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VISUAL METAPHORS IN USER SUPPORT

Guest editors **Karel van der Waarde and Piet Westendorp**

ADVISORY BOARD

SPECIAL ISSUE

Visual Metaphors in User Support
Guest editors: Piet Westendorp
and Karel van der Waarde

Piet Westendorp and Karel van der Waarde

Visual in user

Abstract
Introducing this special issue, Visual Metaphors, the role of metaphor and our various understandings of metaphor are discussed. Articles are introduced revealing their particular foundational position with regard to metaphor. The array of information applications covered by authors in this issue is broad, from italic type to nutrition diagrams, from computer interface to designers' abstraction processes. Examples with analyses regarding abstraction and reference are all part of the investigation.

The increasing complexity of the world around us is reflected in the increasing complexity of our communication with this world. Finding our ways in complex surroundings, installing and using more and more complex technological products, software and services, traveling and interacting more and more internationally, meanwhile getting less and less direct personal help—it has all created massive quantities of instructions, from tooltips to guided tours to interactive tutorials to safety instruction cards to wayfinding signage systems. Complexity and communication only seem to increase more rapidly than ever, and there is no reason to believe that it will get less in the near future.

Increasing complexity of the world around us not only implies increasing quantities of information; it also implies increasing complexity of the communication. Technical phrases, color-coded drawings, multimedia presentation, higher levels of abstraction, more symbolism, more metaphoric communication—all possibilities are applied to get the difficult messages across. Micro-electronics forced instructional graphic design to make giant leaps.

Because of nternationalization, distant marketing, increase of functionalities per device, together with miniaturization of the devices and displays, verbal language can often not be applied or may not be the most efficient way to communicate. As a consequence, we see the application of visuals,

Piet Westendorp is an Associate Professor in Visual Communication Design at Delft University of Technology and Eindhoven University of Technology, both in The Netherlands. His doctoral dissertation is entitled 'Presentation Media for Product Interaction.' He wrote numerous articles and several books focusing on visual aspects of user assistance design, including *Open here: the art of instructional design* (with Paul Mijksenaar, translated into English, Spanish, German, French, Dutch and Japanese). He has been a consultant for such international companies as Philips, Oce Copiers, Fokker Aircraft,Canon, Alcatel / Lucent and for governemental institutes.

metaphors instructions

Karel van der Waarde studied graphic design in the Netherlands (Eindhoven) and in the UK (Leicester, Reading). He received his doctorate in 1994 for a dissertation entitled: 'An investigation into the suitability of the graphic presentation of patient package inserts.' In 1995, he started a design-research consultancy in Belgium specializing in the testing of information design with most projects related to pharmaceutical information. His company develops patient information leaflets, instructions, forms, protocols and the information architecture for websites. He is moderator of the InfoDesign and InfoDesign-cafe discussion lists and Professor in Visual Rhetoric at Avans University, Breda, The Netherlands.

instructive pictures, schemas, signs, icons, visual symbols and other visual tools, all part of a visual instructive language which is supposed to be understood internationally.

Such visuals may be thought of as just direct representations of reality. But of course they are not. Every visual—however realistic—is an interpretation or abstraction of the reality it depicts. A photo may be only a selection of reality—and further be completely realistic. But technical drawings, pictograms, icons, schemas and other visualizations are always interpretations and abstractions from reality.

In our view, metaphors are a specific type of abstraction and when we started conceptualizing this special issue of Visible Language, we thought of metaphors as abstractions in the ancient, traditional, literary way: a metaphor describes one thing in terms of another. That enables us to grasp abstract concepts, for instance the complex technological problems which we are confronted with when using modern electronic devices. Such metaphors are omnipresent in user interfaces of electronic devices, software, way signage systems, etc. We all know the famous examples: the wastebasket on the computer screen that indicates that we throw away a document or a program or whatever from the computer hard disk by dragging the icon into the wastebasket. Some may remember the only interesting alternative: the black hole on the NeXT computer. By far the most used—but rarely mentioned visual metaphor—is the arrow to indicate direction (*see figures 1, 2 and 4*). Another nice metaphor in the strict sense is the bird's feather on a gas pedal in a car to indicate: 'drive carefully' (*see figure 3*); the idea can be seen in various other car manuals. Metaphors in the wider, but still literary sense, figures of speech, are for example the *pars pro toto* (a kind of metonymy) (*figure 5*), a *euphemism* (*figure 6*). On the edge of being a metaphor in its widest meaning may be for instance the *anacoluthon* (*figure 7*)—if the anacoluthon can be a figure of speech at all.

These were the kind of visual metaphors that we were thinking of when we asked for contributors for this issue. But all contribu-

Figure 1 Arrow to indicate direction.

tors have a much wider interpretation of the word 'metaphor' than we had in mind. Implicitly or explicitly, they all follow Lakoff and Johnson, who consider metaphors not at all as something related to language—neither verbal nor visual. For them, all abstract concepts are understood in terms of something else: more specially concrete and typically spatial concepts. They consider all abstract thinking as metaphoric, and this comes close to Terrence Deacon's conclusion that human beings are different from other animals because they are a symbolic species. Maybe we are humans—and differ from all other animals—because we think metaphorically.

This wider interpretation of metaphors by the contributing authors of this issue produced a rich variety of articles around the issue of visual metaphors in user instructions.

Isabel Meirelles explicitly indicated that she followed Lakoff and Johnson's interpretation of the word 'metaphor.' She presents a study into metaphorical visual aspects of presentations in dietary visual displays, comparing eight versions from seven different countries. She convincingly supports the Lakoff and Johnson interpretation of 'metaphor' showing that all eight visual presentations that she examined are spatial concepts (both hierarchically ordered or non-hierarchically ordered) and that metaphors can be defined as cross-domain conceptual mechanisms. We were glad to notice the metaphors of the pizza, the pie-chart, the food-plate and the pyramid of food in her examples, bringing these close to visual literature.

Marilyn Mitchell and ***Peter van Sommers*** describe the graphic representation of time in computer interface design, based on the spatial metaphor that time is a path or trajectory. They present an overview of diverging ways in which time has been expressed in computer interface design, sometimes in ways that we hardly realize that time is involved. By making comparisons with both spoken language, the sign language of the deaf and the impact of the structure of writing, they explain how these metaphoric representations of time help users interpret where they are in a process, in the past and the future, the time to complete tasks, what functionalities are available now and how to move through data, etc. To be useful, Mitchell and Van Sommers conclude, representations of time in computer interface designs must reflect people's conceptions of time and represent the kinds of time that people require when using a computer.

Phil Jones pinpoints that even typefaces themselves can be metaphors, for instance to indicate movement. He specifies how italic and oblique typefaces can possess a kinetic quality because of their slant to the right. Closely following Lakoff and Johnson's interpretation of metaphor, Jones argues that the dynamic quality of italics arises from preconceptual structures, such as image schemas, related to experiences of two very different activities: writing and running. Indeed, this is an intriguing interpretation of Lakoff and Johnson's rendition of metaphors as 'concrete and typically spatial concepts.' Although Jones' subject is quite down-to-earth typeface design, his argumentation is quite abstract. Maybe that is why he argues that the meaning that we construct from italic type is not a simple correspondence between slanted letters and a body in motion, as a reader might have thought. Using both verbal and visual examples, Jones shows

Figure 2 Arrows to indicate direction.

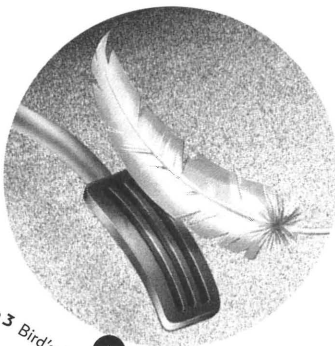

Figure 3 Bird's feather to indicate careful use of gas pedal.

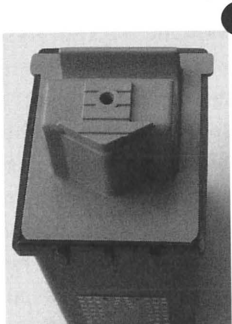

Figure 4 Arrow in plastic to indicate direction to press the HP cartridge.

Figure 5 Pars Pro Toto (a kind of metonymy) to indicate sports.

Figure 6 Euphemism to indicate that there will be some sex in a movie on tv.

Figure 7 Anacoluthon warning sign for playing children.

that meaning is constructed in a context, spatial and horizontal, but also for instance including meaning and place of occurrence, where italicization is just one aspect. 'Italics are salient because of the sense of movement they suggest, and this sense of movement can be used to construct metaphoric associations in different ways.'

'Metaphors are a kind of abstraction,' we stated above, and two papers describe how to reach graphic abstraction and depiction. 'To turn a real object (3D) into a 2D representation is an example of graphic abstraction,' ***Regina Wang*** and ***Chun Cheng Hsu*** write in their opening sentence. Indeed, this is often also the case with representing something that is already two-dimensional (a photo for instance) in another type of graphic, visual representation. The levels of abstraction have been explained so well and in a totally visual way by Scott McCloud in his wonderful best-seller *Understanding Comics-the invisible art,* from 1993. Wang & Hsu start out showing these levels of abstraction, but they quickly proceed to the question: To what degree is it possible to let computer software do the abstraction for designers. They present an overview of abstraction methods in functional graphic design and then present the results of a test with some filtering functions in Adobe Photoshop, varying for instance the curve precision, the angle threshold, the size of the pixels and the cell-size of a digital picture. Wang and Hsu conclude that the 'simplification' command of the software's internal program is not satisfactory. Their second study reported in this article may help computer software designers to produce better components to produce graphical simplifications through: the 'shape simplification method,' the 'quantitative reduction method' and software-aided simplification. The latter, however, obviously needs human intelligence—something that computer programmers over many years have tried to implement—in vain.

O ➔I➔M➔V➔P is the formula that ***Steven Boyd Davis*** proposes in his schema of the design process in constructing visual representations. In his opinion this schema is valid for both 'realistic' and 'metaphorical' graphics; it even emphasizes the commonalities between these apparently distinctive modes.

In this formula, the 'M' is the Model, the observable object in the world; 'P' is the Picture that is going to represent this Model. Since every Model in the real world is based on an Idea, 'I,' this also goes into the formula, right before the 'M.' The Idea must be based on Objectives, 'O.' In Davis' view, Model is pre-pictorial and probably three-dimensional [something we think is not always the case, see above] and the Picture is flat, many design decisions must be made and it is useful to separate geometry and such attributes of the Model from the design decisions that relate to the Visualization, 'V,' such as point-of-view and framing. Davis further contrasts 'PI-realism.' which is the Pictorial Ideal, with the

Visual Experience, 'VE-Realism' and concludes that the schema is grounded in the impossibility of making perfect representations. He thinks that a preferable model of visual representation might be based on the view of design as a form of rhetoric, as proposed by Sharon Poggenpohl in *Visible Language*(1998, 32.2, pp. 200-233). We couldn't agree more, especially since in our view we are close again to our interpretation of the word 'Metaphor.'

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The use of metaphors in dietary visual displays around the world

Northeastern University *Visible Language* 41.3 Meirelles, 204-219
Rhode Island School of Design Providence, Rhode Island 02903

Isabel Meirelles

Abstract

Many countries have developed visual displays summarizing key scientific information on diet and health for the general public. The article analyzes the use of metaphors in dietary visual displays in seven countries. The objective is to examine how spatial organization and its graphical representation reflect conceptual organization. It investigates the correspondences between metaphors, schemas and visual depictions in the diagrams vis-à-vis the nutrition concepts they stand for:

Do the displays foster understanding of dietary information?

Do they support perceptual inferences?

Do they facilitate decision-making in food consumption?

Isabel Meirelles is Assistant Professor in Graphic Design at Northeastern University in Boston. Meirelles holds a B.Arch from Febasp, Brazil, an M.Arch from the Architectural Association School of Architecture, London, and an MFA in Graphic Design from Massachusetts College of Art. Professional experience includes work as architect and urban designer, head of museum departments and art director in publication and interactive design projects. Her research focuses on the theoretical and experimental examination of fundamentals underlying how information is structured, represented and communicated in different media.

Several countries around the world are committed to devising dietary strategies that promote and protect health through healthy eating and physical activity. Many of these countries have delineated national dietary goals and nutrition systems in the form of food-based dietary guidelines. Guidelines are educational tools designed to provide practical guidance with the purpose of promoting wellness and preventing chronic diseases among the general public. They synthesize current scientific research as well as national food consumption patterns and policies (e.g., Truswell, 1987; FAO, 1996; Painter, 2002; WHO, 2003). In many cases, they also reflect the influences of the local food industry (Nestle, 2002).

National food guidance systems vary according to geography, cultural and ethnical traditions and year of publication.Most systems share a common set of wellness principles that promotes variety in food intake, emphasizing the consumption of fruits, vegetables and grains and limiting the consumption of fats. A recent trend is acknowledgment of different nutritional requirements for different age and gender. For example, the most recent American (USDA, 2005) and Canadian (Health Canada, 2007) food guidance systems offer online tools with personalization of food recommendations.

Dietary guidance systems are disseminated in various ways, including brochures, labels with nutrition information on packaging and most recently online resources. Most countries provide a visual display presenting the key concepts. These graphics may be considered snap-shots of the dietary guidelines. The World Health Organization (WHO) emphasizes the need for visual graphics by recommending that the guidelines should "be accompanied by posters or food selection guides. These visual guides should assist users to select a diet ... reflect a concern for promoting food choices ... be culturally inclusive and incorporate foods that are generally available.... In addition a guide should be based on sound educational principles and be accessible to a wide range of educational levels" (2003, p. 6).

This article examines eight dietary visual displays of seven countries: Australia (*figure 1*), Canada (*figure 5*), China (*figure 6*), Portugal, (*figure 2*) Sweden (*figure 4*), the United Kingdom (*figure 3*) and the United States (*figures 7 and 8*).

