# Appendix A

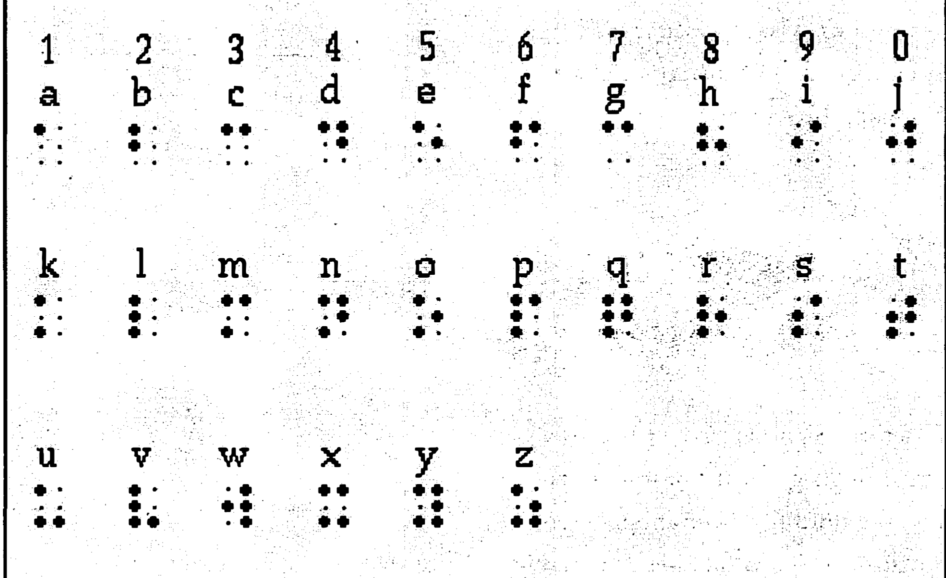
## A Gallery of Codes

**A code is a system of symbols that work together as a unit. The symbols used in a code are often arbitrary, so a key is needed to unlock the code. The key provides synonyms in a language that is already familiar. For example, a map key translates the graphic symbols used on the map into words. In this appendix, we will examine and decipher codes from six very different fields, ranging from Braille to refund coupons.**

## Braille

Braille is an arbitrary system that uses only two basic symbols, the dot and the absence of a dot. The dots are raised, so that a visually impaired person can feel them. The dots are clustered in little 2 x 3 grids called cells. Figure A-1 shows a key for interpreting the number and letter symbols of Braille. Note that the Braille language reuses the symbols for the letters "A" through "J" to encode the digits "1" through "0."

