A rule-based system for the evaluation of environmental communication for public transportation facilities

by

Jen Yen

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INTRODUCTION

During the past decade, many aspects of our environment have become tremendously complicated because the quantity of information has greatly increased. The "dreadful threat" of information, according to Richard Wurman, has become a driving force in people's lives, making them anxious and confused (Wurman, 1989). It is therefore important to develop an information system.

A number of information systems have been developed in environmental communication. Unfortunately, many of these systems are considered unsuccessful because they have not been proven workable, and the users become disoriented and lost. According to Henry Lucas, Jr., a failed information system is one in which users do not understand most of the information they are given (Lucas, 1975). For example, when the metro system was built in Washington D. C., the vertical layout of messages in the sign system could not be understood by the passengers.

Thus, the awareness of user needs and behavior has become an important factor in a successful communication process between users and their environment. A workable communication process must convey understandable ideas and information between users and the specifications for a developed information system. During this developing process, the designer is the one who analyzes the problems and creates a solution to a series of functional and psychosocial needs. In other words, a successful information system in an environment is dependent upon the functional solutions between users and the information system.

As people pass through an unfamiliar environment, an effective graphics and sign system may be a useful solution for identifying user need, according to John Follis and Dave Hammer. They also point out that generally each viewer's perception and response to a sign system is conditioned by certain physical and psychological characteristics. Besides, when an environment is visually controlled by the graphic designer, the viewer's awareness of the information system will be dramatically increased (Follis & Hammer, 1979).

During the past 20 years, many technologies, materials, applications, and processes have been developed for the communication industry. New technologies have provided more convenient transportation systems for international travel. Many countries around the world are opening their doors to millions of visitors and the demand for more effective graphic communication techniques is international. The role of the graphic designer is becoming more influential and necessary.

This thesis will define what factors need to be considered for an effective environmental information system, and will provide rules/guidelines for specific graphic communication elements in sign systems in terms of evaluation criteria for environmental graphic designers. Furthermore, this thesis will provide a methodology with which environmental graphic designers can use to examine a sign system and propose improvements. In order to demonstrate this methodology, the Des Moines International Airport will be used as an example.

The Des Moines International Airport is located in the southwestern corner of the city of Des Moines, the capital of the state of Iowa. It is owned and operated by the City of Des Moines on approximately 1200 acres of land. The Des Moines International Airport is a full service facility capable of accommodating aircraft

ranging from Boeing 747 jumbo jets to the smallest pilot trainer aircraft. The reason for selecting Des Moines International Airport is that it plays an important role in providing access to the state's capital city and to Central Iowa.

LITERATURE REVIEW

The need for an effective visual communication of guidance and direction information is obvious all around us, in all kinds of buildings and on many roads. A well-planned system of visual information makes information visible, legible, noticeable, and understandable. It is necessary to understand the factors that contribute to success at conveying information in environmental communication. For example, how do humans perceive the object? Or what color is the best choice for text? This research will compose a basis for an examination of the most effective information system.

A Communication Process

What is Communication?

Since earliest time, human signs have been found in places such as on a triangular grave slab in a rock shelter. Human beings began to create graphic symbols as a way to express themselves and to share information among people. In their book, *Self, Symbols & Society,* Baran, McIntyre, and Meyer define communication as a "process of sharing meaning." The major concept of this process is that "communication–the sharing of meaning–is ongoing and dynamic" (Baran, McIntyre, Meyer, 1984,11).

According to these researchers, four elements are required in this ongoing and dynamic process: a source, a message, a channel, and a receiver, . They explain that the process of communication occurs when the source forms a message, puts the message on the selected channel for transmission and then sends it into the receiver (Fig. 1). In addition, the process of communication is

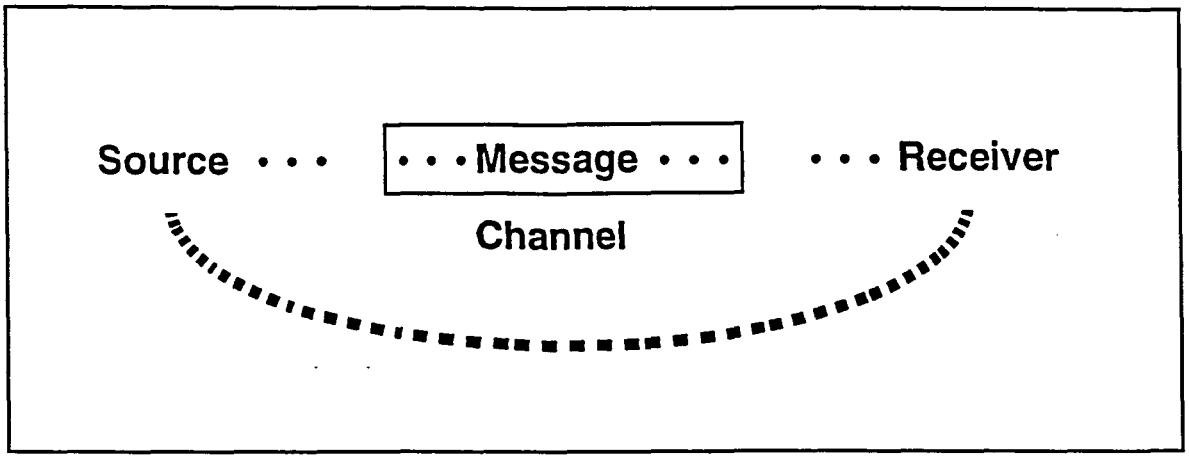


Fig. 1 The basic process of communication

"goal-oriented," because most interpersonal communication has several goals operating in a given situation (Baran, McIntyre, Meyer, 1984).

Wilbur Schramm gives more details about the process of communication. A source takes the information or feeling that he or she wants to share or exchange and puts it into a form. This form is like a picture in his or her head, which can be transmitted and encoded into spoken words or written words that can easily and effectively convey the information. However, during the working process, if the source is unclear or does not have enough information or if the message is not fully or effectively encoded into transmittable signs, then the process will be reduced in efficiency. He emphasizes that all the steps in a successful communication process have to be accomplished with relatively high efficiency (Schramm, 1954).

In *Architecture as Environmental Communication*, Asghar Talaye Minai states that communication requires three elements: a source, a message, and a destination. The source may be an individual speaking, writing, drawing, or dancing, or it can be the environment - events, patterns or objects. The message may be sound waves, printed works, gestures, electrical impulses, or visual

symbols. The symbols can be reached through meaningful environmental images. The destination may be an individual person or group of people who can get the message through listening, reading, watching, or experiencing environmental communication language (Minai, 1984).

What is Information?

Richard Wurman defines information as "the action of informing; formation or molding of the mind or character, training, instruction, teaching; communication or instructive knowledge"(Wurman, 1989, 38). He expands upon this idea by saying that people are all surrounded by information that operates at varying degrees directly related to their lives. He divided these degrees into five rings (Fig. 4). The rings radiate out from the most personal information, essential for physical survival, to the most abstract form of information, involving personal myths, cultural development, and sociological perspective.

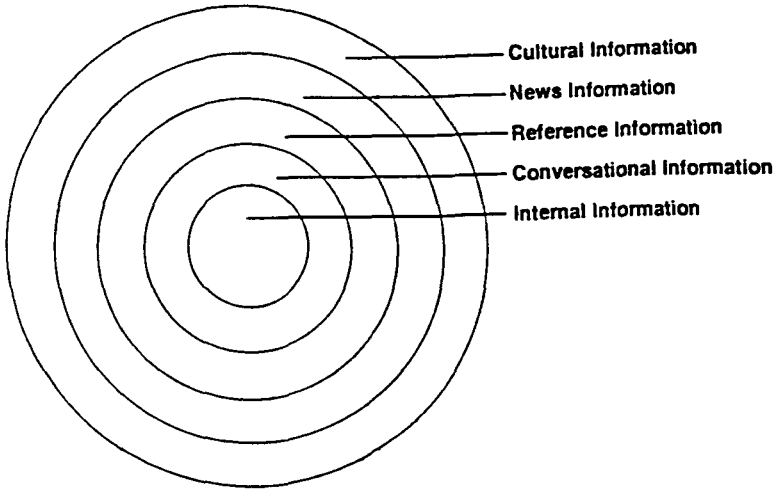


Fig. 2 The informational ring in five different degrees

The first ring is internal information, which represents the messages that run the internal systems and enable the body to function. The second ring is conversational information, which represents the interpersonal, formal and informal exchanges and conversations. The third ring is reference information, which represents where people turn to for the information that organizes/codes the systems of the world. Reference information can be anything from a telephone book, a directional map, or a signing system in a building. The fourth ring is news information, which represents the information that contains current events and is transmitted to people through media. It can influence people's vision of the world. The fifth ring is cultural information, which includes history, philosophy, the arts, or any expression that represents an attempt to understand and come to terms with human civilization (Wurman, 1989). The third ring and fifth ring will be the areas of concentration for the study of this thesis.

Cultural Influences

Culture, with its many aspects of societal life and social relationships, is an element that influences the communication process. During a communication process, an understanding of culture is necessary to ensure message flow, understanding, and satisfying results. Carley H. Dodd defines culture as "the total accumulation of many beliefs, customs, activities, institutions and communication patterns of an identifiable group of people" (Dodd, 1982, 38). Furthermore, culture is reflected in speech, thought, and action. Members of a culture are also identifiable. They can define themselves perceptually as part of the group.

Dodd explains that generally culture includes several elements, "cultural history, cultural personality, material culture, role relationships, art, language,

cultural stability, cultural beliefs, ethnocentrism, nonverbal behavior, spatial relations, time, recognition and reward, and thought patterns" (Dodd, 1982, 40). However, though we may not learn and understand each element of every culture, we can sensitize ourselves to the common substance of virtually every culture. Several important elements are discussed as follows:

The basic cues for understanding a culture are found in its cultural history. Historical development and traditions are fundamental factors for analysis. Dodd expands the definition by saying that cultural history generates insight into the norms of group and individual behavior and explains many attitudes of the culture.

Cultural personality can be described as having a certain social characteristic likened to a personal behavior, only expanded to an entire group. In other words, the cultural personality affects interpersonal relationships and expected models of individual personality behavior. Dodd gives an example that to speak up against a village chieftain's decision would be inappropriate and inconsistent with African villagers' conceptions of correct behavior.

Role relationships refer to certain attitudes toward categories of persons and their behaviors, which often are expected to correspond to predetermined patterns. Bowing in Asian culture shows an example of correlation with the perceived social relationship: The higher the status of the person being shown courtesy, the lower one should bow.

Art is an universal element for cultural analysis, being the relevant artistic expressions of a particular culture. One perceives music, sculpture, painting, and so on as reflections of underlining themes of a culture at a given time in its history.

Language refers to "the basic sound system (phonology), meaningful sound combinations (morphology), and grammar (syntax) of a language. The relation

between language and culture is important, inasmuch as language and its categories filter our reality, shaping ideas and organizing reality by the lines and boundaries that linguistic systems draw" (Dodd, 1982, 46).

Cultural beliefs are described as "a perceptual frame of reference". Dodd explains that "the frame of reference is like a screen through which information passes. Since the frame of reference filters our encoding and decoding, we can account for different interpretations of reality by considering perceptual 'window' through which we view our world and the universe and by which specific beliefs about that view develop" "(Dodd, 1982, 47). He also indicates that another unique element to constitute the belief system in each culture is values and cultural themes (Dodd, 1982).

One of the important elements in cultural analysis is the culture's pattern of thought, which relates to the way a cultural group views such things as practical logic, the nature of truth, decision- making, and cognitive pathways of thought. For example, western culture believes in cause-effect reasoning, which means for every effect there must be a cause. On the other hand, another culture may reason that no one can really know the causes of life events and that humans should not try to understand them but rather accept them.

Alfred Smith, in *Communication and Culture*, points out that the relationship between communication and culture is shown as follows:

> Our perception is behavior that is learned and shared, and it is mediated by symbols. Culture is a code we learn and share, and learning and sharing require communication. And communication requires coding and symbols, which must be learned and shared. Communication and culture are inseparable. (Smith, 1966, 7)

Minai's idea of the relationship between culture and communication is that "culture is man's adaptation to and utilization of universal environmental space-time energy patterns and their attributes as communication systems" (Minai, 1984, 11). The channel of this communication system is the entire world. The messages are used according to the form of "symbols" and "values." The meaning of symbols is the sequential characteristics of matter in space and time, and the values are the results of the social interactions (Minai, 1984).

Culture plays an important role in understanding and influences almost every aspect of sign design. According to the Institute of Signage Research, communication elements such as the shape of the sign, lighting, materials, colors, and lettering of a sign system in a specific culture demonstrate subtle messages (ed. Pollet and Haskell, 1979).

Environmental Communication

What is the relationship between the human and the environment, and how does the relationship affect the human? According to Minai, the relationship is viewed in terms of communication. Minai explains that the path of communication is through a selected channel, with specific information, to be transmitted to the receiver in order for the communication process to be achieved. If the message is communicated by means of an organized system, it becomes more meaningful to people.

In everyday life, events and objects communicate messages to the general public. Objects such as printed pages, photographs, maps, signs, and architecture transmit messages to people. These messages could be in the form of familiar symbols or abstract ideas. The approach to symbolism or ideas may be certain

words or symbols which represent something to the communicator and may determine how the communicator replies to these messages. For instance, the color red in some cultures is a symbol for danger. The color red in a sign system can cause one to become cautious and respond more attentively than one would to softer colors.

For the concept of meaningful messages, Minai defines three general bases. The first is the environmental message, affected by physics and nature. The second base is the behavioral message, caused by socio-culture and psychology. The third one is symbolic messages, which have associative meanings relative to environmental and behavioral messages.

The environmental messages are viewed in three groups. There are "a set of a priori geometrical elements," "a set of meanings," and "a set of messages." The "priori" and objective information conforms to physical properties. However, "the set of meanings" carry along with the information individual and sociocultural values. Therefore, the environmental communication field is defined as "consisting of complex fields of interaction between man and man, and man and the environment, using tangible and intangible environmental, behavioral, and symbolic cues." (Minai, 1984, 144)

Sign System

Signing Terms

According to Mitzi Sims, "signing," "signs," and "sign systems" are the main words used in signing, and signing is a specific aspect of environmental graphic design. He explains that *signage* is not a real word. It is a term that associates wayfinding as a "mindset," in which problems in finding one's way around an

environment can be solved by putting up signs. For the consistency of terms in this thesis, author will use the terms from Sims, "signing" or "sign system."

SEGD, the Society of Environment Graphic Designers, defines environmental graphic design as the planning, design and specifying of graphic elements in the built and natural environment. These elements are used to communicate specific kinds of information. Furthermore, Sim points out that environmental graphic design provides three basic functions, which assist users in negotiation through space. These functions are identifying, informing and directing, which also serve to visually enhance the environment and guard the safety of the public (Sims, 1990).

Sign System

What kind of information system will effectively handle large crowds of people? In his *Telling People Where to Go*, William Lansing Plumb points out that the New York subway system was probably the first subway system in the world which could handle huge numbers of passengers per day. He believes that a clear and efficient presentation of information in the New York subway system is the primary reason for its success (Plumb, Print 1965, 9/10). Follis and Hammer expand his view by saying that the sign systems provide a clear and efficient way to show the information in a public environment. They also point out that people who walk through a new environment are looking for information which the environment provides. Sign systems compete for the viewer's attention with all other elements in the environment. If a specific environment is visually controlled by a sign system, the viewer can be made aware of the sign system and its effectiveness can be significantly increased (Follis & Hammer, 1979).

In addition to the fact that sign systems are involved in environmental communication, Carr points out the importance of the quality of sign systems. That is, the best sign systems require understanding and little effort to learn. "They must be simple and logical and, where possible, derived from known symbolism" (Carr, 1973, 91). Thus, the information in a sign system must communicate unambiguous directions and destinations, and give systematic preparation for making decisions. Therefore, sign systems not only communicate information among people as simply as possible, but they also communicate it quickly and effectively.

Wayfinding

Environmental information systems are used in all levels of spatial problem-solving. They provide identification in a wayfinding problem and enhance the solution in environmental communication. How does a human's ability to focus on the surrounding environmental messages determine his or her direction? When people arrive at a new environment such as an airport, terminal, or highway, they commonly have difficulty in the task of wayfinding. Romedi Passini, in *Wayfinding in Architecture*, gives an example to explain the sense of direction. When people first begin driving lessons, they may not have any trouble with operating the clutch, shifting gears, looking in the rear view mirror, remembering to brake, etc. Difficulties begin when they drive in a traffic-congested city, the experience on the road being entirely different than in the class (Passini, 1984).

From this point of view, mental or cognitive processes should be observed as the sense of direction. The major understanding of the cognitive process is cognitive map. Passini uses the idea of taking a vacation as an example. When a person prepares for a trip, he might just have a rough plan of action, instead of a

full and detailed plan. However, new information will be acquired during travel which will change the previous plan and the cognitive map. Thus, the cognitive map can not be seen as something stable. When new information is gained and other information forgotten, the cognitive map will change.

Because cognitive process can organize the perceived parts of the environment into a maplike band respecting certain geometric properties, Passini defines the sense of direction as "a person's ability to mentally determine his position within a representation of the environment made possible by cognitive maps" (Passini, 1984, 35). In other words, a person has the ability to know a direction while moving, or to independently point in the direction of one's location in space.

As cities have grown in size, people have also increased their mobility. People's environment has become more complex. Because not everybody has a good sense of direction in the complex environment, solving the problems of wayfinding really depends on a variety of keys coming from the circumstances. These keys include signs, directories, maps, and so forth, which may be decided by people developing the information system in the environment (Passini, 1984).

The Categories of Signs

Signs communicate environmental information. They can tell the viewer what is where. According to Sims, signs can be divided into six main categories or sign types. The first is orientation signs. They give users a frame of reference within a particular environment. These types of signs include maps, exploded views, plans of entry, decision points, architectural reference points and landmarks. The second type, information signs, communicate knowledge concerning

destinations, facts, and circumstances. Informational directories are vehicles for listing large amounts of information. They are used in many different contexts, such as restaurants, reception areas and retail stores. If these signs are comprehensive and appropriately placed at major entrances and decision points, they help to reduce confusion. Informational signs tell people what to do or what not to do.

The third type, direction signs, guide users to destinations. They are usually part of a sign system, such as those found in "high-stress" environments like airports and hospitals. The design and implementation of these sign systems are essential for their safe and efficient use and provide valuable reassurance for users. The fourth type, identification signs, confirm destinations and help establish recognition. These types of signs identify a place, an object, or a person in space. The identificational signs offer the information necessary to develop decision-making ability, such as street numbering, or main entrance signs. The information has to be read within some understandable reference system, and the people must know how to reach the place associated with the destination easily.

The fifth type, regulatory signs, display rules of conduct prescribed by local regulations, owners, or other authorities. They exist mainly to safeguard and protect people against danger, such as "stop" and "no parking" signs. The last type is ornamental signs. They enhance or beautify the environment with individual elements, such as banners, murals, and gateways (Sims, 1991).

The Problems of Sign Systems

Several problems need to be addressed by designers. According to Passini, the first problem with signs is finding their location and the message on them. To a wayfinding person, the ability to process information is made according

to his disposition at a particular time and to those perceptual channels involved. Conceptualized perception plays an important role in the interactive relationship between a human being and his or her environment. If a person knows what to look for, he or she must be able to proceed with the information and make a decision about his or her direction. If a person knows where to look for the desired message, his or her location can easily be determined. This can enhance a person's confidence in a new environment.

The second problem is understanding the meaning of the message within the environment provided. Passini explains that most people are verbally oriented, therefore giving information through words will allow them to respond more quickly to visual communication. Follis and Hammer also point out that the viewer expects a sign system to be consistently worded and logically organized. Schramm expands their ideas by saying that four things need to be considered in a successful visual communication:

1. The message must be so designed and delivered as to gain the attention of the intended destination.
2. The message must employ signs which refer to experience common to source and destination, so as to "get the meaning across."
3. The message must arouse personality needs in the destination and suggest some ways to meet those needs.
4. The message must suggest a way to meet those needs which is appropriate to the group situation in which the person finds himself at the time when he is moved to make the desired response (Schramm, 1954, 13).

The final problem is the structure of information. Passini suggests that "Information has to be visually structured so that the setting of the message can be picked up in glance" (Passini, 1984, 100). The level of generality in the hierarchy also needs to be considered in the structure, because it may indeed encourage the user to make a major wayfinding decision (Passini, 1984).

Human Factors

Examining the effectiveness of a sign system in an environment with a variety of user needs and use patterns is very different from simply putting up signs. How do people respond to the traffic sign system at a busy street intersection that they cross every day? Probably there will be a number of different responses. Some people may respond out of habit. They react to traffic lights and to other traffic signs often without conscious thought. This automatic response leaves the conscious mind free for the assembly of information and decisions making. For this reason, each individual's perception and response to signs is different, and these differences are influenced by a number of physical and psychological factors, such as reading ability, memory, quality of eyesight, color sensitivity, and mental attitude.

Eye and Brain

How does information from the eyes become coded into neural terms, into the language of the brain, and reconstructed into an awareness of surrounding objects? The eye can be compared to a camera. As a human being perceives the object, the eyes produce "pictures" in the brain, and these pictures need some kind of "internal eye" to see it. "Our eyes are typical vertebrate eyes, and are not among the complex or highly developed, though the human brain is the most elaborate of all brains. Complicated eyes often go with simple brains - we find eyes of incredible complexity in prevertebrates serving tiny brains" (Gregory, 1966, 27).

