B o W

Advancing

Icon Design

for Global

Non Verbal

Communication:

Or What Does the
Word Bow Mean?

Advancing Icon Design for
Global Non Verbal Communication:
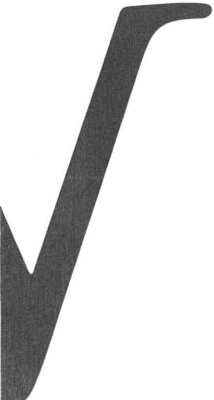### Or What Does the Word Bow Mean?

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ABSTRACT

Written language is limited in effectiveness to those who can read. Verbal language is effective only for those who understand the particular language being spoken. But everyone, except those with obvious visual impairment, can effectively perceive images without regard for literacy or language. For decades these realities have suggested the promise of a universal visual language but with little real result. The occasional Olympic event sign or restroom door sign are state of the art for global non-verbal communication. While icon design has evolved little since the 1970's, the world has moved on. Increasing economic globalization and the expansion of global communication networks have made it easier to deliver messages and more important to do so, while science has advanced understanding of perception and cognition establishing principles only speculated about in the 1970's. The dream of using images to greatly facilitate global communication persists. Unfortunately, image-based communication is not currently well enough informed by principles of effectiveness to attempt such a project.

To address this problem a team of researchers assembled at the University of Cincinnati to explore the development of advanced techniques for global non-verbal or image based communication. The team explored novel approaches and identified several principles designed to expand icon based communication so that it can communicate more complex messages and more abstract concepts with greater specificity than previously.

bow

What does the word "bow" mean? Several things, but the most accurate answer is it depends on the context.

To illustrate:

shoe | bow
ship | bow

arrow | bow
rain | bow

take a | bow
bow | down

IN EACH OF THE ABOVE PAIRS SOMETHING SPARKS a different meaning for the single typographic sign: "bow." That something is simply another sign, a context. In some pairs the context sparks a meaning that is only subtly different, no doubt in homage to the vagaries of linguistic etymology, but in other instances the context spotlights a meaning that is a different part of speech altogether, a verb instead of a noun for example. In each case context is what illumines the meaning (Wittgenstein, 1961 [1921]). This is as true for sentences and stories as it is for words (Wright, 1992). Unfortunately, written language though rich in context is limited in effectiveness to those who can read. Even verbal language is effective only for those who understand the particular language being spoken. But everyone, except those with obvious visual impairment, can understand images without regard for literacy or language. Donis A. Dondis even goes so far as to claim "Among illiterate constituencies, visual communication's effectiveness is undisputed"(Dondis, 1973). From street signs to Olympic venues, images communicate where words fail.

What exactly does the icon of a man mean? Again, it appears to depend in part on the context:

street sign | human icon
park sign | human icon
airport door sign | human icon
(left to right Figure 1 below)

The visual changes in the human icons are minimal and fairly subtle yet, in their context, viewers from all over the world have 'read' these icons as meaning specific and very different things: a crosswalk, a hiking trail, a restroom. In a park context adding two additional strokes to the man icon suggests a backpack and walking stick. The park context combined with two immediate iconic clues redefine the 'crosswalk' icon to a hiking trail icon. Like words, the overall context of the human icon changes its meaning. This is an impressive transformation accomplished with an economy of means.

However, as successful as these icons are in their contexts, they are not as comprehensive or as definitive as words. The system from which the hiking icon came has no icon for 'pleasant hiking trail' or 'difficult hiking trail' or even 'dangerous hiking trail.' Complex messages that include specific modifiers or actions or states of being are not generally communicated in current icon systems. One standard icon system, published by the American Institute of Graphic Arts (AIGA) and United States Department of Transportation (US DOT), consists of fifty icons. That's a good number but it's not enough of a vocabulary for communicating complex messages. More comprehensive attempts at developing universal systems of communication such as Isotype and Esperanto, are widely regarded as having failed (Lupton, 1989). Apparently the sophisticated role context plays

FIGURE 1

in linguistic communication has not been successfully duplicated in visual communication.

How can the inadequacies of communicating with icons be overcome? What role does context play in causing a viewer to read a 'walking man' icon as 'crosswalk' not 'hiking trail?'

Would placing the restroom man icon on the yellow background of a street sign context change the reading *(figure 2)*? How much of any reading change that results from the new context is learned? Is any part of altered meaning, the color yellow for example, a change that is integral to human perception and cognition rather than learned? How do more abstract elements, such as the rectangular containing shape standing on its corner and the linear border, interact with the more literal element of the man icon to suggest meaning? How can the icon be refined to express complex messages such as abstract concepts, states of being or processes? These are some of the questions addressed by the research on which this paper reports.

Context: a Strategy for Building Sophisticated Message

CONTEXT'S ABILITY TO CHANGE THE MEANING OF WORDS made it an attractive field in which to search for answers to visual communication questions. Perceptual psychologist Rudolf Arnheim (1969) affirmed that everything is affected by context, "The mind meets here, at an elementary level, a first instance of the general cognitive problem that arises because everything in this world presents itself in context and is modulated by that context." Arnheim goes on to say that because everything is af-

FIGURE 2

fected by its context, to understand how an object is perceived you can either abstract it by removing it from its context or you can analyze both the object and its context.

The object under consideration must, then, be abstracted from its context. This can be done in two fundamentally different ways. The observer may wish to peel off the context in order to obtain the object as it is and as it behaves by itself, as though it existed in complete isolation. This may seem to be the only possible way of performing an abstraction. However, the observer may wish to find out about the object by observing

all the changes it undergoes and induces because of its place and function in its setting. Here the abstraction, while singling out the object, does not relinquish the effects of the context but relies on them for an indispensable part of the information.