**A-1: Key to Braille letters and numbers**

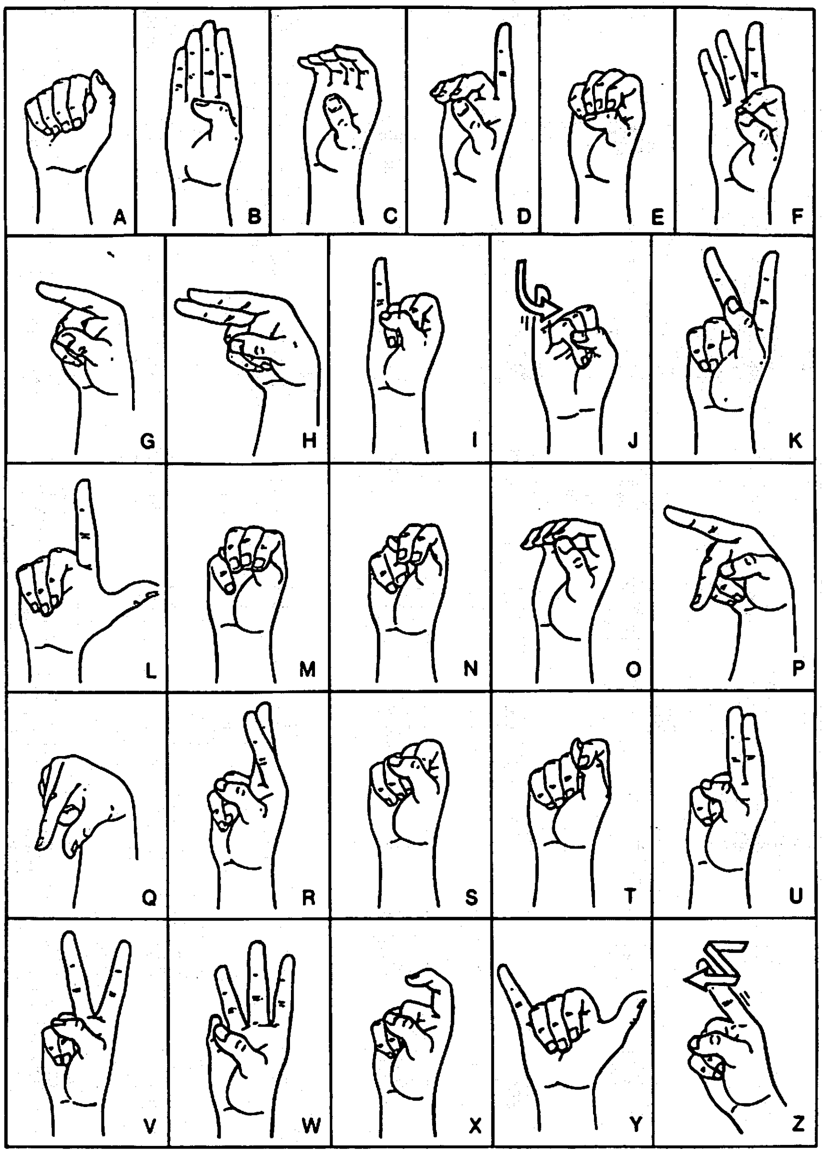


Because each of the six positions in a cell has two possibilities—"dot" or "no-dot"—there are 64 (2 x 2 x 2 x 2 x 2 x 2) possible cells. A cell that has no dots at all represents a space between words, leaving 63 other combinations. The key in Figure A-1 shows only 26 of these. The others are used to encode punctuation marks, dozens of common letter combinations, and many common words. A complete guide to Braille is available on the web at the following address:

http://www.brailleauthority.org/def.html

The site also provides information about other Braille codes, such as those used to represent math and science symbols, musical notation, and computer information.

**A-2: Key to the ASL lettersigns**



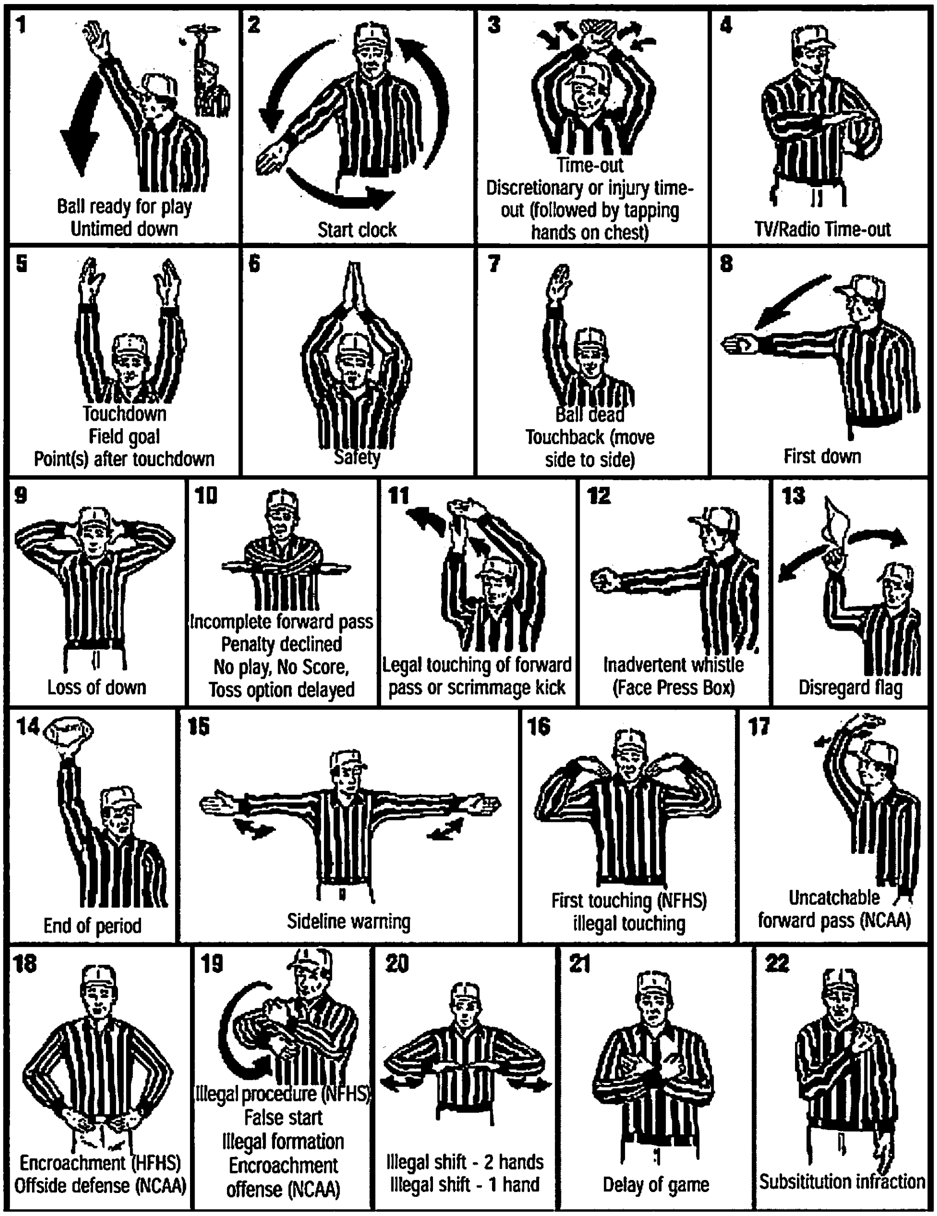

# American Sign Language

American Sign Language (ASL) is a visual language for the hearing-impaired. It is the third most commonly used language in the U.S., after English and Spanish. ASL includes a largely arbitrary set of "lettersigns" that form a code for representing the letters of the alphabet. (See Figure A-2.) A few of these signs look similar to the letters they represent. The lettersigns are actually only a small part of the language, which also has thousands of signs for words and concepts, and takes considerable effort to learn. Many of these signs are very expressive. For example, to make the sign for "car," you put both hands in front of you and pretend to be turning a steering wheel back and forth.