The eyes feed the brain with information coded into neural activity, which are the chains of electrical impulses. The neural activity forms information patterns representing objects, such as words from a book, which have specific meanings. Although these words are recorded into the reader's brain correctly, they are not

pictures. When people look at something, the pattern of neural activity illustrates the object and the brain interprets the patterns as the object.

When people see a diamond and a crystal, they may look and feel alike, but they act very differently. Similarly, human beings do not generally classify objects by how they look, but they consider the object's uses and characteristics. Gregory also explains that the perceptual system does not always accept the rational thinking of the cortex. For example, the distance of the moon is a quarter of a million miles in the cortex, but to the visual part of the brain it is only hundreds of miles. Although the cortex view is the right one, we still see the moon as if it were only hundreds of miles away (Gregory, 1966).

Human Memory

What aspects of information are retained in memory? How does the brain store information? Michael J. A. Howe defines memory as "a label, a concept used to indicate that people do retain information." How do people remember information? How do people see a telephone number and then remember it? A human first perceives the telephone number and then encodes it so that it can be stored in some form in the human cortex. When he or she needs to remember the number, this information is recalled from the memory and retrieved (Howe, 1970). There are a number of functions that take place when performing the memory process. One of the most important functions of human memory is to store information. Howe says that " memory is more than a passive repository in which information is retained, and the function of storage is carried out by one subsystem of the numerous processes required for memory" (Howe, 1970, 4).

Graphic Communication Elements

Signs are a communication channel that convey a visual message from a sender to a receiver. In order to communicate effectively, signs need to involve several graphic communication elements: color; legibility and readability; typefaces, size and spacing of letters, size of signs; use of symbol; and sign placement.

Color

Color is an astonishing vehicle for communication. It is a link, a carrier of messages. In a broader sense, colors are a kind of code which can be easy to understand and which are an immediate and linear language. Favre and November observed that color "gives life to the visual message, it animates it, accentuates it, and makes it more perceptible and of easy identification" (Favre & November, 1979,13). Furthermore, people seem to vary considerably in their ability to distinguish and remember colors. For these reasons, color is widely used in sign systems for its functionality, where it is meant to designate areas such as highways, airports, and subways.

Color, in fact, is not the property of objects or spaces. It is the sensation caused by certain qualities of light that the eye recognizes and the brain interprets. The concept of color come from Sir Isaac Newton. He discovered that when a beam of sunlight passes through a glass prism, the white light breaks into a brilliant array of colored bands, later called the "spectrum". Each distinctive color noted in the spectrum is named a "hue". Red, which is at the end of the spectrum with the longest wavelength, vibrates at the lowest frequency. When eyes progress through the spectral range, wavelengths become shorter and the frequency increases. The

eye then registers a progressive change in hue sensation as it passes through the yellows, greens, blues, and finally the purples.

According to Follis and Hammer, six colors can be easily remembered and identified by normal viewers--red, yellow, blue, green, orange, brown. However, individuals belonging to different cultures seem to react in a different manner when exposed to the same color. For example, red is the most vital color in the spectrum. It has been given the symbolic meaning of love. In *Color in Your World,* Faber Birren says that red is the symbol of pride for the Egyptian and Arabian races. To the Chinese, red signifies the sun and happiness. Native Americans look upon red as the day, success and triumph. Hence, reaction to colors is greatly individual and dependent on the culture and experience of the person.

Some of the symbolic values of colors are described by Birren. Red represents love, power, life and excitement, but its aggressive masculine nature is also linked with disturbance, competitiveness, war, and blood. Green is one of the chief colors of nature, yet it is also the color of peace, equanimity, and the good life. Since the lens of the eye focuses green light exactly on the retina, it is also the most restful color to the eye. Brown represents the earth, steady and reliable, but sometimes it may tempt a person to be unreasonable and even cruel (Birren, 1962).

Researchers, Favre and November further describe the symbolic values of color. Orange, they say, expresses radiation and communication, and has the receptive, warm and intimate character of a fire burning in the fireplace. It means generosity or effusion of feelings. Blue is a deep and feminine color which rests in a relaxed atmosphere. It is concerned with the inner, spiritual life. It gives a feeling of freshness and cleanliness, especially when it is combined with white. It does not

wish to consume itself like red does, but wants to be with linked with love and not with wildness. Yellow is the most luminous color of all. It is also the loudest and brightest. It is young, vivacious and extroverted. In contrast to blue, there is no impression at all of depth (Favre and November, 1979).

Besides having symbolic values, color can improve the legibility of words, signs, and logos. The intensities of colors next to each other will create different effect. In other words, the degrees of contrast between different colors and their sign panel background will cause different results. Karl Borggrafe tells about the legibility of colored letters on colored backgrounds. The numbers in the following table show the level of advantage of using certain colors in a certain background (Fig. 5). The smaller the number is, the better the legibility of color combination is. For example, the best choice of color combination for legibility under daylight is black text on yellow background (1.31). However, if the light source is artificial, the best selection is red text on white background (1.26). Stephen Carr also points out that the visibility of a sign is a function of its "target value," the combined effect of size, shape, and color. He gives a roughly equivalent target value at a range of 250 yards of the color-areas of signs: 14 sq. ft. yellow, 16 sq. ft. white, 18 sq. ft. red, 20 sq. ft. blue, 22 sq. ft. green, 36 sq. ft. black. Thus, it is disadvantageous to use blue, green or black backgrounds, especially for small signs (Carr, 1973).

Color coding may be used for a sign system. Selfridge points out that "it works only when it is repeated clearly enough so that people notice that color is functional and not merely decorative" (ed. Pollet and Haskell, 1979, 62). When a color-coded system is used in a building, the name of the place, floor, or color itself should appear with the color so that people can associate the color directly with the place it represents.

Table 1 The level of advantage of using certain colors on certain backgrounds

Jean-Paul Favre and André November, *Color and und et Communication*, 1979, p 50

First color: letters Second color: background	Classification	Daylight	Artificial light
black on yellow	1	1.31	1.33
yellow on black	2	1.34	1.40
green on white	3	1.35	1.30
red on white	4	1.36	1.26
black on white	5	1.36	1.32
white on blue	6	1.36	1.37
blue on yellow	7	1.36	1.39
blue on white	8	1.37	1.35
white on black	9	1.40	1.35
green on yellow	10	1.40	1.38
black on orange	11	1.40	1.40
red on yellow	12	1.41	1.38
orange on black	13	1.41	1.40
yellow on blue	14	1.41	1.42
white on green	15	1.41	1.45
black on red	16	1.42	1.45
blue on orange	17	1.42	1.45
yellow on green	18	1.42	1.46
blue on red	19	1.43	1.40
yellow on red	20	1.44	1.50
white on red	21	1.47	1.43
red on black	22	1.48	1.43
white on orange	23	1.48	1.45
black on green	24	1.48	1.54
orange on white	25	1.50	1.50
orange on blue	26	1.52	1.60
yellow on orange	27	1.52	1.62
red on orange	28	1.54	1.64
red on green	29	1.57	1.50
green on orange	30	1.58	1.47

Legibility and Readability

Charles B. McLendon and Mick Blackistone explain the difference between legibility and readability for perceiving a sign. Legibility is the viewer's physical ability to see and distinguish a sign and its encompassed message. Readability is the viewer's ability to understand the message.

The legibility of a sign, whether it be a speed limit sign on the highway or a direction arrow in a busy international airport, depends on many factors, such as the environment in which the sign is seen, the design of the sign itself, and the person who sees the sign. According to Tinker, the legibility of type "is concerned with perceiving letters and words, and with reading continuous textual material. The shapes of letters must be discriminated, the characteristic word forms perceived, and continuous text read accurately, rapidly, easily, and with understanding" (Tinker, 1963, 7). In *Symbol Signs*, legibility is viewed as a universal consistency in presentation, such as layout, accompanying letter style, size relationship, color relationship and distance formula. Furthermore, the environmental architectural conditions and cultural factors must be incorporated for an intelligent sign system (AIGA, 1981).

Carr gives a similar view of legibility. He observes that the importance of legibility is not only a matter of simple, clear design, but is also a combination of many interrelated factors. Optimal legibility of signs is accomplished by typographical factors such as the style of type, type size, and line width. These factors are integrated to produce comfortable vision and easy and rapid reading with comprehension (Print, 1969/11).

Selfridge expands the typographical factors by saying that typography is an important consideration for sign design. Typefaces have very distinct characters: they can be dignified, beautiful, simple, bold, classic, modern, and much more. Some are easy to read, some are not. Some styles designed a long time ago may be perfect for signs today; some of the current ones probably work poorly in sign systems where legibility from distances is needed.

Some alphabets contain more vertical space than others because they have different sizes of ascenders and descenders, which may change the amount of space left open between lines of text. Each typeface has its own proportions, which influence the space around them, which in turn donate to the final degree of legibility. Selfridge cites the example of helvetica, a sans serif typeface commonly used on signs, because it has contemporary quality, enough weight, even proportions and strokes for good legibility, and spacing that can be read clearly (ed. Pollet and Haskell, 1979).

The stroke width of the letters also play an important part in readability and legibility. According to Clasus and Claus, if the ratio of stroke width to height is varied, the distance at which the letters in a message become visible will vary. The optimal ratio between stroke width and letter height is 1: 6 to 1:8 for black letters on a white background. The ratio is 1:8 to 1:10 for white letter on a black background. The reason for the difference of stroke width to letter height ratio between white and black letters on black and background is caused by the phenomenon of irradiation. The irradiation effect causes the brighter white characters to flow into the black background. This is caused this by light energy, which is given off by the lighter colors (Claus and Claus, 1974).

Spacing and layout influence the decision of typefaces and the size of characters. Because spacing affects legibility, it determines the maximum number of letters that can be used per line. The designer then determines the length of messages and from what distances the signs can be read. Although there is no certain number for letter spaceing, McLendon and Blackistone point out that the letter spacing terminology of "close, normal or standard, and open" in sign industry is acceptable. Generally, close letter and word spacing will be decreased by half

the normal spacing, and open letter word spacing will be increased by half the normal spacing (McLendon and Blackistone, 1982).

Thus, the amount of letter space depends on weather normal, tight, wide, or touching spacing is desired. Furthermore, AIGA suggests that white lettering on a dark background needs more letter spacing than does black on white; internally lighted letters need much more spacing, which depends on intensity of light; and open letter spacing increases legibility from great distances.

Selfridge observes that "consistent layouts are the basis for creating a smooth presentation of messages" (ed. Pollet and Haskell, 1979, 61). As one perceives inconsistent margins and layouts, such things as too much variation in typefaces, letter sizes or weights or sign sizes, one may lose the direction because of the busy and disorganized signs. Furthermore, Selfridge discusses the fact that crowded messages discourage viewers from reading signs, but with enough white space around the messages in the layouts the messages can be read easily. Furthermore, he suggests that crowded messages discourage viewers from reading signs, but with enough white space around the messages in the layouts the messages can be read easily.

Follis and Hammer expand upon legibility by studying distance. They state "that under normal daylight, when standing still, a person with normal 20/20 vision can read 1-inch (25-millimeter) high letters on a standard Snellen eye chart used by optometrists at a distance of 50 feet (15 meters)" (Follis and Hammer, 1979, 18). On the other hand, McLendon and Blackistone suggest 1-inch cap height for each 30 feet of viewing distance in interior signs, taking into account angular distortion and varying conditions on signs. Furthermore, they recommend a minimum size of

1/2 inch cap height for all signs except in directories and maps (Fig. 3) (McLendon & Blackistone, 1982).

Symbols

People using a directional sign expect the sign system to help them reach their destinations. In order to be easily perceived and understood, to symbolize the message of a sign is the primary approach for sign systems in environmental communication. The use of symbols allows people to engage in relatively complex behaviors. Don Faules and Dennis Alexander explain how people use symbols:

> The use of significant symbols allows humans to engage in complex behaviors. The possibilities of response to a given situation are extended because one can respond in terms of not only previous experience, but also the accumulated learning experience of others, both living and dead. A symbol stands for something else–another stimulus, another response, some combination of these (Faules & Alexander, 1982, 76).

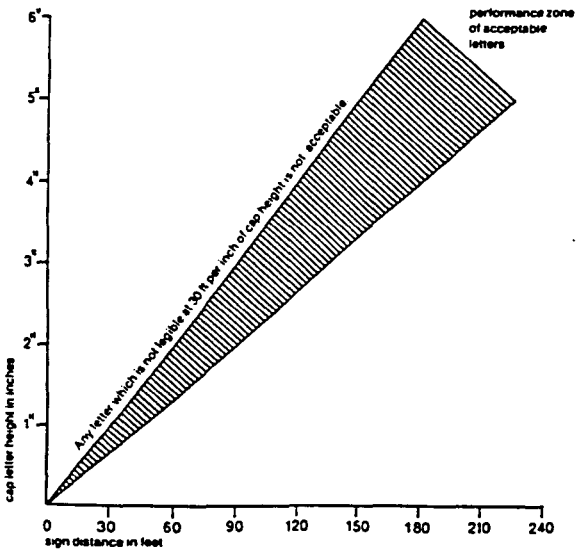


Fig. 3 Cap letter height at acceptable distance

This concept is widely accepted. Taylor says that symbols have five functions: "they identify events in time and space, characterize the qualities of objects, evaluate by producing positive or negative feelings, prescribe a form of behavior, or provide a general frame of reference for comparison purposes" (ed. Whitney, 1960, 130). A similar view is stated by Eliot, who explains that the essential logic and objective of symbolism is to offer a language that can be universally understood. It can be accepted without any confusion as to the symbols (ed. Whitney, 1960).

Wilt and Maienschein expand this idea by saying that symbol signs are useful in any situation for which signs are needed, such as for identification, direction, and instruction. They emphasize the functionalism of symbols "when they are easily recognized, symbol signs represent their intended messages clearly and effectively without words. When symbols are less easily recognized, they should be used with explanatory words" (ed. Pollet and Haskell, 1979, 108). For the purpose of designing and adopting symbols, they indicate that the symbols are "to present messages directly and efficiently. If a symbol is too complex, it may be harder to interpret than words. It may even prove incomprehensible" (ed. Pollet and Haskell, 1979, 109). They provide the following principles for applying effective symbols:

> 1. Each symbol must be direct and not ambiguous conceptually; simple and efficient; stylized, but not too abstract; easily and widely identifiable; timeless, not subject to changes in style; easy to learn and remember; noncontroversial; and unique in meaning.
> 2. The entire symbol system should be coordinated so that styles, colors, shapes, sizes, and backgrounds remain consistent.
> 3. The number of symbols used should remain as small as possible, with no more than one symbol for each message.
> 4. Symbols should be placed on signs consistently with respect to words. Locating symbols to the left of words seems preferable, with arrows to the left of both symbols and words (ed. Pollet and Haskell, 1979,109).

Follis and Hammer explain the differences between pictograms and symbols. Pictograms are based on distinguishable objects closely associated with the idea they communicate. For instance, a representation of a suitcase may identify a baggage claim area in an airport. On the other hand, symbols can be the abstract or geometric forms that are associated with an idea. For example, a specific kind of cross may stand for a hospital (Follis and Hammer, 1979).

In fact, symbols and pictograms are seen with increasing use all over the world. International airports, international trade shows, and fairs are depending more and more on this international language to cross-culturally communicate information. However, it is difficult for symbols and pictograms to express complete messages; a person has to associate them with other symbols or previous experiences. This confusion is exacerbated by the fact that no one symbol system has been subscribed for use in all countries.

The most widely used and universally understood symbol is the arrow. According to Follis and Hammer, there are several reasons that the arrow has been used universally. It can be understood regardless of the language barrier. It is more adjustable and requires less space than a verbal direction such as "go downstairs," which it might replace. It provides a consistent look to directional sign copy layouts (Fig. 4) (Follis and Hammer, 1979).

Wilt and Maienschein indicate that "there is a problem when arrows are used pointing downward or upward to point "straight ahead" because they could also be interpreted as pointing to something directly below or above the sign, or even to a change of level" (ed. Pollet and Haskell, 1979, 106). The Department of Transportation provides a standard of ambiguity usage: movement straight ahead

should be presented by a downward arrow, with straight horizontal arrows to indicate sideways movement. Changes of level (by stairs or escalators) call for diagonal arrows. Moreover, they emphasize that any sign with arrows should be placed at the point where the change of direction occurs so that the direction indicated is completely clear.

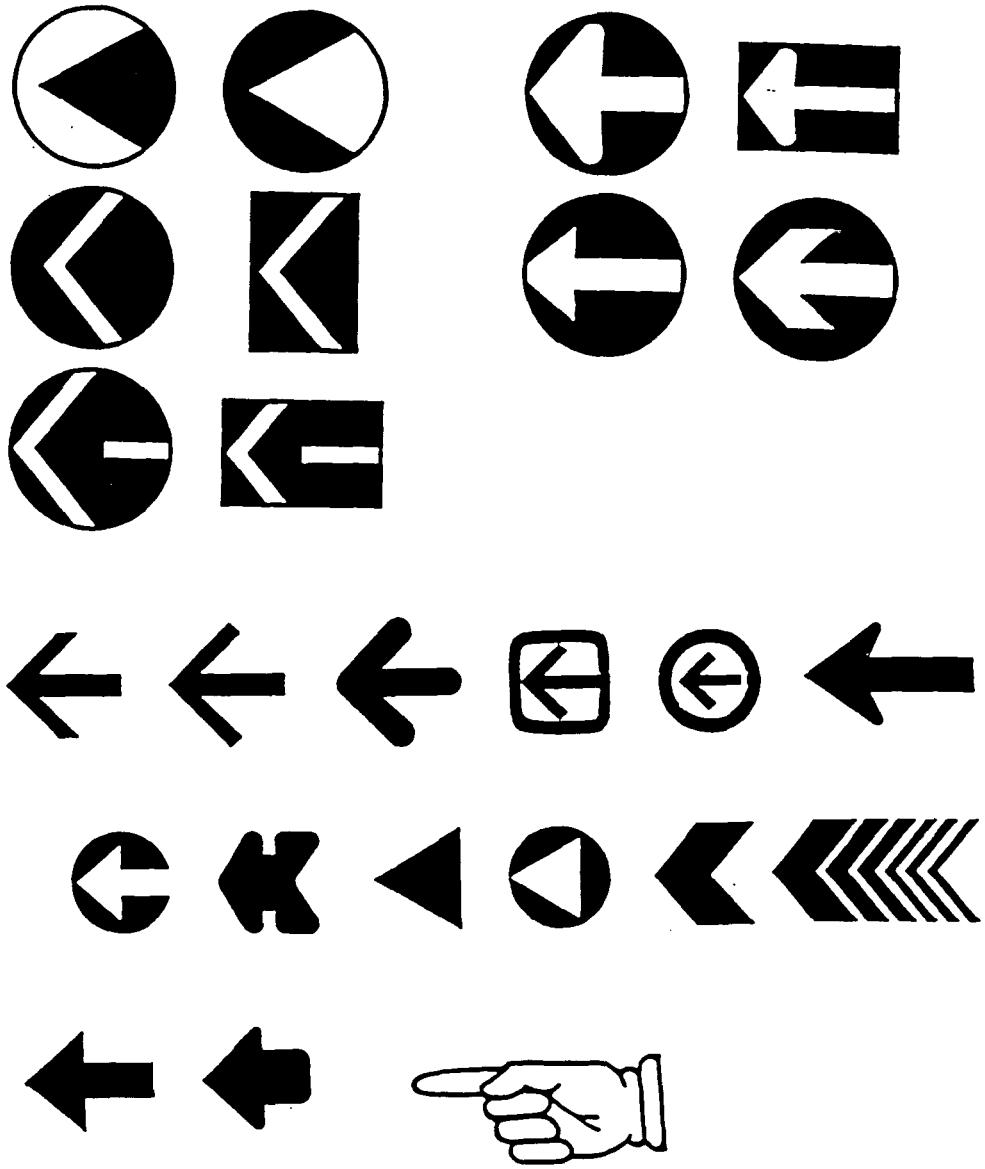


Fig. 4 Arrow symbols

The American Institute of Graphic Arts (AIGA) developed a series of travel symbols (Fig. 5) which were tested at both national and international levels in order to reduce the number of existing symbols. The AIGA committee based their criticisms on three aspects of the developed symbols. *Semantic* refers to the relationship between the visual image and its meaning, and the symbols required to represent the message clearly to people of many cultures. *Syntactic* refers to the relationship of one visual image to another and how well a symbol fits into the entire system of symbols. *Pragmatic* refers to the relationship between the symbol and its users and requires that it can be seen clearly under varying conditions and when reproduced in various sizes.

From the American Institute of Graphic Arts, the result of pragmatic testing of several symbols (Ticket Purchase, Elevator, and Taxi) produced a rough guide to the relationship between the size of symbol and distance (Fig. 6). The results revealed that within certain distances, the symbols are easier to understand without the aid of words. The sizes of symbol is also considered. The closer to one's natural line of vision, the better its effect. According to *Symbol Sign*, "a useful rule of thumb is to avoid exceeding a 10° angle from the natural line of vision" (AIGA, 1981, 190). However, if the viewing angle exceeds 10° in some circumstances, the relationship between size and distance may have to be adjusted. For instance, a sign at 15 feet above the floor will probably have to be larger than the same sign at 8 feet, or the smaller sign may need to be added for short-distance reading. In fact, AIGA recommends pragmatic testing of symbols and lettering on-site, or in simulated on-site conditions to determine the sizing of all the symbols and text in a sign system (AIGA, 1981).