Dietary visual displays

The graphics examined in this article represent information that is not inherently visible: a healthy diet. The concept of a healthy diet involves many aspects, among them nutrition advice. Because nutrients are a hard concept to grasp, all countries provide information about food, which is a concrete entity. All graphics categorize food according to nutritional properties. Information is presented in the form of food groups (e.g., Milk and Dairy Products). Each group is represented by a selection of food choices (e.g., milk, yogurt, cheese). Quantitative information is measured in terms of recommended daily servings for each group (e.g., gram, ounce, cup).

The number of food groups and the suggested servings vary depending on the country and the year of publication (e.g., Truswell, 1987; FAO, 1996; Painter, 2002; WHO, 2003). In the selected food diagrams the country with the largest number of food groups is Portugal, with eight groups. It is also the only country with distinct groups for Meat and Beans (grouped together in all other countries) and to include a Fluid group within the main visual schema. The history of American food guidelines shows how the number of food groups has changed over time: from seven food groups in the '40s, to four groups in the '60s, to six groups in the '90s, and to five food groups in the 2005 system. It is relevant to mention that it is outside the scope of this article to analyze the appropriateness of the scientific data depicted. The focus is on the visual representation of health information.

Because the different countries are dealing with a similar problem—a system of food groups that involves food choices and quantities—the strategies used to depict the information are also very similar. The selected food graphics use spatial metaphors to represent information in a diagrammatic form.

Metaphors

Traditionally, metaphors are considered figures of speech "in which a name or descriptive word or phrase is transferred to an object or action different from, but analogous to, that to which it is literally applicable" (Oxford English Dictionary Online, 2007).

Recent studies in cognition and in linguistics, however, claim that "the locus of metaphor is not in language at all, but in the way we conceptualize one mental domain in terms of another" (Lakoff, 1993, p. 206). This new approach to the study of metaphors, was led mainly by George Lakoff and Mark Johnson, and introduced in their book *Metaphors We Live By* (1980).

Lakoff and Johnson (1980) contend that abstract concepts are metaphorically understood in terms of more concrete and typically spatial concepts. The role of metaphors in our conceptual system is described as a mechanism: in order to grasp concepts that are abstract or not clearly delineated in experience, we use other concepts that are clear to us such as spatial orientations, physical experiences, known objects, etc. Metaphors are part of our conceptualizing processes and help us understand one domain of experience in terms of another.

This article uses metaphor as a "cross-domain mapping in the conceptual system"(Lakoff & Johnson, 1980; Lakoff, 1987, 1993) to analyze the food diagrams.

Visual representations of data

Visual representations of data have a long history and can take different forms, such as notation systems, maps, diagrams and other graphical inventions (e.g., Tufte, 1997; Tversky, 2001; Wainer, 2005). Independent of the medium, of data type and of function, all visualizations are spatial representations of data. They make use of graphic elements and properties to encode data into a schema. The visual schema can reflect knowledge schemata, the use of metaphors, or involve the creation of new models. The schema makes the system—elements and relations—and the patterns within the system readily visible, explicit and easily perceived.

Diagrams (in general) represent and communicate information in a way that is easy to perceive and to understand because they tend to exploit general perceptual and cognitive mechanisms effectively. Diagrammatic representations are dependent on visual perception for both their creation (encoding) and their use (decoding). Literature in visual perception explains that spatial properties (position and size) and object properties (e.g., shape, color, texture) are processed separately by the brain (Cleveland, 1994;

Kosslyn, 1994; Tversky, 2001). And that position in space and time has a dominant role in perceptual organization (MacEachren, 1995; Card et al, 1999). Central to informational schemas is the way data is indexed in space, how elements and relationships are graphically represented.

Meaning is conveyed by means of visual references, where the graphic elements and the graphic structure in a diagrammatic representation stand for elements and relations in another domain. Efficiency in conveying meaning will depend on how the visual description stands for the content being depicted, whether the correspondences are well defined, reliable, readily recognizable and easy to learn (Pinker, 1990).

Visual representations support visual spatial reasoning and they can serve as an effective interface between perception and cognition. They can be considered cognitive artifacts, in that they can complement and strengthen our mental abilities. Literature in Cognition and in Information Visualization (e.g., Bertin, 1967/1983; Norman, 1993; Ware, 2000; Tversky, 2001) suggests that the cognitive principles underlying graphic displays are: to record information, to convey meaning; to increase working memory, to facilitate search; to facilitate discovery, to support perceptual inference,to enhance detection and recognition and to provide models of actual and theoretical worlds.

If a dietary visual display is effective it will enhance reasoning and foster understanding of fundamental health guidance, thus facilitating good decision-making in daily food consumption, resulting in a healthier population.

Metaphors and dietary visual displays

Lakoff claims that "image schemas define most of what we commonly mean by the term 'structure' when we talk about abstract domains. When we understand something as having an abstract structure, we understand that structure in terms of image schemas" (1987, p. 283). Basic-level and image-schematic concepts structure our experience of space and they are used metaphorically to structure other concepts.

Two image schemas play a major role in the selected graphics: the container and the part-whole. Lakoff (1987) explains that these schemas are meaningful because they structure our direct experience, and in particular, our bodily experience. We experience ourselves as entities, as containers with a bounding surface and an in-out orientation. We tend to project this view onto other physical objects, events and actions and to conceptualize them as entities and most often as containers. The result is an act of quantification, in that we are defining territories, bounded areas, that can be quantified in terms of the amount they contain. We also experience our bodies as wholes with parts. We tend to use the metaphorical projection of part-whole configurations to structure other concepts. The structural elements of a container schema are: interior, boundary and exterior. The structural elements of a part-whole schema are: a whole, parts and a configuration. The configuration is a crucial structuring factor in the part-whole schema. Because the parts can exist without constituting a whole, it is the configuration that makes it an image-schema.

Lakoff explains that "we have general capacities for dealing with part-whole structure in real world objects via gestalt perception, motor movement and the formation of rich mental images. These impose a preconceptual structure on our experience" (1987, p. 270).

All countries depict qualitative and quantitative information in enclosed shapes—containers. The choice of the container metaphor doesn't appear to be arbitrary. Containers are the most appropriate schemas to structure categories (Lakoff, 1987, 1993; Tversky, 2001). As observed earlier, all diagrams represent dailynutritional goals in the form of food groups. The food groups are represented in the system as sub-containers and also as parts of the part-whole schema.

What distinguishes the various diagrams is the source metaphor that structures the target domain of daily food intake. Australia (*figure 1*), Portugal (*figure 2*), Sweden (*figure 4*) and the United Kingdom (*figure 3*) use a circle that corresponds to a plate, a pie or even a pizza. The plate metaphor is depicted directly in the British diagram, where a fork and knife are placed on its sides. It is worth noting that we commonly call graphs that use a circle to structure quantitative data "pie graphs." Canada (*figure 5*) depicts a healthy diet using the rainbow metaphor. And, two countries use architectonic metaphors: a pyramid in the case of the United States (*figures 7 and 8*) and a pagoda in China (*figure 6*).

The food graphics can be divided into two groups: non-hierarchical and hierarchical informational structures.

Non-hierarchical schemas: circle and rainbow

The circle is universal and unspecific and it doesn't single out one direction. The attraction to the center creates a centric symmetry. Circles have been extensively used throughout the years as schemas in the representation of both physical and nonphysical data. For example, wheels were the most common organizing form used in medieval manuscripts (Murdoch, 1984). These circular schemas were mainly used to display calendric, astronomical and cosmographic information. In other words, doctrines where information would fit well with the circular form.

The use of circular schemas to represent quantitative data is more recent. The "pie graph" as a graphical invention is attributed to William Playfair who devised and published a series of statistical graphs between 1786 and 1801 (Wainer, 2005). Pie graphs are among the most common displays of quantitative data nowadays, specially in mass media and business publications (Cleveland, 1994).

In the selected diagrams, circles are divided into segments that originate at the center and end at the edge. The segments are clearly bounded wedges, perceptually well segregated from each other as enclosed areas (sub-containers). In the Australian, Portuguese and British diagrams (*figures 1, 2, 3*) the wedges map both categorical and quantitative data. Each wedge stands for a food group and its area represents the recommended serving size. Each serving size is perceived in relation to the whole of a healthy daily diet (main container).

These three food displays use the same graphical method of encoding data as pie graphs. The advantage of using a familiar schema is that it helps comprehension by the general public. Research on the cognitive operations a person executes in the process of reading quantitative graphs indicates that "people create schemas for specific types of graphs using a *general graph schema,* embodying their knowledge of what graphs are

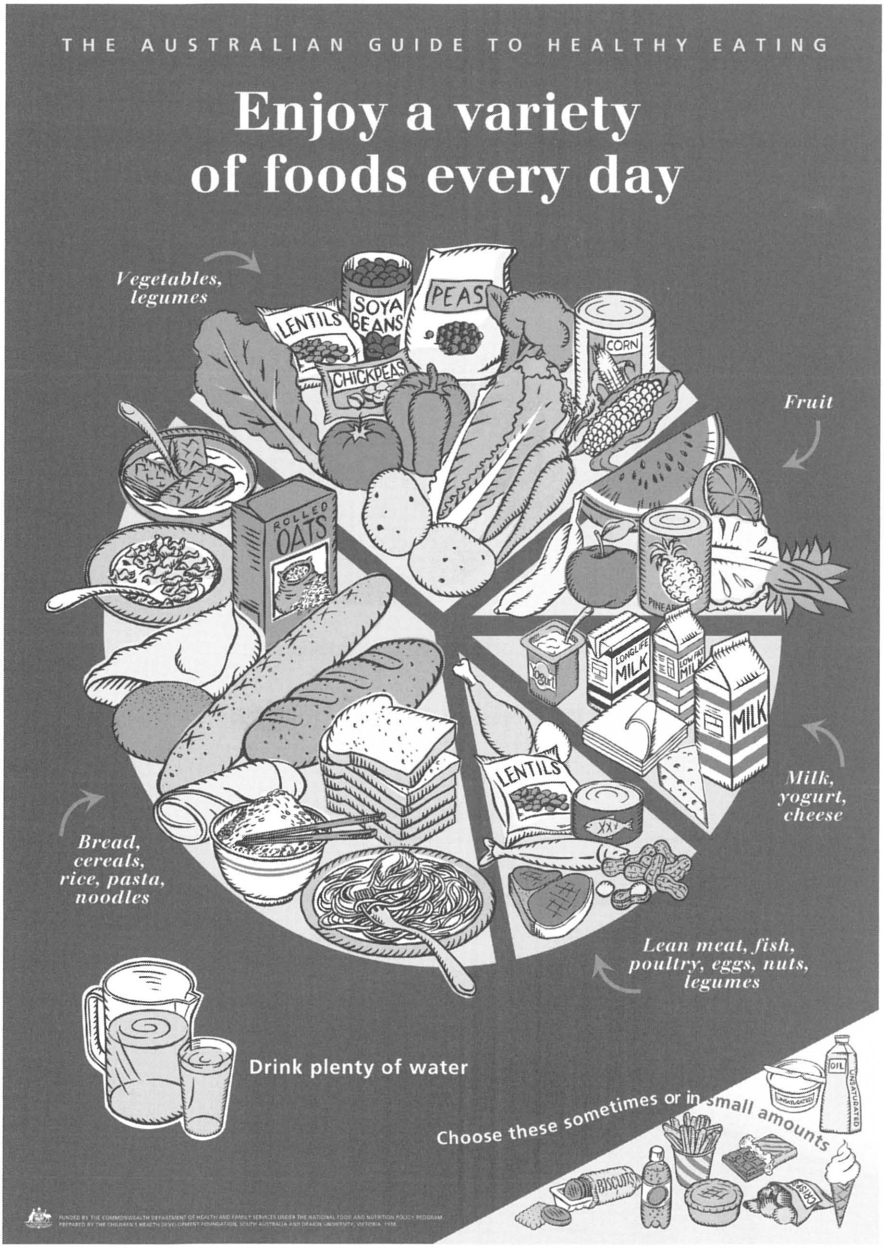
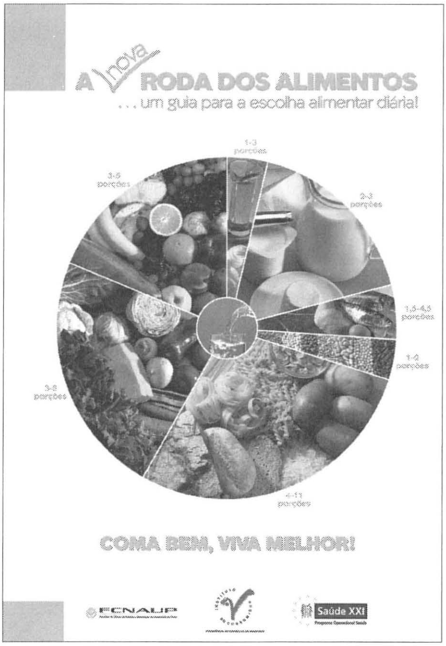


Figure 1 The Australian Guide to Healthy Eating, The Australian Government Department of Health and Ageing, Australia, 1998. Image © Commonwealth of Australia, reproduced by permission. Source: http://www.health.gov.au

Figure 2 A Nova Roda dos Alimentos, Direcçao – Geral de Saúde, Portugal, 2004. Source: http://www.dgs.pt