# Football Referee's Signals

A system of signs and symbols can be found in nearly any team sport. In a relatively quiet sport like tennis it may be possible to hear the scorekeeper, but in a sport such as football, it is nearly impossible to hear anything. Thus, football requires a visual code for transmitting information. Figure A-3 shows a key to some of the official referee's signals for football.

A-3: **Some of the referee's hand signals used in football**



# Postal ZIP Codes

There are some codes that everyone needs to know a little about because they are used in ordinary communication. An example of this type is the postal ZIP code. Originally, "ZIP" stood for "Zoning Improvement Plan." Before ZIP codes were introduced in 1963, major cities had already been divided into numbered zones. These numbers were incorporated into the new ZIP codes as the last two digits. For example, "New York 25, NY" became "New York, NY 10025."

The use of ZIP codes became nearly universal by the late 1970s. In 1983, four more digits were added, resulting in the nine-digit code currently used. This system was originally known as "ZIP + 4."

ZIP codes are the basis for automated sorting of the mail. A typical piece of mail is fed into a large scanning machine that reads the entire address and looks up the nine-digit ZIP code in a database. The machine then prints the nine-digit ZIP code on the bottom of the envelope, along with its bar code representation. The bar code is later used to sort the mail for delivery to its final destination. Figure A-4 shows the nine-digit ZIP code 10025-1944 and corresponding bar code, which were printed on an envelope by a scanning machine.

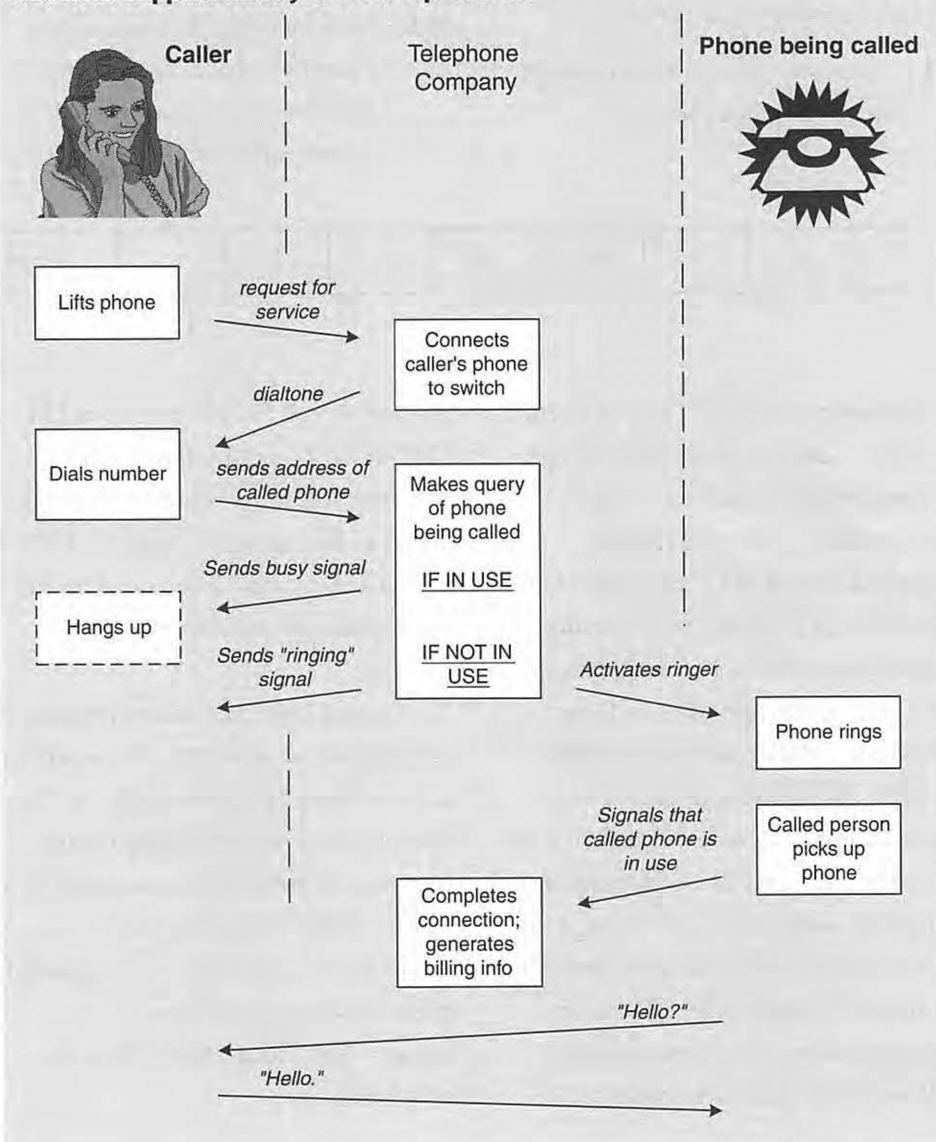
A-4: **Numerical ZIP code and bar code printed on an envelope by scanning machine**