Fig. 5 AIGA developed a series of travel symbols for the U.S. Department of Transportation (DOT)

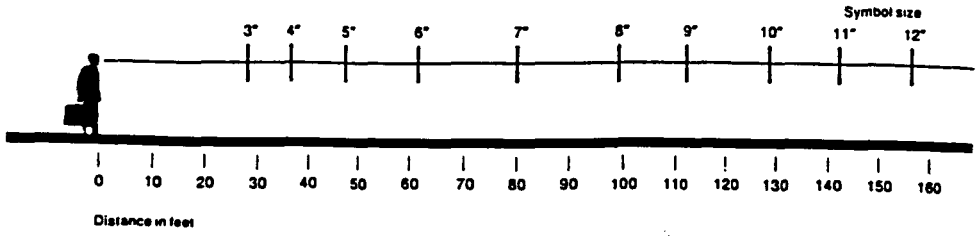


Fig. 6 The relationship between size of symbol and distance

Sign Placement

Placement is another important consideration in designing a sign system. Katherine Selfridge points out that consistent placement of signs can make people quickly learn to look for signs at reliable repeated heights (ed. Pollet and Haskell, 1979). Follis and Hammer observe that the height of signs will determine the effective legibility for viewers. According to them, a guideline for determining the sign height should be based on the average height of a viewer's eye level, which measured from the floor when the viewer is standing, is about 5 feet, 6 inches. Moreover, Panero and Zelnik indicate that approximately 2.5 cm. or 1 inch should be added for men's shoes and 7.6 cm. or 3 inches for women's shoes.

They also indicate that the standard for human head movement in a vertical plane ranges from 0° to 30° in either direction, without discomfort. In other words, the average field of human vision covers an angle of about 60°, within which the details of objects can be seen without turning the head or feeling uncomfortable (Fig. 7). Generally, viewers are not willing to make any uncommon head motions in order to see a sign which is not within their normal field of vision (Panero and Zelnik, 1979).

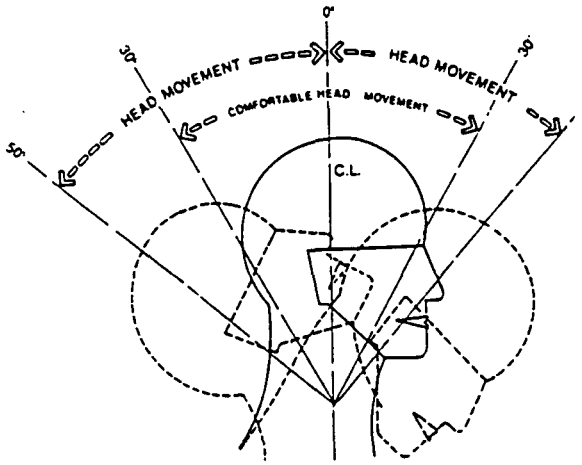


Fig. 7 Head movement in a vertical plane

Summary and Conclusions

The literature review examined several important elements of communication in the environment. A workable information system is not a separate entity, but rather is an integral part of a functional and effective environmental communication process. There are four parts that can be reviewed among the areas that were studied. They include a communication process, environmental communication, the sign system, human factors, and graphic communication elements.

The first part of the literature review examines the communication process. The communication process basically involves a source forming the information or message, putting the message on the selected channel for transmission and then sending it to the receiver. A communication process can also be viewed as the vehicle between a human being and the environment. If the message is communicated by means of an organized system, it becomes more meaningful to people.

The cultural aspect, presenting societal life and social relationships, is an element that influences the communication process. An understanding of culture in a communication process is necessary to ensure message flow, comprehension, and satisfying results. Culture is defined by Carley Dodd as "the total accumulation of many beliefs, customs, activities, institutions and communication patterns of an identifiable group of people" (Dodd, 1982, 38).

Generally culture includes several elements: "cultural history, cultural personality, material culture, role relationships, art, language, cultural stability, cultural beliefs, ethnocentrism, nonverbal behavior, spatial relations, time,

recognition and reward, and thought patterns" (Dodd, 1982, 40). The study of these elements is a necessary part of the communication process.

The second part of the review discusses environmental communication. The environmental messages are observed in three groups. There are "a set of priori geometrical elements," "a set of meanings," and "a set of messages." The "priori" and objective information conform to physical properties. However, "the meaning" carries along with the information individual and sociocultural values. Thus, environmental communication is defined as "consisting of complex fields of interaction between human and human, and human and the environment, using tangible and intangible environmental, behavioral, and symbolic cues." (Minai, 1984, 144)

The third part of the literature review focuses on sign systems. Although "symbolic cues" are defined as part of environmental communication, how to organize them to let information transmit effectively is more important. Through the communication process between people and their environment, the systematic signs contend for the viewer's attention with all other elements in the environment. If a specific environment can be visually controlled by a sign system, the viewer can be made aware of the signing system and its effectiveness can be significantly increased. Furthermore, an effective sign system not only communicates information between people and their environment, but it communicates information quickly and effectively.

Wayfinding is also linked to sign systems. How does a person's ability to focus on the surrounding environmental messages then determine his or her direction? Passini explains that the mental or cognitive process can be seen in a human being's sense of direction. The cognitive process helps develop a cognitive

map. This cognitive map is not something stable, and will be changed by new information. The cognitive process can structure the perceived parts of the environment into a maplike band respecting certain geometric properties. Wayfinding or seeking one's sense of direction is defined as a person's ability to mentally determine his or her position within a presentation of the environment made possible by cognitive maps.

After studying the effective information or messages on sign systems, several factors must be acknowledged. The first factor is to find the appropriate position for the signs and the message on the sign. The second factor is understanding the meaning of the message in its environment. The message needs to be consistently worded and logically organized to assist the viewer to respond more quickly. The third factor is the structure of information, which includes content and hierarchy. Understandable content helps the viewer pick up a message at a glance, and a thoughtful hierarchy can assist the user in making a major wayfinding decision.

A functional sign system is also affected by human factors. When people enter a new environment and perceive the sign system, there will most likely be a number of different responses. This is because each individual's perception and response to signs is different, and these differences are influenced by a number of physical and psychological factors such as reading ability, memory, and color sensitivity.

The eyes and brain are the first to react to signs. The eyes feed the brain with information coded into neural activity in the form of chains of electrical impulses. The neural activity forms information patterns representing objects such as words from a sign which have specific meanings. Although these words are

recorded into the reader's brain correctly, they are not pictures. When people look at something, the pattern of neural activity illustrates the object and the brain interprets the patterns as the object. The information patterns can be stored in human memory after eyes see an object or words.

The final part of the literature review is about graphic communication elements. It includes color, legibility and readability, symbol, sign placement and material. Color is a very important factor in communication. Color is a kind of code which is easily understood; it is an immediate and linear language. Color can make visual messages more perceptible and easily identifiable. Thus, color is widely used in sign systems for its functionality. There are six colors that can be easily remembered and identified by normal viewers: red, yellow, blue, green, orange, and brown. However, reaction to colors is extremely individual and depends on the culture and experience of the person.

Moreover, color can improve the legibility of words, symbols and signs. Karl Borggrafe's test ranks the reading time of colored letters on various colored backgrounds. The best color combination for legibility under daylight is black text on a yellow background. The best selection under artificial light is red text on a white background. On the other hand, the worst choice under daylight is green text on an orange background and under artificial light is red text on an orange background.

For the graphic designer, the legibility in a sign system is quite different from that on the printed pages. This is a result of legibility being affected by different sized spaces. The average field of human vision suitable for sign systems covers an angle of about 60°. If the angle is larger than 60°, the detail is difficult to see. People are not willing to make any extra head motions in order to see a sign which

is not within their normal field of vision. Furthermore, the height of signs will determine the effective legibility for viewers. The average height of a viewer's eye level, measured from the floor when the viewer is standing, is about 5 feet, 6 inches.

Carr indicates that the importance of legibility is accomplished by typographical factors such as the style of type, type size, and line width. These factors are integrated to produce comfortable vision and easy and rapid reading with comprehension. Selfridge explains that typographical factors are an important consideration for sign design. Typefaces have very different characters: they can be dignified, beautiful, simple, bold, classic, or modern. Some are easy to read, some are not. Each typeface has its own proportions, serif or sans serif, which influences the space around them, which in turn donate to the final degree of legibility. Moreover, he points out that helvetica is commonly used on signs because it has a contemporary quality, enough weight, even proportions and strokes for good legibility, and spacing which can be read clearly (ed. Pollet and Haskell, 1979).

Stroke width plays an important part in readability and legibility. According to Clasus and Claus, the optimal ratio between stroke width and letter height is 1: 6 to 1:8 for black letters on a white background. The ratio is 1:8 to 1:10 for white letter on a black background. Spacing influences the decisions about typefaces and the size of characters. The designer measures each line, then determines the length of messages and from what distances the signs can be read.

Selfridge indicates that consistent layout is also an important factor in legibility. When people perceive inconsistent margins and layouts, and things such

as too much variation in typefaces, letter sizes or weights or sign sizes, they may become lost because the signs are simply busy and disorganized.

Follis and Hammer point out that distance also affects legibility. They state that a person with normal 20/20 vision can read 1-inch high letters on a standard Snellen eye chart used by optometrists at a distance of 50 feet. McLendon and Blackistone suggest 1-inch cap height for each 30 feet of viewing distance in interior signs.

Symbols are useful for sign systems in environmental communication because they are easily perceived and understood. Taylor says several functions of symbols include: identifying events in time and space; characterizing the qualities of objects; prescribing a form of behavior; or providing a general frame of reference for comparison purposes (ed. Whitney, 1960). The essential logic and objective of symbolism is to offer a language that can be universally understood.

Wilt and Maienschein point out the purpose of designing and adopting symbols is to show messages directly and efficiently. A complex symbol may be harder to interpret than words. It may even prove incomprehensible. They indicate several principles for dealing with symbol; each symbol must be direct and not ambiguous conceptually; the entire symbol system should be consistent regarding styles, colors, shapes, and sizes; the number of symbols used should be limited; symbols should be placed on signs consistently with respect to words.

It is necessary to consider the relationship between the size of symbol and distance in a sign system. The AIGA symbol study revealed that within certain distances, the sizes of symbols are easier to understand without the aid of words. For instance, a 3-inch-high symbol is good for viewing about at 28-30 feet of distance.

Sign placement is also an important consideration in designing a sign system. A consistent placement of signs can encourage people to learn to look for signs. Follis and Hammer determined that when a viewer is standing, the average height of his or her eye level is about 5 feet, 6 inches. This, then, is the optimum height for sign placement. They also indicate that the placement of signs needs to consider the angle of human head movement. Normally, the average field of human vision covers an angle of about 60°. Within this field, the details of objects can be seen without turning the head or feeling uncomfortable. Viewers are not willing to make any uncommon head motions in order to see a sign.

Based on some of the factors, from the literature review an evaluation criteria for information systems will be proposed and discussed.

METHODOLOGY

Evaluation Criteria

The method used for this evaluation system is based on the key elements discussed in the literature review. To develop an effective and workable information system in a built environment, numerous factors ranging from the architectural to graphic communication elements need to be considered. These elements can enhance the sign system with an entirely new aspect of design and construction, something more than mere "pictures" to hang up.

For each graphic communication element, some guidelines/rules from existing standards will be used to help establish an evaluation method and evaluation criteria. The intent is not to create a "golden rule," but rather to provide assistance with technical considerations for environmental graphic designers.

A well-designed sign system takes into consideration many factors typically used in visual communication by the graphic designer, such as color, scale, form, and typography. With printed pages, readers can bring the written words into their field of vision at their own pace. However, information in the environment is without a person's control. He or she may be pressed by time and must use the information to make crucial decisions regarding his or her destination. Therefore, legibility plays an important role in the visual communication process. To define operational legibility in environmental communication is a complex problem and it depends on many interrelated elements such as the size of typography, lighting, or the color distinctiveness of the sign. Thus, how a sign system can enrich the environment and improve its functionality depends to a great extent on the design and typography of the system.

To develop an effective evaluation system, several communication elements were studied and analyzed. The eleven elements chosen for evaluation were selected because they were identified through the literature review as the most important factors in an effective environmental communication system. Each element will be given a ranking on a scale from 1 to 5, representing five different levels. The higher the number, the more effective the usage.

Each element has a different level of importance in a sign system. The viewing sequence is the most important factor in determining whether or not a sign system will be effective because it allows a viewer to make the necessary decisions about what to do next. Consistency is another important factor in an effective sign system: people quickly learn to look for signs in repeated patterns in an unfamiliar environment. Therefore, the viewing sequence and consistency will be used to evaluate the effectiveness of a group of signs in the system. Other elements such as color, typeface, size and spacing, list all other elements which contribute to the relative effectiveness of a sign system, will be used to evaluate individual signs with this evaluation method.

Definition and Rating Scale of Criteria

Sequence

This factor refers to a logical series of informational steps which relate to a viewer's progression through the system. In other words, a sign should provide the information necessary to assist a viewer in determining the correct direction for the next step. When designing a sign system, the best method for finding a functional sequence is to assume the role of an individual coming into a building and perform a walk-through. Thus, the ranking scale of this element depends on the degree of

assistance that the sign system provides to a viewer passing through the environment. The rule of thumb here is that the designers execute a "walk-through" simulation, and the smoother the progression from sign to sign, the higher the score. In other words, a score of five for the evaluated sign in this criterion will offer better guidance than would a score of three (Table 2).

Consistency

The consistency of a sign system refers to a uniform usage of communication elements such as typefaces, use of size and spacing of type, use of symbols and arrows, use of color, copy layout and standard placement of signs. Consistent communication elements and messages can enhance a viewer's unified understanding of the system.

This ranking scale is based on the sign system's consistency in the following nine graphic communication elements: color, typeface, type size, spacing, symbol, arrow, sign size, copy and placement. For each additional inconsistent element, the numeric value is decreased by one point (Table 3). The discussions and rating criteria of the eight elements related to consistency will be addressed in the following sections.

Color

Color is an important aspect in the design of signs. Color can unite individual buildings that are different in scale, material or style. Color can also be used as an "informational and directional coding device, distinguishing one category of information from another. And finally, color expresses the character of the material" (Sims, 1991, 49).

Table 2. The rating criteria for the sequence of a sign system

Score	Criteria
5	• the signs convey the information very clearly and logically • the progression between signs is very smooth (depending on the "walk-through" simulation) • users reach destination without any difficulty
4	• the signs convey the information clearly and logically • the progression between signs is smooth (depending on the "walk-through" simulation) • users reach destination with a little difficulty
3	• the signs convey the information adequately • the progression between signs is fair (depending on the "walk-through" simulation) • users reach destination with some problems
2	• the signs do not convey the information clearly and logically • the progression between signs is difficult (depending on the "walk-through" simulation) • users reach destination with a lot of problems
1	• the signs convey the information very ambiguously and inconsistently • the progression between signs is very difficult (depending on the "walk-through" simulation) • users lose their ways

Table 3. The rating criteria for the consistency of a sign system

Score	Criteria
5	elements including color, typeface, type size, spacing, symbol, arrow, sign size, copy layout, and placement are all consistent.
4	inconsistent in one to two out of nine elements
3	inconsistent in three out of nine elements
2	inconsistent in four out of nine elements
1	inconsistent in five or more elements

Some color combinations are difficult for the eye to perceive. The most important consideration for the readability of a sign system is the contrast between the background color and the color of the lettering. In order to ensure the legibility and recognition of the symbols, the use of dark figures on a white field is recommended. American Institute of Graphic Arts (AIGA) provides some examples to show the relationship between symbols and various backgrounds (Fig. 8).

The ranking scale is divided into five levels, based on the most visible to the least visible of 32 color combinations from the Borggrafe test. The reason for using Borggrafe's results is because they take into consideration the differences between daylight and artificial light. The effect of color distinctness under artificial light is different from that under daylight conditions. The ranking scale is shown in the following table (first color representing letters, second color representing background) (Table 4).

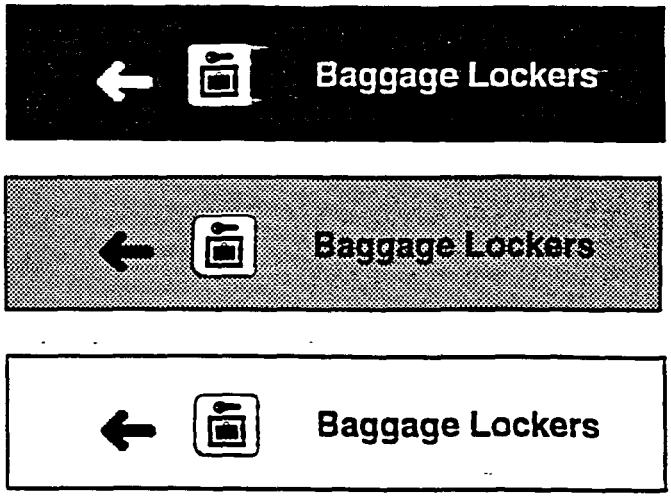


Fig. 8 The relationship between symbols and various backgrounds

Table 4. The rating criteria for the color of a sign system

Score	Criteria
5	red on white, green on white, black on white, black on yellow, blue on white, white on black
4	white on blue, green on yellow, red on yellow, blue on yellow, yellow on black, black on orange, orange on black, blue on red
3	yellow on blue, white on red, red on black, white on green, black on red, blue on orange, white on orange, yellow on green, green on orange
2	yellow on red, red on black, orange on white, red on green, black on green, orange on white, black on green
1	orange on blue, yellow on orange, red on orange

Typefaces

Typeface refers to a full range of characters of the alphabet numberals and signs with the same style. An effective typeface can enhance the optimal legibility of a sign system. Because all typefaces differ in the way they are constructed, in weight, in contrast of thin and thick strokes, and in the proportion between stroke and counter, they can affect the speed and ease with which a sign can be read (Fig. 9). Indeed, words may be read and recognized by their overall shape and not by the shape of each letter. The top half of a word is more critical to viewer recognition than is the bottom half of the word (Fig. 10). Due to their irregular shapes, lowercase letters have more distinctive outlines than uppercase letters. Signs, therefore, should use both uppercase and lowercase letters in one word (Fig. 11).

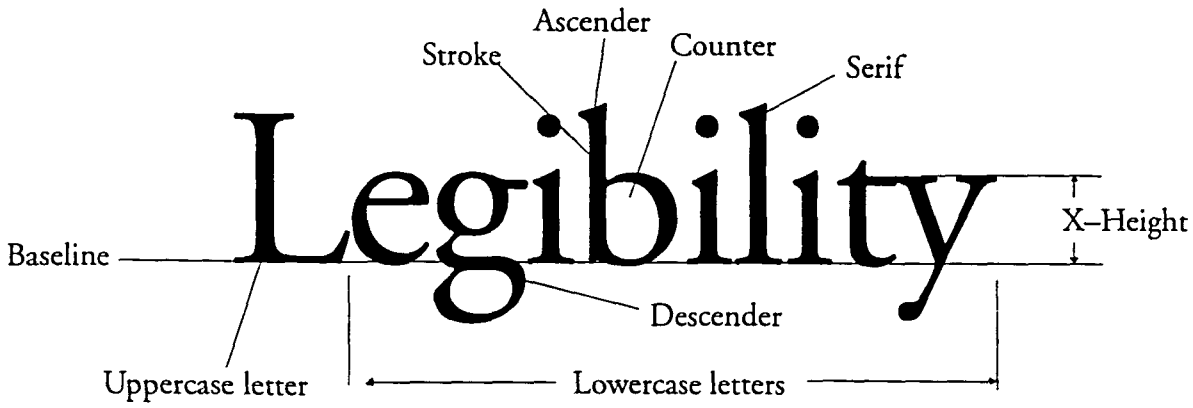


Fig. 9 Uppercase and lowercase letterforms

Script and slanted letters are less legible than straight letters. The stroke weight of a typeface also affects legibility. Typefaces with very fine hairline strokes should be avoided. They do not totally utilize a basic shape, and the hairlines tend to fade into the background, becoming invisible at a distance and thus reducing legibility. When the stroke weight of a typeface becomes too heavy, it has a tendency to lose its internal pattern of counterforms. The general optimal ratio between stroke width and letter height is from 1:6 to 1:8 for black letters on a white background. The ratio is from 1:8 to 1:10 for white letters on a black background.

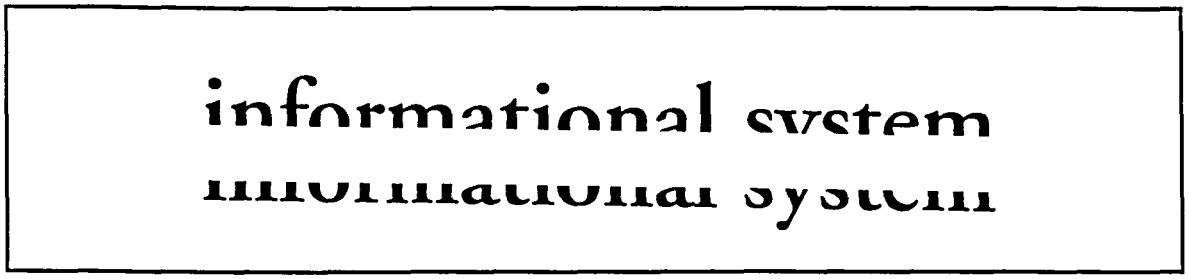


Fig. 10 The top half of the words is easier to recognize than the bottom half of the words

Fig. 11 Lowercase letters have more distinctive outlines than uppercase letters

A number of serif typefaces such as Times or Garamond may be considered to have good legibility in a sign system because of their effective proportions and well-designed structures. However, the typeface should harmonize with the architecture and function of the building. In a public transportation building, people are always in a hurry and want to find and understand the information quickly. It is a different pedestrian environment than a place such as a shopping mall, where people may be casual or relaxed. Therefore, Sheldon Wechsler indicates that the best choice of typeface for a public transportation building is Helvetica Medium or similar styles because of their clarity, readability, and modern design (ed. Pollet and Haskell, 1979).