Communication designers in the past have followed the first part of Arnheim's advice and abstracted the object primarily by peeling it from its context. In the AIGA/US DOT symbol/sign system and other similar systems, the context is erased by limiting iconic signs to an object on a plain, unadorned, blank background (see analysis below). This effectively isolates the object from its context. But as Arnheim goes on to say, this is not the only means of abstracting an object. What Arnheim implies above and goes on to say subsequently is that by retaining context additional communication potential is also retained. Designers who wish to develop more robust icons might follow the later part of Arnheim's statement and focus on expanding rather than limiting context as a means to communicate more precisely. This is exactly what is proposed here.

Contextual Complexity

Context is a profound, but not necessarily a simple, concept. In the complex field of exegesis, which develops principles for the accurate interpretation of texts often in ancient languages in Biblical studies, context is a rich principle of interpretation. Exegetes identify multiple levels of context. Each level has a different degree of effect in determining the meaning of a word or text. One illustration given is that of concentric circles of context (Osborne, 1991). Picture concentric circles of contextual influence with the key word at the center and each successive concentric circle representing a different kind of context. In this model each successive circle has less influence on defining the meaning of the core idea. The target word is placed in the center. The most immediate and most influential context surrounding the center is the phrase surrounding the word. The next circle of influence would be the passage, then the chapter, the book, then other works by the same author, other literature in the same genre and historic period, other writings in the same language in different historic periods and so on to the global context. Each circle helps both to clarify and to amplify the word meaning.

This conceptual model has possible parallels with the reading of icons. Images in general, and icons in particular, live in various contexts. As a starting point, it is possible to envision three levels of context for a given icon: the Immediate Context of an individual icon, the Proximate or System Context of an icon in its local or immediate setting with other icons and the Environmental Context of the icon. These three contexts are proposed based on observation of the role of context on existing icon systems (see AIGA analysis below), and concern over adopting the greater number of contextual layers from the field of exegesis in the early phases of such a study.

Environmental Context
The Environmental Context may be defined as the environment in which the images function, not the images themselves.
The importance of environmental context is suggested in existing icon systems. Airport signs are in airports, creating an apt context to promote the reading of an airplane icon as meaning 'departing flights.' What the same airplane icon might mean in a funeral parlor, a museum or a hospital is intriguing to consider, but it almost certainly would not mean 'departing flights.' In the funeral parlor the airplane icon might take on a metaphorical meaning for the movement of the dearly departed, or even as a crude joke sparking offense. In a museum it might offer the promise of an exhibition of historic aircraft. In a hospital it might mean pure confusion or might not be read as an airplane at all. Study should be done, but even this mental experiment suggests the importance of context in general, and of environmental context in particular, in establishing the meaning of icons.

Proximate Context
The Proximate Context might be described as the field of interaction where images in a system interact with other images in the same system. An overarching graphic style is what often creates a proximate context. By definition, no system of images works alone. Image systems frequently employ devices to circumscribe themselves: a bounding box or border, setting themselves off from their environment while defining an internal context for interaction. These 'framing devices' bridge the Proximate and Immediate contexts, often serving to define

individual images while stylistically linking one image in a system to another. These 'framing devices' are seldom neutral. Often they carry a communication message of their own such as the shape of highway signs. Graphic novels, comics, are a well cited example of a highly developed system of supporting images and devices that enhance communication (Ashwin, 1989, 208.) As has been stated previously, the Environmental Context influences the reading of images placed within it. It may be surmised from the 'circles of context' in exegesis that Proximate Context has more influence on meaning than Environmental Context, but that has yet to be established by this study.

Immediate Context

The Immediate Context may be defined as the local space, defined by some boundary, where elements of an image interact with each other to form an integrated message. Rudolf Arnheim in *Visual Thinking,* (1969) quotes Gustaf Britsch as formulating "the earliest condition of visual thinking as follows: 'An intended spot is detached from a nonintended environment by means of a boundary.'" The boundary or containing shape forces objects within it into formal and cognitive association. Through perception and visual thinking, we strive to solve the riddle of association and find meaning. Some form of graphic containment, a frame, often creates an Immediate Context particularly even if that graphic element is a restrictive 'white space.' Within a field of containment, images are not read as solitary, single objects but as associated ones. For example, in Figure 1 the walking man in the middle image is not seen as a man and a rectangle on his back and a line, but is seen and interpreted together as a unit: man | burden on back (backpack) | line (walking stick) = hiking. Another aspect of Immediate Context relevant to this study because of the study's exploration of reading image sequences is the role of focal point in a reading process. Because our eyes have a small field of detailed focus, and because that focus can be directed around the visual field, the immediate context can and does change even within a single image. Immediate context works within the Environmental and Proximate contexts and though influenced by them are still separated from them. Again, based on principles of exegesis, it may be tempting to surmise that Immediate Context is most relevant for reading meaning, but that remains unproven.

Summary

Through our study we hypothesized that manipulating and expanding the context of images would enable the reading of more sophisticated messages from images alone. But before examining the ways context can be used to guide the interpretation of images, a little more needs to be said about the nature of images and how they function in communication.

Images

WE UNDERSTAND MORE OF THE WORLD around us through visual perception than all the other senses combined (Ware, 2004; also Gregory, 1997). Individuals from all over the world, with little or no training, are able to not only understand reality through perception but to identify images and associate them with objects or activities (Ware, 2004). Using images for communication is quite ancient. Tombs in Egypt dating from millennia before Christ contain hieroglyphic symbols describing the life and the after life of the tomb owner. Starting from the Christian era in the West and continuing to today, images and icons were used extensively for communication of spiritual truths regardless of literacy or language. In the twentieth century, icons have been in use for communication in secular environmental graphics. Several of these twentieth century icon systems were designed specifically to communicate across linguistic barriers in international venues through highway signs, airport and transportation signs and Olympic signs.

Images clearly communicate, but exactly how images communicate is still not fully understood even though diverse ways that images might function in communication have been described. In Malcolm Barnard's recent summary, he describes Jacques Aumont as having three image functions: symbolic, epistemic and aesthetic, and others as defining four image functions: Information, Persuasion, Decoration and Magic (Barnard, 2005).