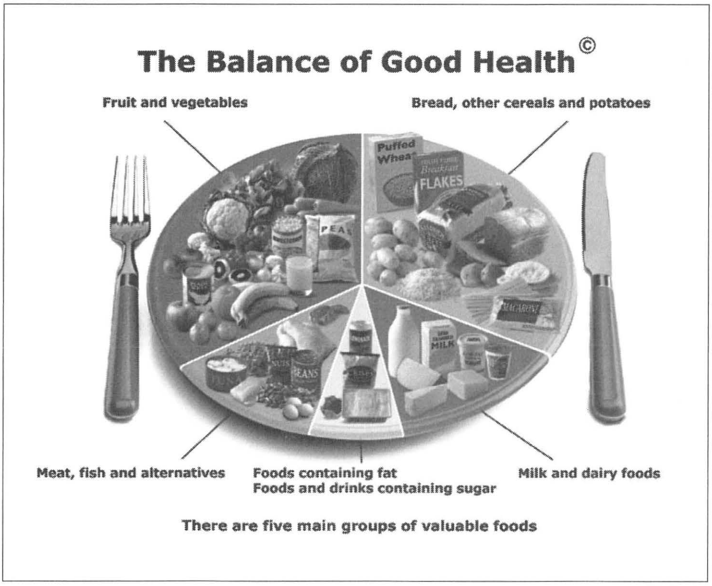
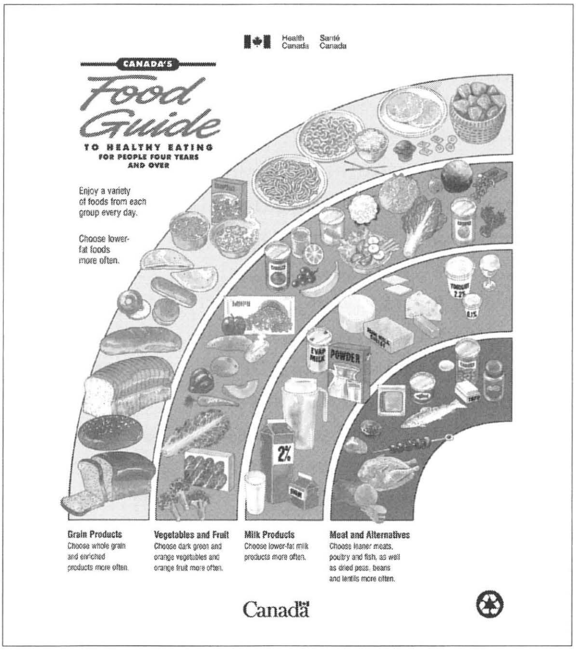


Figure 3 The Balance of Good Health, The British Nutrition Foundation, UK, 2001. Image © British Nutrition Foundation, reproduced by permission. Source: http://www.nutrition.org.uk

Figure 5 Canada's Food Guide, Health Canada, 1997. Image © Minister of Public Works and Government Services Canada. Source: http://www.hc-sc.gc.ca



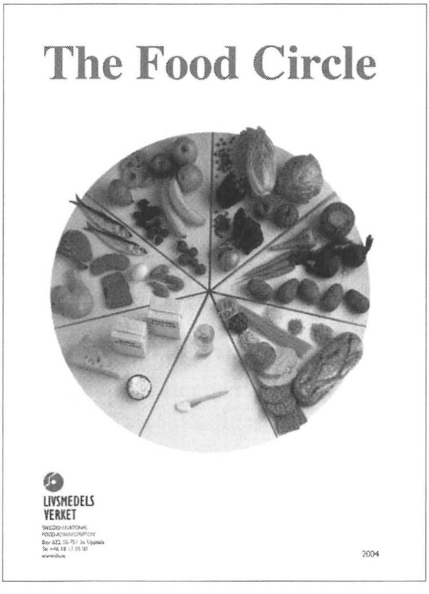


Figure 4 Swedish Food Circle, National Food Administration, Sweden, 2004. Image © National Food Administration, Sweden, reproduced by permission. Source: http://www.slv.se

for and how they are interpreted in general" (Pinker, 1990, p. 104, italics in original). Pinker suggests that the theory can be easily extended to diagrams used to represent qualitative information, where again, the reader would use schemas to mediate between perception and memory.

Pie graphs are good at conveying general information about proportions of a whole. Because our visual system tends to distort the dimensions of area sizes (Cleveland, 1994; Kosslyn, 1994, 2006), we cannot infer absolute amounts from the perception of the wedges. Area sizes represent relative amounts in comparison with each other and in relation to the whole. Kosslyn explains that "about one-fourth of graph readers apparently focus on relative areas of wedges when they read such [pie] graphs—which means that they will systematically underestimate the sizes of larger wedges" (2006, p. 39).The only country to provide labels with absolute amounts of recommended portions is Portugal.

It is through discrimination (same-different dichotomy) in early stages of object perception that elements and patterns are detected and ordered. Patterns are central to how visual information is structured and organized. Literature in perception and graphical methods (Cleveland, 1994; Kosslyn, 1994, 2006) explains that it is easier to detect patterns if categories are ordered. This principle complies with Lakoff's (1987) Form Hypothesis that linear quantity scales are understood in terms of linear order schemas. In the case of pie graphs, segments should increase circularly in a clockwise progression to enhance comparison of quantitative data (Kosslyn, 1994, 2006). The only diagram to conform—in part—to this rule is the Australian, where the food groups are ordered according to serving sizes.

It is worth noting that in the British diagram, even though the food groups are unordered, the configuration allows for easy comparison of relative serving sizes. The diagram uses the vertical axis as a main structuring divider to position food groups in an almost symmetrical relationship.

In the Swedish food graphic (*figure 4*) the wedges are all the same size; different from the previous three circular diagrams, this is not a pie graph. At first, familiarity with the general pie graph schema might impair the public's comprehension of the graph. The recommended serving sizes are represented by the amount of food entities depicted within each food group. It is clear that the Oil and Dairy groups have less food examples than all the others. However, actual differences in the data are not easily perceived and it is hard to infer relative amounts of food intake.

In all four circular diagrams, the source domain, a plate as a container that holds food, corresponds to the target domain, a healthy daily diet with recommended food choices. The metaphor of the plate is appropriate to structure the kinds of food and the servings for each category—"what" and "how much" to eat every day. However, in general, discrimination of recommended serving sizes is poor.

Canada uses the rainbow as the source metaphor for its visual display (*figure 5*). A rainbow is an arch of colors. The schema has a meaningful configuration from which the basic logic of the metaphorical mapping follows. In the diagram each colored ring represents a food group. The rings are well defined enclosed areas, making the distinction between categories easy to detect. All rings have the same width. Quantitative values are expressed by the radius of each ring in relation to the center of the main (invisible) circle, and can be detected by the length of the arcs. Food groups are ordered according to area size—from larger to smaller—enhancing perception of food consumption patterns. Groups follow a center-periphery schema, where the orientation maps amount of food consumption rather than categorical relevance. The smaller the arc, the least important the food group, and the types of food that should be least ingested.

It could be said that the rainbow schema is a variation of the circular schema, in that it uses the circle—in this particular case one-quarter of a circle—as the container. The difference is in the configuration: in the rainbow schema the circle is divided into rings in polar coordinates, rather than in wedges.

Hierarchical schemas: pyramid and pagoda

Pyramid schemas are used to map things or actions that are structured more or less in a pyramidal form. Examples we commonly find in language descriptions are of piles arranged with fewer elements at the top (pyramidal piles), social structures (social pyramids), the dubious building up of finances (pyramid schemes). In general, "up" is designated as more, better, good and so on (Lakoff & Johnson, 1980; Lakoff, 1987). Visual representations of hierarchical data have repeatedly used the pyramidal schema. A common use has been in what we call "tree diagrams," such as genealogical structures showing the lines of descent of a family.

The overall shape of the Chinese pagoda (*figure* 6) fits in a triangular schema of the same configuration as the 1992 American pyramid (*figure* 7). Similarity is also found in the use of architectonic structures as the metaphorical mappings. Pagodas are familiar and common buildings in China, whereas pyramids are not particularly embedded in the American culture. (One could argue that Americans face a pyramid in their daily lives, in that a Masonic pyramid is printed on the one dollar bill. But that would be pushing a cultural concept a bit too far.)

In these two diagrams the triangular shape is used as the main container with the base coinciding with the horizontal axis with the apex opposite. The container is divided horizontally with food groups stacked on top of each other. The configuration follows an architectonic structure in which the base is larger so as to hold the upper levels. In this model, the lowest level food group could be considered the foundation for a healthy diet, in that it is the largest food group and represents the largest amount necessary for maintenance of a healthy body. If we look only at the representation of quantitative information, it could be said that the structure of the image-schema is preserved by the metaphor. The food groups are ordered according to quantitative values and facilitate detection of food intake patterns.

However, there is another mechanism which plays an important role in these diagrams: the up-down orientation mapping. Lakoff and Johnson (1980) contend that there is a coherence in this orientation, where up is mainly used to map concepts related to well-being (e.g., happy is up, health is up, alive is up, good is up) and to power (e.g., control is up, status is up). In these diagrams, the Fat (or Oil) group is at the very top and could be interpreted hierarchically as the "best."

Lakoff's Invariance Principle hypothesizes that "metaphorical mappings preserve the cognitive topology (that is, the image-schema structure) of the source domain, in a way consistent with the inherent structure of the target domain" (1994, p. 218).

The 1992 pyramid and the pagoda diagrams are well suited for the depiction of the quantitative values of food intake, but not the best schema to represent the reversed hierarchy in food consumption. The hierarchical mapping conflicts with the quantitative organization of the data to such an extent that it violates the inherent structure of the target domain. This would not be the case, for example, if the triangle was rotated 180 degrees with the vertex at the base line.

While the majority of health and nutrition experts condemned the food pyramid, hierarchy was one of the few aspects of the 1992 graphic that they applauded (Harvard University, 2006). When the Harvard School of Public Health redesigned the food graphics to reflect their scientific research, they maintained the pyramid image-schema as the container with a hierarchical configuration (Harvard University, 2006). It is worth noting that the 1992 pyramid became "the most widely distributed and best-recognized nutrition education device ever produced in this country. The Pyramid now is an icon"(Nestle, 2002, p. 65).

The 2005 pyramid (*figure 8*) uses a very different configuration: the main container is divided into triangular sections that start at the apex and end at the base. The up-down orientation is obliterated. The result is that the 2005 pyramid is a non-hierarchical schema that could be grouped with the non-hierarchical schemas discussed above. It was kept here for easy comparison between the two pyramid versions.

The 2005 pyramid is the only graphic to depict examples of recommended food choices outside the food groups that they stand for. This spatial arrangement violates the schema's inherent structure. Recall that the logic is that interiors will be mapped to interiors, and so on. Both the pyramid and the food groups stop functioning as container metaphors. Detection of what food entity belongs to what group is also impaired, mainly because they all seem to be clustered and spatially associated. The Gestalt Principle of Proximity (Wertheimer, 1923/50) states that we tend to group into a perceptual unit visual elements that are near one another.

Several factors hamper understanding of food intake patterns in the 2005 pyramid. First, the food groups are not arranged in any specific order. Second, the area sizes vary only slightly and actual differences are not easily perceived. The food depictions also effect the perception of area sizes, in that they obliterate the visibility of the base of the triangles. Finally, there is a conflict between how proportionality is conveyed in the diagram and in the rectangular bands carrying the names of food groups at the bottom of the display. All the rectangles have equal areas and as such carry no information in terms of proportionality. Research in cognition has shown that we "are impaired when the two messages, that from the physical stimulus itself and that from the meaning, conflict. The brain attempts to fit all inputs into a single coherent pattern and balks when there is a conflict" (Kosslyn, 1994, p. 8).

Soon after the release of the 2005 pyramid, a series of alternative diagrams appeared in major media vehicles in the US. The newspaper *USA Today* (2005) and the web magazine *Slate* (2005) were among those that invited well known designers to discuss and respond to

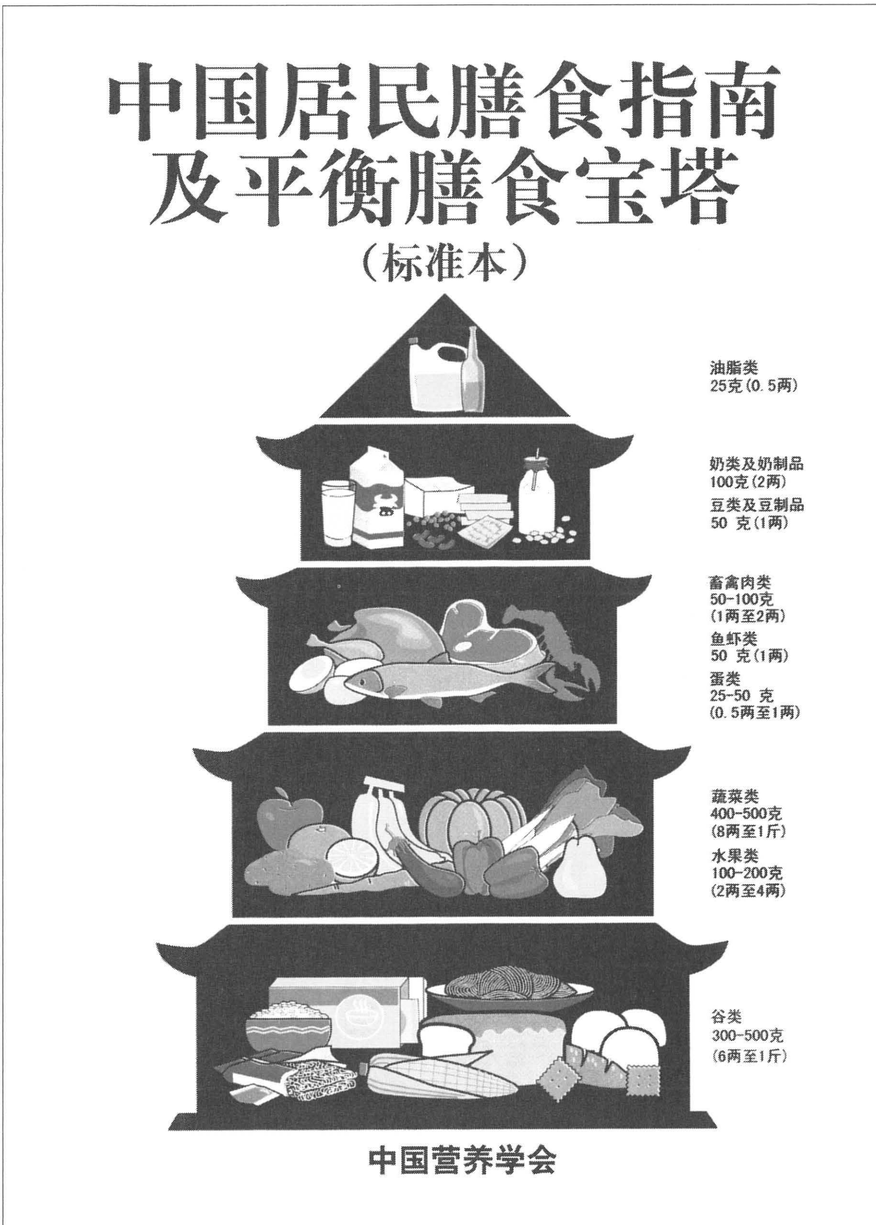


Figure 6 Balance Dietary Pagoda. Image © Chinese Nutrition Society, China, 1997. Source: http://www.cnsoc.org