The ranking scale of this criterion is based on the above researchers' recommendation to avoid the following situations: all capitals, condensed letters, extreme contrasts in the width of strokes within a character, too thin or too heavy a weight, ineffective proportions and a decorative style. For each deviation from the ideal legibility factors in the ideal typeface, the numeric value is decreased by 1 point (Table 5).

Type Size

The size of the typography affects the distance at which that typeface can be distinguished. Small type reduces legibility, which affects word recognition. Large type can force a viewer to perceive type in sections rather than as a whole message. The impact of x-height can also affect the legibility of a sign. Because their x-heights vary radically, different typefaces of the same point size may appear to be of different sizes. Thus, when determining the best type size for a specific sign system, testing is appropriate.

Table 5. The rating criteria for the typeface of a sign system

Score	Criteria	
5	**Sign Design**	• uppercase and lowercase within one word • no condensed letters • same width of strokes and medium weight • effective proportion and well-designed structure such as Helvetica (**Sign Design**) and Univers (Sign Design)
4	Sign Design	• uppercase and lowercase within one word • no condensed letters • different width of strokes and medium weight • effective proportion and well-designed structure such as Garamond (Sign Design) and Times (**Sign Design**)
3	**SIGN DESIGN**	• all capitalized within one word • condensed letters • same or different width of strokes and medium weight • effective proportion and well-designed structure such as all capitalized using a condensed form of Helvetica (**SIGN DESIGN**) Garamond (SIGN DESIGN) or Univers Condensed (SIGN DESIGN)
2	*SIGN DESIGN*	• all capitalized within one word • condensed letters • same or different width of strokes and light weight • effective proportion and well-designed structure such as all capitalized using a Univers Condensed Light (SIGN DESIGN), or Garamond Italic (*SIGN DESIGN*)
1	*SIGN DESIGN*	• all capitalized within one word • normal or condensed letters • different width of strokes and medium weight • ineffective structure for a sign in a public transportation building, such as Bellevu (*SIGN DESIGN*) or Biffo (***SIGN DESIGN***)

The general guideline for determining an adequate type size is a letter with 1-inch x-height for every 50 feet of viewing distance. However, McLendon and Blackistone propose taking into account angular distortion and varying imposed conditions on signs by using 1-inch x-height for each 30 feet of viewing distance for interior signs. In addition, they indicate that the size of the letters will depend on the distance at which it is expected to be read within certain environmental and lighting conditions. The ranking scale therefore is based on the ratio of 1-inch x-height for each 30 feet of viewing distance (Table 6).

Table 6. The rating criteria for the type size of a sign system

Score	Criteria
5	1-inch x-height for a maximum 25 to 30 feet of viewing distance for each additional 9 feet of viewing distance from the ideal distance the numeric value is decreased by 1 point.
4	1-inch x-height for a maximum 31 to 40 feet of viewing distance
3	1-inch x-height for a maximum 41 to 50 feet of viewing distance
2	1-inch x-height for a maximum 51 to 60 feet of viewing distance
1	1-inch x-height for a maximum 61 to 70 feet of viewing distance

Spacing

The spacing of a message refers to the space between letters, the space between words, the space between lines, and the space between graphic symbols and the written message.

According to the research from the National Electric Sign Association (NESA), the legibility does vary in relation to the amount of space between letters. The maximum visibility of the spaces between the letters should be half the width of a lowercase letter "o" in its horizontal dimension (Claus and Claus, 1974). Word spacing should not be so narrow that the words run together or so wide that the spaces interrupt the flow of reading. To assemble words for a sign panel, a module and a grid are always recommended. The designer can divide the sign panels into a number of equal-sized message units. Each unit consists of a number of equal vertical divisions. A consistent spacing between all message elements is sufficient to develop a readable sign and is relatively easy to accomplish.

Mitzi Sims indicates that the space between lines (leading) needs to be considered. The amount of leading is dependent on several factors. San serif faces tend to require greater line spacing because of the visual monotony of their letter forms. Serif faces create a stronger baseline, which tends to prevent the eye from jumping from one line to another. Letters with short ascenders and descenders require greater line spacing. Typefaces with larger x-heights need more leading than those with smaller x-heights.

Because the spacing of a message is variable, based on the suggestion of researchers, the word spacing should be one-half the height of uppercase letters for one unit in dark text on a white background. The spacing between letters, words, and spacing between words and symbols will be illustrated in Table 7.

Table 7. The rating criteria for the spacing of a sign system

Score	Criteria
5	• letter spacing: half the width of a lowercase "o" in its horizontal dimension • word spacing: one unit (one-half the height of uppercase letters) • symbols and words: three units 
4	• letter spacing: half the width of a lowercase "o" in its horizontal dimension • word spacing: one-half of one unit • symbols and words: two units 
3	• letter spacing: twice the space of half the width of a lowercase "o" in its horizontal dimension • word spacing: two units • symbols and words: four units 
2	• letter spacing: three times the space of half the width of a lowercase "o" in its horizontal dimension • word spacing: three units • symbols and words: five units 
1	• letter spacing: extremely close spaces between the letters • word spacing: smaller than one-half of the one unit • symbols and words: smaller than one-half of the single unit 

Symbol

If used properly, nonverbal signs convey their messages more effectively and efficiently than words alone. An effective symbol can deliver an idea or message clearly and effectively without words. However, when symbols are less easily recognized, they may be used with explanatory words. The differences between pictograms and symbols are that pictograms are based on distinguishable objects closely associated with the idea they communicate. Symbols, on the other hand, can be abstract or geometric forms that are associated with an idea. For this criterion, symbol distinctiveness refers to the relationship between the symbol and its meaning, the relationship of one symbol to another, and the relationship between the symbol and its users.

Although establishing a unified set of symbols may be very difficult, there are basic principles which can be used to help develop them. Simplification of the image is one of the primary principles. A complex symbol often causes confusion, particularly in a crowded environment. Boldness is important when the symbols function as signs in a large environment where unnecessary details would reduce the legibility of the symbols. The entire symbol system should be coordinated so that styles, colors, shapes, and sizes remain consistent.

The ranking scale is based on the principles of the researchers and the American Institution of Graphic Arts (AIGA). As AIGA developed a series of travel symbols, the committee evaluated the developed symbols based on three aspects. First, semantic refers to the relationship between the visual image and its meaning. How well does this symbol represent the message? Do people from different cultures understand this symbol? Second, syntactic refers to the relationship of one visual image to another. How does this symbol look? How well this symbol fits

into the entire system of symbols. Third, pragmatic refers to the relationship between the symbol and its users. Does this symbol can be seen clearly under varying conditions ? Does this symbol remain visible throughout the range of typical viewing distances?

Thus, as an environmental graphic designer deals with symbols in a sign system, analyzing the relationship between guidelines and certain conditions is very important. In order to define the ranking scale practically, the "waiting room" symbol is used from an AIGA-developed symbol set (Table 8).

Arrow

The arrow is the most widely used symbol and is universally understood. For this criterion, an arrow is judged by its appearance, the layout of the arrow and its use, whether it is positioned appropriately, and whether it can direct passengers to correctly navigate through the system. The arrow for each direction should be consistent throughout the sign system, whatever the style and size may be. The style of the arrow depends on the sign type of the system. Any sign with arrows should be placed at the point where the change of direction occurs so that the sign clearly communicates the information.

The structure of arrow should be taken into consideration. The structure and eight different directions with the correct positioning of the arrows are illustrated in Figure12.

The ranking scale for the usage of arrows, based on Figure 12, is illustrated in Table 9.

Table 8. The rating criteria for the symbol of a sign system

Score	Criteria	
5		• simplified and well-drawn objects (smooth line and simple representation of objects) • clear expression of message (three objects for a complex message) • consistent bold weight • high contrast between figure and background
4		• lacking a simplified drawing • clear expression of message (three objects) • consistent bold weight • normal contrast between figures and background
3		• lacking a simplified drawing • complex expression of message (four objects) • consistent bold weight • high contrast between figure and background
2		• lacking a simplified drawing (uneven line and poorly drawn figure) • unclear expression of message • consistent bold weight • high contrast between figure and background
1		• lacking a simplified drawing and poorly drawn objects • unclear expression of message • inconsistent bold weight • low contrast between figures and background

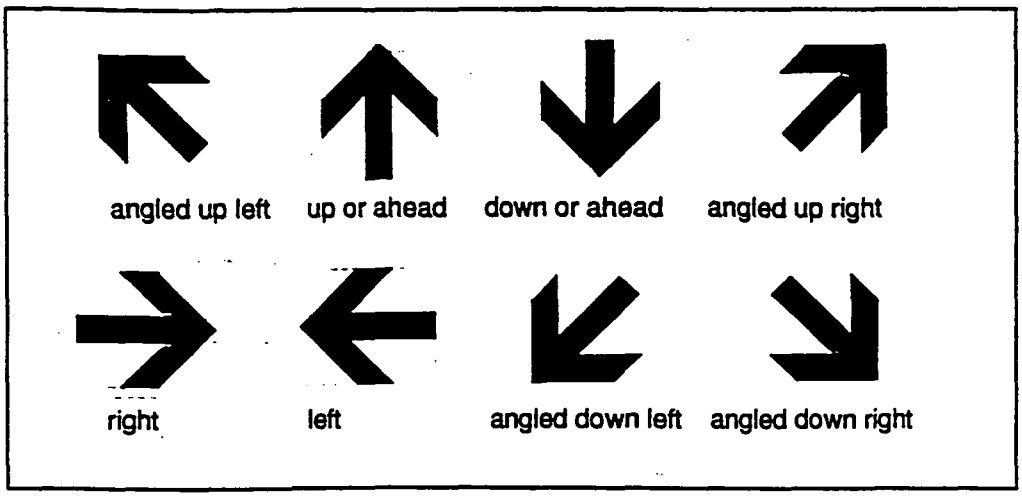


Fig. 12 Eight different directional arrows and their correct position

Sign Size

The sign size refers to the physical dimensions of a specific element correlated with the one-dimensional characteristics of the environment as a whole. Most sign systems require a selection of different sized panels for several reasons. They may be determined by the importance of the communication, the position and site, or the length of the message.

According to McLendon and Blackistone, for maximum ease of reading interior signs, 30 characters in width is recommended. They also provide the table (Table 10) to reflect various panel widths required for given type sizes, allowing for a maximum of 30 characters per line. The establishment of a perimeter by the unit measurement scale is a practical method for placing a message on a panel area. The ranking scale is based on the proportion of one-inch cap height of type size for 20 inches panel width and up to a maximum of 30 characters per line. As the width of the panel increases above 20 inches, the legibility of the message deteriorates, thus reducing its ranking in the scale (Table 11).

Table 9. The rating criteria for the arrow of a sign system

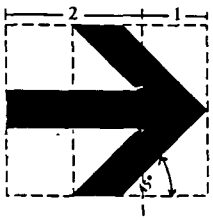
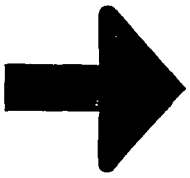
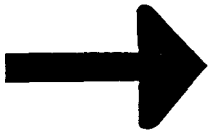
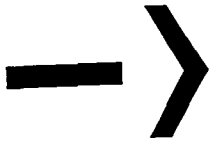
Score	Criteria
5	 • clear, simple and well-structured (the ideal proportion is shown at left) • consistent bold weight without above two criteria, the numeric value is decreased by 1 point)
4	 • clear and simple, but only fair structure • consistent bold weight
3	 • clear and simple, but structure only fair • consistent bold weight
2	 • simple, but unclear and poorly structured • consistent bold weight
1	 • simple, but unclear and poorly structured • ambiguous meaning

Table 10. The relationship between type size and panel width

(McLendon and Blackistone, *signage,* 1982)

Type Size, Inch	Panel Width, Inch
1/2	12
3/4	18
1	21
1 1/2	30
2	45
The sizes are based on Helvetica Medium typeface with normal letter spacing.	

Table 11. The rating criteria for the sign size of a sign system

Score	Criteria
5	30 characters per line with one-inch cap height for 20 inches panel width for each additional or deficient 4 inches of panel width from the ideal width, the numeric value is decreased by 1 point.
4	30 characters per line with one-inch cap height for 21 inches to 25 inches or 15 inches to 19 inches panel width
3	30 characters per line with one-inch cap height for 26 inches to 30 inches or 10 inches to 14 inches panel width
2	30 characters per line with one-inch cap height for 31 inches to 35 inches or 5 inches to 9 inches panel width
1	30 characters per line with one-inch cap height for 36 inches to 40 inches or 1 inch to 4 inches panel width

Copy Layout

Copy layout in sign design is concerned with the spatial relationships between or among all of the components. There are three major copy justification systems in sign design: flush right, flush left and centered. McLendon and Blackistone highly recommend the flush-left arrangement, because "it is always better, from the reader's point of view, to bring the eye back to the same relative position at the beginning of each line" (McLendon and Blackistone, 1982, 40). When a sign system is established, the copy layout style that makes up that system must be consistent. The ranking scale is based on this author and the guidelines of other researchers (Table 12).

Placement

This refers to the height of signs that are installed in an appropriate way to provide a suitable height for a viewer passing through the system. Follis and Hammer provide a guideline for determining the height of the signs based on the fact that the average height of a viewer's eye level is about 5 feet 6 inches when the viewer is standing. McLendon and Blackistone suggest that the height should be 7 feet from the finished floor to the top of the sign panel. The farther a sign is positioned outside a viewer's natural line of vision, the less its efficiency (Table 13).

Table 12. The rating criteria for the copy layout of a sign system

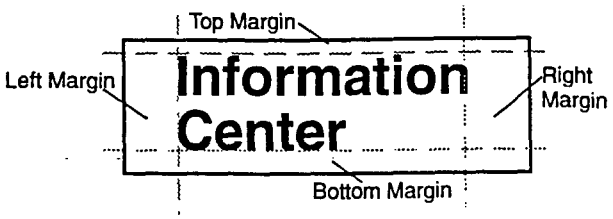
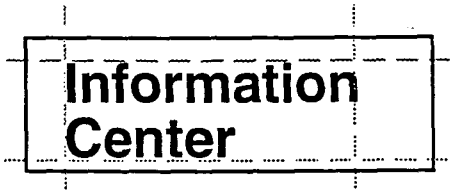
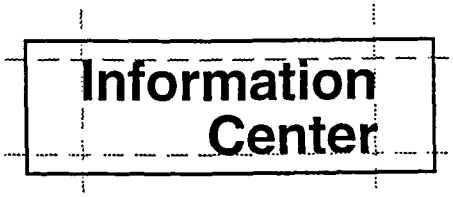
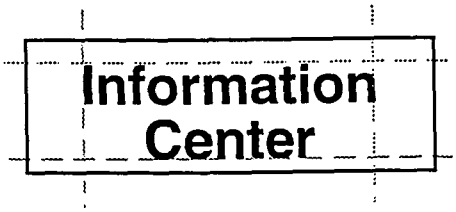
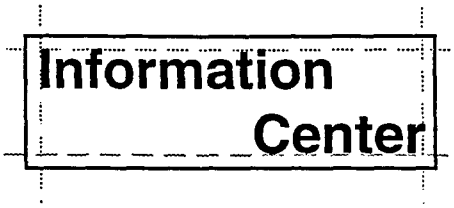
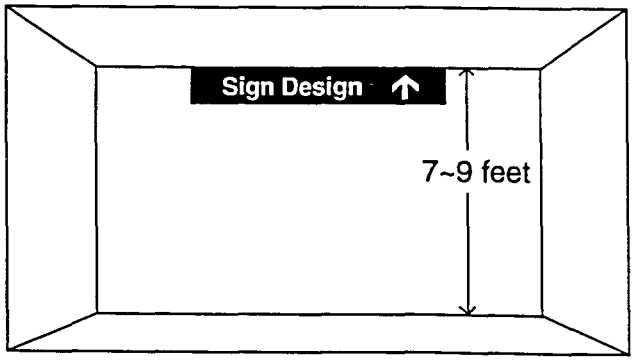
Score	Criteria	
5		• Flush left • Margins: top equal or smaller than bottom, right equal or bigger than left
4		• Flush left • Margins: right bigger than left, top bigger than bottom (from the viewer's perspective showing visual unbalance).
3		• Flush right (viewers experience difficulty in bring eyes back to the same position) • Margins: top equal or smaller than bottom, right equal or bigger than left.
2		• Centered (viewers experience difficulty in bring eyes back to the same position) • Margins: top bigger than bottom.
1		The copy layout was done without regard for standards or rules

Table 13. The rating criteria for the placement of a sign system

Score	Criteria
5	the signs are hung at 7 to 9 feet from the finished floor to the top of the sign panel for 1-inch cap height in 30 feet of viewing distance  for each additional 2 feet of hanging height from the ideal height the numeric value is decreased by 1 point
4	the signs are hung at 9 to 11 feet from the finished floor to the top of the sign panel for 1-inch cap height in 30 feet of viewing distance
3	the signs are hung at 11 to 13 feet or less than 5 feet from the finished floor to the top of the sign panel for 1-inch cap height in 30 feet of viewing distance
2	the signs are hung at 13 to 15 feet or less than 3 feet from the finished floor to the top of the sign panel for 1-inch cap height in 30 feet of viewing distance
1	the signs are hung at more than 15 feet or less than 3 feet from the finished floor to the top of the sign panel for 1-inch cap height in 30 feet of viewing distance

The following table lists all the above elements used in the evaluation matrix. This matrix will be used to evaluate the effectiveness of public transportation facilities. The top part of the matrix is used to evaluate a group of signs that may be shown on a path of boarding or exit. The bottom part is used to evaluate one of the signs on the top part of the matrix. Only after determing the effectiveness of the sequence and consistency of signs will it be useful to go on and look at the individual factors that make an individual sign successful.

Table 14 . The evaluation matrix

Evaluated Area:							
Elements	**5**	**4**	**3**	**2**	**1**	**Final Score**	**References**
Sequence							
Consistency							
Evaluated Sign:							
Elements	**5**	**4**	**3**	**2**	**1**	**Final Score**	**References**
Color							
Typeface							
Type Size							
Spacing							
Symbol							
Arrow							
Sign Size							
Copy Layout							
Placement							

Score Scale	**5 - 4.1**	**4 - 3.1**	**3 - 2.1**	**2 - 1.1**	**1 - 0**
	Excellent	**Good**	**Fair**	**Poor**	**Unacceptable**

AN IMPLEMENTATION OF THE EVALUATION MATRIX USING THE SIGN SYSTEM OF THE DES MOINES INTERNATIONAL AIRPORT AS A CASE STUDY

This section will show how the evaluation matrix is used to analyze and evaluate the sign system in the Des Moines International Airport (DMIA) . The purpose of using the evaluation matrix is to rate the specific public transportation facility and then determine the effectiveness of the sign system in the DMIA.

Des Moines is the capital of the state of Iowa. The DMIA is operated by the city of Des Moines on approximately 1200 acres of land on the southwestern side of the city. It opened at its present location in 1931. Today it is a full-service facility capable of accommodating aircraft ranging from Boeing 747 jumbo jets to the smallest pilot trainer aircraft.

The airport is accessible from highway 235 via Fleur Drive and from Interstate 35 via Army Post Road (Fig. 13 and 14). In order to illustrate an overall view of the sign system, the Figures 15, 16, 17 and 18 show the exterior signs used for directing travelers from highway 235 through downtown and from Interstate 35 via Army Post Road to the DMIA.

People coming from highway 235 to the DMIA may encounter a bit of confusion when they get off the highway at the exit (the middle picture in Fig. 16). The sign "Airport 6" is the first sign after exit but it is hidden by bushes. It is very easy to get lost at this point because the intersection is only 20 feet ahead. The signs displayed in the downtown area are also very confusing. Because of their placement, most of the signs are very difficult to follow. For example, the height of the sign installed on Grand Avenue is extremely low (the bottom picture in Fig. 17). If a truck is in front of regular car, the driver of the car may not see the sign for the airport because the truck would obstruct this view.

People coming from the exit of Interstate 35 via Army Post Road to the DMIA receive better information from signs (Fig. 18). They are shown signs in the appropriate size, height and location without obstructions such as bushes. However, there is no sign to indicate the direction of airport when people drive to the important intersection of Army Post Road and Fleur Drive (the bottom picture in Fig. 18).