Clive Ashwin, in his 1974 article "Drawing, Design and Semiotics," classifies signs into three groups, saying:

> Following Peirce's lead (Charles Sanders Peirce, *Philosophical Writings of Peirce*) signs have traditionally been classified into three groups, each with numerous possible subdivisions. The index is a sign that arises as a result of, or in congruity with, the thing that it signifies. Classic examples are the

foot-print as a sign of an earlier presence at a given spot or smoke as a sign of fire. The icon (from the Greek word for image) is a sign that bears similarity or resemblance to the thing it signifies. Road signs that present a schematic image of, for example, animals or vehicles fall into this category. Finally, the symbol is a sign which bears no apparent resemblance to its related signified, but operates within an agreed set of conventions.

For purposes of this study, we developed a three-fold definition of image function similar to that proposed by Ashwin, but based on the terms used by Rudolf Arnheim in *Visual Thinking*, (Arnheim, 1969) because, quite simply, Arnheim's definitions more closely match the current English usage. We defined three image functions as: picture, symbol and sign. In the usage here, symbol and icon are nearly synonymous.

Image Functions and Degrees of Abstraction
Picture Function
IN COMMUNICATION IMAGES serve different functions. Some images function by representing a literal object while others represent a concept or idea. The range from literal to abstract defines one visual attribute associated with these various image functions (Arnheim, 1969). Arnheim suggests that literal representational images such as pictures or photographs often serve a 'picture' function, that is, they are less literal than what they represent. For example, a photograph of President Kennedy is an abstraction of the living person. A drawing may be even less literal than a photo, yet such a drawing may still function as a picture in so far as it represents the specific individual characteristics of John F. Kennedy while still being an abstraction of him. Literal or representational images present enough essential features of an individual instance to evoke that instance in a viewer's mind. Images serving a picture function abstract only to the point where individual characteristics remain discernable. Pictures evoke an instance of an object.

Symbol / Icon Function
Less representational images such as pictograms, symbols or icons often serve a 'symbolic' or 'iconic' function. Symbols are more literal than what they represent because an image serving a symbol function does not represent a specific object but a category of objects or an object concept. A concept is more abstract than any

particular representative object used to express it. A symbol or icon comes to represent a concept or category through a process of abstraction limiting particular features in favor of those general features shared by an entire class of objects (Dondis, 1972, 71-72). For example, an icon of a man on a restroom door represents the male gender, not an individual or specific man such as Grandpa John. More abstract representational images tend to serve a symbol or icon function. Literal or representational images present enough essential features of an individual to evoke that individual in a viewer's mind. Images serving a symbol function abstract to the point where those features essential to the concept are visualized. Symbols evoke a class or an object concept.

Sign Function
Graphic images such as letterforms serve a 'sign' function. These signs communicate content without reference to any particular visual attribute of the thing being represented. Numerals and letters of the western alphabet are signs. For example, the letters "Grandpa John" function as signs in so far as they represent a particular individual but probably look nothing at all like him. Images that serve a sign function are abstract and not representational.

Evocative?
A fourth image function might be proposed for images that are abstract but not representational. These images communicate but without representing a specific object. For example, an orange glow might suggest heat. In the study described here, these images serve to evoke or modify the meaning of more representational images. Highly abstracted visual forms tend to serve what might be called an evocative function.

Icon Construction
Icons, images that serve a symbolic or iconic function, are created by visualizing the essential features of a class of objects while excluding features inessential to the class. A chair icon might illustrate four legs, a seat and a back while excluding visual forms that illustrate details such as the material of the legs: wood, metal, plastic; the seat: fabric, padding, wood, metal, plastic, etc. The essential features are drawn visually in a simplified, abstracted, form so that only the essence of the

object category is communicated. The ability of simplified icons to suggest the essence of objects has been widely demonstrated in media from posters to computer screens (Meggs, 1992).

Thus far: two basic concepts have been proposed here as means to enhance non-verbal communication: context and image abstractness. As a first step, these will be used to analyze an existing icon system to validate their workableness as theoretical models. Then, these concepts will be used to identify novel creative opportunities to enhance non-verbal communication.

Context and Image Abstraction in Existing Icon Systems

DURING THE TWENTIETH CENTURY several icon-based sign systems were developed with similar themes and approaches. Beginning with the 1936 Olympic games in Berlin, Olympic events through the current day have developed distinctive systems of pictograms to aid communication with participants from various countries who have different languages. Concurrently, transportation hubs such as airports developed pictogram-based signage systems. As these systems developed it became apparent that they shared a common iconic approach with subtle variations. In the 1970's government agencies such as United States Department of Transportation, in conjunction with private organizations such as the American Institute of Graphic Arts, initiated efforts to identify the best icon systems and standardize them in an effort to further facilitate global communication. These efforts produced standards for icons for use in public spaces, particularly transportation related facilities.

AIGA/US DOT *Symbol Sign System*

Analysis of these icon systems reveals that they are effective at communicating objects at a basic level. For example, of the fifty icons in the AIGA/US DOT Symbol/Sign system published in 1974 and revised in 1979, forty-three are primarily tangible things or physical objects (AIGA/Hora, 2004). Using linguistic terms, these are labeled in Figure 3 as NOUNS. In several cases, the AIGA/DOT system effectively applies the contextual principles described above to clarify the meaning of these objects.