Figure 7 The Food Guide Pyramid, U.S. Department of Agriculture, Center for Nutrition Policy and Promotion, USA, 1992. Source: http://www.cnpp.usda.gov

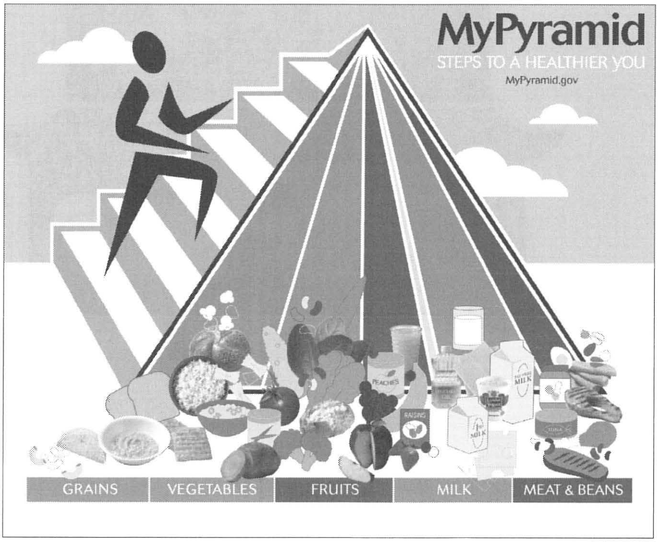


Figure 8 MyPyramid, U.S. Department of Agriculture, Center for Nutrition Policy and Promotion, USA, 2005. Source: http://www.mypyramid.gov

the controversial display. It would take another article to analyze these diagrams which included graphics by Roger Black, Nigel Holmes, Visual i|o among others. But it is worth noting that five of the nine diagrams reproduced in the two articles used circular schemas, of which three maintained the compound of whole-part and container image-schemas and the remainder represented isolated food groups without a main container connecting them. Finally, only Black represented data in a typographical inverted pyramid schema (base at top).

Conclusions

This article investigated the use of metaphors in the visual representation of dietary information. Metaphor was used not as a figure of speech or poetic expression, but rather as a cross-domain conceptual mechanism. Lakoff's theories on metaphor and categorization were used to scrutinize the visual displays. The article investigated the correspondences between source and target domains and whether the structure of the source domain was projected onto the target domain in a consistent way.

The study of the selected food diagrams showed that:

▲ The target domain—a healthy diet with food recommendations—was not inherently visible and required the use of metaphor to structure the information.

▲ The concrete (and in some cases cultural) experiences of physical space served as source metaphors.

▲ Three metaphors were used as source domains: the plate, the rainbow and the building (pyramid and pagoda).

▲ Two metaphorical mechanisms played a major role in structuring the target domain: image schemas and orientation mappings.

▲ A compound of two image schemas was used to structure information: the container and the part-whole.

▲ Information was structured in three levels: 1) the whole: representing the daily food recommendations as the main container; 2) the parts: sub-containers standing for the categories (food groups) with associated quantitative values; 3) the individual entities of food choices: standing for prototypical examples of the food categories they represent.

▲ Orientation mappings played a role in three displays: the up-down (in the 1992 pyramid and pagoda diagrams) and the center-periphery (in the rainbow diagram).

▲ Conflicting metaphors were used to structure data in the hierarchical schemas causing interpretation problems: "up" meaning good or healthy (qualitative data), as opposed to "up" meaning the least recommended amount (quantitative data).

▲ Previous experience with graph schemas, especially in relation to "pie graphs" played a role in graph comprehension (note difficulties in relation to the Swedish display).

▲ The depiction of food entities in the 2005 pyramid violated the inherent structure of the container metaphor.

▲ In most graphics, detection of recommended serving sizes was impaired, which affected the perception and cognition of food intake patterns.

Several issues remain to be investigated with respect to the visual representation of dietary information, including the study of how the visual displays are being interpreted and used by their target audiences. Important graphical methods used in the representation of nutritional data were also not analyzed here.

For example, the color code systems used to differentiate food groups, the graphical vocabularies used in the depiction of food entities and the verbal information provided in titles, labels and captions.

To conclude, I would like to suggest that metaphorical mappings are essential mechanisms in diagrammatic representations of information. It is possible to argue that visual/spatial representations of abstract (not inherently visible) domains rely extensively on metaphorical correspondences and orientation mappings.

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Representations of Time

Marilyn Mitchell and Peter van Sommers

Abstract

The linguistic representation of time or ***tense*** is based upon a spatial metaphor: ***time is a path or trajectory***. This metaphor has analogies in computer interface design in graphics such as feedback indicators, buttons and application windows that represent their current availability, icons that contain arrows to represent screen movements, and icons used to help users temporally orient themselves within an interface. It is generally agreed that the success of graphical user interfaces is based upon their ability to provide appropriate conceptual models for enabling human-computer action. One important model for such interaction is for time, which incorporates notions of change and movement. To describe how time is represented in computer interfaces, the paper makes comparisons to the structure of tense in both spoken language and in the sign language of the deaf, and also looks at the impact of the structure of writing on representations of time. It is argued that visual representations of time help computer users by providing information about the ***length*** of time for a process to complete; the functions that are available ***now*** versus those used in the past or ones available in the future; how to ***move*** through a set of data; how an object on screen can ***move***; and for some applications, the ***time order*** in which data has been received or used, or the order in which operations were or are to be performed.

Marilyn Mitchell is Assistant Professor of Communication at Bond University in Australia. Prior to moving to academia, she worked as an information developer and systems engineer for IBM. Her doctoral research involved how time is represented graphically in devices such as clocks, timers and calendars, and also in graphics such as timelines.

Formerly a Professor of Psychology and more recently graphic arts, **Peter van Sommers** is now a botanical photographer and fine art printer. His research interests are in the neuropsychology of art production and imagery. He authored *Drawing and Cognition* (Cambridge University Press) in which he explored the complex variables involved in the production of drawing and writing.

in Computer Interface Design

Bond University *Visible Language* 41.3 Mitchell and van Sommers, 220–245

Introduction

A fundamental representation in language is for time or *tense*, which appears in every spoken sentence to identify when an event happened, how it generally happens, how it might happen and so on. Many studies across many languages have noted that the deep structure of tense is based upon a spatial metaphor: *time is a path or trajectory* (Clark, 1973; Traugott, 1975; Lakoff and Johnson, 1980, 1999; Nunez and Sweetser, 2006).

This structure of tense has direct analogies in graphics that represent time directly, such as clocks and calendars, and in graphics that represent time as a secondary construct, such as family trees or process diagrams. Tense is also present in the interfaces of computer applications and web pages in the designs of graphics that provide feedback regarding computing processes (e.g., progress bars), in buttons and application windows that visually indicate their state of availability (e.g., in Microsoft Word 2000, there are visual markers that differentiate between icons that are active *now*, for example **B** and icons that *were or could be active at other times*, for example B), in icons such as arrows that directly represent computer movements or actions (e.g., represents the action of indenting text in Microsoft Word 2000) and in icons and text that help users to orient themselves temporally in the interface (e.g., in Windows Explorer represents possible movements through web pages). There are also a variety of icons and feedback indicators that represent time using images of clocks, sundials and other time-measurement tools (e.g., the history icon in Windows Explorer and the coffee cup, the hourglass and the rotating radial lines that appear on Macintosh screens). Tense is also present in some arrangements of information on the screen such as the history of user actions in Adobe Photoshop.

The aim of this paper is to provide descriptions of visual representations of time in computer graphical user interfaces (GUIs). The paper considers these representations from a linguistic framework following Clark's (1996) pragmatic approach. Clark defines languages as *signals*, which are deliberate actions made by one person to mean something for another person. To this analysis, the paper also brings a cognitive perspective since according to Nuyts

(2004, p. 135), "an adequate account of language in general, or of any linguistic phenomenon in particular, has to focus on both the communicative functional and cognitive dimensions simultaneously in an integrative way." Our aim is to build a description of functional representations of time in GUIs that could be useful in the design process. We have previously built a taxonomy of visual representations of

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(2004, p. 135), "an adequate account of language in general, or of any linguistic phenomenon in particular, has to focus on both the communicative functional and cognitive dimensions simultaneously in an integrative way."

Our aim is to build a description of functional representations of time in GUIs that could be useful in the design process. We have previously built a taxonomy of visual representations of time in clocks, timers and still representations of time (Mitchell, 2006), and this research builds on that taxonomy with descriptions of the animated representations of time that are found in GUIs. For spoken and signed languages, researchers are building evermore detailed descriptions of the representation of time, with aims of capturing the rich variety of ways in which people represent their experiences of the world, for attempting to determine what motivates these representations, to establish whether there are common motivations among cultures for these representations and for using this knowledge to generally improve communication. We have the same aims as these researchers. While we do not wish to imply that verbal and visual communication serve the same communication functions or are built upon the same cognitive models, we believe that the detailed models provided in language provide a useful starting base for understanding the models in visuals.

As a background to this analysis of the visual structure of time in GUIs, this paper first presents a general psychological definition of the term *time*, and then discusses the types of time that appear to be of use to computer users as evidenced by visual representations of time in computer interfaces. Next, the paper looks at the structure of tense in both spoken language and in the sign language of the deaf. Then, the paper considers the impact of writing on time-related graphics since there is a known correlation between strategies of writing and the perception of time on two-dimensional surfaces (Lieblich, Ninio and Kugelmass, 1975; Kugelmass and Lieblich, 1970; van Sommers, 1984; Zwann in Winn, 1994). Finally, comparisons are made between computer icons that directly represent movement and comic-style illustrations of sign language of the deaf such as found in sign language dictionaries. We have chosen illustrations of sign language of the deaf as models for comparison because there is an existing taxonomy provided by Stokoe (1960) of the features of this language to which we can bring an analysis of the representation of movement.

Many of the examples in this paper come from Microsoft and Adobe products since they are familiar to most computer users, have been tested widely, have been used successfully for many years and are readily available for analysis. Other examples come from various web sites and utilities.

Types of visual representations of time that appear in GUIs

While time is not something that can be directly seen, smelled, tasted, touched or heard, it is something that as the psychologist Fraisse (1984) has noted, we perceive through changes in the world and the duration between changes. To effectively communicate about the many and varied perceptions of time, people have developed a broad array of representational frameworks. As stated earlier, these include devices that represent time in a primary way, such as clocks, timers, calendars and planners, and devices that represent time as a secondary construct such as timelines, family trees and process diagrams. Each framework was developed to meet particular human needs regarding time.

In looking at computer interfaces, there are particular time-related graphics that assist with human-computer interaction. The ones that we have noted and will discuss in this paper are as follows:

- *Animated progress bars:* These visuals represent the relative amount of completion over time of a requested computer action. The purpose of these bars is to show users that the computer is actively processing a request (and is not stalled) and are recommended for any process that takes longer than five seconds (Galitz, 1994). They also help users estimate how long a process will take.
- *Icons and windows that visually represent their current state of activity:* These visuals assist users by marking the functions that are currently selected and in operation on the screen so that users can find them more easily.
- *Icons that contain arrows that directly represent computer*

movements or actions: These icons are a type of process diagram that contain only one movement. They help users by providing a concrete representation of a particular computer action.

- *VCR-style icons:* These icons help users to orient themselves in an interface.

We will also discuss some time-related arrangements of information in GUIs.

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• *VCR-style icons:* These icons help users to orient themselves in an interface.

We will also discuss some time-related arrangements of information in GUIs.

The linguistic representation of time

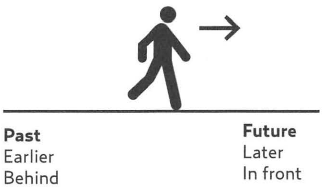
As mentioned earlier, time in language is represented primarily through spatial metaphors. The two most commonly found in languages around the world are referred to as the *moving-ego* and *stationary-ego* metaphors of time (Clark, 1973; Traugott, 1975; Nunez and Sweetser, 2006). In these metaphors, speakers *stand in the present*. They see the future ahead of them and have the past at their backs. In every sentence they speak, there is at least an implication of *now*, which is their current position upon the path, and *then*, which points to the location of the event that they are discussing. In the moving-ego metaphor, speakers walk along the path of time whereas in the stationary-ego metaphor, speakers stand still while time flows past them. Figure 1 illustrates these metaphors and presents examples of their use.

The path of time also appears in the sign language of the deaf, which represents time as a horizontal path that extends from the front of speakers towards the back. Figure 3 shows this line of time in American Sign Language (ASL) and Figure 2 shows graphic representations ofthe handsigns for *past*, *present* and *future*.