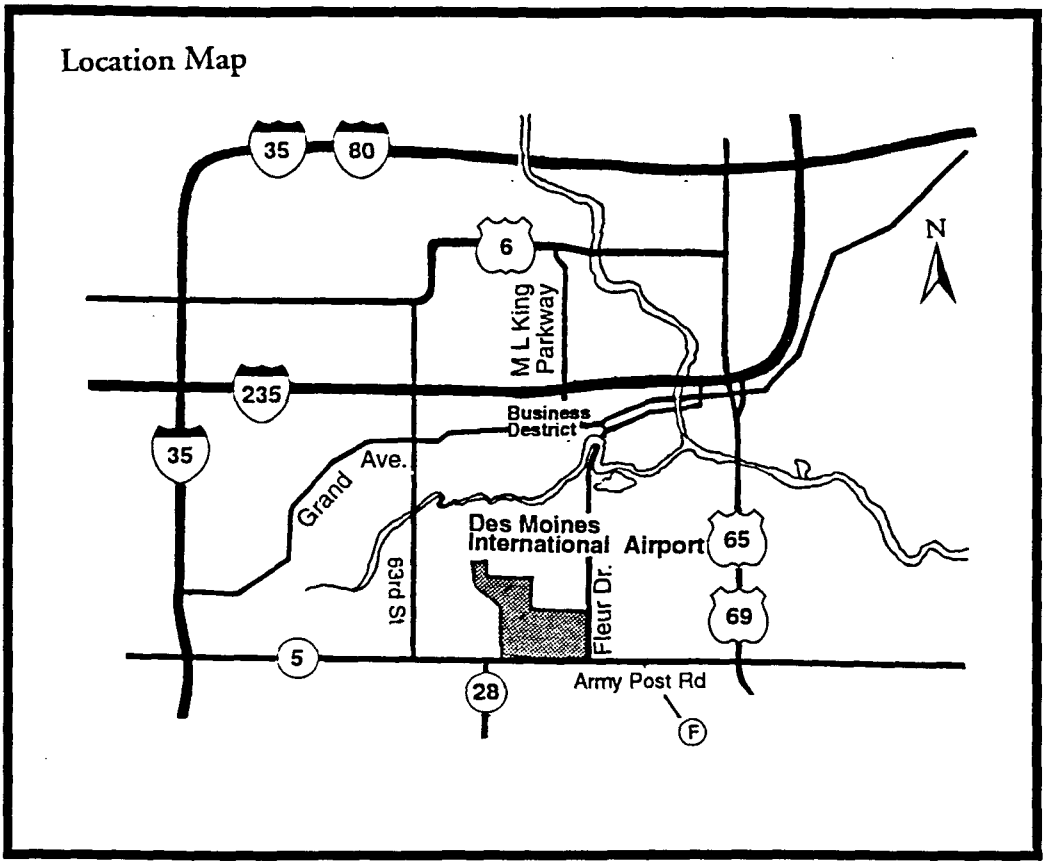


Fig. 13 The location map of the DMIA

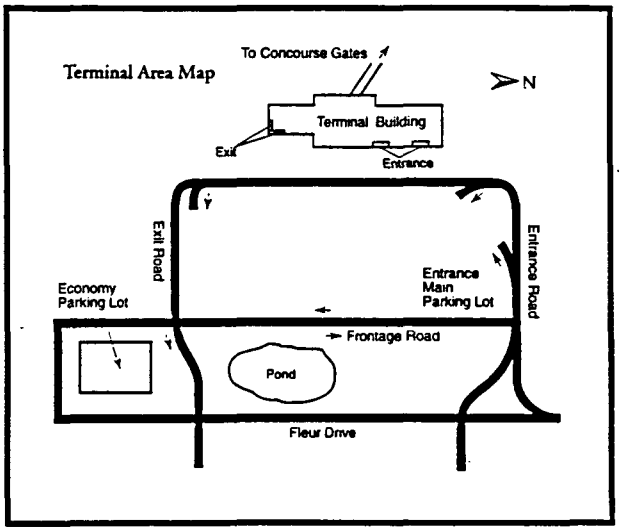


Fig. 14 The terminal area map for the DMIA

The Categories of the Signs in the Des Moines International Airport

The sign system in the DMIA is divided into three groups by this author (Fig. 19). The first group of signs, which direct people from the terminal entrance to the boarding gates in the concourse, is referred to in Figures 20 to 23. The second group of signs, which guide passengers from the boarding gates to the exits in the baggage claim area (E), is referred to in Figures 24 to 26. Most of the signs in the DMIA fall into these two categories. The third group of signs, which direct people navigating from the baggage claim area to the boarding gate D1 (N), is referred to in Figure 27. The standard proportions of the symbols and text are shown in Figure 28, and detailed measurements of each sign are shown in Figures 29 to 35. Because the first two groups play the most important and functional roles in the system, the evaluation will emphasize them. A discussion of these groups, including their rated results, will be given in terms of each criterion proposed in the preceding evaluation criteria section.

