues**

Basic principles for designing systems of icons and symbols are similar to those for designing the larger-scale windows and screens. Consistency, clarity, simplicity, and familiarity are key attributes. Sometimes these factors will be at cross purposes, but this is not unusual in design tasks. The skilled professional knows when to weigh one factor more heavily than another. Let us look at a few typical symbols exhibiting these properties.

Figure 3.1 shows a set of signs that demonstrate how graphic design consistency can be established among icons and symbols. The grid indicates the number of pixels used to display the icon. The pixels must be of sufficient quantity and size to establish clear differences of form so that the icons can be identified by the user at normal viewing distance. On high-resolution screens (60 to 150 dots per inch), 30 to 60 pixels are
and symbol consistency through limiting the variations of angles, line thicknesses, shapes, amount of empty space, etc.

Figure 3.2 shows icons from the Intran Metaform system, one of the earlier iconic user interfaces that appeared in 1983, about one month before the Apple Lisa. In comparison to the typical icons of the Apple Macintosh, the Metaform icons are very elaborate illustrations describing the typical activities within the module. They resemble illuminated letters from medieval manuscripts and clarify what is happening in a particular module. Our firm designed these prototypes for clerical staff who operated the equipment and were unfamiliar with computer technology. The signs are intended to intrigue and appeal to this user group.

Figure 3.3 shows how the style of symbol drawing can be varied to present a corporate-identity approach to depicting the basic shape or form. Care must be taken to ensure that such manipulations do not adversely affect legibility.

Figure 3.4 shows how complex even simple symbols can become. One symbol from Perq's Accent operating system, which our firm also designed, shows an icon with a subicon inside of it. These variations of signs show how using a simple set of sign parts can help communicate many different pieces of information.

Conclusion

We are seeing an evolution of writing systems in computer-based visual communication. Some companies are beginning to devote significant time to the graphic design of these new icons and symbols. We have already mentioned the pioneering work of developers at Xerox and at Apple. Dicomed, another manufacturer of CRT display equipment, spent considerable time in the 1980s improving the icons and symbols of workstations intended for graphic artists and designers. Interleaf's document layout system
introduced in the 1980s also showed sophisticated, comprehensible approach to icons and symbols.

More investigation needs to be done in this important area. The design and use of icons and symbols can be expected to increase for most popular computing and for many specialized professional workstations. Bibliography Sections 3.1, 3.2, and 3.3 will help readers recognize the elements that contribute to the design of effective symbols and icons for electronic publishing and user-interface design.

3.2 Icon Design Tips

Icons, symbols, pictograms, ideograms, and other signs are quickly becoming indispensable as components of user interfaces in successful computer graphics products. In recent years, icons have become more colorful, dynamic, acoustic (that is, accompanied by voice or music elements), three-dimensional in appearance, and certainly more ubiquitous. In fact, it is not uncommon for CAD/CAM/CAE systems to employ thousands of these small images to help convey choices of functions, data, tool kits, window-manipulation markers, or navigation devices. Successful icon design involves approaching the problem systematically, analyzing the sometimes conflicting needs that determine appearance and interaction characteristics, designing prototypes, and evaluating the designs.

In Section 3.4, a reading list is provided on icon design. One of the best references cited Ota's Pictogram Design (see also Bibliography, Section 3.2 and 3.4). This profusely illustrated, bilingual (Japanese and English) work provides an historical overview, with examples in color, and many excellent case studies of icon and symbol design.
Icon Design Issues
Lexical Issues:
How are signs produced?

The following is an initial list of issues that the icon designer faces. The list is based on the terminology of semiotics.

What spatial resolutions are available?
What size limits (minimum and maximum) exist?
What duration and frequency of change (animation) attributes exist?
What brightness levels and colors are available?
What acoustic attributes exist?
What shading, corner, angle, line thickness, and other appearance attributes are available?

Syntactic Issues:
How do the signs appear in space and time?

What are the systematic, regular conditions of these attributes:
Size, shape
Line thickness, line pattern, line terminations
Patterns
Orientation
Location
Color
Animation
Spatial grids
Modular parts

Semantic Issues:
To what do the signs refer?

What are the systematic references of the signs?
Concrete objects
Abstract objects
Part of referent versus whole referent
Moment in time (before/during/after event)

Pragmatic Issues:
How are the signs used?

Are the icons legible under typical viewing distances and ambient lighting?
Can the icons be identified easily both individually and within groups?
Can the icons be remembered easily?
Do the numbers and kinds of shapes, patterns, or colors create confusion?
Are the icons pleasing to the eye?