10025+1944

What exactly does the nine-digit code represent? The first digit represents a group of states. "1" means either New York or Pennsylvania; "9" could be California, Oregon, Washington, Hawaii, or Alaska, etc. The first three digits, in this case "100," signify a Mail Processing Facility (MPF), a large postal center where mail to or from a region is scanned and sorted. The nine-digit ZIP and bar codes in Figure A-4 were printed on the envelope by a scanner at the MPF from the region where the letter was mailed. After the letter arrived at the "100" MPF, the bar code was read by a scanning/sorting machine, which put it into a bin for "10025-1944." Of this code, the "10025" stands for a local post office from which mail is delivered. The full nine-digit code represents a route that a letter carrier follows when delivering a single bundle of mail.

# Telephone Signals and Phone Numbers

A-5: **What happens when you make a phone call**




An ordinary phone call involves extensive use of symbols and signals, most of them hidden from the user. As with ZIP codes, however, there are some parts of the telephone signaling code that every telephone user needs to know something about. For example, everyone knows that you have to wait for the dial tone before you can dial a phone number.

Some of the signals involved in a typical phone call are shown in Figure A-5. Lifting a telephone from its cradle sends a signal to the central station requesting service. The telephone company responds, sometimes after a short delay, with a signal called a dial tone, which means, "Your telephone is now connected to a machine that can interpret a phone number." You then dial the number, which is a code for another person's telephone. The telephone company now determines whether that phone is already in use. If so, it sends you back a busy signal. If not, the phone company does two things:

1. It sends you a ringing signal.
2. It sends a signal to the called phone to activate the ringer.

These are not the same! You cannot actually hear the other person's phone ringing. The person you called picks up the phone, which is a signal to the phone company to complete the connection between the two phones. Finally, the verbal messages begin: "Hello?" "Hello."

A telephone number is a very powerful code that can select a unique phone from among the billion or so hooked up around the world. How do telephone numbers manage this feat? To make a call from any phone in the U.S., Canada, and parts of the Caribbean to any other, you have to dial up to 11 digits. These 11 digits have the following structure:

**1** = signal that the call is being made to another area code;

**AAA** = three-digit area code;

**LLL** = local exchange number, which identifies where the signaling equipment for an individual phone is located;

**PPPP** = individual phone number, one of nearly 10,000 available in each exchange.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | – | A | A | A | – | L | L | L | – | P | P | P | P |

This system is called "Direct Distance Dialing," and was introduced in the early 1960s (except for the initial "1"). Before Direct Distance Dialing, you had to dial "211" to make a long-distance call, and the long-distance operator would have to complete it for you. In the early days of Direct Distance Dialing, you did not dial "1" before dialing the area code. Every area code had to have "0" or "1" as its middle digit, and the local exchange number could only use 2 through 9 in this position. Otherwise, the switching equipment would have no way of distinguishing a local from a long-distance call. Also, area codes could not begin with "0" or "1" nor end in "00" or "11," because these codes were reserved for other purposes, such as "911" for Emergency and "411" for Information. These restrictions limited the number of possible area codes to 136.

Around 1980, the country began running out of area codes. By requiring a "1" in front of an area code, the restriction on the middle digit could be removed, because now any sequence starting with "1" must be for a call to another area code. This expanded the number of possible area codes to over 700. About 250 of these are now being used.

Three-digit local exchange numbers have to follow roughly the same rules as area codes. The total number of possible phone numbers in an area code is about seven million. In many large cities and suburban areas, the telephone company frequently finds it necessary to introduce new area codes. Why? Apparently, the seven million or so numbers per area code can easily become exhausted, due to the proliferation of cell phones, fax machines, modems, beepers, and pagers, as well as ordinary phone lines.

# Bar Codes

ZIP codes and telephone numbers are numeric codes designed to be sent by people, even though they are interpreted largely by machines. They are not too difficult to remember or use. There is another category of code that most people never become concerned with, because they are designed for machine-to-machine communication. These include the electronic codes used to communicate within or between computers; the electromagnetic codes used in radio and TV transmissions; the magnetic codes used on credit cards, audio tape, and video tape; and the optical codes used on CDs and DVDs. The examples just mentioned do not use visible symbols, and the codes are therefore impossible to see without special equipment.