Immediate Context

The AIGA/US DOT system exhibits use of Immediate Context: icons combined in the same space to clarify meaning, as evident by the combination of icons within a single bounding box. For

example, the man icon or some variant of it is used in combina-
tion with other icons for eleven of the symbol signs. In several
cases the man icon combined with another icon suggests a new
meaning:

Man | bed = Hotel
Man | water box = Drinking Fountain
Man | seat + clock = Waiting Room
Man | open box + small irregular shapes = Litter Disposal
Man | scissors + comb = Barber Shop

In each case the icons are read together and a new meaning
is formed. The integrated meaning is different from how the
individual icons would likely be understood alone. A clock alone
would be ambiguous, suggesting time but not waiting room.
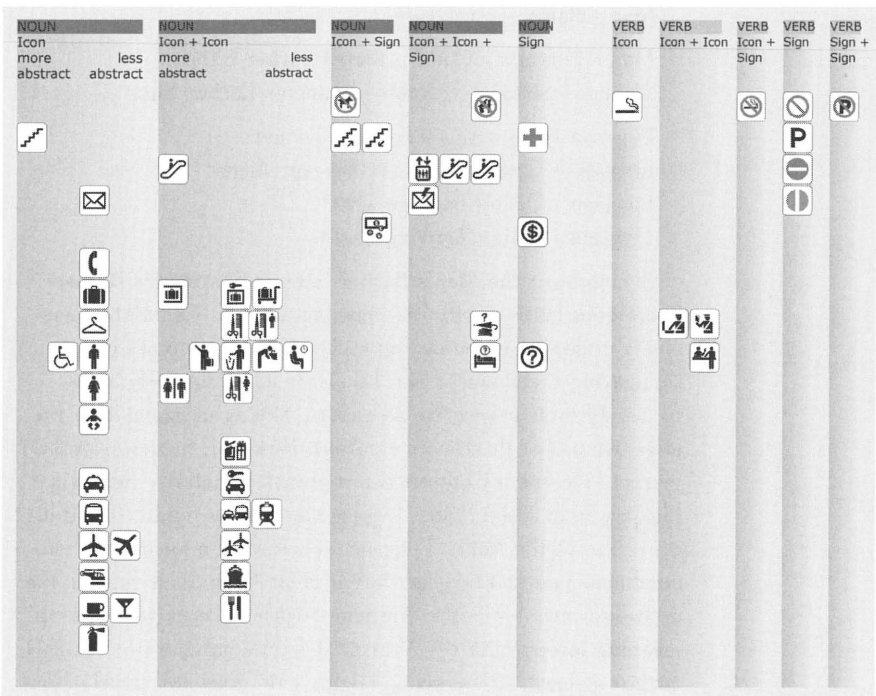A box with water spewing out could mean toilet, sink, washing

FIGURE 3
AIGA/US DOT Symbol Sign System Analysis

or something else, but in the context of a man icon is seems to suggest drinking fountain. Each of these seems to clearly suggest a tangible object: Hotel, Drinking Fountain, Waiting Room, Trash Can (litter disposal), and Barber Shop. The closest any of them comes to communicating an action is Litter Disposal and in reality it more precisely indicates the location of a trash can, not the action of disposing.

Proximate Context
Proximate Context, one icon or icon combination in a system relating to another to clarify meaning, is also evident in the AIGA/DOT system from its repetition of icons and overall consistent graphic style. In several of these cases the icon combination relates to a similar icon combination in another symbol to clarify the meanings:

Man + Containing Box = Elevator
Man + Ramp = Escalator

Man + Scissors + Comb = Men's Barber Shop
Woman + Scissors + Comb = Women's Barber Shop

Luggage + Box + Key = Baggage Lockers
Luggage + Open Box = Left Baggage Area
Luggage + Cart = Baggage Cart
Luggage + Man = Arriving Flights

Seeing both the Men's Barber Shop and Women's Barber Shop icons helps clarify the meaning of each. Certainly once one is understood the meaning of the other becomes clear. Comparing the Elevator and Escalator icons similarly helps to clarify their respective meanings. This is an example of the effective use of Proximate Context. However, in the AIGA/DOT system Proximate Context is not always so helpful. Seeing a Luggage icon and a Man + Luggage icon helps guide the interpretation of the Man + Luggage icon toward a meaning which combines man and luggage, but it is far from decisive that the delivered meaning is the 'Arriving Flights / Passenger Pick-up' meaning intended in the AIGA/DOT icon combination. For this author at least, the Arriving Flights icon does not clearly communicate the intended meaning on its own and trying to use proximate context to clarify its meaning could prove disastrous. Used singly, the man icon stands for 'Men's Toilet.' Clearly, this meaning is not to be transferred to the man + luggage icon

combination. Trying to do so would suggest, at best, men's luggage. Apparently social conventions (there is no men's specific luggage) and environmental contextual clues rule out such miscommunication. However, it seems possible to build a system where proximate contextual clues would be meaningful. In such a case icons designed to work together to clarify and reinforce meaning would build consistently upon their individual meanings. The AIGA/DOT system clearly does not always do this. It is unclear how much, if at all, the AIGA/DOT icons were designed to use Proximate Context for proper interpretation.

Environmental Context
The AIGA/DOT system functions in various environments, but based on analysis of the icons themselves, the system has an airport or transportation venue environmental context. Ten of the fifty-plus icons specifically identify transportation types and five are devoted to baggage issues. It appears that the creators of this system conceived of the system in a transportation context and assumed the support of this context for part of the system's success.

Degrees of Abstraction
The overarching visual characteristic of the AIGA/DOT system is a high degree of abstraction. Each image serving a symbol or icon function has been reduced to a very simple but still recognizable visual form. Complexity and detail have been eliminated. Straight lines and arcs and circles dominate. Heads, headlights and coins are all circles. Shoulders are arcs, while arms, legs and bedposts are all straight lines. Lines do not vary in width. Line endings are uniformly flat or semi circular. This degree of simplicity corresponds to the kind of abstraction associated with representational images serving a symbol or icon function as described above. The system is well crafted in its simplicity and its consistency of abstraction. There are however, variations, as noted in Figure 3. The icon for stairs is simplified along the lines of a diagram or cross-section, as are the icons for escalator and luggage storage. In the AIGA system these variations are very minor but they suggest the possibility, perhaps the necessity, of using varying levels of abstraction to communicate varying levels of conceptual complexity.