Icon Design Guidelines

As for forms, the following recommendations are some general tips for good icon design.

Analyze the verbal contents and the display environment.

Determine how icon parts and complete icons should relate. Existing icons have developed in an often chaotic manner with elements that may not be relevant, consistent, or useful. Too many parts may confuse the viewer. The icon-display equipment may have severe limitations in appearance or interaction characteristics (for example, monochrome CRTs or touch-screen input), which will affect the appearance of the icons and their use by the viewer.

Design the initial icons by creating quick sketches.

Once the semantic contents has been organized, create many quick sketches that may vary from logical abstractions to concrete images. Indicate all visual elements, their approximate size, and their approximate location. This is a typical stage in the visual design of a complex system of images. At this stage it is easier to manipulate broad differences in the icons and their hierarchy. It is important not to be too precise or detailed early in the design process. It is more important to
explore possible variations. Evaluate which icons seem to meet the needs of the sender, the receiver, the message, and the medium.

**Sort the icons into styles.**

Consistent stylistic treatment has a major effect on the perceived complexity of the icons. Styles should be established in which all the icons are grouped by consistent approach (for example, part for a whole) or appearance (for example, curved versus angular shapes). By sorting the sketches, it is easier to keep track of trade-offs in optimizing the entire set of icons with regard to simplicity, clarity, and consistency.

**Design a layout grid that organizes all major elements of the icons.**

Determine an underlying spatial grid (see Fig. 3.5) to make consistent all visual components, including point elements, gray patterns, curves, angles, the length and width of rules, etc. It is especially important to use the grid to establish standard horizontal, vertical, and oblique lines and a limited set of sizes for objects.

**Use large objects, bold lines, and simple areas to distinguish icons.**

Once a style of presentation is selected, continue to use the same approach as often as possible within the icon set. Avoid sudden changes in the means of emphasizing or de-emphasizing the importance of certain objects, structures, or processes. Avoid making crucial elements of the icon’s significance too small in comparison to the total size of the icon.

**Simplify appearance.**

Icons should be simple and clear. Any extraneous decorative parts should be carefully weighed against the confusion they may cause the viewer. On the other hand, the icons should not be so simple that they all seem identical; they should be clearly distinguishable. The visual differences in an icon should be as significant as possible from a communication perspective; otherwise, the random or idiosyncratic changes merely add more processing time for the human mind and create a possibility of errors of interpretation.

**Use color with discretion.**

Too much variation will confuse the viewer with distracting clutter. In general, for color displays it is reasonable to use five or fewer colors (including black, white, and/or gray) for icons. Simple color patterns often can be used effectively for background or low-lighted areas that do not need to be examined carefully.

**Evaluate the designs by showing them to potential viewers.**

After prototypes are available, these should be reviewed and tested by typical viewers. Green and Burgess’ report (see Bibliography, Section 3.2) explains how to set up an evaluation. Evaluations, which can affect all aspects of icon design, should be repeated if resources and project deadlines permit.

**Icon Design Trends**

Icon design has entered a new phase in recent years. In May 1988, Xerox was awarded U.S. design patents for icons such as file folder, wastebasket, floppy disk drive, and telephone (see Fig. 3.6). Design patents, which protect the aesthetic appearance of “ornamental” designs, have been granted in other areas of the design professions, but these are some of the first to be awarded in computer graphics.
Staff members for whom even basic CAD/CAM functions may appear confusing. These opposing factors place increasing pressure on manufacturers to improve the ease of learning and using CAD/CAM systems.

One approach to upgrading CAD/CAM user interfaces is to enhance the visible language presentation of the screens: the typography, symbolism, color, layout, and sequencing of all command-control and documentation content. The general design goals are to improve the legibility and readability of screens and to increase simplicity, clarity, and consistency of all functions and data. Other chapters of this book concern various facet of user-interface design. This section will focus on selected aspects of the redesign of the screens for a particular product, the Computervision (now part of Prime Computer) CADD Station.

Several vendors offer CAD/CAM products with a wide range of functionality, medium- or high-resolution screen display, and icon-oriented user interfaces. Computervision's solution is one of the more highly integrated approaches, and the user-interface design issues described here should be instructive to all those professionals engaged in advanced graphical user-interface design.

At the time of the design project in the late 1980s, the Computervision CAE/CAD/CAM software ran under the UNIX operating system and the Sun-based Network File System. The workstation included functionality for schematic capture, logic simulation, printed circuit-board layout, numerical control, plant design, mapping, and other modules.