In an analysis of the Aymara language, which is spoken in western Bolivia, southeastern Peru and northern Chile, the researchers Nunez and Sweetser (2006) have found a linguistic model of time that differs from those of other languages. In Aymara, the present is just in front of speakers, the past is further in front and the future is behind them. A researcher on Chinese languages (Yu, 1998), has also reported vertical metaphors of time in which some Chinese phrases have earlier times above later times.

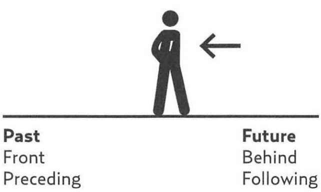
Figure 1 Moving-ego and stationary-ego versions of time.

The moving-ego version of time:
We walk through time



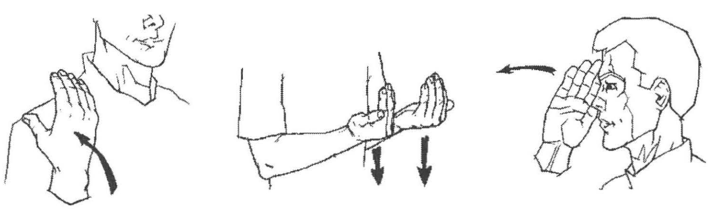
Examples:
"We look forward to meeting you."
"There are many years ahead of us."
"I'll see you later."
"Put that behind you."

The stationary-ego version of time:
We stand still and time moves past us



Examples:
"The meeting has been brought forward from 4:00 to 2:00."
"Autumn has passed."
"The school holidays are approaching."

Figure 2 Signs for past, present and future in ASL. © 2006, reproduced by permission. Source: http://www.Lifeprint.com



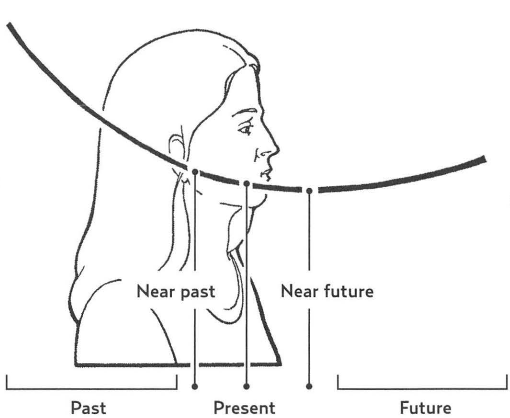


Figure 3 The timeline in American Sign Language (ASL). (Adapted from Frishberg and Gough, 1973.)

Considering all of these representations together, Nunez and Sweetser (2000) have suggested a model of tense that is based upon reference points rather than movement. The commonalities among these representations are that time is a unidirectional line, that the position of the speaker marks the position of the present and that the future and the past lie on opposite sides of the speaker. In most languages of the world, however, tense is represented as a horizontal path and the future lies in front of speakers.

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A description of time in language is pivotal to the description of time in graphics since it is primarily through language that we derive nuances regarding time. As evidence consider the following graphics from a linguistic textbook (*figure 4*).

Traugott (1975) referred to the three important subsystems of linguistic time, which are tense, temporal sequencing and aspect. *Tense* indicates when events are happening, have happened or will happen (e.g., past simple – "I watched a film last night"; present – "I am watching a film right now"; future – "I will watch a film tonight"). *Temporal sequencing* indicates how events occur relative to each another (e.g., "We met Mary and Lee and then we watched the film together"). *Aspect* indicates how long events last, what

southeastern Peru and northern Chile, the researchers Nunez and Sweetser (2006) have found a linguistic model of time that differs from those of other languages. In Aymara, the present is just in front of speakers, the past is further in front and the future is behind them. A researcher on Chinese languages (Yu, 1998), has also reported vertical metaphors of time in which some Chinese phrases have earlier times above later times.

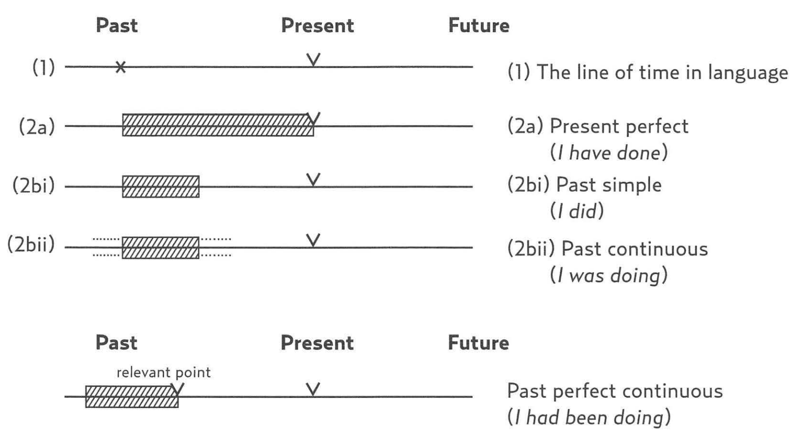

Figure 4 Timelines used to represent tense (graphics in Quirk and Greenbaum, 1973, pp. 42, 45).

boundaries they have and how they recur (e.g., "The film lasted for two hours"-fully-bounded aspect); "We started going to that theater six years ago and have been going there ever since" (bounded beginning and unbounded end); "They watch a film every Saturday night" (regular recurrence); "That's just the way things are around here" (unbounded). In addition, there is a subsystem of future tense, namely *mood*, which expresses information about such things as the likelihood of events occurring (e.g., event A *will* happen versus event A *might* happen). As will be shown, tense, temporal sequencing, aspect and mood in language all have analogues in graphical interface design.

As has been implied above, the past and future are represented asymmetrically in language (Harner, 1982). For example, in English, verbs are represented in their past tense usually by adding *–ed* to their present tense form. In contrast, to create the future form, speakers place *modal auxiliaries* before the present tense. Some examples of modal auxiliaries are: *must, will, shall, is going to, could, might* and *should*. The difference in the representation of the past and future occurs because of a fundamental fact about the world, which is that the past is resolved while the future is yet to happen and has varying amounts of certainty about it. The amount of certainty that speakers perceive is indicated through their choice of modal auxiliary. If they perceive an event as more certain, they will choose the modal auxiliaries *is going to*, *will*, *shall* and *must*. If they perceive less certainty, they will choose among *could*, *would* or *might*. As will be discussed shortly, the sense of such modal auxiliaries appears in the design of computer interfaces.

The visual representation of tense in GUIs

To represent *tense*, graphic representations must include the following (Mitchell, 2006, p.20):

1. Something that points to now (the reference point)
2. Something that points to then (the time of the event, which could be in the past or in the future)
3. Something that differentiates the past from the future, and
4. If an event is predicted to happen in the future, something that indicates the degree of certainty we have over whether the future event will happen.

One visual representation of tense in computer interfaces appears in progress indicators, which clearly indicate the past, present and future in their designs. In the example in Figure 5, which represents the starting of a remote-access computing application, the past is clearly differentiated from the future by its position in relation to the present and by its contrasting color.

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Progress bars also often include a digital readout of the amount of time left for processing and a percentage and a numerical summary of the amount of data that has been processed. One might ask why a graphical representation is useful for presenting the processing of data and why a numerical read-out of the remaining time or the amount of data processed is not satisfactory enough. This is the same issue as that affecting analogue versus digital clock and watch faces. Although both types of representations indicate the time, some people select the analogue because of the eloquence of the spatial relationships and the redundancy.

The progress bar design correlates directly to the linguistic representation of time as a horizontal path. Designed specifically for providing computer feedback, it better suits this need than designs based upon previous technologies such as circular countdown timers, which are associated with a 60-second or 60-minute timeframe, or kitchen sandglasses associated with a 3-minute timeframe. Users can associate any amount of time with a progress bar.

Sometimes in computer interfaces, reference points in time are created not through a path across, up or down a screen, but through visual layers and unique marking of the currently active layer (*figure 6*). This pattern for representing time is taken when users need to work with several applications or documents at the same time, there is limited screen space or a need to conserve space. Galitz (1989) has noted that layered or cascaded windows (in contrast to tiled windows) are useful when users need to switch between tasks. In this design, the specially-marked top layer represents the *present* and underlying inactive layers represent both the *past* (layers that were previously active) and the *future* (layers that could be active later). When considering the underlying layers from a past perspective, the layer that is immediately beneath the top layer

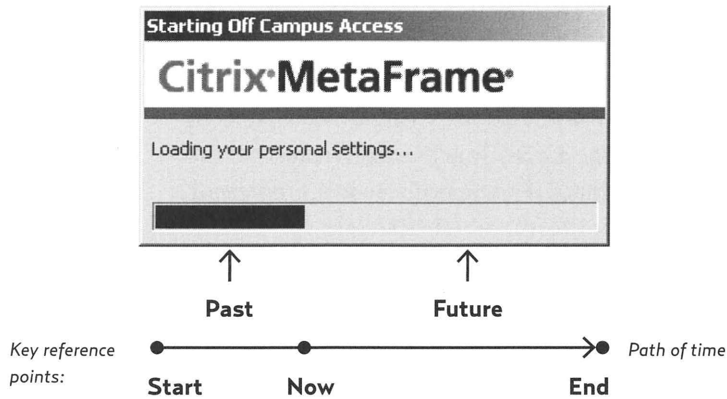

Figure 5 Representation of the past, present and future in a progress bar (this animated bar represents the starting of an application).

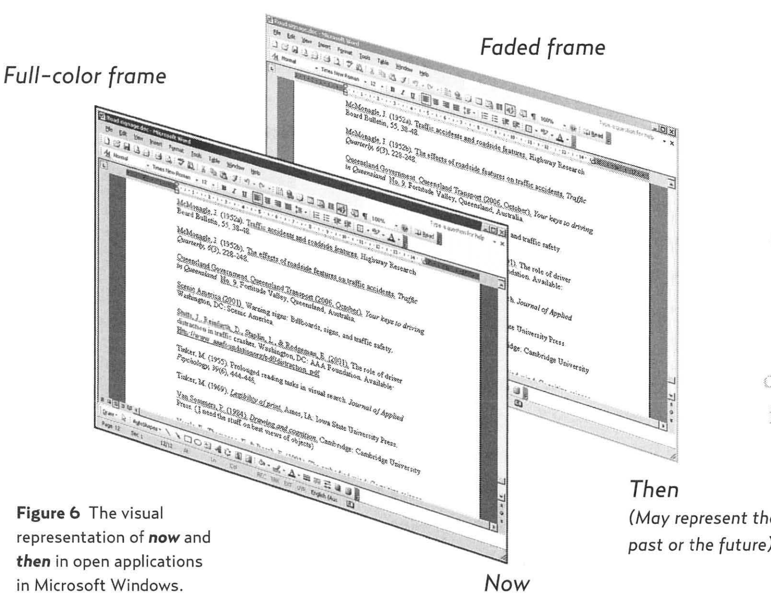

Figure 6 The visual representation of ***now*** and ***then*** in open applications in Microsoft Windows.

represents the one that was last used. When considering the underlying layers from a future perspective, any of the layers could represent the future. Another technique for representing reference points in time is through changes in an object's color, background and framing (*figure 7*). Designers use this visual approach on icons to indicate those that are currently active, inactive or available. In terms of tense, the currently active icon represents the *present* and the inactive or unavailable icons represent either the *past* or the *future*.

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The visual representation of temporal aspect in GUIs

In visual representations of time, *temporal aspect* (how long events last, what boundaries they have and how they recur) can be represented by different graphical starting and ending points and can be reflected in a graphic's shape. For example, in the progress bar previously discussed, time is represented as having a definite starting point (the beginning of a solid line) and a definite ending point (the ending of a solid line). In contrast, in the 'rotate' icon  of Microsoft Word 2000, the circular line with an arrowhead on the end indicates that the movement can continue indefinitely in the same pattern (around and around).

The visual representation of temporal sequencing in GUIs

Temporal sequencing, which describes when one event happens relative to another, can also be present in computer interface design. Sequencing involves, for example, whether one event preceded another and if so, by how much; whether one event happened after another event; or whether the events overlapped in time. Some examples of temporal sequencing in verbal language are as follows:

- She is going to the library *before she goes to the shop.*
- The boy delivered the gift *the day before his friend's birthday.*
- She'll go to work *after she visits her mother.*
- He was in Chicago *while she was traveling to Sydney.*
- After she *had opened her email*, she sent notes to her friends.

The key difference between *tense* and *sequencing* is that tense refers to the speaker, who stands in the present and

Galitz (1989) has noted that layered or cascaded windows (in contrast to tiled windows) are useful when users need to switch between tasks. In this design, the specially-marked top layer represents the *present* and underlying inactive layers represent both the *past* (layers that were previously active) and the *future* (layers that could be active later). When considering the underlying layers from a past perspective, the layer that is immediately beneath the top layer

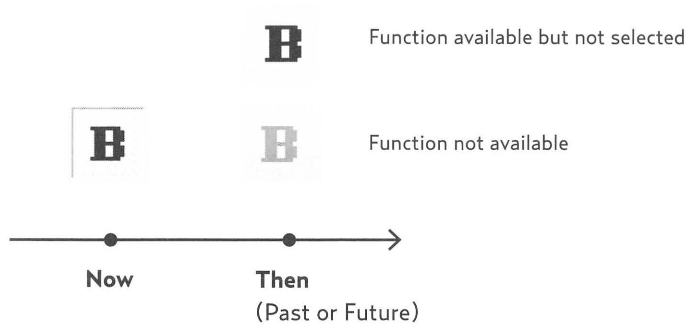

Figure 7 The visual representation of tense in Microsoft Word 2000 command icons.