Accompanying the highly abstracted representational images in the AIGA/DOT system are highly abstract non-representational

images serving a sign function. As stated previously, signs are images that communicate content without reference to any particular visual attribute of an object. One example of a sign is a letterform or punctuation mark. In the AIGA/DOT system, images serving a icon and sign function are combined in several symbols:

Umbrella + Glove (icons) + Question Mark (sign) =
    Lost And Found
Man + Bed (icons) + Question Mark (sign) =
    Hotel Information.
Steps (icon) + Arrow (sign) = Stairs
Box + Man + Woman (icon) + Arrows (sign) = Elevator

Dog (icon) + Negation Circle (sign) = No Pets
Gun + Knife (icons) + Negation Circle (Sign) = No Weapons

The first two use a letterform sign, the question mark, which is familiar to readers of western alphabets. Two others use a conventional directional sign, an arrow. Others use a more recent convention that represents "do not," the 'negation circle.' In each case, the sign meaning is not self evident but must be learned. The use of these particular signs is apparently widespread enough across cultural and linguistic boundaries to work, though it could be argued that they privilege readers of Western alphabets. Some of these combinations benefit from reading in Proximate Context, the Man + Bed icon mentioned above for Hotel is combined with a question mark sign to communicate Hotel Information.

Whether the images serve a symbol or a sign function, they are highly simplified, one or two flat (no tone) color images on a plain background. There are several possible explanations for the level of abstraction of the AIGA/US DOT system, ranging from prevailing style to a commitment to an international or modernist philosophy. From a range of options at least two seem likely and relevant: the signage function with its environmental context and production techniques associated with signage.

The AIGA/US DOT system is frequently used in signage. Signs, "posted notices bearing a designation, direction, or command" (*American Heritage Dictionary*), serve the function of labeling and instruction in public spaces. As stated earlier, Environmental Context plays a significant, perhaps defining role in the

interpretation of images and therefore in their design. Icons designed for a signage context take a visual form relevant to that context. The visual form of the AIGA/DOT and similar signs may have been even more specifically influenced by their display in transportation environments such as airports, highways and Olympic competitions where movement and traffic flow are important considerations.

In addition, it may be surmised that the simple visual form of these icons was influenced by prevailing production techniques associated with signage. Signage production techniques through this period generally limited signs to simple graphic shapes in one or two flat colors with few or no photographic images. Even if these techniques were not specifically held in mind, there may have been a commitment by the designers to designing these icons so that they would reproduce well using the lowest quality reproduction means imaginable, further limiting complexity.

Whatever the motivation, it's logical that contextual and functional needs have shaped the visual approach of the AIGA/ US DOT and similar systems. There is nothing wrong with this approach. But it is reasonable to conclude that in order to advance the development of icons and symbols we might explore possibilities beyond limitations of simplicity imposed by past contexts and technologies. Released from past limitations, new approaches might be less simple but more effective at communicating complex messages.

Summary: as stated previously, the AIGA /US DOT system is effective in many cases at communicating simple messages about basic objects and their relationship to physical things: water fountains, baggage, elevators and the like. However, this is far short of the goal identified in this paper to visually communicate more complex messages and more abstract concepts. In linguistic terms, the AIGA/US DOT system uses mostly nouns. Only seven of the fifty icons attempt to deal with an action or state of being. All seven of these resort to the use of the sign function that is learned and privileges Western alphabets. This means the AIGA/US DOT iconic language is not truly global. It has few verbs, and no systematicallowance for modifiers such as adjectives and adverbs. The AIGA/ US DOT images all serve an icon function with very similar degrees of abstraction.

The limitations make it understandable why this system and those like it are unable to communicate complex messages involving not only things, but also processes or states of being. Until these limitations are overcome, the communication of more complex and abstract messages using images alone is likely to remain an unreachable goal.

Applying context and levels of abstraction to the analysis of the AIGA/DOT system demonstrates that these concepts are both suitable and profitable. They are suitable because they help provide insight into how the system works and how it might be made to work better. The role Proximate Context might play in the 'Arriving Flights' icon is an example of an insight that might be used to clarify the system. They are profitable because they suggest that conventions of simplicity might be based on the Environmental Context and past production limitations rather than an essential aspect of iconic communication. If this is true, it suggests that a single, high level of abstraction may not be necessary for an image to function as an icon and that an expanded context and various levels of complexity might be profitably explored as means to enhance nonverbal communication.

Expanding Context: a Strategy to Enhance Non Verbal Communication

AS THE FOREGOING ANALYSIS SUGGESTS, manipulation of context and degrees of abstraction are meaningful theoretical foundations to use to analyze the limitations of existing systems and might provide a meaningful theoretical basis for developing techniques that expand context and therefore overcome limitations in current icon systems. As examples of ways to build on this foundation, three techniques for manipulating context are described below:

Expand Immediate Context: Icon Combinations through Layering,

Expand Immediate Conceptual Context: Degrees of Abstraction,

Expand Proximate Context: Sequence.

Expand Immediate Context through Layering

COMBINING MORE THAN ONE ICON IN A SHARED SPACE is a simple but rational way to expand Immediate Context. The interaction of two icons in a shared space was shown to have created new meaning in the AIGA/DOT system. Where the AIGA/DOT system places icons together but does not touch or overlap them, the UC team

explored overlapping icons in layers and altering their stacking
order as a controlled means of modifying meaning. The intention
was to add icon to icon to stimulate a new, third meaning that
was both different from and more specific than the meaning of
the icons seen individually.

For different icons to be read as a unit the team discovered
that the icons must be forced into association. The principle
applied to accomplish this was called 'icon containment.' In
order to encourage that separate layered icons be read and
interpreted together the team created a common containing
device, in the first cases, a square. A square was selected as
being simple in form, neutral in meaning and self-contained.
In the square, icons were stacked together on top of each other
in various layers. The effect was analyzed.

A demonstration of the efficacy of this approach is shown in
Figure 4. A definite shared space was created. In this space two
icons, selected in a nearly random fashion from an icon-based
font (Zapf Dingbats), were placed so that they were contained
at least in part in the same space and in at least some measure
overlapped each other. A new meaning seems to be formed.
The stacking order was switched and checked for new meaning.
A new meaning seems to be formed by the change in the stack-
.ing order. A lot of unanswered questions are raised even in this
simple study. What role does containing shape play in expres-
sing meaning? What is suggested when one object breaks out
of the containing shape to some degree but the other doesn't?
For example, does the wholly contained object tend to have
a more passive voice than the object that extends beyond the
container? What is the role of position and value in affecting
the meaning in the stacking order? Answers to these and other
questions one might pose regarding this study are unknown.
This highlights a key difficulty in researching design and com-
munication: the number of factors and the complexity of inter-
action among visual attributes that lead to intended meaning.
More studies will have to be conducted to examine the relative
roles of containing shape, icon position within or outside it,
stacking order, value, size and position.