There is, however, one large category of codes that use visible symbols for machine-to-machine communication. These are the ever-present bar codes found on mail (see Figure A-4), airport luggage tags, books, consumer products, coupons, library cards, property tags, standardized forms, and much, much more. It is interesting to explore what these bar codes actually represent. You don't have to crack the bar code itself because the corresponding number is usually written just below or to the left of the bar code. We will not focus at all on the bar patterns, but only on the numbers they represent. Palmer (1995) provides detailed information about the actual bar patterns.

A-6: **Refund coupons for pasta (left) and pasta sauce (right) of the same brand**


A-7: **50-cent refund coupons for two cereal products**


Bar codes are found on manufacturer's refund coupons, such as those in Figures A-6 through A-9. These bar patterns use the Universal Product Code (UPC) system. UPC bar codes are also found on most non-durable consumer products, particularly those sold in supermarkets and pharmacies. By looking at a few coupons carefully, it is not too hard to figure out what these numbers mean.

A-8: **One-dollar refund coupons for ice cream**


A-9: **Cereal coupon offering "$1.00 on any 2"**


Look at the numeric codes circled in Figures A-6 through A-9. Each of the bar codes has a small number "5" in the leftmost position. As you might guess, a "5" in this position simply means "refund coupon." On most packages sold in supermarkets, the first digit is "0," which means "nationally branded item, non-health-related." Most drugstore items use "3" in the first position; and items packaged in the store, such as meat and cheese, have a "2." You will also notice a small number at the extreme right end of the 12-digit code. This is a check digit, which is the result of an arithmetic computation on all of the other numbers. By doing the same calculation and comparing it with the check digit, the bar code scanner verifies that it has read the code correctly.

Next, let's figure out what the other ten digits mean. Consider the two coupons in Figure A-6. These coupons are for different products and different refund amounts. The only thing they have in common is they are both products sold under the same brand name. The bar codes on the two coupons both have "24842" on the left side, and then differ in some of the five digits on the right side. The "24842" must represent the brand name, which is owned by the Nestlé's conglomerate. But this raises another question: Does "24842" represent Nestlé's or the particular brand? A quick check at the supermarket reveals that "NesQuik," one of Nestlé's other brand-name products, has the code "28000" and "Carnation," another Nestlé's brand, uses "50000." So "24842" probably represents only one of the Nestlé's brands.

To find out what the last five digits mean, let's look at the coupons in Figure A-7. Both are issued by the same cereal company, which is represented by the manufacturer's code "38000." Both are for 50 cents, and both show "50" in the last two digits. However, the other three digits are different, to correspond to the different cereal products, represented by "590" and "543," respectively. We notice that in Figure A-6, the last two digits also correspond to the amount of refund in each case, 55 and 75 cents, respectively.

Now, let's test our hypotheses on the ice cream coupons in Figure A-8. All three are for $1 refunds, but the amount codes are not the same, and neither corresponds directly to $1.00. They couldn't put "100" as the value code, because only two digits are available, but why are both "76" and "42" used to represent $1 refunds?

This mystery is resolved when we look at the cereal coupon in Figure A-9, which promises "$1 on any 2," and has an entirely different number, "33," in the refund value position. "$1 on ANY," "$1 on ANY 2," and "$1 on ANY 4" are not the same value, so they are represented by three different codes: "76," "33" and "42," respectively.

# REFERENCES

## Chapter 2

Argyle, Michael (1975). ***Bodily Communication.*** London: Methuen & Co.

This is a comprehensive description of nonverbal forms of communication, including gestures, facial expressions, posture, and nonverbal utterances such as "Um-hmm."

Arnheim, Rudolf (1974). ***Art and Visual Perception: A Psychology of the Creative Eye.*** Berkeley: University of California Press.

Chapter IV, "Growth," discusses how children develop the ability to make representational drawings.

Bang, Molly (2000). ***Picture This: How Pictures Work.*** New York: Sea Star Books.

Molly Bang is a well-known illustrator of children's books. In this book she explores the graphic meanings of simple shapes and colors by developing a set of illustrations for "Little Red Riding Hood."

Berger, Arthur Asa (1984). ***Signs in Contemporary Culture: An Introduction to Semiotics.*** New York: Longman.

This is one of the very few accessible explanations of what semiotics is about. Berger uses many examples from popular culture, including ads, cartoons, and soap operas. The book is both entertaining and instructive.

Bickerton, Derek (1996). ***Language and Human Behavior.*** Seattle: University of Washington Press.

Bickerton's argument is that early languages preceded and permitted the growth of human intelligence. The book also provides considerable insight into the nature of languages and other symbol systems.

Busch, Akito, ed. (1998). ***Design for Sports.*** New York: Princeton Architectural Press.

Busch writes about the factors influencing the design of sports apparel and sports equipment. A beautifully illustrated chapter, "Symbol, Status and Shoes: The Graphics of the World at Our Feet," analyzes the symbolism employed in the design of sneakers and sneaker ads.

Donald, Merlin (1991). ***Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition.*** Cambridge, MA: Harvard University Press.

Using research findings from anthropology, animal studies, linguistics, and neurobiology, Donald constructs a comprehensive account of the development of human intelligence. Much of his argument turns on the uniquely human use of symbols.