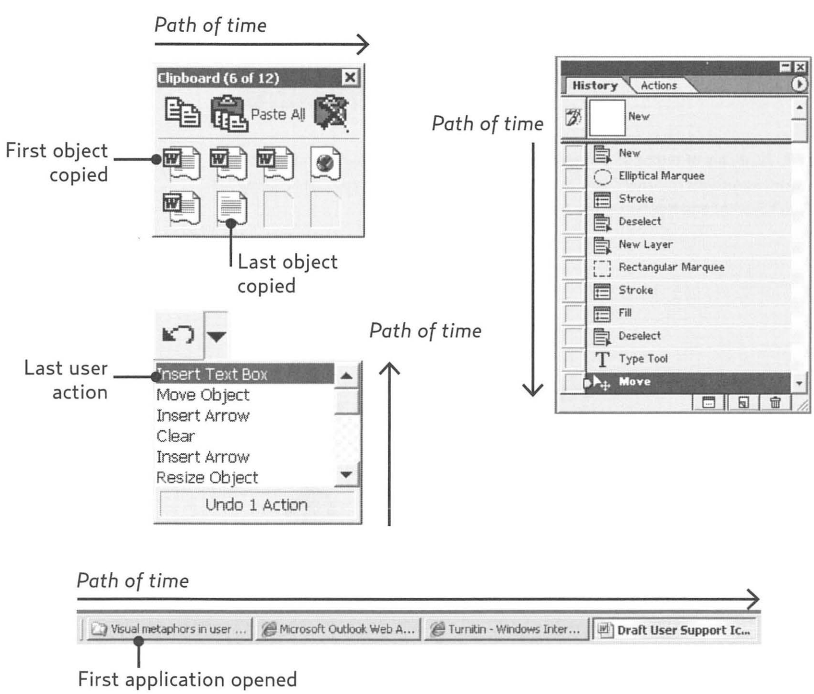

Figure 8 Examples of temporal sequencing of past events in Microsoft Word 2000, Windows XP and Adobe Photoshop 6.0

points at times in the past and future, while sequencing attaches events to one another in time. Temporal sequencing appears in a graphic when the graphic represents more than one event. Temporal sequencing of visual information can be helpful in numerous ways: It can help users to locate information such as email notes, data files and the last application window that they opened;It can help users to locate information such as email notes, Some examples of temporal sequencing in verbal language are as follows:

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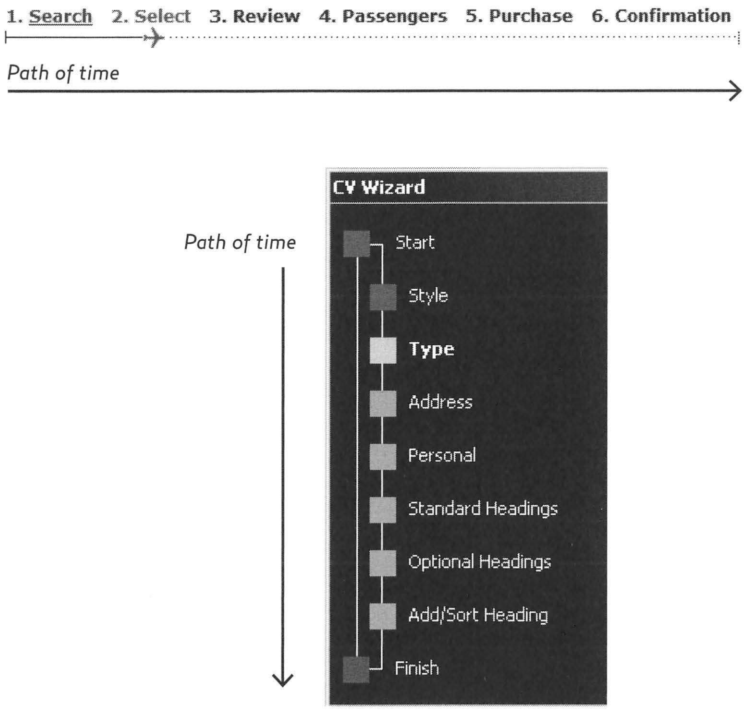

Figure 9 Examples of temporal sequencing for events that could happen at any time in the Qantas Airlines Internet flight selector (http://www.qantas.com.au/regions/do/dyn/QuickSearch) and the Microsoft Word 2000 Resume Wizard.

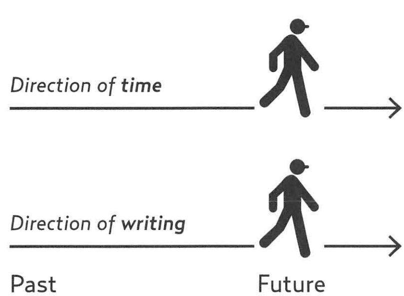

Figure 10 The relationship between writing direction and the flow of time on the screen in cultures that read from left to right.

points at times in the past and future, while sequencing attaches events to one another in time. Temporal sequencing appears in a graphic when the graphic represents more than one event. Temporal sequencing of visual information can be helpful in numerous ways: It can help users to locate information such as email notes, data files and the last application window that they opened; it can help users undo the entries that they made to a file up to a certain point in time (e.g., the 'undo' command in Microsoft Word 2000 and the 'history' list in Adobe Photoshop both provide this assistance); and it can help users see all of the steps they need to perform to complete a task. Figure 8 presents examples of temporal sequencing of past events and Figure 9 presents examples of temporal sequencing of events that occur in the same way all of the time. A discussion regarding horizontal and vertical sequencing and the reference points for starting a sequence is explored in more detail in the next section.

Effects of writing on the path of time

As stated earlier, not only does language itself affect how time and movement are graphically represented, so does the direction of writing on two-dimensional surfaces. Zwaan (as cited in Winn, 1994) found that people generally perceive the flow of time across a page to match the direction in which they read. He based this finding upon research conducted with Dutch and Israeli subjects. The Dutch subjects, who read from left to right, associated the left sides of pages with the concepts of 'proximity,' 'past' and 'self,' while the Israeli subjects, who read from right to left, associated these concepts with the right sides. Other research having similar results is reported by Kugelmass and Lieblich (1970; 1979) and Lieblich, Ninio and Kugelmass (1975). The same correlation applies to text on a computer screen (*see figure 10*).

In this paper, we argue that for carefully-made drawings that represent movement towards the future, illustrators will deliberately turn objects so that they face the future (that is, the right side of the page or screen). As an example, refer back to Figure 2, which illustrated the timeline in sign language (with the future on the right), with a person's profile oriented towards the right. This argument regarding

facings and time is based upon research by van Sommers (1984) who studied both the direction of facing of objects drawn in profile and the place within an object where people begin drawing the object. Van Sommers found that when asked to draw a face in profile, most right-handed people will orient the face towards the left and will begin drawing it on the left (*figure 11*).

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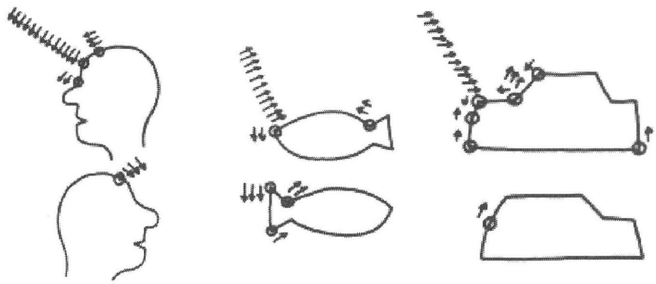
Figure 11 Most right-handed people begin drawings on the left and face objects in profile towards the left (van Sommers, 1984).



An animated document flies from the left to the right of a panel to represent time passing (in Microsoft Outlook Web Access)

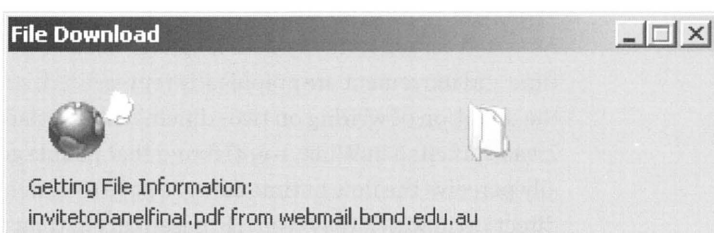


Figure 12 Visuals of computer processing activities also take advantage of the left-to-right path of writing and its association to the flow of time.

Figure 13 Example of a progress bar for Arab speakers.

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Van Sommers found that the direction of facing and the starting position of a drawing are based ultimately upon preferred finger and wrist movements. Therefore, when illustrators orient a face towards the right in the context of a visual representation of time as the illustrator of Figure 2 did, they are overriding these production constraints and are motivated to do so by the orientation of time on the page. (More detail regarding preferred movements of the fingers and wrist while writing and drawing is available in van Sommers, 1991.)

The orientation of objects to reflect the path of time on the page is seen in many computer-interface designs, for example in the progress bars shown earlier. Another example is shown in Figure 12, which represents a document being downloaded from the world-wide web to a folder on the user's computer.

For cultures that read from right to left, time-related graphics such as progress bars should be oriented from right to left as in Figure 13. The design shown, however, still contains text in English, which is obviously not ideal for Arabic readers.

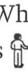
Since many computer users in Arabic-speaking countries have learned to use interfaces that are written in English, it is probably prudent (and good practice) for designers to conduct research on their Arabic audiences before making any final design choices. For example, one Bahraini informant told us that although English is his second language, he learned to use the computer in English and would find this right-to-left progress bar annoying.

To examine the visual perspective that people take of time on the page, van Sommers (1984) asked people to imagine or depict themselves on a horizontal timeline across a page. All of the subjects placed themselves inside-on perspective on the far left of the timeline. None

provided a top-down or map-like perspective. Van Sommers suggested that they represented themselves side-on since they see time as one-dimensional and a side-on representation provided the best and simplest view of themselves in time. He further noted that a two-dimensional map-like time perspective is a special-purpose device. Let us now consider some vertical arrangements.

provided a top-down or map-like perspective. Van Sommers suggested that they represented themselves side-on since they see time as one-dimensional and a side-on representation provided the best and simplest view of themselves in time. He further noted that a two-dimensional map-like time perspective is a special-purpose device.

Let us now consider some vertical arrangements. Time is sometimes represented along the vertical, but sometimes it is represented as moving up the page (as in many evolutionary-tree diagrams) and sometimes down the page (as in many family trees). To understand how people conceptualize time along the vertical, van Sommers (1984) asked people to place themselves in a plan view along a vertical path. Some people drew themselves traveling up the page, some drew themselves traveling down and some represented the arrow of time traveling both up and down. Van Sommers proposed that the representations were inconsistent because the vertical plan view is not a natural way for people to represent time and the subjects faced various contradictions.

These contradictions are that different types of vertical representations of time are based upon different visual structures. When a model follows the vertical pattern that is set up by reading, time should start at the top of the page and flow down. When a model follows the pattern created by a Cartesian-grid, time should begin at the bottom of the page and flow up. When the model is of walking forward or into a page like this , the path of time will flow up from the bottom of the page. Often, time flows up the page for pragmatic reasons. For example, when email notes are represented on the page, it is more useful to have the most current or last received note at the top of the page where reading begins.

The representation of movement within icons

It is useful for designers of computer-support icons to understand the visual principles that underlie comic-style representations of sign language since like computer-support icons, drawings of sign languages are designed primarily to be functional. In addition, these drawings provide excellent models for many types of functional images since sign language itself is considered by many

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Figure 14 An inventory of handshapes (Friedman, 1977, pp 16–17.)

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to be difficult to draw (Bailey and Dolby, 2002) and illustrators take great care to make the illustrations easy to understand. Further, comic-style representations of sign language are drawn to be concrete (that is, to represent body movements directly) and the most useful computer-support icons are considered to be those that provide direct representations of screen actions. Although some applications use icons to represent the most abstract commands, Mullet and Sano (1995, p. 202) have recommended that icons be reserved for those actions that allow users to directly act upon screen information. They have argued that more abstract commands should be placed as words in menus and "the visible portion of the display [should be reserved] for important tools and direct access to properties with an inherently spatial character." For all of these reasons, principles for creating comic-style representations of sign language are important and relevant for computer-support icons.

As an introduction to the visual representation of movement in sign language, the next few paragraphs describe the visual parameters of sign language as provided by Stokoe (1960). He observed that the language was formed by handshapes, body locations, paths of movement of the hands, palm orientation and sometimes non-manual features such as those found in movements of the mouth, brows, shoulders, head and body. Friedman (1977) has listed forty-one different handshapes and these are presented in Figure 14. From a graphical point of view, these handshapes must be drawn in their best view with particular attention to the visibility of curved or clenched fingers so that they are easily recognizable. Like handshapes, the objects chosen for computer icons must also be drawn in their canonical position for ease of recognition.

Some meanings are created simply by a single handshape, but many are created by the placement of a particular handshape against a particular location of the body. Parts of the body other than hands are included in an illustration usually only when the location at which a sign is made effects the sign's meaning. For example, the motions for the signs *summer*, *ugly* and *dry* are identical except for the location across the face at which they are made (*see figure 15*). Different researchers have noted different numbers

Figure 15 The same handshape made at different locations on the body can create different meanings. (Reprinted by permission of the publisher from *The Signs of Language*, Edward Klima and Ursula Bellugi, p.42, Cambridge, MA: Harvard University Press. ©1979 by President and Fellows of Harvard College.)