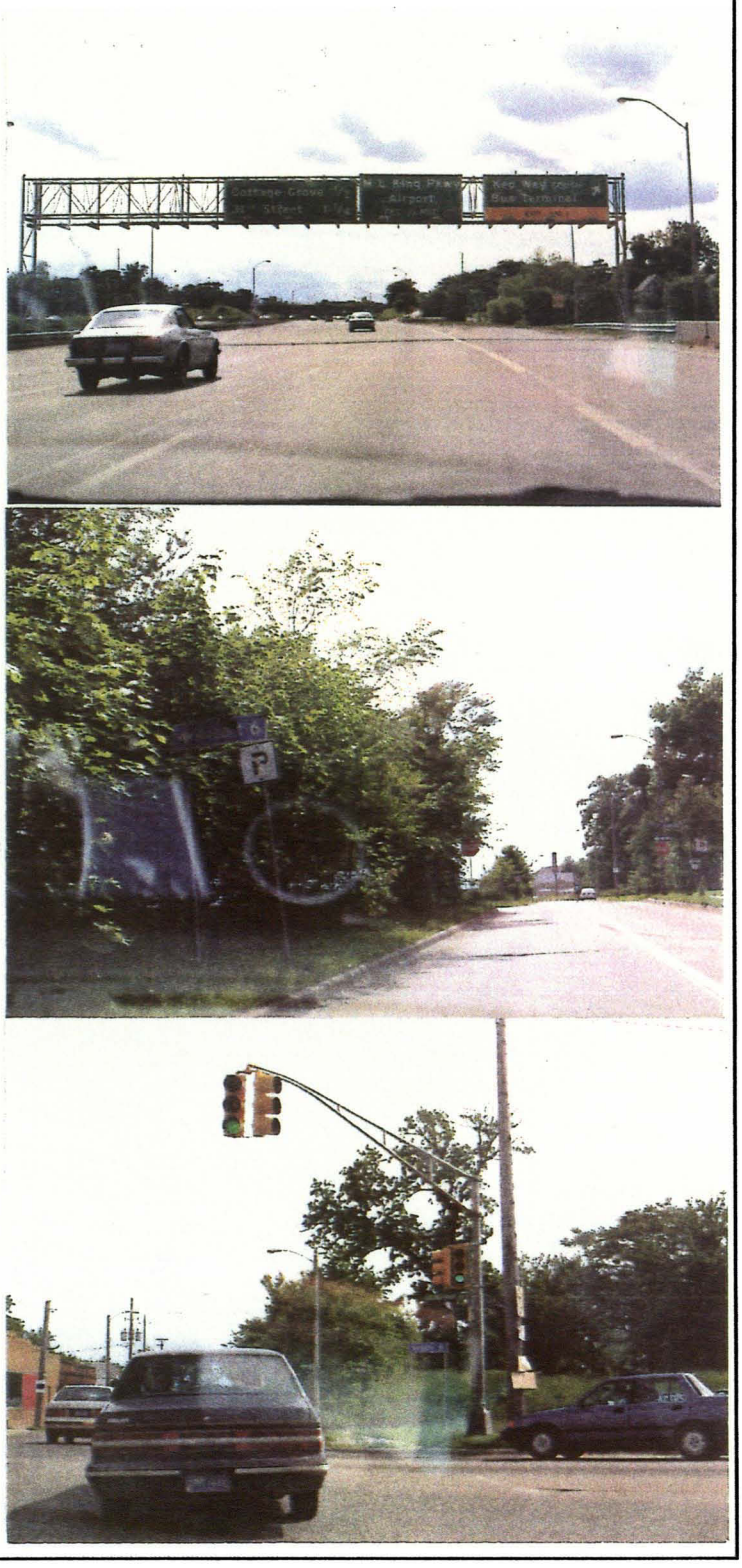


Fig. 15 The "Airport" signs are shown near the exit of highway 235

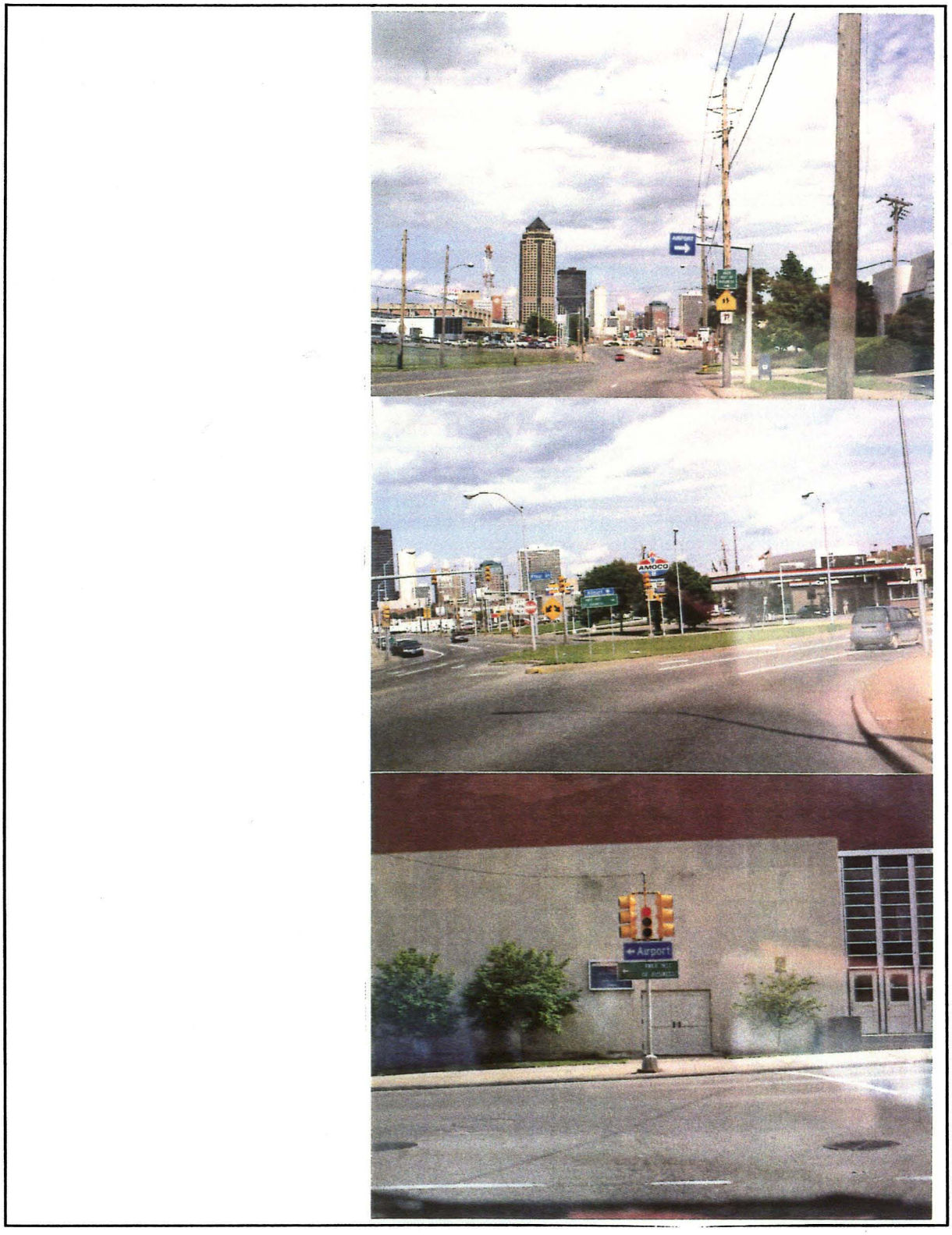


Fig. 16 The "Airport" signs are shown in the downtown area

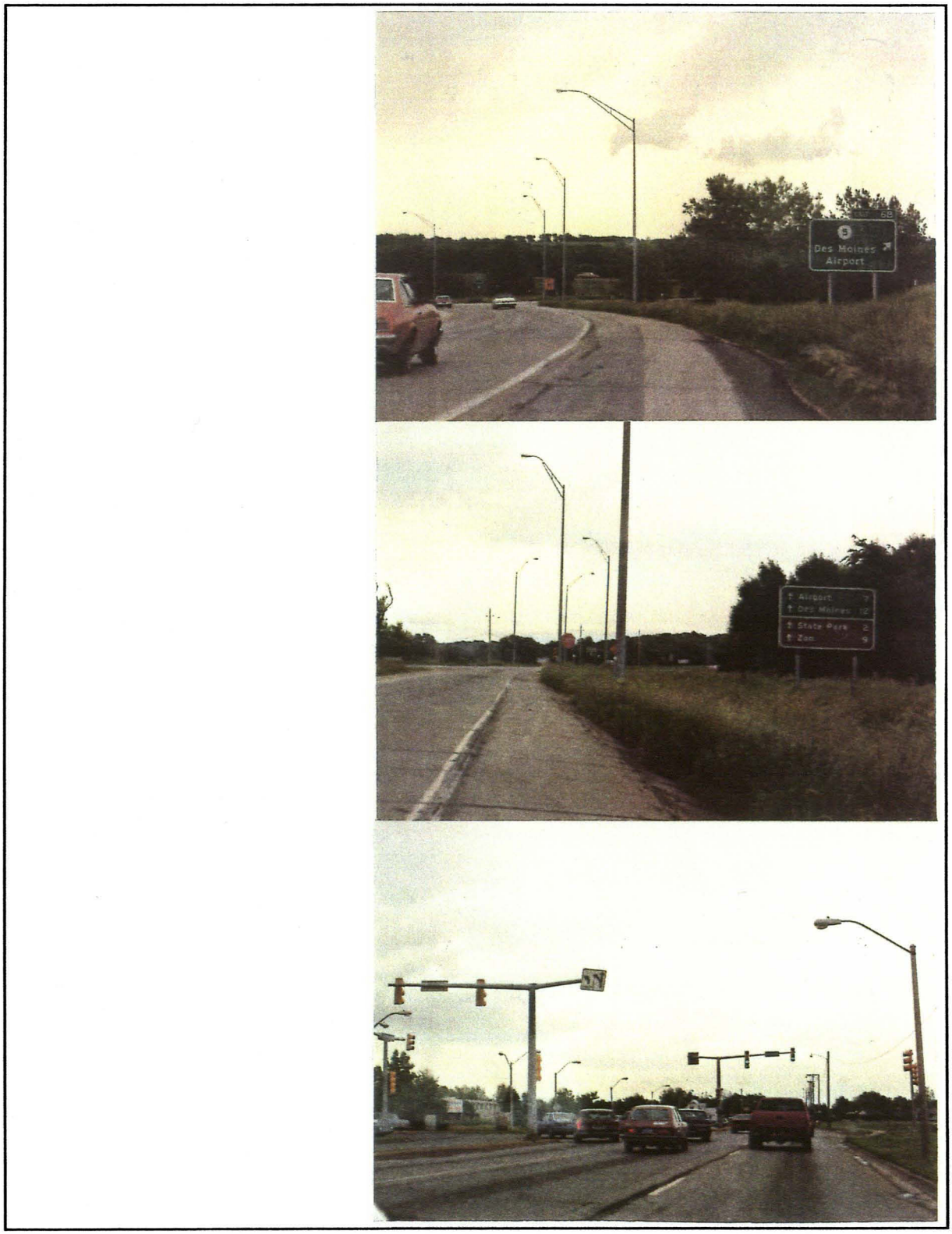


Fig. 17 The "Airport" signs are shown at the I-35 exit to Army Post Road

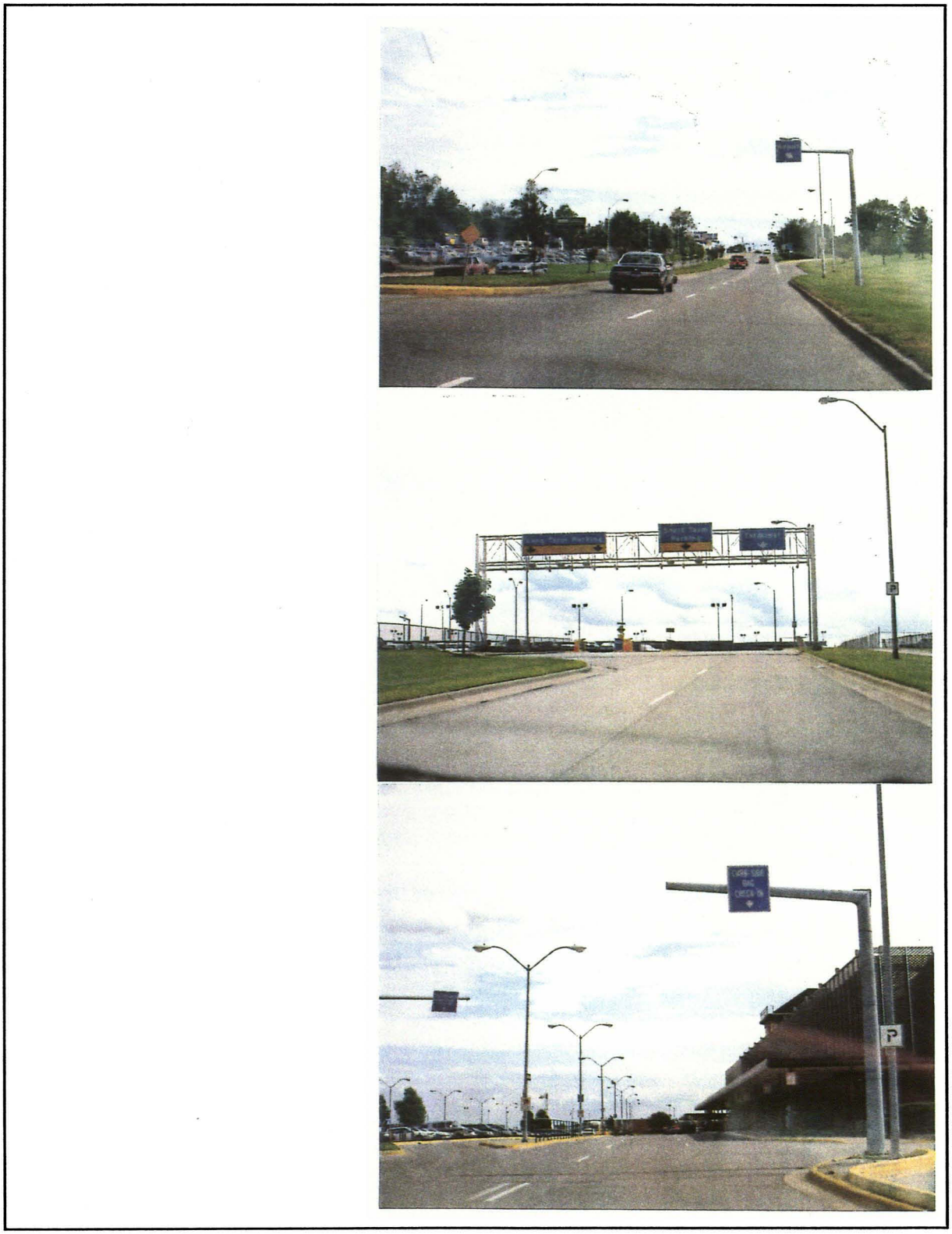


Fig. 18 The exterior signs are displayed in front of the DMIA terminal building

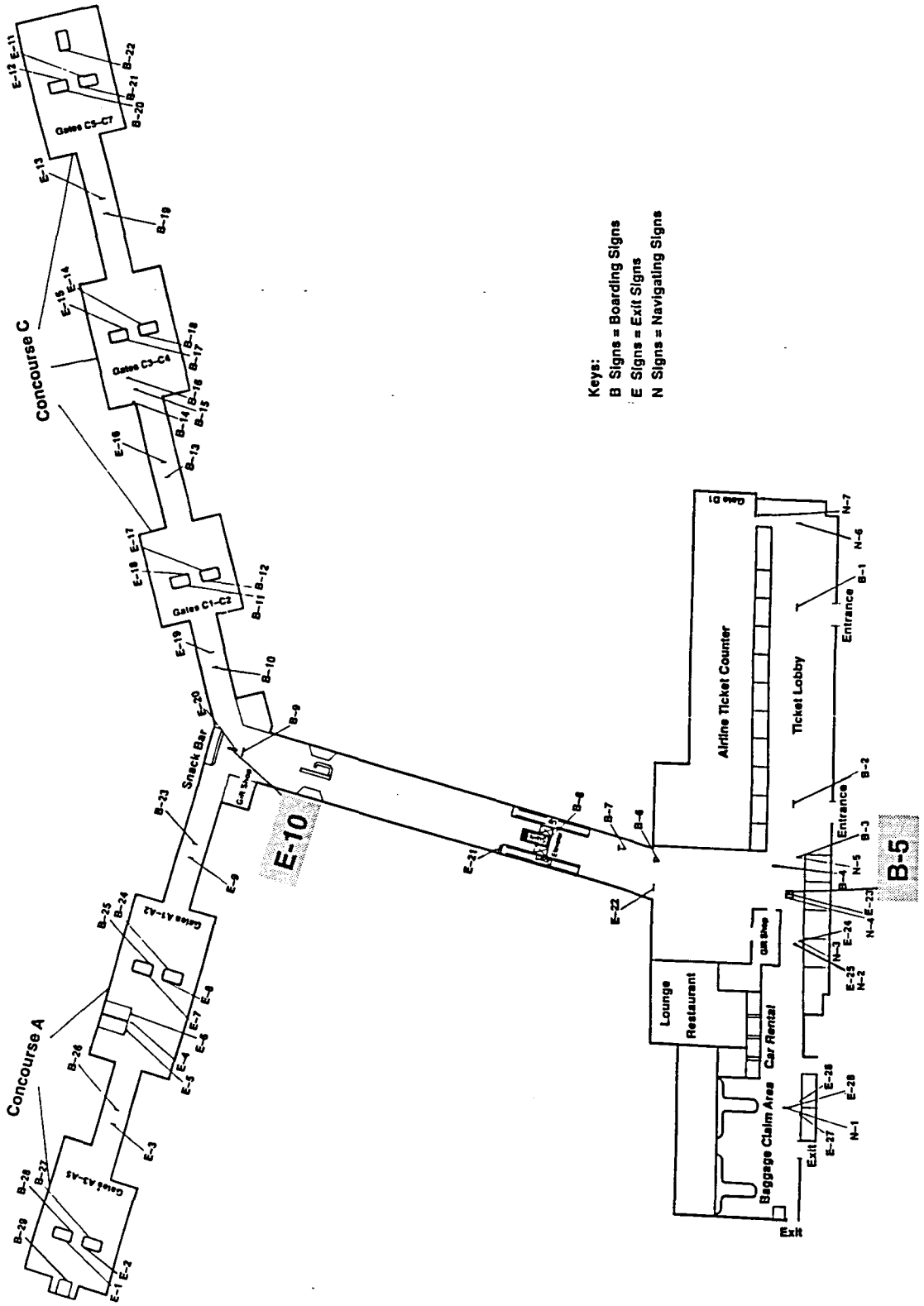


Fig. 19 The map of the categories of the DMIA's signs

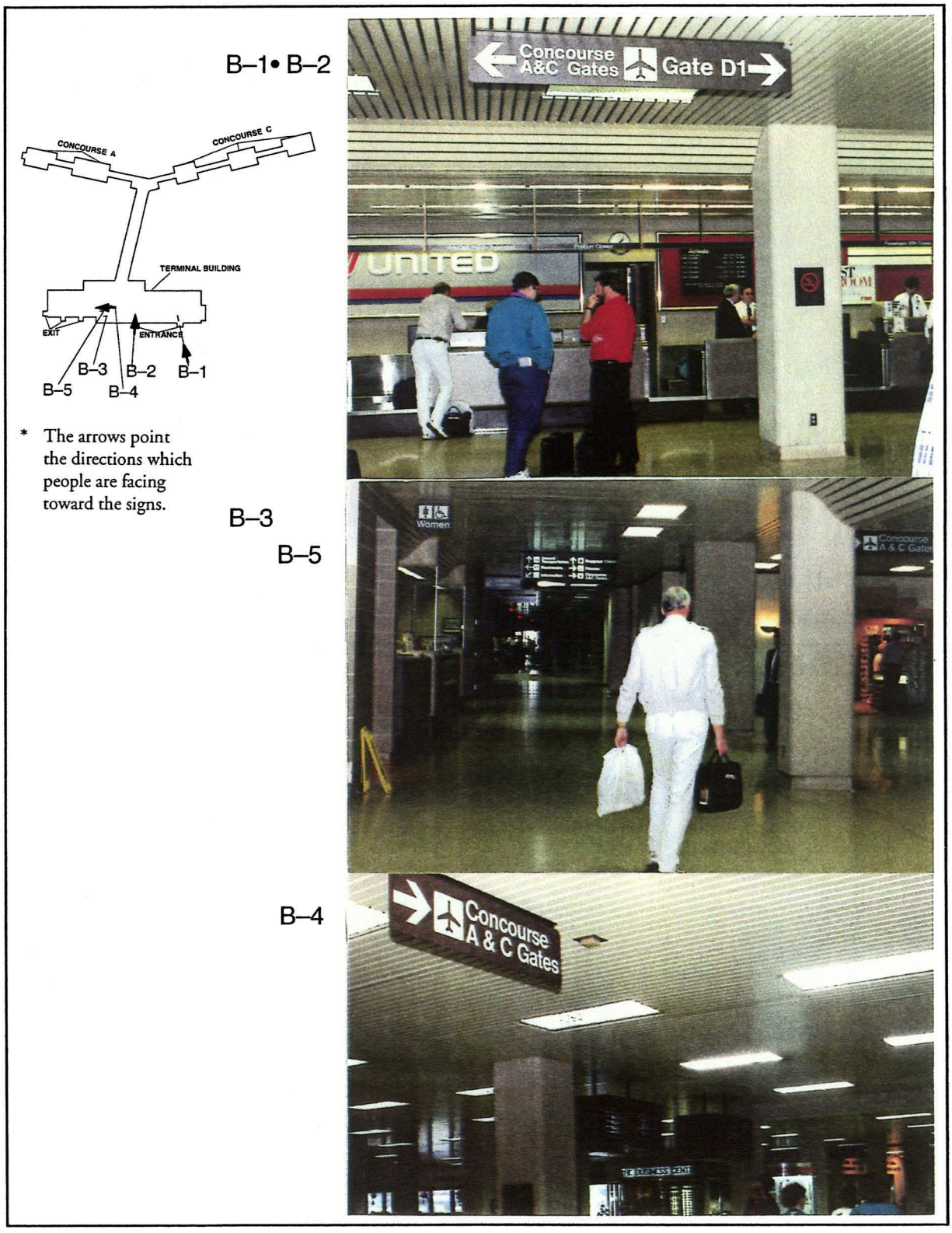
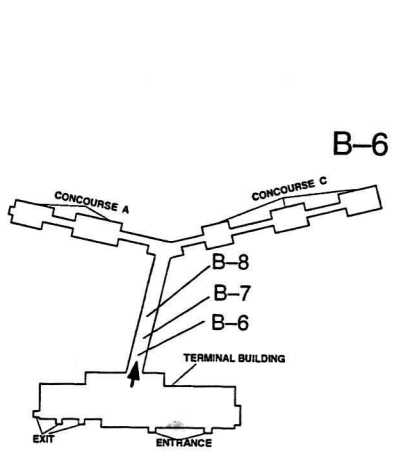


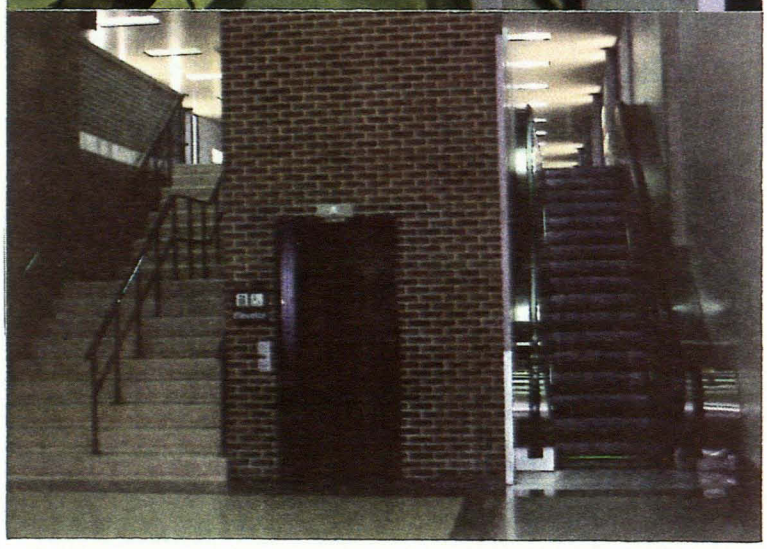
Fig. 20 Signs directing people to the boarding gates (from entrance to elevator)



B–6

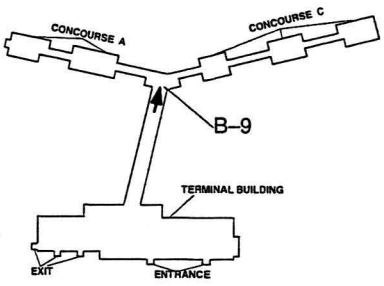
B–7

B–8



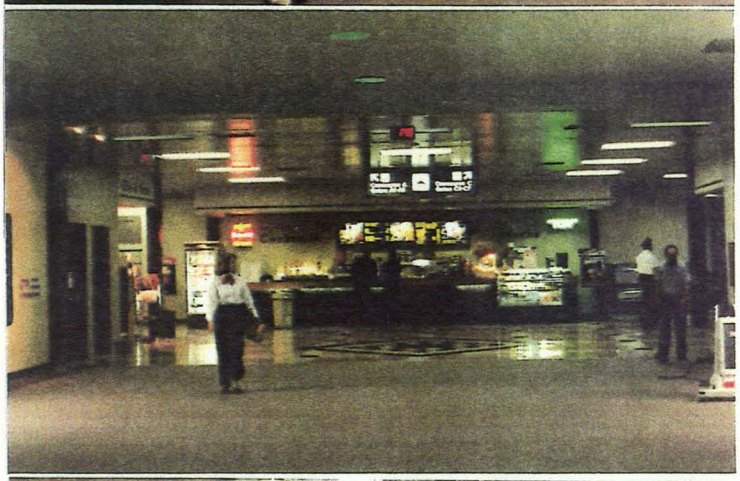
* The arrow points the direction which people are facing toward the signs.

Fig. 21 Signs directing people to the boarding gates (from elevator to security doors)



* The arrow points the direction which people are facing toward the sign.

B–9
(a vista)



B–9

Fig. 22 Signs directing people to the boarding gates (from security doors to concourse)

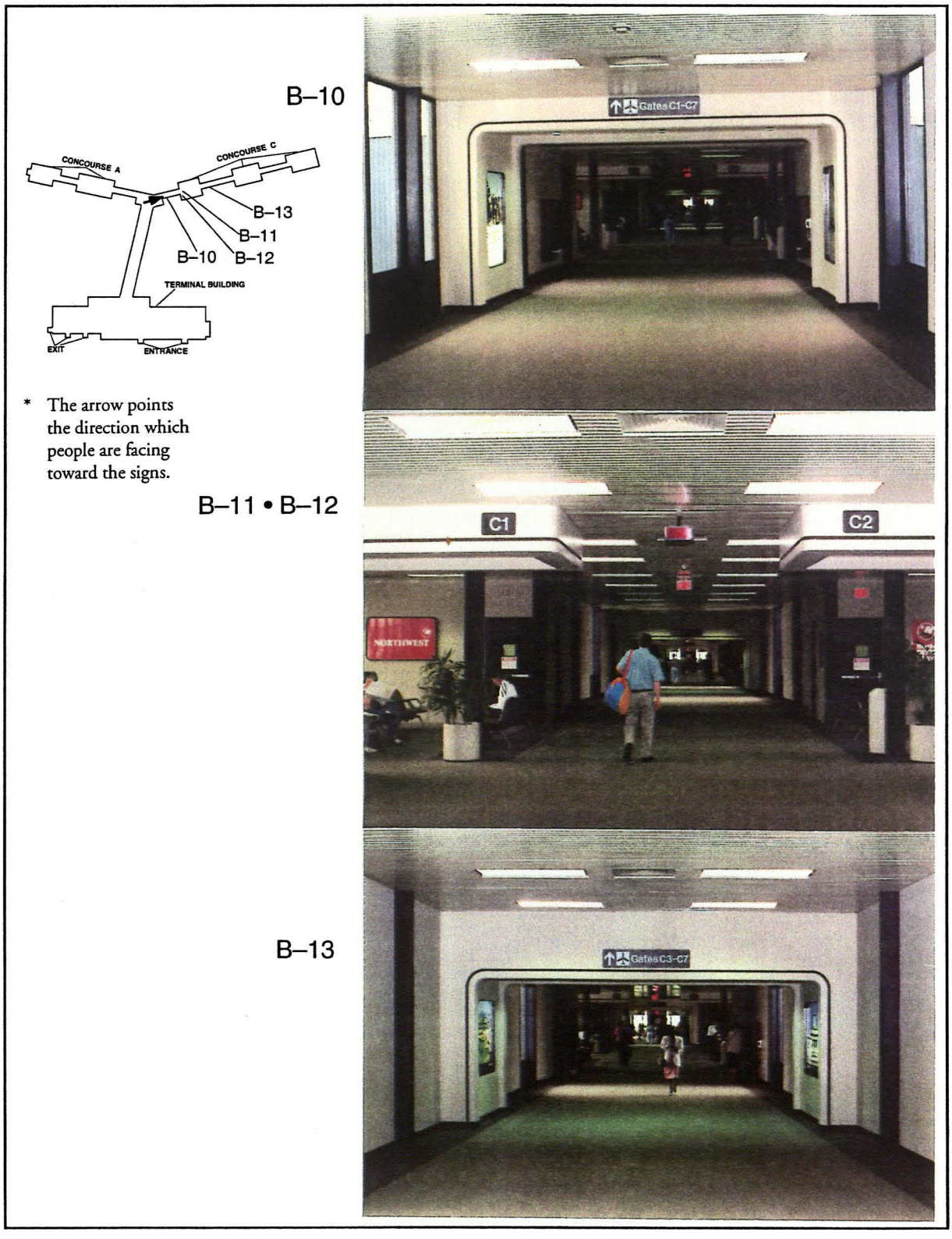
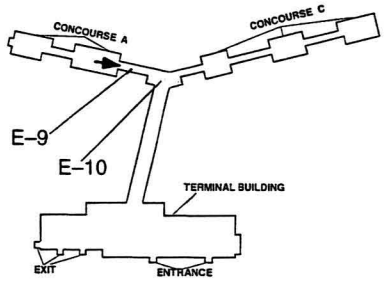


Fig. 23 Signs directing people to the boarding gates (from Gates C1 to C7)

E–9

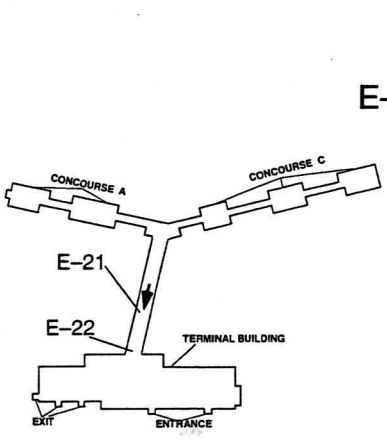


* The arrow points the direction which people are facing toward the signs.

E–10
(a vista)

E–10

Fig. 24 Signs directing people to the exits (from concourse to elevator)



* The arrow points the direction which people are facing toward the signs.

E–21

E–22
(a vista)

E–22

Fig. 25 Signs directing people to the exits (from elevator to ticketing area)

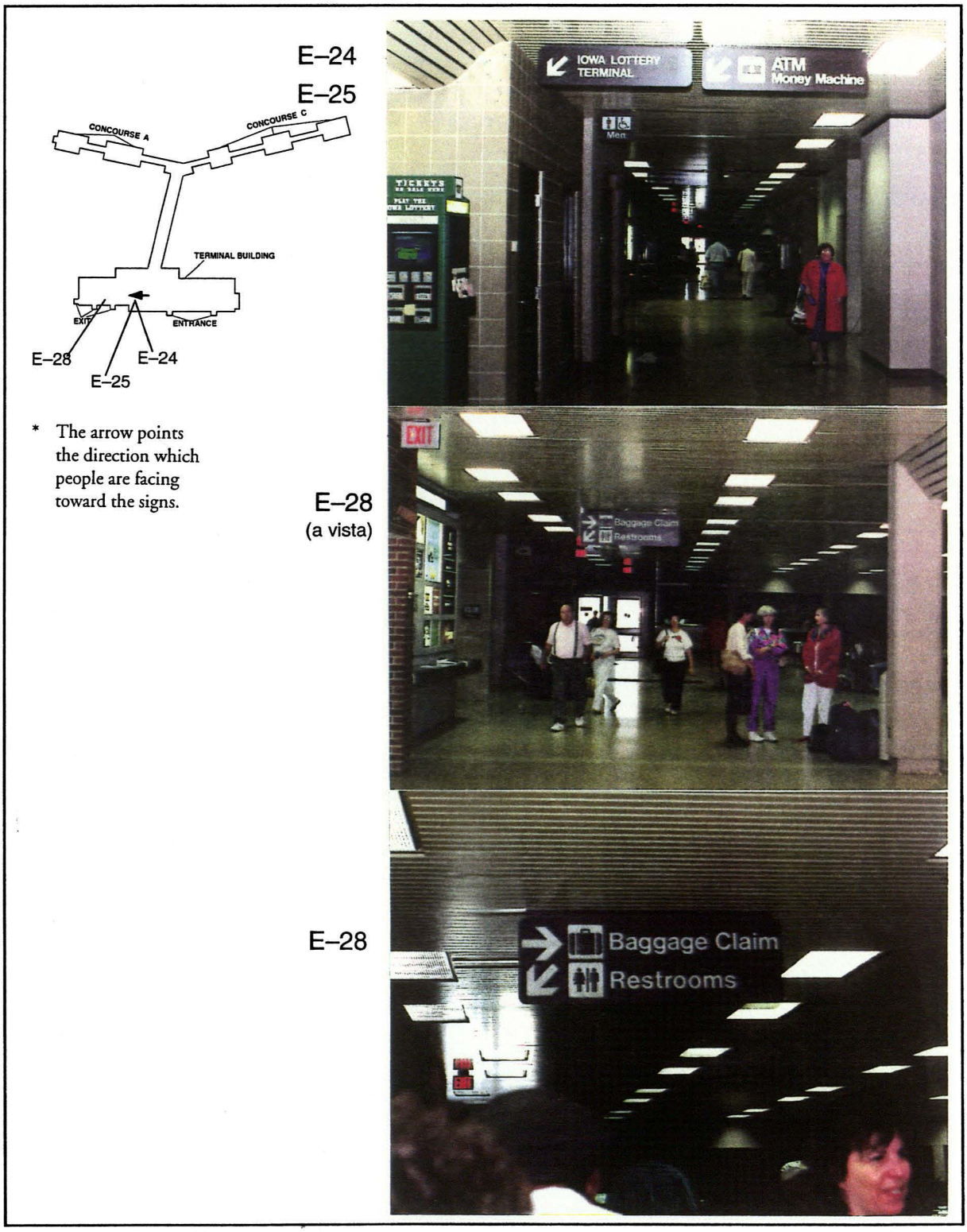
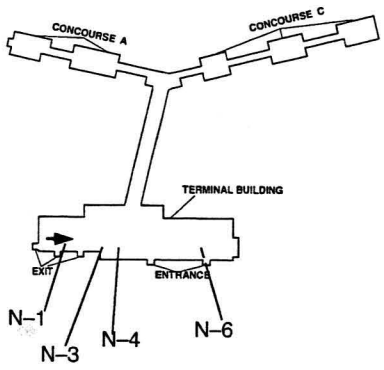


Fig. 26 Signs directing people to the exits (from ticketing area to baggage area)



* The arrow points the direction which people are facing toward the signs.