In order to further test the ability of icons to form new
meaning through combination, a similar procedure was employed
using icons, again selected nearly at random, in this case from

the AIGA/US DOT and related Society of Environmental Graphic Designers (SEGD) systems *(see figure 5)*. The three icons in the first instance are hiking man, stairs and gift shop. These are given immediate context by placing them in a shared space. A new meaning is implied that is different from any of these icons seen individually *(see original icons in figures 1 and 3)*. It does not matter that the original 'meaning' of the icons be recognized, in fact, for the purpose of this study it is significant if the original meaning is not preserved.

In the second example in this series the drinking fountain icon replaced the gift shop icon. A newer, more narrative meaning is the result. This suggests rich story telling possibilities for icon combinations. The narrative in figure 5 suggests action without directly visualizing it: 'a person with a load is climbing stairs past a person drinking at a fountain.' In iconic terms this is an object + object + object narrative: man + stairs + man
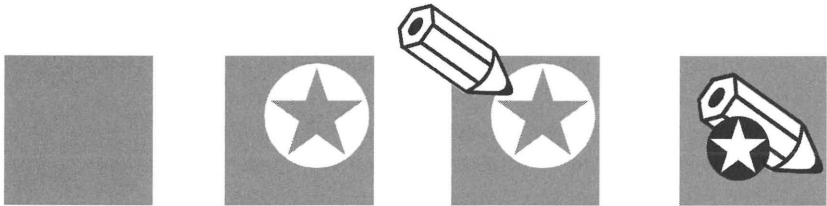

FIGURE 4
Left to right: Containing Shape, Base icon, Secondary icon layered over Base icon forming a new meaning.

drinking: noun + noun. The action is suggested by the combination of visual nouns, not stated overtly by using an action icon. Though implying an action using only visual nouns is theoretically interesting, the team theorized that the visual equivalent of a verb and a visual modifier will be needed to communicate at a level approximating language.

Expand Immediate Context with Degrees of Abstraction

AS STATED EARLIER, images serve different functions in part due to different degrees of abstraction in representation. The study of icon layering suggested that images serving different functions might combine effectively to clarify meaning. In Figure 4, a pencil and a star were combined. While both images seem to serve an icon function, the pencil is less abstract than the

star icon. The star is nearly a sign: an image that communicates a learned meaning without particular reference to an object, similar to the arrow in the AIGA/USDOT system. What effect, if any, comes from the combination of degrees of abstraction on the communication?

To answer this question an attempt was made to create icon combinations representing more than just objects (a pencil and a star). The team created a modifier image, approximating an

Evocative Function (above), hypothesizing that this kind of expansion might provide more targeted meanings for iconic communication. To test this theory, a more abstract modifier image was designed to relate to the message of the two icons used in Figure 4 *(see figure 6)*. The modifier, a 'scribble,' seems to change the implied message. As in the first test, the stacking order of the three layers was changed to see if a new meaning resulted with the modifying scribble being contained within the star icon to further modify the meaning. The results seemed promising. In this case the modifier changed the meaning enough to warrant further study of the role abstraction might play in modifying context and changing meaning in non-verbal communication.

To explore the opposite end of the continuum from abstract to literal, an icon was combined with a more literal photographic image. A series of wavy lines seen in isolation might be interpreted in various ways *(see figure 7)*. These lines were then placed in a more literal photographic context in order to clarify their meaning *(see figure 8)*. The graphic lines have considerably less detail than the photograph, which has greater line shape and width variance, tonal quality and curve complexity. However,
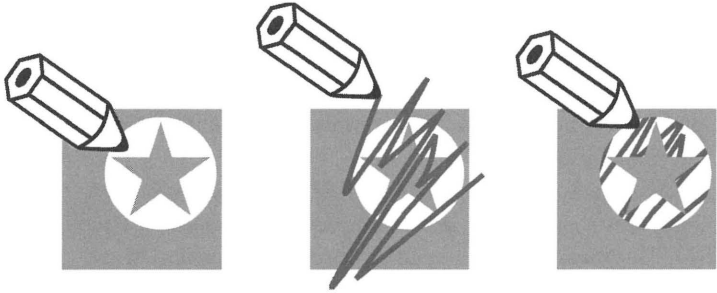
the photo still serves something of an iconic function, despite its literalness, because it suggests 'hair' more than a particular individual's hairstyle, color, state, etc. This is arguable and the parameters for how abstract an image must be before it is inevitably read as a concept and not as an instance are not defined. In fact, attempting strict parameters may be misguided given the implications of context proposed in this paper. What may be possible are parameters that describe how images at various levels of abstraction interact to influence each other toward a more conceptual Iconic Function or more individual Picture Function. What was intended in Figure 8 was to combine a less abstract photographic image serving an Icon Function with a more abstract graphic image serving an Icon Function to help clarify the meaning of the combination. To press the meaning to a more complex level, subtle variations in the alignment of the lines were designed to suggest a process of removing tangles. The intended effect was not to communicate, "this individual woman can detangle her hair" but "this is hair detangler." In theory, an image serving a Picture Function plus an icon would do the former while two images both serving an Icon Function would do the latter. Note also than in Figure 8 the photo and icon are forced into association by a surrounding box and therefore are not read as separate, unrelated entities.