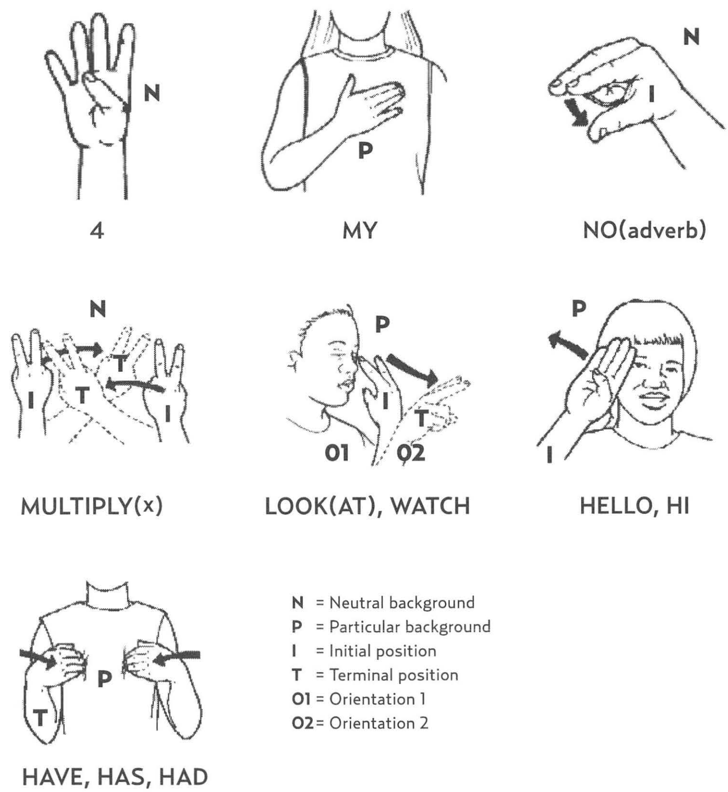

Figure 16 Typical compositions in sign language. (ASL graphics from Terry, Witherell and O'Connor, 1998. Figure based upon Mitchell, 2006.)

Word 2000 and the 'history' list in Adobe Photoshop both provide this assistance); and it can help users see all of the steps they need to perform to complete a task. Figure 8 presents examples of temporal sequencing of past events and Figure 9 presents examples of temporal sequencing of events that occur in the same way all of the time. A discussion regarding horizontal and vertical sequencing and the reference points for

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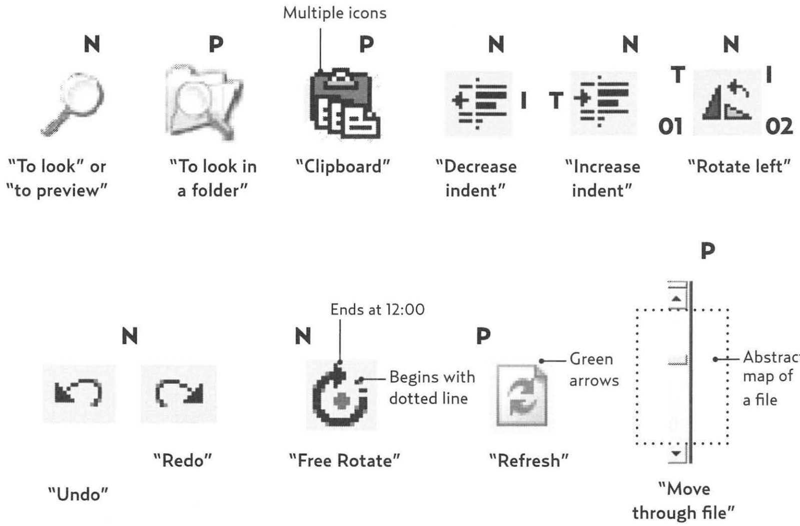

Figure 17 Compositions of icons in Microsoft Word 2000 that have similar structures to those in comics of sign language. The lower set differs from representations of sign language in that arrows appear alone.

Figure 18 Multiple lines with arrowheads can represent more of something in sign language. (Reprinted by permission of the publisher from *The Signs of Language*, Edward Klima and Ursula Bellugi, p.257, Cambridge, MA: Harvard University Press. ©1979 by President and Fellows of Harvard College.)

of distinct signing locations on the body: Corina (1990) listed thirty-six, while Johnson and Liddell (1988) found fifty-six.

In composition, the following differences are typical in sign language. Some illustrations contain only a handshape, some show a handshape drawn against a particular location, some show a handshape and a line with arrowhead that represents the path of movement, some show the initial and the terminal positions of handshapes, some show the initial and terminal handshapes in different orientations against particular locations with a line and arrowhead. Some show just the initial or terminal position with an arrow. Figure 16 illustrates these different compositions. Similar compositions and some others that are related to time are found in computer-support icons as shown in Figure 17.

At least two explanations can be provided as to why both the initial and terminal handshapes are drawn in a single image. First, both are drawn when the handshape is different in each phase, and second when the orientation of the handshape is different in each phase. Among the computer icons shown in Figure 17, the 'rotate left' icon is the only one that represents both the initial and final position of an object. In this case, the icon's purpose is to indicate that the orientation of the object changes when the icon is selected and so both positions are shown.

Sometimes when illustrators draw both the initial and terminal handshapes, they may draw the handshapes in different ways. Typically, one of the representations will be less detailed than the other. Such a difference in representation is helpful since if the handshapes overlap, the different drawing styles will allow the shapes to be clearly differentiated from one another. The difference in representation is also helpful because it provides visual redundancy and also because showing each handshape differently is analogous to the linguistic model of time in which the past and future are marked differently. Among the computer-support icons shown, the 'rotate left' icon represents the initial and terminal positions differently, with the initial presented as outlined (less detail) and the terminal as solid.

Since many lines with arrowheads appear in the Microsoft Word 2000 interface, they are represented

to differentiate among their various functions. The simplest arrowhead design is ▲ (or ▼) and this design is used more frequently on the screen than any other style of arrowhead. Its function is to move application-related information. In its smaller size, it opens small drop-down windows and in its larger size it assists users in scrolling through files; sometimes a shift through 90 degrees codes for the listing of contents of a file.

The difference in representation is analogous to the linguistic model of time in which the past and future are marked differently. Among the computer-support icons shown, the 'rotate left' icon represents the initial and terminal positions differently, with the initial presented as outlined (less detail) and the terminal as solid. Since many lines with arrowheads appear in the Microsoft Word 2000 interface, they are represented

differently to differentiate among their various functions. The simplest arrowhead design is ▲ (or ▼) and this design is used more frequently on the screen than any other style of arrowhead. Its function is to move application-related information. In its smaller size, it opens small drop-down windows and in its larger size it assists users in scrolling through files; sometimes a shift through 90 degrees codes for the listing of contents of a file. For example, the downward pointing arrowhead ▼ points to the revealed content.

Color occasionally helps to differentiate among the arrowheads with lines. Not only are different colors used, but for some icons, the colors carry meaning, for example as in the green arrows on the *refresh* icon, which requests the computer to check for updates to the screen. (Reading patterns for icons that consist primarily of arrowheads are discussed in the next section.)

Klima and Bellugi (1979) have studied how *temporal aspect* is represented in sign language. As mentioned earlier, aspect indicates an event's boundaries, such as when it began and ended or whether it is always occurring, or whether it occurred all of a sudden. One type of aspect, which refers to *a lengthy event*, is indicated with repeated hand movements and is graphically represented with multiple movement lines with arrowheads. An example is shown in Figure 18. In computer interfaces, types of movement other than the norm are often represented with double arrows (for an example, *see figure 19*).

Arrangements of VCR-style icons

Along the horizontal, there appear to be different possibilities for organizing time-related, VCR-style icons and each possibility may be explained by pragmatics or by the type of time that a designer wishes to convey. Commonly they are arranged so that the icons that move the data forward are all on the right and those that move the data backwards are on the left. Sometimes they are arranged according to the type of forward and backward motion that they provide. For example, the icons that move a video forward by frames are grouped together and the icons that move a video forward by sections are grouped together. Often, a combination of strategies is used. For example, the most commonly-used icons are grouped together on the left and those that move forward and backward in any way are grouped together on the right. Figure 20 presents these different possibilities. Another arrangement of arrowheads (an example of which is shown in *figure 21*) is to have the most current item on the left and the oldest item on the right.

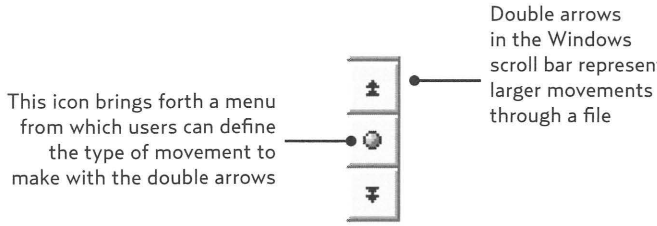

Figure 19 In Windows, double arrowheads represent larger movements through a file.

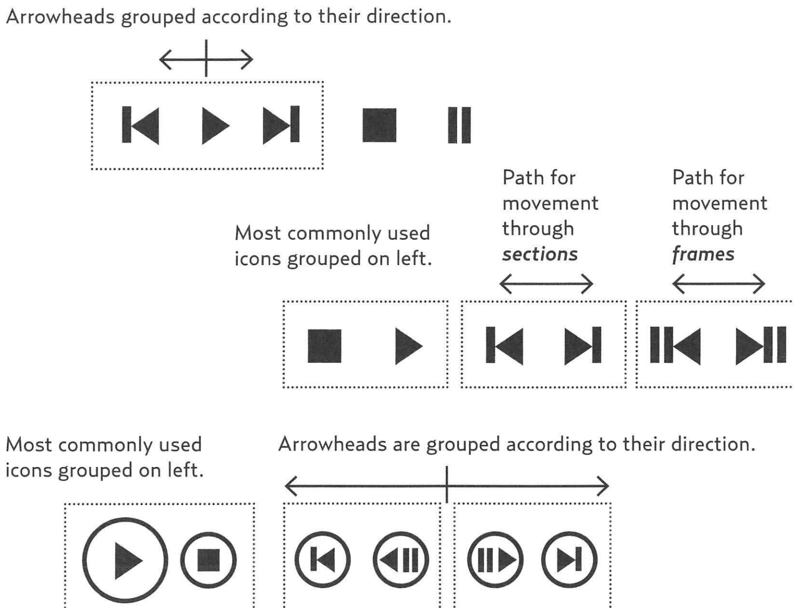

Figure 20 Arrangements of icons in computer video players.

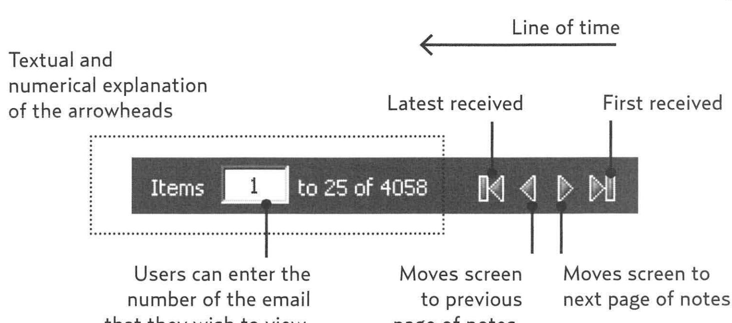

Figure 21 Icons arranged along a reversed horizontal timeline (Microsoft Outlook Web Access).

those that move the data backwards are on the left. Sometimes they are arranged according to the type of forward and backward motion that they provide. For example, the icons that move a video forward by frames are grouped together and the icons that move a video forward by sections are grouped together. Often, a combination of strategies is used. For example, the most commonly-used icons are grouped together on the left and those that move

forward and backward in any way are grouped together on the right. Figure 20 presents these different possibilities.

Another arrangement of arrowheads (an example of which is shown in *figure 21*) is to have the most current item on the left and the oldest item on the right. Since this arrangement is a reversal of the norm, it is typically supplemented with text. Such an arrangement is useful when a user needs to view first the latest item received or the last action performed. This example is from the email software Microsoft Outlook Web Access.

Conclusions

The paper began with a discussion of the linguistic representation of time: *time is a path or trajectory*. Using this model, the visual representation of time in computer interface design consists of a line that has a direction and a key reference point. As discussed, this line may be represented in the two dimensions of virtual depth in the form of layers or it may go across the screen. Sometimes, only a single reference point along the line is represented. Along the horizontal, representations of time tend to follow writing but may be reversed for pragmatic reasons. Along the vertical, there appears to be no particular standard for whether time travels up or down and depends upon the particular design situation. For example, when designers find that a situation requires them to follow the pattern created by writing, time will start at the top of the page. If however, they think that for example, the latest event in a series is most important, they will graphically represent that event in a position that makes it stand out or be most convenient for a user. To be useful, representations of time in computer interface designs must reflect people's conceptions of time and represent the kinds of time that people require when using a computer.

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Italicization and understanding texts through metaphoric projections of movement

The Arts Institute at Bournemouth *Visible Language* 41.3 Jones, 246-265 © *Visible Language*, 2007
Rhode Island School of Design Providence, Rhode Island 02903

Phil Jones

After working as a graphic designer for twenty years, Phil Jones became a Senior Lecturer at the Arts Institute at Bournemouth in 2002. He is currently completing an MA by Project at the London College of Communication under the supervision of: Teal Triggs, Head of Research, School of Graphic Design, and Paul McNeil, Subject Lead Tutor, Postgraduate Graphic Design.

Abstract
Bellantoni and Woolman (2000) note that "Italic and oblique typefaces possess a kinetic quality because of their slant to the right." But what is the nature of this kinetic quality and why is it imparted in this way? This paper explores kinetics, not as a property of italics, but as a manifestation of cognitive work involving metaphoric projection, for which the typeface is but a cue. It will use concepts from cognitive semantics (Lakoff and Johnson, 1999; Fauconnier and Turner, 2002) to posit the idea that the dynamic quality of italics arises from preconceptual structures (such as image schemas) related to embodied experiences of writing and running. These structures forming the basis for higher level metaphors to be constructed in cognition. Consequently, a layout incorporating italics is metaphorical to the extent that the concept of running is used (consciously or unconsciously) to understand an arrangement of type characters. Furthermore it is argued that the meaning we construct from italic type is not a simple correspondence between slanted letters and the body in motion, but is situated; resulting from a blend of concepts triggered by such things as the meanings of the words italicized and the site/s where they appear.