N–1

N-3

N-4

N–6

Fig. 27 Signs directing people to the boarding gates D1

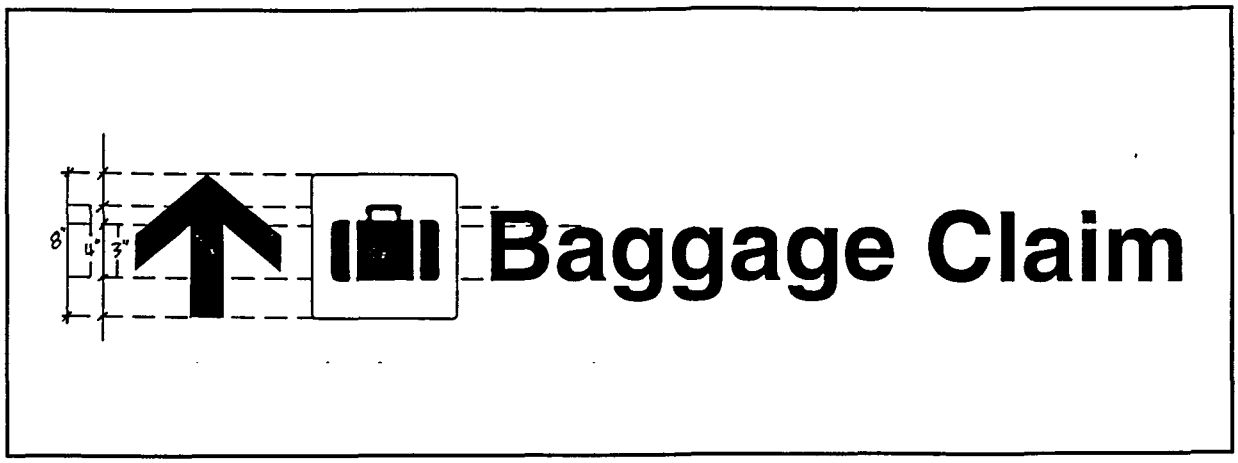


Fig. 28 The standard proportions of the symbols and text

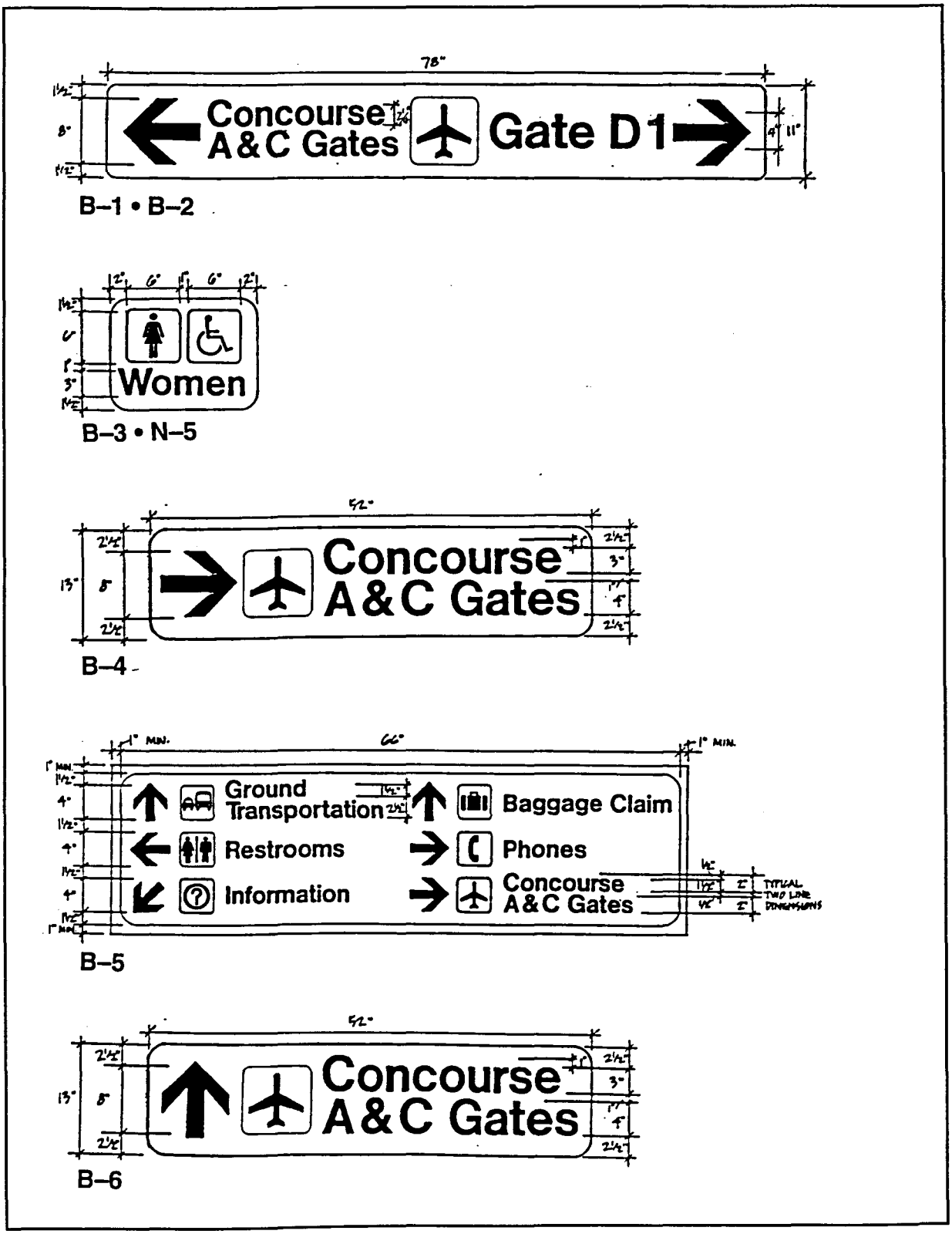


Fig. 29 The measurement of the signs

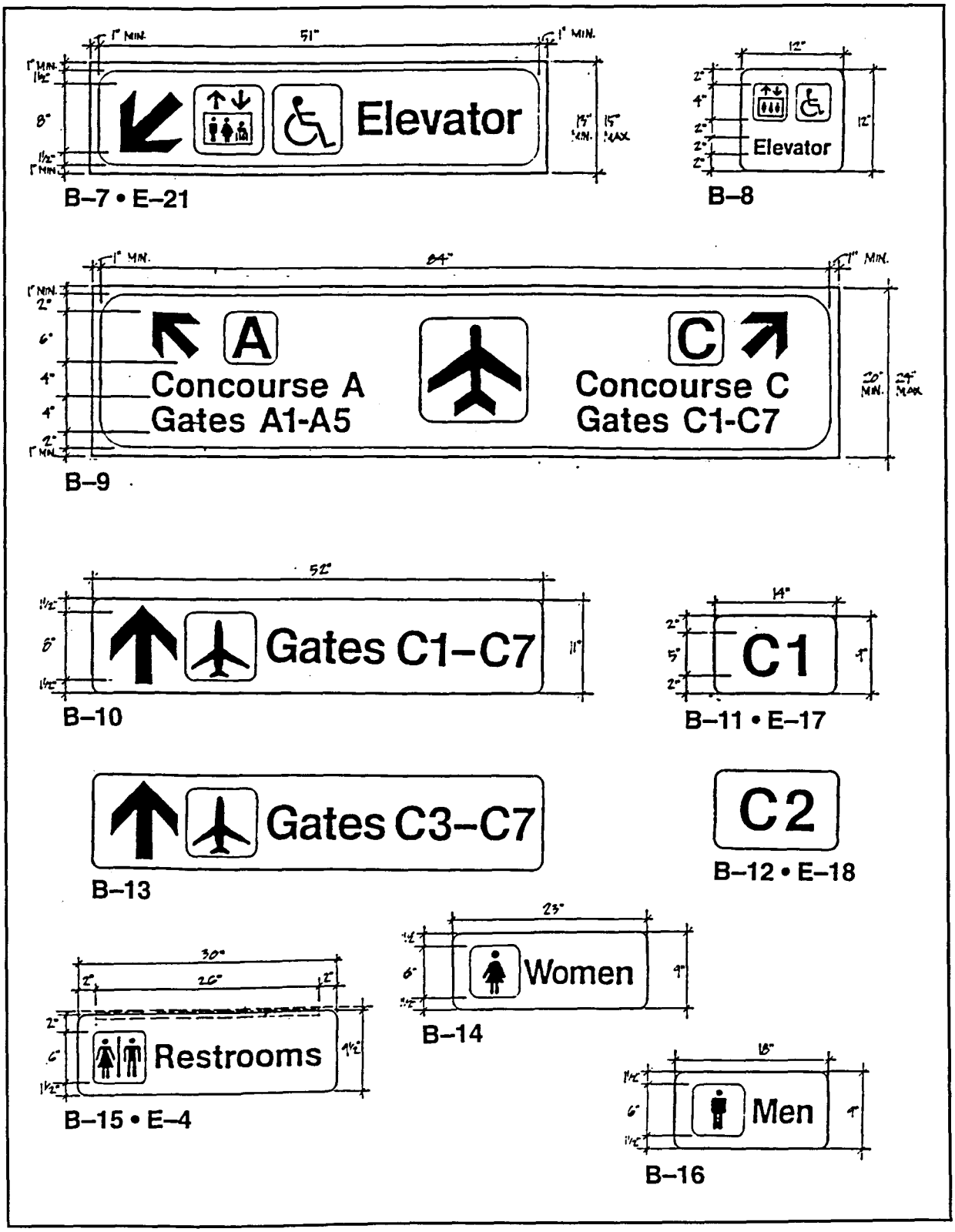


Fig. 30 The measurement of the signs

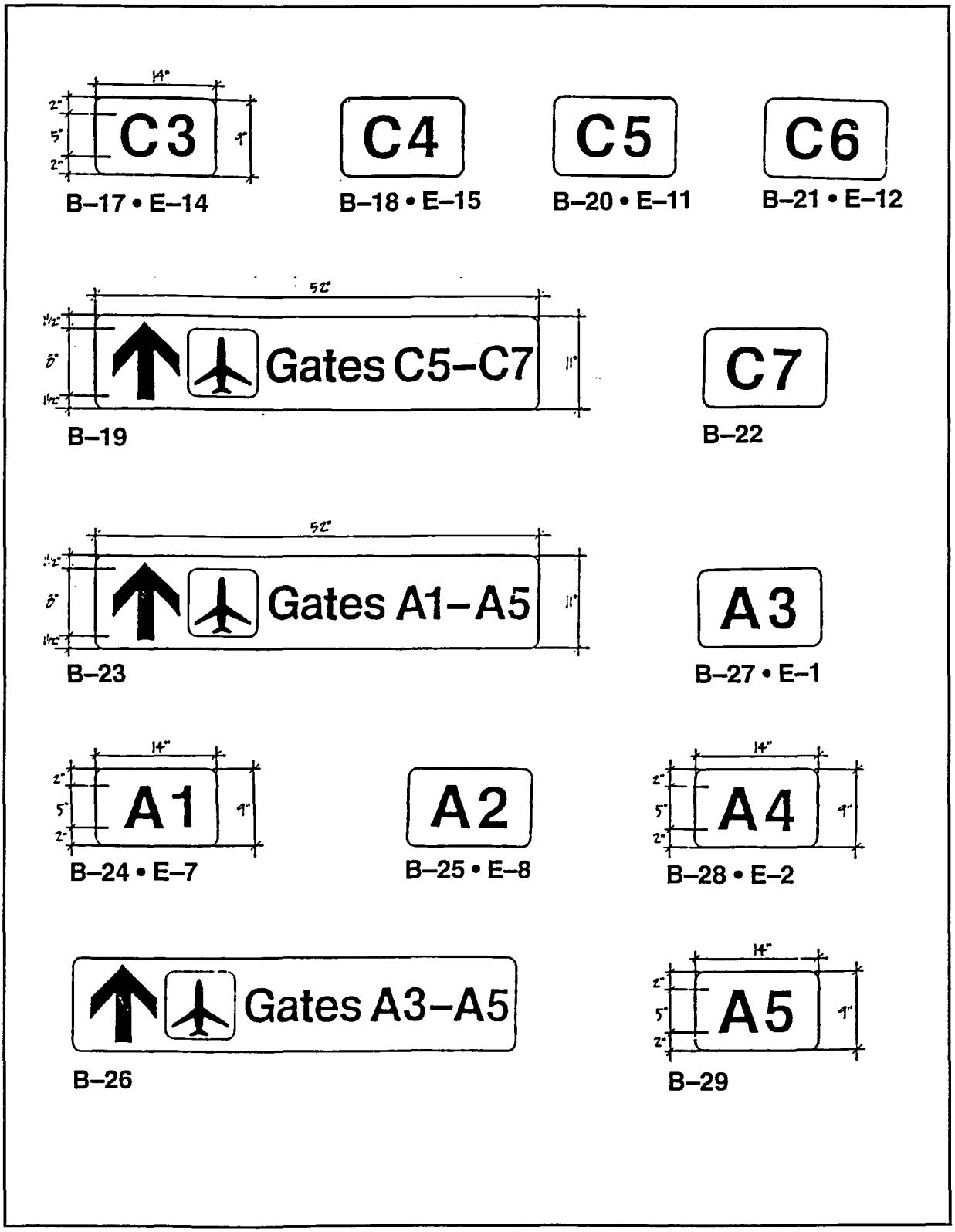


Fig. 31 The measurement of the signs

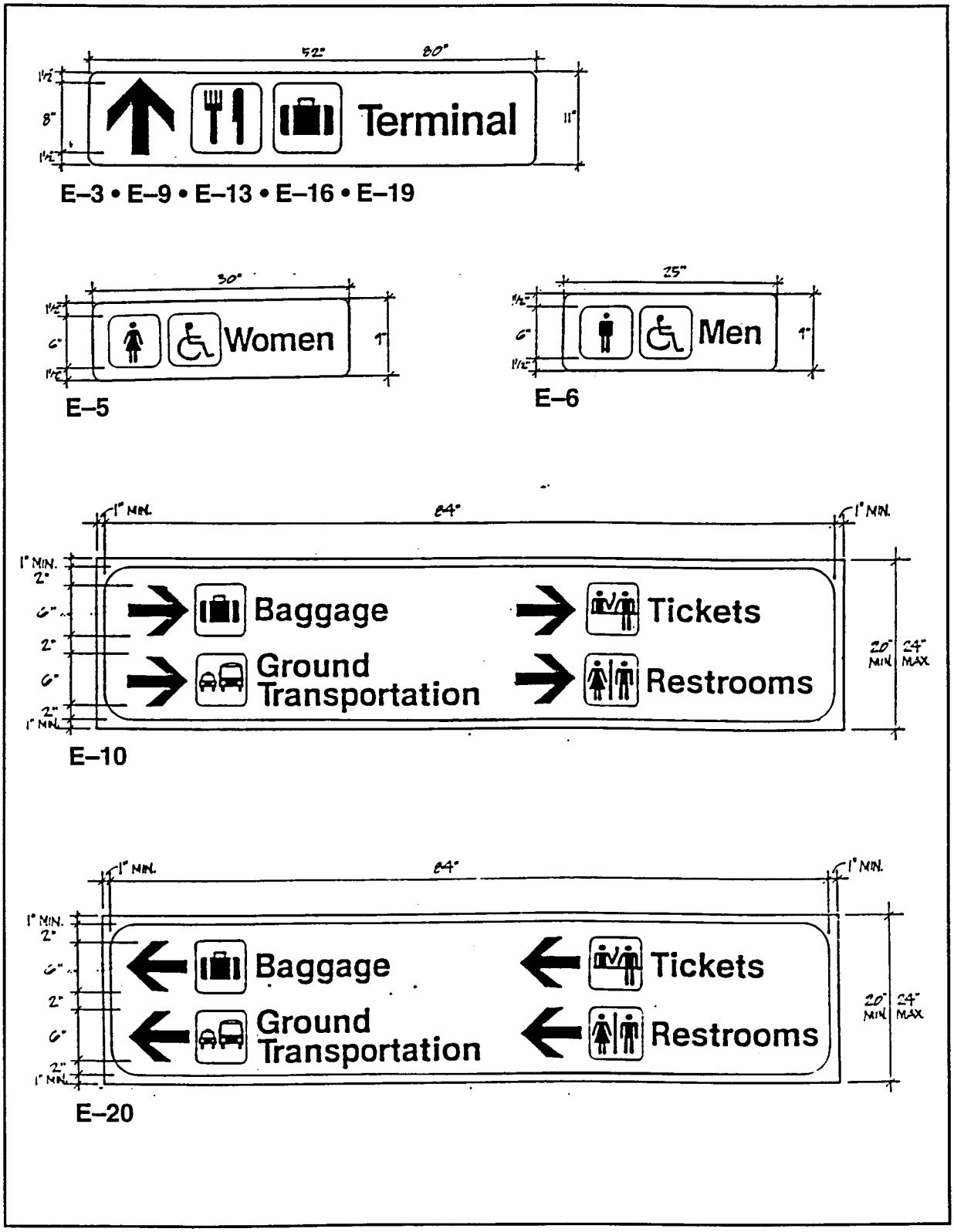
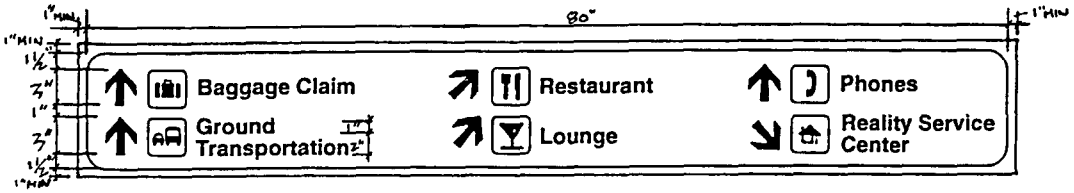
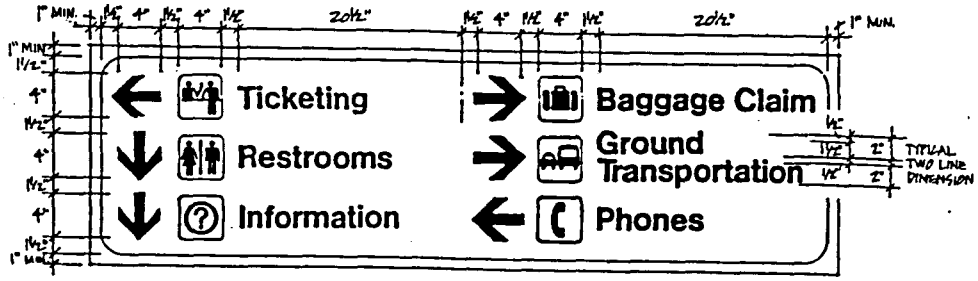


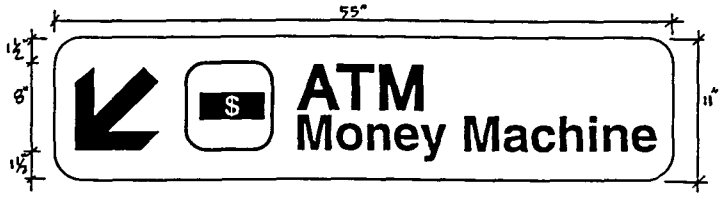
Fig. 32 The measurement of the signs



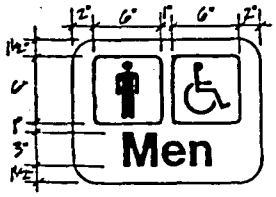
E–22



E–23



E–24



E–25 • N–2

Fig. 33 The measurement of the signs

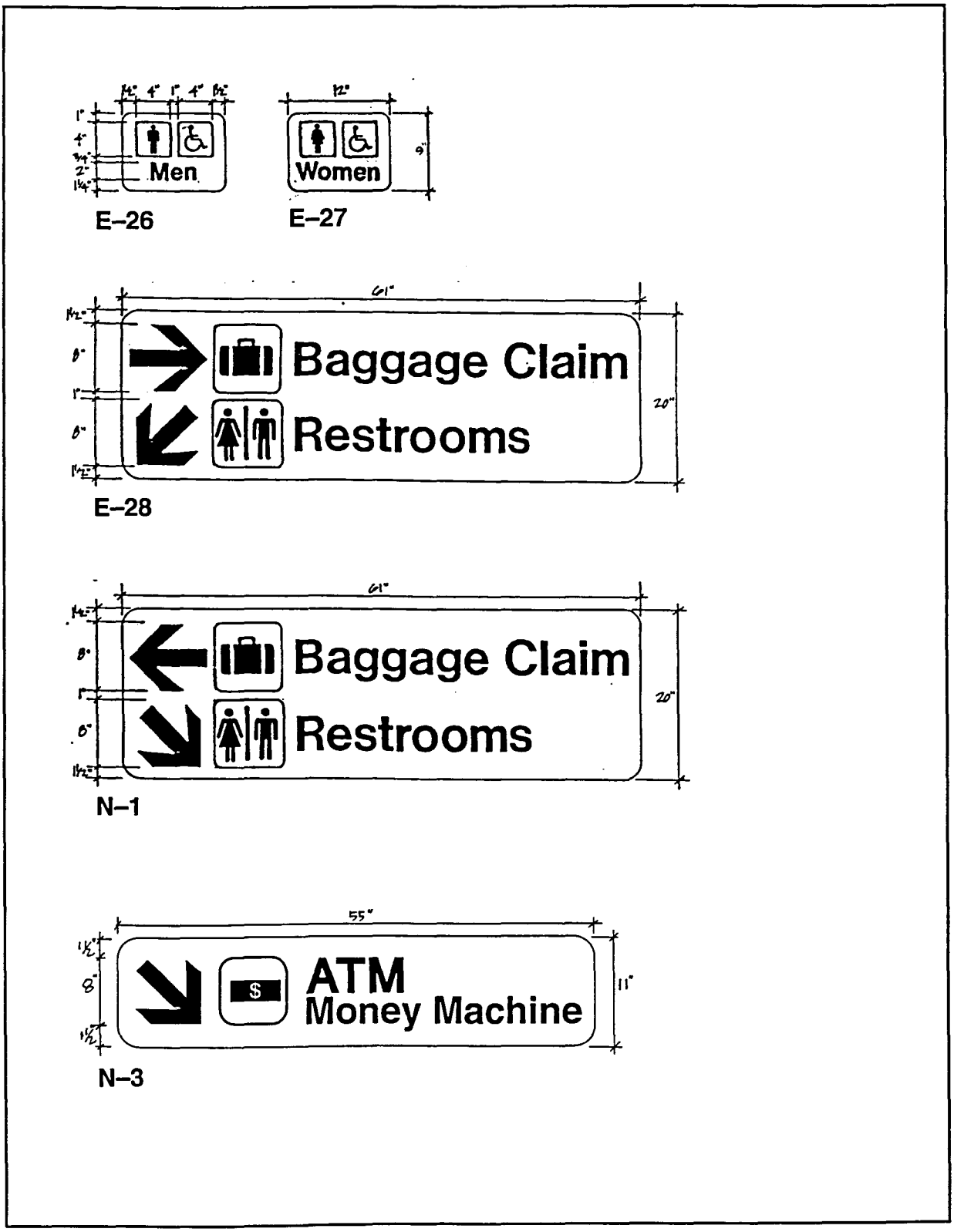
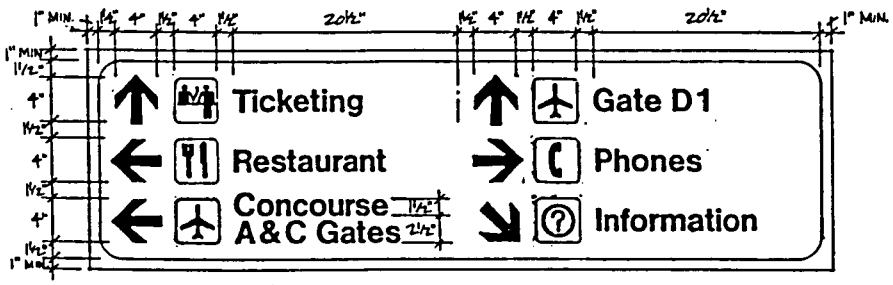
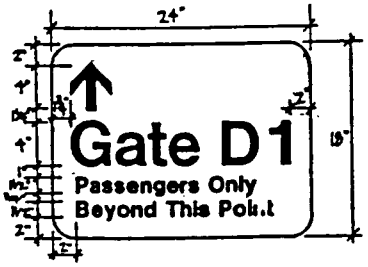


Fig. 34 The measurement of the signs



N–4

N–6



N–7

Fig. 35 The measurement of the signs

The Evaluation of Boarding Signs (B-1 to B-29)

Sequence (4)

In a sign system, "sequence" represents a logical series of informational steps that relate to a viewer's progression through the system. As a passenger enters the DMIA terminal building, he or she has to depend on these signs which are from B-1 to B-29 to find his or her boarding gate. In order to show a clear representation of these signs, they are divided into two parts. One part is from the entrance to the security doors (B-1 to B-8) and another is from security doors to the gates (B-9 to B-29). Signs B-10 to B-22 are displayed in concourse C and signs B-23 to B-29 are shown in concourse A. The sequence of the signs indicates the similarity between concourse A and concourse C after passing through sign B-9 area (the snack bar). This author will only discuss the sequence of signs in concourse C.