Elkins, James (2000). *How to Use Your Eyes.* New York: Routledge.

This beautiful book helps you to train your eyes by looking carefully at such diverse items as postage stamps, hieroglyphics, and movie special effects.

Ewen, Stuart (1996). *PR! A Social History of Spin.* New York: Basic Books.

This revealing book shows how the public relations and advertising industries developed in the U.S. It contains many quotes from pioneers in the field, who explain the techniques of commercial manipulation.

Fontana, David (1993). *The Secret Language of Symbols.* San Francisco: Chronicle Books.

Here is a visual dictionary of symbols from historical sources, diverse cultures, and occult fields such as alchemy, Tarot, and astrology.

Furtiger, Adrian (1998). *Signs and Symbols: Their Design and Meaning.* New York: Watson-Gupthill Publications.

Furtiger is a designer of typefaces. His book offers a wealth of information about the origins and uses of a wide variety of symbols, including letters, numerals, punctuation marks, arrows, and much more.

Gallas, Karen (1994). *The Languages of Learning: How Children Talk, Write, Dance, Draw and Sing Their Understanding of the World.* New York: Teachers College Press.

Gallas, a first- and second-grade teacher, relates her own experiences about how children reveal and develop their thinking through a variety of means of expression. Some of the narratives are very moving.

Goodnow, Jacqueline (1977). *Children Drawing.* Cambridge, MA: Harvard University Press.

This is a classic work on how children learn to draw and what their early drawings reveal about their developing capability to symbolize. It is illustrated with dozens of children's drawings.

Guiraud, Pierre (1975). *Semiology.* London: Routledge and Kegan Paul.

Along with Berger (1984), this is one a very few accessible accounts of semiotics. Guiraud argues that an understanding of symbols is necessary to counteract manipulation by the mass media.

Herscovics, Nicolas (1989). "Cognitive Obstacles in the Learning of Algebra." In Wagner, S. & Kieran, C., eds. *Research Issues in the Teaching and Learning of Algebra,* pp. 60-86. Reston, VA: National Council of Teachers of Mathematics.

Citing cognitive research, Herscovics discusses how many algebraic misconceptions stem from difficulties in interpreting symbols.

Hine, Thomas (1995). ***The Total Package: The Evolution and Secret Meaning of Boxes, Bottles, Cans and Tubes.*** Boston: Little, Brown and Company.

This is a fascinating account of how consumer goods packaging developed in the U.S. Much of the book focuses on the promotional material that appears on packages.

Holmes, Nigel (1990). ***Designing Pictorial Symbols.*** New York: Watson-Gupthill Publications.

Holmes describes how he designed some famous graphics for *Time* magazine, showing how each symbol or logo evolved from its initial conception to its final form.

Horton, William (1994). ***The Icon Book: Visual Symbols for Computer Systems and Documentation.*** New York: John Wiley & Sons.

Horton describes how to analyze and design icons for computer software. It contains hundreds of examples and is very easy to follow. One chapter deals with the testing of icon designs.

Jackson, Robert (1996). ***Secret Codes.*** Philadelphia: Running Press.

This brief children's book is packed with information about various codes and symbols, and includes a kit with telegraph keys and semaphore flags, as well as directions for making invisible ink.

Jean, Georges (1998). ***Signs, Symbols and Ciphers.*** New York: Harry N. Abrams, Inc.

Jean offers an intriguing overview of symbols in history, including road and railway signs, codes for long-distance communication such as semaphores and smoke signals, and symbols used in rituals and religious services.

Lupton, Ellen & Miller, Abbott (1999). ***Design Writing Research: Writing on Graphic Design.*** London, UK: Phaidon.

This book includes short essays on the histories of punctuation marks and number signs, symbols used on international signs, Chinese and Japanese characters, the meanings conveyed by different typefaces, and the use of racial and ethnic images in ads.

Maurer, Stephen (1987). "New Knowledge About Errors and New Views About Learners: What They Mean to Educators and More Educators Would Like to Know." In Schoenfeld, Allan, ed. ***Cognitive Science and Mathematics Education,*** pp. 165-187. Hillsdale, NJ: Lawrence Erlbaum Associates.

Using examples from arithmetic, Maurer shows how students' errors are often very consistent, and reflect coherent logical processes. Most of the problems involve the interpretation of mathematical symbols.

Mijksenaar, Paul & Westendorp, Piet (1999). ***Open Here: The Art of Instructional Design.*** New York: Joost Elffers Books.

This delightful book is about graphic instructions for opening, installing and using things. Along with a discussion of basic graphic principles, the book includes examples from a huge variety of instruction manuals.

Mijksenaar, Paul (undated). ***Visual Function: An Introduction to Information Design.*** New York: Princeton Architectural Press.

In this little book, the author provides abundant and beautiful examples of good visual designs and some examples of products that had to be redesigned to make them easier to use.

Norman, Donald (1992). ***Turn Signals Are the Facial Expressions of Automobiles.*** Reading, MA: Addison Wesley.