Based on this experience, it seems possible to combine images serving different functions in an intentional and systematic way to simulate the way nouns and adjectives, verbs and adverbs, combine in language to modify each other and communicate complex messages.
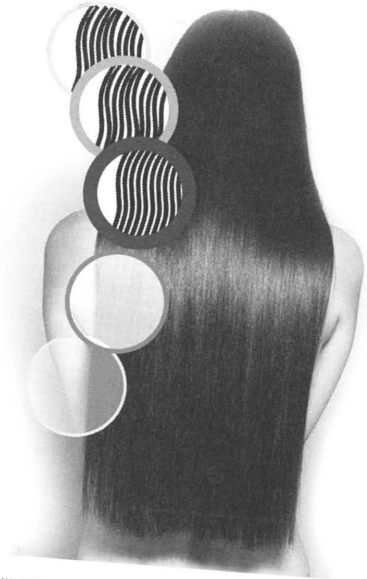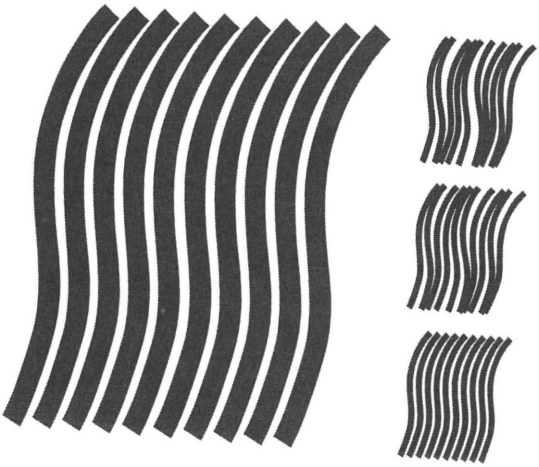
FIGURE 7

FIGURE 8

Expand Proximate Context by Sequencing

IF COMBINING ICONS IN STACKED LAYERS IS EFFECTIVE, then combining icon stacks in horizontal and vertical relationship seems a rational way to extend that. The team hypothesized that clustering or sequencing groups of contained and layered icons could add context and expand the ability to communicate. Image sequences, associated with time-based media such as film and video, have a proven capacity for communicating narrative forms, actions and states of being. The ability to communicate actions and states of being would be a significant expansion of the object orientation label function of existing global icon systems such as the AIGA symbol/sign system referenced previously. For background, the team examined graphic novels and comic books to analyze how these proven forms work. Graphic novels were selected rather than film or video because they are print media, more akin to the product package context established for this study. The special ability of comics to combine simultaneity, multiple voices and serial images to bridge time and space was described by Muriel Cooper in 1989. The team built upon these observations.

Initially, the team explored clustering groups of icons. Image groupings suggested the possibility of communicating complex concepts such as the state of being lost or confused or the general idea of emotions. Based on this, the team identified several types of comparative images: a pair (one-to-one), a sequence, a group without an ordered sequence and a time or chronological sequence. While each of these possibilities showed promise, a specific case of X / Y arrangement or sequence that establishes a progressive form of context, was explored in greater detail.

A comparison of a single image with a simple two image sequence indicated that while the single image was ambiguous as to meaning, a two image set had much more specific implications. In one example, an image of man holding a cigarette was ambiguous but when coupled with another image of the same man with a cigarette in his mouth the message became 'smoking.' The image pair added context that served to more sharply define the meaning of both images. From these initial studies, the team hypothesized that expanded message complexity might be possible with sequences of icon images that include the techniques of icon layering and levels of abstraction identified

in previous studies. An early study *(figure 9)* shows a left to right sequence combining an icon of a man and a flower. The icons combine different degrees of abstraction: the man more abstract, the flower more literal. The man was kept highly abstract through extreme simplicity to suggest not a specific human but human emotion. The flower was made less abstract to suggest a specific flower and flower character: a daisy-like flower. The changes occur through the addition of the flower and an upturned mouth. The implication seems obvious: the thought of a flower makes a man happy. The change in facial expression reflects the team's discovery of research suggesting that certain human facial expressions are universally interpreted: smiling is a universal sign of happiness.
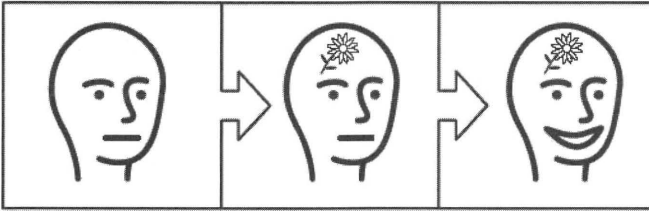