At the entryway to the terminal, the sequence demonstrates a clear progression for people coming from the entrance of the terminal to the security doors at B-9. People can easily follow the signs from the ticket area to the elevator and then to the security doors. However, there is an architectural problem when passengers walk through from signs B-2, B-4 and B-6. A column obstructs sign B-4 which is a key decision- making point for people to progress from the ticket area to the gates. The second group of signs (B-9 to B-22) demonstrates very clearly the direction for passengers to get to their gates. Sign B-9 is another key point for decision making. This is where passengers decide whether to go to concourse A or concourse C. This sign is displayed in an appropriate place to assist people and thus avoid any unnecessary confusion. Because of the architectural problem, this element is rated as "good' (4).

Consistency (5)

Consistency plays the most important role in an effective information system. All functional graphic communication elements should be integrated consistently in order to unify a viewer's memory of the sign system. This group of signs presents a great deal of consistency in their color, typeface, type size, spacing, symbol, arrow, sign size, copy layout, and placement. As a result, this part is rated as "excellent" (5).

The Evaluation of Sign B-5

Sign B-5 located near the terminal entrance and the intersection of the ticketing area of the terminal building was selected as an example for the evaluation because it is the largest sign on the way to the boarding gates (Fig. 20 and Fig. 29).

Color (5)

The evaluation criteria for color is based on the most legible to the least illegible color combinations. The higher the contrast of the color combination, the better the legibility. It is particularly important in an ambient light environment. Sign B-5 uses white text on a dark brown (close to black) background. The contrast between dark brown and white is very high, and thus this combination is very easy to read. The selection of color is rated as "excellent" (5).

Typeface (5)

The most important considerations in sign system for selecting a typeface are weight and good legibility. It is important to avoid letters that combine thick and thin strokes, are all capitalized, and use condensed letters. Thus, the medium sans serif typeface (Helvetica) is the right choice in this sign. This typeface is so simple in style and form that the shapes can be easily seen and recognized. So, the typeface is rated as "excellent" (5).

Type Size (4)

The standard ratio of the cap and x-height in the sign system is 3:2. The x-height of the text in this sign is 1 1/2 inches. The farthest viewing distance of this sign (in front of United Airline counter) is 63 feet (the middle picture in Figure 20). The 1 1/2-inch x-height is sufficient for 40 feet or less viewing distance but is not sufficient for 63 feet. Thus, if people want to see the information on this sign, they may need to move approximately 20 feet ahead for better legibility. Because of the smaller type size of B-5, this element is rated as "good" (4).

Spacing (3)

The letter spacing of sign B-5 is very close to half the width of the lowercase letter "o" in its horizontal dimension, which is close to ideal letter spacing. The word spacing of this sign is half the height of the uppercase letters (one unit) such as the space between "Baggage" and "Claim", which is the same as the criteria for a score of "5". However, the spacing between symbols and words, and the spacing between words and arrows is about one unit so that they are viewed almost touching from distance. As the result, this element is rated as "fair" (3).

Symbol (5)

An effective symbol can communicate an idea or message clearly and effectively without words. The symbols of sign B-5 are used from AIGA-developed travel symbols, which are approved and widely used nationally and internationally. It is rated as "excellent" (5).

Arrow (5)

The ideal arrow for a sign system requires a simple appearance, appropriate position and consistently pointed directions to direct passengers correctly through the building. The arrows in this sign are consistently employed in terms of style and pointed directions. They are the same size as the symbols but bigger than the type size. This makes the arrows stand out and get more attention from the passengers. This element is rated as "excellent" (5).

Sign Size (5)

Type size and message length can determine the size of a sign. Ideally, the sign size can be determined by 30 characters per line with a one inch cap height for 20 inches of panel width. When compared to the 2-inch height of uppercase letters for 34 characters per line (one arrow or one symbol equal to two characters), the 66-inch long panel is long enough. This element is rated as "excellent" (5).

Copy Layout (5)

The major concern for information layout in a sign system is consistency, which is the basis of good design and sufficient readability. The copy layout of B-5 is flush left with equal margins on four sides so that it presents an adequate design and readability. The score of this element is rated as "excellent" (5).

Placement (5)

The height of signs will determine their effective legibility for viewers. The guideline for determining the height of the signs in the ranked list is based on the fact that the average height of a viewer's eye level is about 6 feet. The farther a viewer's natural line of vision, the worse a sign's efficiency. Furthermore, an average field of human vision covers an angle of about 60°, within which the details of objects can be seen without turning the head or feeling uncomfortable. Sign B-5 is installed at the height of 9 feet from the floor to the top of the sign panel with a 2-inch cap height. The sign is thus rated as "excellent"(5).

Table 15 shows the result of the evaluation.

The Evaluation of Exit Signs (E-1 to E-28)

Sequence (4)

In this sign system, "sequence" not only represents a logical series of informational steps for people finding their boarding gates (B signs), but directs people from the gates to pick up their baggage in a reasonable progression (E signs). As passengers get off the planes and into the concourses, signs E-1 to E-28 direct them to the baggage claim area in the terminal building. Signs E-1 to E-9 are displayed on concourse A and signs E-11 to E-19 are shown on concourse C.

Table 15 . The evaluation matrix

Evaluated Area: B-1 to B-29							
Elements	**5**	**4**	**3**	**2**	**1**	**Final Score**	**References**
Sequence		√				4.5	
Consistency	√						
Evaluated Sign: B-5							
Elements	**5**	**4**	**3**	**2**	**1**	**Final Score**	**References**
Color	√					4.7	
Typeface	√						
Type Size		√					
Spacing			√				
Symbol	√						
Arrow	√						
Sign Size	√						
Copy Layout	√						
Placement	√						
Score Scale	**5 - 4.1 Excellent**	**4 - 3.1 Good**	**3 - 2.1 Fair**	**2 - 1.1 Poor**	**1 - 0 Unacceptable**		

Because the signs are presented in the same sequence in concourse A and concourse C, this analysis will omit the signs in concourse C to avoid redundancy (E-11 to E-19).

The exit signs exhibit a logical sequence for the passengers from the gates to the terminal building. However, an additional sign between E-10 and E-21 (The top picture in Figure 25) may be needed because there is only a sign for the elevator from the gift shop to the elevator (about 200 feet). The sign system can not provide smooth guidance. People may feel anxious due to a lack of further information. The signs from the elevator to the baggage claim area also indicate a clear and easy to follow sequence. This element is rated as "good" (4).

Consistency (3)

Most of signs in this group are consist with the use of the listed graphic communication elements, but sign E-22 is inconsistent in type size, spacing and sign size. The type size of this sign is noticeably smaller than the other signs. Generally, the type sizes in this system for various sign sizes range from 1 1/2 to 3 inches in x-height. However, the type size of this sign is only 1 inch for about 80 feet viewing distance. To compare the same amount of information with sign size, the proportions of width and length of E-22 is approximately 1:8. On the other hand, the proportions of E-23 is 1:3.6. Obviously, sign E-22 is inconsistent with the other signs in the proportions of type size and sign size. Moreover, the spacing between the first column of copy and the arrows ("Baggage Claim" and "Restaurant") is extremely wide. As a result, this part is rated as "fair"(3).

The Evaluation of Sign E-10

Sign E-10 was selected as an example for the evaluation because it is displayed at the intersection of three corridors: concourse A, concourse C and the terminal building (Fig. 24 and Fig. 32).

Color (5)

This sign uses the same color combination as B-5. The discussion of the rating scale is the same. The color in this section is rated as "excellent" (5).

Typeface (5)

Sign E-10 uses the same medium sans serif typeface (Helvetica) as the previous sign. The typeface is rated as "excellent" (5).

Type Size (4)

The x-height of the text in this sign is 2 1/4-inches. The greatest viewing distance of this sign is about 80 feet. The ideal type size is a 1-inch x-height for 20 to 30 feet of viewing distance. So, the 2 1/4-inch x-height type size can only provide about 70 feet of viewing distance. As a result, this element is rated as "good" (4).

Spacing (3)

The spacing of the copy in this sign is consistent with the previous sign. The spacing between symbols and words is about one unit, which is less than the three units of ideal spacing. This element is rated as "fair" (3).

Symbol (5)

The symbols of this sign is also taken from the AIGA-developed travel symbols. They are rated as "excellent" (5).

Arrow (5)

The quality of arrow in sign E-10 is the same as in the previous sign. This element is rated as "excellent" (5).

Sign Size (5)

E-10 is part of a two-sided internally illuminated sign and consists of four messages. With 4 1/2 inches height for uppercase letters and a maximum of about 35 characters per lines, the 84-inch long panel is sufficient for an adequate legibility. This element, thus, is rated as "excellent" (5).

Copy Layout (5)

The copy layout of this sign is similar to the previous sign. It is rated as "exceilent" (5).

Placement (5)

The placement of sign E-10 is about 9 feet height from the floor to the top of the sign panel. The rating of the sign is "excellent"(5).

The results of the evaluation are shown in Table 16.

Table 16. The evaluation matrix

Evaluated Area: E-1 to E-28							
Elements	**5**	**4**	**3**	**2**	**1**	**Final Score**	**References**
Sequence		√				3.5	
Consistency			√				
Evaluated Sign: E-10							
Elements	**5**	**4**	**3**	**2**	**1**	**Final Score**	**References**
Color	√					4.7	
Typeface	√						
Type Size		√					
Spacing			√				
Symbol	√						
Arrow	√						
Sign Size	√						
Copy Layout	√						
Placement	√						

Score Scale	**5 - 4.1**	**4 - 3.1**	**3 - 2.1**	**2 - 1.1**	**1 - 0**
	Excellent	**Good**	**Fair**	**Poor**	**Unacceptable**

Summary

An effective sign system communicates information clearly. It enables people to familiarize themselves in unfamiliar surroundings, to find their way to destinations easily and comfortably, to move without confusion from zone to zone, and to notice and understand regulations and information about special conditions.

The architecture of a building influences the level of the need for signs around and within the building. However, a successful environmental communication system not only fits in with the architecture, but also integrates effective interior signs and exterior signs. The average score for evaluating sequence and consistency is 4 (4.5 and 3.5, respectively) in the Des Moines International Airport building. This result indicates that the information system in this environment communicates effectively. Although there are a few problems in the graphic communication elements, the scores for individual signs are remarkably high (4.7). The individual signs provide appropriate color, functional typographic factors, clear symbols and arrows, effective sign size and copy layout, and suitable placement for the necessary information.

The exterior signs on the way to the terminal building are unclear and provide insufficient information. Several signs are installed in very inadequate positions and some of the signs lack clear information to direct people to the DMIA. Improvements should be considered by the city of Des Moines.

RECOMMENDATIONS

Although the sign system in the Des Moines International Airport terminal building is effective, it still has several problems that need to be improved. The following recommendations are intended to improve the present system and enhance the effectiveness of the system.

The major problem of this sign system is the spacing between the text and symbols. The text and symbols are too close together to separated from a certain viewing distance. It is recommended that the space between text and symbols be increased. Because sign E-22 has been installed in an important position and illustrates several problems, the comparison between the original sign and an improvement is demonstrated in Figure 36.

The original type size of E-22 is exceedingly small (1 inch for x-height), and thus it can not support about 80 feet viewing distance. In order to be consistent with the system, the x-height of type size should be increased to 3 inches, 4 inches height for uppercase letters and 8 inches of symbols, for better legibility.

When designing a sign system, the module and grid is the most effective approach. The improved space of one unit is one-half the height of the uppercase letters. In order to be consistent with the signs in the system, the space between symbols and arrows is one unit, but the space between words and related symbols should be increased to three units. The original space between one message and the arrow of the next message is too large, so that the sign can not be seen as a whole. Five units are used to give the appropriate space for separating two set of information which are still seen as one sign.

Because of the increased type sizes and spaces, the size of the sign increases to a 23-inch wide and 160-inch long panel.

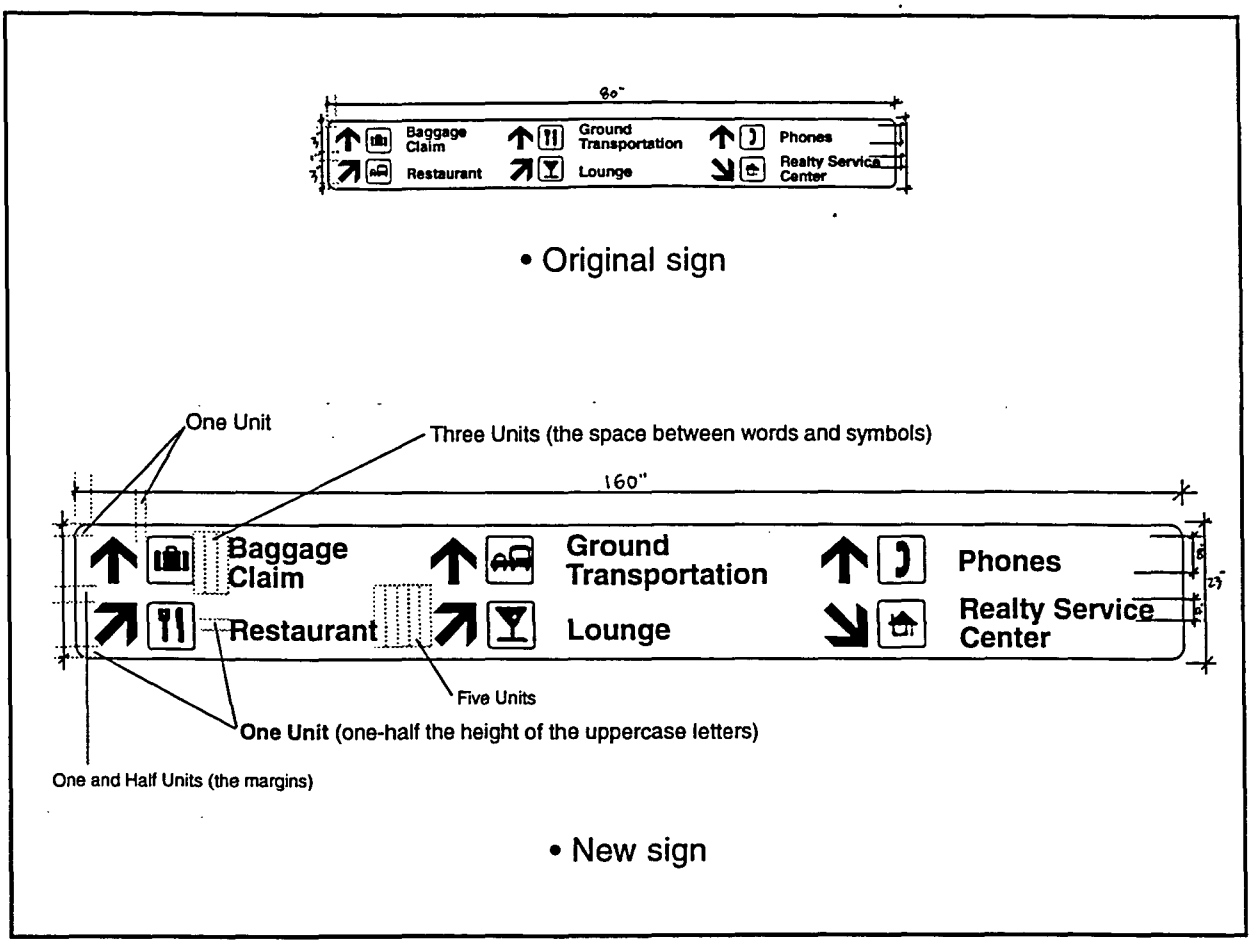


Fig. 36 The improvement of the sign E-22

The second recommendation for this system is to install an additional sign between signs E-10 and E-21 because E-10 is the only sign that indicates the information about the terminal building in the concourse. People may feel anxious when they arrive at an unfamiliar environment without any proper information for more than 200 feet. A new sign, illustrated in Figure 37, can be installed about 90 feet away from the security door on the way toward the elevator.

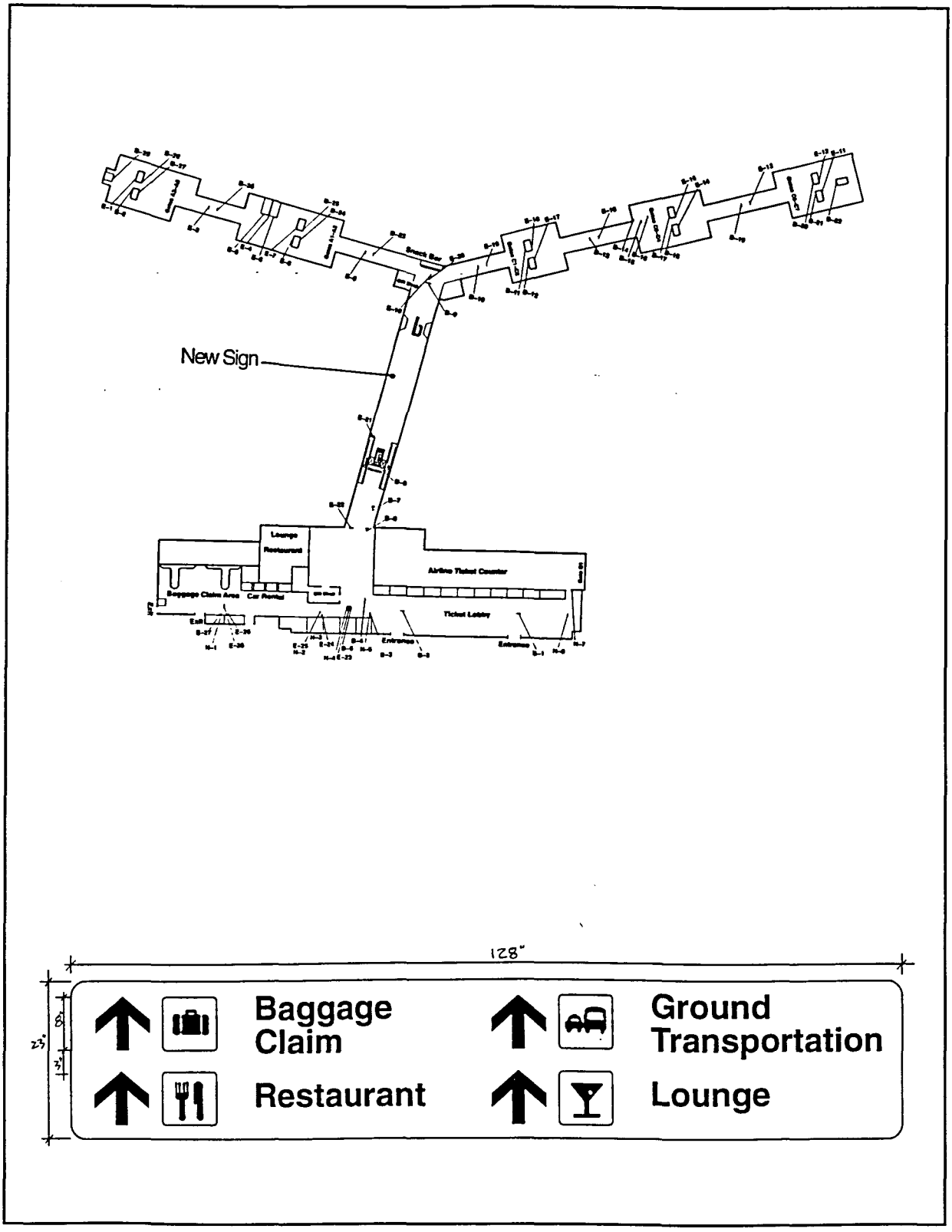


Fig. 37 An additional sign in the sign system

CONCLUSION

It is important to evaluate the effectiveness of a sign system in terms of the functional communication between the environmental graphic designers' work and the users. According to John Lubans and Gary Kushner, to evaluate a sign system is not to find a "scapegoat" for a poorly received sign design, but rather to use an evaluation which provides essential feedback on the needs of users (ed. Pollet and Haskell, 1979).

In order to evaluate a sign system, it is essential to develop a workable rule-based system which can be used to conduct a visual analysis of the sign system. The criteria of the rule-based system consists of graphic communication elements. The rules and guidelines for these elements, such as color, typographic factors, symbol, arrow, copy layout, placement, and material, provide useful information about the effectiveness of the sign system. Because of its rational basis, a rule-based system enables one to make an objective judgment on the outcomes. Without this rule-based system, there is no standard to evaluate a sign system, but only personal likes or dislikes.

The rule-based system may not be useful for evaluating every sign system, because of the variations in environments. It is impossible to include every kind of condition within the criteria. When evaluating a sign system, it is very important to collect all of the necessary information about the specific environment and to analyze the relationship between the guidelines and the environment. Then, with experience and practice, comes the judgment appropriate to evaluate a specific sign system project.

An effective environmental communication not only includes factors which affect the sign system, but integrates qualities of the architectural space. The Des

Moines International Airport provides an example of a successful sign system, but it is important to keep in mind that the scale of this airport is extremely small. Because of the scale it provides a manageable environment for the implementation of this sign system.

As new technologies have provided more convenient transportation systems for international travel, many countries around the world are opening their doors to millions of visitors. Effective graphic communications must be international and allow for cultural variations. For example, the color red may represent danger or warning in some countries, but it may express an idea of happiness or luck in other countries. A further study should be conducted with respect to the effect of multi-culturalism on the environmental communication process. Much of the existing research about sign systems has omitted the study of cultural differences in environment communication. It is worth noting that culture greatly affects the communication process.

An ideal sign system can be likened to markers on a path and can provide a chainlike series of information for the users. A viewer can depend on the information provided to make decisions more quickly. Existing researche indicates that a "walk-through" simulation is the best approach for determining the sequence of the signs. However, since individual perceptions on messages and wayfinding may be different, further study of the effective signs in a viewing sequence should be conducted by environmental graphic designers.

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