Norman, Donald (1988). ***Design of Everyday Things.*** New York: Doubleday.

Norman is a cognitive psychologist who argues strongly for making things easier to use. Both books contain photos of hard-to-use devices, such as stoves, doors, telephones, and faucets. Each of these could be made much more usable by adding graphic instructions.

Palmer, Roger C. (1995). ***The Bar Code Book*** (Third Edition). Peterborough, NH: Helmers Publishing Co.

A definitive volume containing a wealth of technical information about all kinds of bar codes, what they mean, and how they are used.

Piaget, Jean (1981). ***The Child and Reality: Problems of Genetic Psychology.*** New York: Penguin Books.

This short book is one of Piaget's clearest. It includes a discussion of how children begin to develop the ability to use symbols, which Piaget calls "the symbolical function."

Sebeok, Thomas (1986). ***I Think I Am a Verb: More Contributions to the Doctrine of Signs.*** New York: Plenum Press.

Chapter 13 of this book, "Pandora's Box in Aftertimes," addresses the issue of warning future generations about highly radioactive nuclear waste depositories. Sebeok explains basic principles of semiotics, and applies them to a practical problem.

Skemp, Richard (1987). ***The Psychology of Learning Mathematics.*** Hillsdale, NJ: Lawrence Erlbaum Associates.

This is a comprehensive, largely non-technical account of cognitive issues related to mathematics learning. Several chapters deal with the nature of mathematical symbols and the problems involved in learning them.

Slafer, Anna & Cahill, Kevin (1995). ***Why Design? Activities and Projects from the National Building Museum.*** Chicago: Chicago Review Press.

Here is a diverse collection of activities, aimed at the middle school level, intended to teach design principles. Many of the activities involve the design of visual signs and symbols.

Smith, Frank (1997). ***Reading Without Nonsense.*** New York: Teachers College Press.

Smith's comprehensive account of how children learn to read includes eloquent rejoinders to some of the current fads in the teaching of reading. He argues strongly for the role of context in making reading possible.

Thomas, Glyn & Silk, Angèle (1990). ***An Introduction to the Psychology of Children's Drawings.*** New York: New York University Press.

The authors discuss a variety of theories of how children learn to draw and why they like to draw in the first place. They assume some basic knowledge of cognitive and Gestalt psychology.

Thomas, Lewis (1992). ***The Fragile Species.*** New York: Touchstone.

Thomas is a physician who has written several very accessible books mostly about biology and medicine. In the chapter called "Communication," Thomas speculates on whether all languages might have been invented by children.

Tufte, Edward R. (1997). ***Visual Explanations.*** Cheshire, CT: Graphics Press.
Tufte, Edward R. (1990). ***Envisioning Information.*** Cheshire, CT: Graphics Press.
Tufte, Edward R. (1983). ***The Visual Display of Quantitative Information.*** Cheshire, CT: Graphics Press.

In these three classic volumes, Tufte presents some of the masterpieces of graphic design from all over the world and from many historical periods. His extensive commentary develops coherent strategies for organizing and presenting information in graphic form.

Wildbur, Peter & Burke, Michael (1998). ***Information Graphics: Innovative Solutions in Contemporary Design.*** New York: Thames and Hudson.

This is a lavishly illustrated book of outstanding graphic designs. The examples come from a huge variety of applications, including airplane cockpits, web sites, transit maps, instruction manuals, directional signs, and scientific imaging.

Wilde, Richard & Wilde, Judith (2000). ***Visual Literacy: A Conceptual Approach to Graphic Problem Solving.*** New York: Watson-Gupthill Publications.

This is a collection of creative projects done by the authors' college-level graphic design students. The problems included redesigning the back of a truck to show graphically which side to pass on. One student showed a tomato on the left side and a bottle of ketchup on the right.

Yoshio, Yuko & Hirata, Tsutomu (1997). ***Diagram Collection: The Best in Graphs, Charts, Maps and Technical Illustration.*** Tokyo: P.I.E. Books.

This is a collection of outstanding examples of graphic design; the work is magnificent.

# Chapter 6

American Association for the Advancement of Science (1989). *Science for All Americans: A Project 2061 Report on Literacy Goals in Science, Mathematics and Technology.* Washington, DC: Author.

American Association for the Advancement of Science (1993). *Benchmarks for Science Literacy.* New York: Oxford University Press.

American Association for the Advancement of Science (1997). *Resources for Science Literacy.* New York: Oxford University Press.

American Association for the Advancement of Science (1998). *Blueprints for Reform.* New York: Oxford University Press.

American Association for the Advancement of Science (2001). *Designs for Science Literacy.* New York: Oxford University Press.

International Technology Education Association (1996). *Technology for All Americans: A Rationale and Structure for the Study of Technology.* Reston, VA: Author.

International Technology Education Association (2000). *Standards for Technological Literacy: Content for the Study of Technology.* Reston, VA: Author.