FIGURE 9
Designer: Davis Stanard

Based on experience, the team concluded that to be effective, an icon sequence must be read as a single image made up of one icon following another. Both consistency and change are required for the sequence to read as a unified whole with progressive individual variation. When progressivity breaks down the icons read as an arbitrarily ordered group not a sequence. Based on previous experience with containment the team presumed that some kind of graphic containment would be necessary to accomplish this. From comic analysis the team identified several techniques for building systems of containing shapes: the graphic form of the containing shape of individual images in a sequence, the overall or meta containing shapes for sequential groups and their relationship to the individual framing shapes they contain, objects breaking out of containing shapes, contextual images forming a background for meta and individual containing shapes and the role of connecting graphics in affecting sequence and reading direction. Again, as with nearly every other principle in this study, much more work needs to
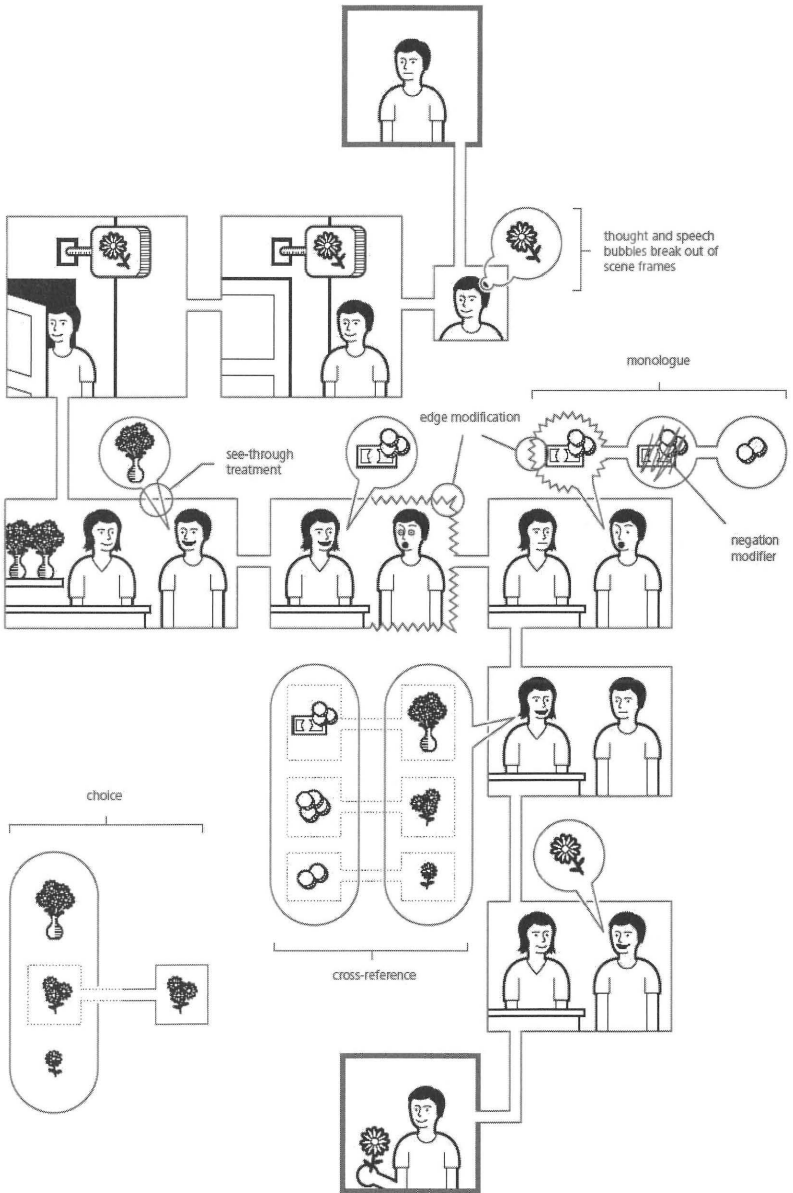
FIGURE 10

Designer: Davis Stanard

be done to qualify the parameters governing containing shapes and image sequences.

Based on this analysis, a more complex story was attempted using a combination of sequential and grouped layered images and variety of containing shape techniques *(figure 10)*. People shown this icon composition have generally been successful interpreting the main story as follows: a man wants a flower, goes into a store, is surprised or disturbed at the cost, the clerk explains that various flower quantities cost various amounts, the man selects a quantity he can afford, makes the purchase and goes away pleased or satisfied. This result is promising. Not only have actions been described but also various states of being: surprised/disturbed, pleased/satisfied. There is still a lot of imprecision in the visual story compared to the verbal summary above. The difference between surprised/disturbed is conceptually significant and effectively conveyed by words but respondents to the visual icons have given various answers ranging across these verbal concepts. Even so, the message is significantly more complex and precise than messages commu-nicated with existing icon systems, sufficiently so to warrant further investigation of these techniques.

Sequential icons certainly seem to have the possibility of expressing action, verbs in language analogy. It is certainly possible to envision individual icons which perform a verb or action function. Animation is a largely unexplored possibility of iconic communication. Animation was not used for this study. However, the author has participated in separate studies that have explored animated icons that give every indication of expressing verbal concepts effectively. As with nearly every aspect of the studies in this paper, more work needs to be done.

Conclusion

IN A VERY REAL SENSE this paper describes nothing new. Icons have been used successfully for millennia. They are used suc-cessfully today. More than that, this paper fails to provide scientific validation of the proposed theories. The only testing to date has been unstructured and informal. What this paper does describe are some potentially interesting ways of think-ing about icons and icon systems: expanding context through layering, degrees of abstraction and sequence. There is ample room to debate where the lines should be drawn around these

concepts, what constitutes degrees of abstraction for example, but the concept this paper proposes to advance is that the extremely reductive approach generally taken is not necessary. These concepts have been raised here partially as an invitation to further definition and greater validation.

As has been discussed in this paper, existing icon systems are generally limited and do not address complex messages involving not only things but also processes or states of being. Since the advent of standardized international symbols and icons in the 1960's and 1970's systems of symbols and icons have evolved little.

While icon systems have evolved little, significant advances have been made that deepen our understanding of the mechanisms underlying visual perception, human cognition and linguistics. One example of this type of advance is made in brain imaging. Advances in non-invasive techniques such as optical spectroscopy, positron emission tomography (PET), single photon emission computed tomography (SPECT) and magnetic resonance imaging (MRI), allow medical researchers to monitor activity in the brain as it processes information or responds to stimulation through the skull, revealing the human brain at work (Mathias, 1996). Some of this work is being incorporated in the science of visual perception which in turn is being applied to the design of scientific visualizations (Ware, 2004). However, to date little of this literature has been applied to the design of picture, icon or sign systems. This seems a serious oversight given that human perceptual processes promise to transcend cultural and linguistic boundaries, an essential for global communication.

The time seems ripe for design researchers to examine recent developments in science and design, including the work reported in this paper, to identify and define theoretical constructs for testing, to conduct tests validating and refuting these theories and positing new questions for further study. The results of such a research program may define principles of design upon which to base design research and practice. Consider this paper an invitation to move forward aggressively.

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Also
AIGA, Symbol/Signs,
http://www.aiga.org/content.cfm?ContentAlias=symbolsigns

Acknowledgements

Mike Zender *is a third generation designer, following in the footsteps of his grandfather, father and now teaching and working with his son Micah. Mike founded the firm Zender + Associates Inc. after attending the University of Cincinnati and Yale University. Mike has written two books on design and contributed to several others. He has lectured internationally at both university and professional venues. He currently teaches digital design at the University of Cincinnati with research emphasis in information design, visualization and informatics, including recent studies in icon systems.*