National Center on Education and the Economy (1997). *New Standards Performance Standards; Vol 1: Elementary School.* Washington, DC: Author

National Council for the Social Studies (1994). *Expectations of Excellence: Curriculum Standards for Social Studies.* Washington, DC: Author.

National Council for the Social Studies (2000). *National Standards for Social Studies Teachers.* Washington, DC: Author

National Council of Teachers of English and International Reading Association (1996). *Standards for the English Language Arts.* Urbana, IL: Author.

National Council of Teachers of Mathematics (1989). *Curriculum and Evaluation Standards for School Mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics (2000). *Principles and Standards for School Mathematics.* Reston, VA: Author.

National Research Council (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

# GLOSSARY

**Arbitrary symbol:** A symbol whose meaning needs to be learned because it does not suggest its own meaning.

**Channel:** The medium, such as light or sound, through which a message is sent.

**Code:** A set of symbols or signals that work together as a unit.

**Decoding:** The process of extracting meaning from a message.

**Design:** The creation of something new in order to solve a problem, and its evaluation to see how well it works.

**Encoding:** The process of converting a concept into a message so it can be transmitted.

**Expressive symbol:** A symbol that expresses its own meaning by depicting some aspect of the concept it represents; also called an icon.

**Graphic symbol:** An image that serves as a symbol.

**Homonym:** A word or other symbol that has more than one meaning; for example, "just" could mean "only" or "fair."

**Icon:** An expressive graphic symbol or image that represents an object, an idea, or an action.

**Ideogram:** A single symbol used to represent an object, an idea, or an action; for example, a Chinese character or an Arabic numeral.

**Key:** A table showing the translation of a set of graphic symbols into words.

**Phonogram:** A symbol that represents a sound; for example, an English letter.

**Pictogram:** A picture or an icon used to represent an object, an action, or an idea; for example, a NO SMOKING symbol.

**Semantics:** The study of the relationships between signs and symbols and the meanings they represent.

**Semiotics:** The study of signs and symbols.

**Sign:** A figure or device that stands for a word, phrase, or operation; an action or gesture used to convey an idea; a board, placard, or other material displayed in order to advertise or convey information.

**Signal:** A gesture or other mechanical or electrical action that serves as a symbol for an object, an action, or an idea; for example, the index finger across the lips as a signal for "Quiet!"

**Symbol:** Something—such as an image, action, or sound—used to represent an idea, object, or action.

**Synonym:** A word or other symbol that means the same thing as a different word or other symbol; for example, "also" and "too."

**Syntax:** The set of rules for organizing and manipulating symbols; the way in which words are put together to form phrases and sentences.

**Technology:** The artifacts, systems, and environments designed by people to improve their lives.

**Translation:** The process of converting symbols or words from one symbol system or language to another; in other words, a way of expressing the correspondences between synonyms.

# Signs, Symbols & Codes

Gary Benenson and James L. Neujahr, *Project Directors, City Technology, City College of New York*
Foreword by George D. Nelson, *Director, Project 2061, American Association for the Advancement of Science*

Now elementary teachers can combine the best of science and technology education in a comprehensive curriculum based on everyday materials and artifacts.

*Signs, Symbols & Codes* uses a novel, engaging approach to teaching different methods for representing information. Signs and symbols can take the form of words and numbers; graphic devices used on maps, signage systems, packages, and consumer products; and even gestures used by teachers and children to get one another's attention and convey messages. A set of symbols organized into a coherent system is called a code. The contexts and activities in this book involve signs, symbols, or codes of some sort and all draw on a broad range of places and situations that are part of everyday experience. Let your students learn how to decipher and use this information both in and out of school. At the same time, meet these broader instructional goals:

- introduce fundamental themes of information, representation, sign, symbol, and communication
- promote literacy by developing a variety of techniques for sending and receiving information
- promote numeracy by increasing awareness of symbols as a means to represent quantitative information
- demystify common artifacts and, by extension, technology in general
- develop process skills in observation, classification, generalization, communication, and design
- foster an appreciation of the immediate environment
- provide rich opportunities for group work.

Stuff That Works! A TECHNOLOGY CURRICULUM FOR THE ELEMENTARY GRADES

*Signs, Symbols & Codes* is one of a five-volume series, *Stuff That Works! A Technology Curriculum for the Elementary Grades*. Developed by City Technology of City College of New York, each volume helps teachers plan and implement classroom activities and units organized around a single topic—how and why a basic technology works. The guides include an introduction to concepts, classroom stories, resources, and information about standards, as well as suggestions for teachers new to the subject. Use a single volume independently or all five to form a powerful vehicle for integrating science, math, social studies, language arts, and everyday technology. The complete series includes:

*Mechanisms & Other Systems*
*Packaging & Other Structures*
*Designed Environments: Places, Practices & Plans*
*Signs, Symbols & Codes*
*Mapping*

**Gary Benenson** and **James L. Neujahr** teach at City College of New York, Benenson in the Department of Mechanical Engineering, and Neujahr in the School of Education.

ISBN 0-325-00470-6
90000>
9 780325 004709

Heinemann
www.heinemann.com