Introduction

Italic and oblique typefaces possess a kinetic quality because of their slant to the right. *Bellantoni and Woolman, 2000, p.35*

The kinetic quality of oblique forms in general and italicized and oblique letterforms in particular has been commented on by practitioners and theorists (Arnheim, 1954 /1975; Bellantoni and Woolman, 2000) and this quality is often discussed as something belonging to the form itself; something intrinsic, for example, to letters on the page. This paper uses theories and concepts from cognitive linguistics (Coulson, 2001; Fauconnier and Turner, 2002; Johnson, 1987; Lakoff, 2006; Lakoff and Johnson, 1999; Talmy, 2000), to explore an alternative account of italicization and kinetics. An account in which the dynamic quality of these letterforms is constructed in cognition, and where an association with motion arises not because of some universally evident property of italics, but because of our shared bodily faculties and experiences which we utilize both consciously and unconsciously to make and to read typographic designs. It will be argued that the use of the body in these designs is metaphorical to the extent that a *source domain* (the body) is utilized to understand a different *target domain* (the letter). Furthermore that this embodied understanding of letterforms contributes to the dynamics we associate with italics.This interest in metaphorical associations between letter and body stems from a concern to make both the designer's and the user's conceptualizations explicit in order to improve communication. In many cases the mental processes investigated are preconceptual, but their functioning is fundamental rather than trivial, and the nature of the links between body and letter are not fixed and predetermined, but are situated in the cognitive work involved in acts of communication.

This paper describes some aspects of an ongoing practice-based master's project concerning the metaphorical associations between italicization and the body. Such associations, though often unconscious, may be reflected in the way that we communicate (Lakoff and Johnson, 1980/2003); for example we might talk of '*running* text' or type '*leaning* to the right.' These are both cases of understanding letters in terms of what we can do with our bodies. There are many such ways of talking about typography that make reference to the body. It is argued here that these ways of talking about type are what Lakoff and Johnson refer to as *metaphorical expressions:* that is, statements that are structured by an underlying *conceptual metaphor* (in this case LETTER IS BODY). Logan has identified similar conceptual metaphors in 'metaphor based discourses' (2006, p.335) that relate to graphic design practice. The master's project described in part here is an investigation into how such conceptual metaphors are manifested in visual, rather than verbal communication. The intention being to identify ways in which typographic designs provide prompts for the construction of metaphors related to the domains of letter and body. Reflections on practice are used to evaluate if basic typographical choices (such as whether to italicize a particular word or not) are motivated by metaphorical associations with the body. These reflections on practice are supported by analysis of existing designs incorporating italics, for example, graphic designs applied to road trucks. The next section provides a brief overview of the theoretical framework that informs the study, followed by an overview of the implications of this framework in relation to how we make meaning from italic and oblique letterforms. This is followed by an analysis of various examples of italicization to try and determine some of the ways that metaphor supports the user in the construction of meaning through *communicative acts* involving typographic forms.

The theoretical framework

The theoretical framework is largely based on theories within cognitive linguistics; primarily conceptual metaphor theory and image schema theory, but also with reference to conceptual blending theory, and Talmy's work on force dynamics in language. In terms of language, cognitive linguistics has been more concerned with verbal rather than visual language, although visual material has been scrutinized in several texts (Fauconnier and Turner, 2002; Johnson, 1987; Lakoff, 2006; Lundmark, 2005). Cognitive linguistics is referred to as an approach rather than a theory that incorporates a "...diverse range of complementary, overlapping (and sometimes competing) theories" (Evans and Green, 2006, p.3). This breadth of activity however, centers around a number of core perspectives, one of which is *embodied realism*.

Embodied realism

Embodied realism proposes that our understanding of the world is based on concepts developed from our embodied experiences of it (Lakoff and Johnson, 1980/2003; Lakoff and Johnson, 1999). It is therefore because of the way that our bodies are, that our conceptual system is the way it is. Ontologically, there is a reality 'out there,' but this reality can only be understood through embodied concepts and metaphorical projections based on these concepts. Meaning is not to be found in objects in the world, such as typographic characters, these things are cues for cognitive work that constructs meaning from them. Consequently, as Evans and Green (2006) note "Semantic structure is conceptual structure..." and "language refers to concepts in the mind of the speaker rather than to objects in the external world" (p.158).

Shared meanings between designers and users in relation to a graphic design therefore, arise not because of some independently existing meaning belonging to a real world referent, but primarily because of similar embodied and cultural experiences that enable designer and user to construct meanings from visual cues in similar ways.

Image schema theory

Repeated interactions with the world provide embodied experiences. The regularities in these experiences enable us to order them, and then to reason about them. An *image schema* therefore, as Johnson (1987, p.29) notes, is: "...a recurrent pattern, shape, and regularity in, or of, these ongoing ordering activities. These patterns emerge as meaningful structures for us chiefly at the level of our bodily movements through space, our manipulation of objects, and our perceptual interactions."

Image schemas, are not limited to the ordering of visual experience but relate to all the senses. They are schemas because they are abstract and used to structure a wide variety of different instantiations of bodily experiences. Image schemas however, are not fixed and immutable frameworks into which experiences are located, but are able to be adapted to fit particular experiences and instances. As Johnson observes (1987, p.44) ordering and pattern creating structures, image schemas are collections of different aspects of experience formed into *experiential gestalts*. Image schemas therefore have parts, although they function as unified wholes. They are pre-conceptual but are the basis for inferences to be made in our conceptual system. Lakoff (1987) and Johnson (1987) both provide diagrammatic representations of image schemas. The diagram for 'path' where points A and B are linked by a path (*figure 1*). This basic image schema can have a left to right directionality applied to it so that point A becomes the source, and point B the goal (Johnson, 1987, p.114).

Image schemas and the brain

The *cog-hypothesis* proposes that areas in the brain which are used to control sensory-motor activities, can also be utilized for reasoning (Lakoff, 2006). So, for example, a motor activity such as running is controlled by a neural ensemble that involves at least two different areas of the brain. One of these (the *motor cortex*) controls simple individual actions (bending of the knee, etc.), the other (the *premotor cortex*) coordinates these simple actions into complex actions (in this case running). In this example the motor cortex is a primary neural structure involved with processing a lot of detail and the premotor cortex is a secondary structure involved with more general coordination and structuring. It is this secondary structure that can function as a cog when used, not to control motor activity, but to "compute complex patterns that can permit inferences and evolve in time" (Lakoff, p.164).

Figure 1 Path image schema (after Johnson, 1987).

Lakoff used the cog-hypothesis to describe how we are aware that a figure in a still image is in motion even when the image is abstracted. This description involves the firing of mirror neurons (which are activated when we perform a coordinated action or see such an action performed). We are able to understand that movement is involved because we can make use of the secondary neural structures that we use to coordinate our own actions, consequently we are able to 'feel' to an extent what such a movement would be like. It is this secondary structure that is the cog, as Lakoff (2006, p.164-165) notes:

> *Cogs include ... image schemas, and force-dynamic schemas. They inhibit connections to the primary neural structures that would fill in specific details ... These cogs are at once embodied, since they are part of the sensory-motor system, and 'abstract,' since they do not include details. Cogs give structure to culture, and conceptual metaphors give substantive meaning to the cogs. Cogs allow us to have an embodied understanding of the form of abstract art, and metaphors apply to cog structures to provide interpretations for abstract art.*

Conceptual metaphors

Conceptual metaphors use sensory-motor experience to structure subjective experiences (Lakoff and Johnson, 1999, p.45). So, for example, sensory-motor experiences of physical weight, can be used to describe how convincing an argument is, so that we talk about 'the weight of an argument.' A related metaphor concerns balance, so that arguments, and even entire minds, can be 'balanced' or 'unbalanced.' These conceptual metaphors are expressed in different ways in everyday language, and are pervasive.

When we regard a two-dimensional image, such as a type character, we also talk about weight and balance. According to Johnson (1987) this kind of talk is also metaphorical in that we are not describing literal, physical weights and forces, but visual ones. Johnson (1987, p,82) discussing an Udo, bronze figure, notes:

> *The balance here is visual; it is not a balance of actual physical weights or masses in the bronze figure. It is a balance of line and of visual forces that can create perceptual motion in an apparently static figure. We can speak of metaphorical projections at this level of understanding, insofar as we are experiencing a meaningful distribution of visual forces. ... It can only be by a metaphorical extension from our experience of physical weight that the sword and right arm could somehow have 'equal weight' with the left arm in the composition. Again, the metaphor consists in the projection of structure from one domain (that of gravitational and other physical forces) onto another domain of a different kind (spatial organization in visual perception).*

Since image schemas are based on repeated sensory-motor experience they can be used as a basis for metaphoric interpretation, so for example, the path schema discussed above provides structure for the conceptualization of more abstract ideas as well as for ordering sensory-motor data concerning the physical movement of some object in space. Image schemas therefore frequently provide an input for metaphors (Lakoff, 1987, p.435), the SOURCE-PATH-GOAL schema for example, providing a structure for many metaphors based on journeys, such as life is a journey.

Metaphorical interpretation of image schematic structure

Evans and Green (2006) provide a partial list of image schemas collected from the literature. Many of these relate to the kinds of movement that can be expressed through italicization. Space schemas, for example, include: FRONT-BACK and LEFT-RIGHT; containment schemas include: IN-OUT; locomotion schemas: MOMENTUM, and SOURCE-PATH-GOAL; balance schemas: AXIS BALANCE, POINT BALANCE, and EQUILIBRIUM; and force schemas: COMPULSION, BLOCKAGE, COUNTERFORCE, DIVERSION, ENABLEMENT, ATTRACTION and RESISTANCE. This is by no means a complete list, however it does provide some indication of how potentially rich conceptualizations based on these schemas can be, especially since these schemas can be used in clusters and modified to fit particular circumstances.

To illustrate the ways in which image schemas might provide structure for metaphorical interpretation, consider an organizational logotype set in italics. Because it is set in italic the logotype provides cues for the construction of metaphors which link the organization concerned with some sense of movement. However movement has many senses, several of which could potentially be applied to the use of italics. So, for a research organization, or a company involved in developing new hi-tech products, an italicized logotype might suggest to a viewer that the organization concerned is moving towards the future. This conceptualization involves some of the schemas above (such as, SOURCE-PATH-GOAL, LEFT-RIGHT and FRONT-BACK) and these help to determine which sense of movement is in question. But these image schemas also provide structure that enables the metaphorical understanding of future time in terms of motion forwards through space, and this use of motion as a source domain underlies much of our understanding about time (Lakoff and Johnson, 1999, p.139). Alternatively, the same italicized typographic treatment for a logotype for an investment company might result in a reading that the company concerned is responsive to turbulent situations and energetically pursues opportunities. The motion and energy described here, is once again being used metaphorically, and Lakoff and Johnson describe a number of metaphorical statements based on the 'moving activity metaphor,' (1999, p.203). The inferences based on image schemas however do not have to be metaphorical; the use of italicization in a logo for a demolition organization might prompt for force schemas that metonymically represent the forces involved in the destruction of a building for example.

The SOURCE-PATH-GOAL image schema, is used in all these examples and informs the conceptualization of a certain type of movement. Italicized type could conceivably move in different ways (*figure 2*), however the elements comprising the SOURCE-PATH-GOAL schema, are consistent with the linear motion associated with reading, so that, with Latin characters, the start of a passage of text is the source,the path is the baseline on which the letters stand, and the goal is the end of the text.

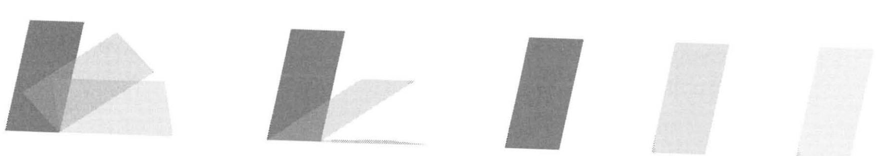


Figure 2 Alternative potential movements of italics.

These readings of the logotypes above are not assumed to be fixed correspondences between a type of organization, on the one hand, and italicization, on the other, but rather, need to be creatively constructed by the viewer. The meaning making here utilizes the viewer's existing knowledge, including knowledge about organizations, and this meaning is prompted for by the range of cues provided in the act of communication.

The communicative act

The 'communicative act' is a term used by van Leeuwen (2005) to describe an alternative approach to the analysis of communication including 'speech acts,' 'image acts' and 'sound acts.' Rather than addressing a communication event as a series of distinct *monomodal* exchanges; focusing say on verbal language, then image, etc., the event is approached as a "single, multilayered, multimodal communicative act, whose illocutionary force comes about through the fusion of all the component semiotic modes" (p.121). These acts are necessarily complex, and therefore may well prompt for both metonymical and metaphorical links between different conceptual domains. The italicized word '*car*' therefore might be made to resemble a car pictorially, yet might still call for metaphorical links to be activated in cognition.

The meanings we make from italic types

Although the first italic types were used to print entire texts, after 1530 italics were produced by designers such as Garamond, Granjon and Guyot for the purpose of complementing roman type rather than as independent typefaces (Lawson, 2005). This development reflects an understanding of the use that italics can be put to, that is, to emphasize certain kinds of information by differentiating it from the bulk of the text. By designing a set of italics to have the same typographic color and similar visual characteristics as their roman companions, type designers conventionalized their use as a 'secondary type' (Tracy, 1986, p.61) and an instrument of emphasis. In order to emphasize, italics must stand apart visually from the rest of the text. Two different ways in which italics differ visually from roman fonts are explored here: a) through the cursive, handwritten cues provided by italics and b) through their oblique construction.

Italics and movement; associations with handwriting

For many typographers it is the cursive nature of italics that is their primary characteristic (Baudin, 1984/1989, p.40; Jury, 2006, p.144). These cursive characteristics are reflected in the construction of the letterforms. Writing usually demands a degree of speed effecting the way we form letters. It is time consuming to have to remove the pen from the page, consequently there is a pressure to form characters from as few strokes as possible and to join-up letters when convenient. Chancery scripts were designed for speed and this sense of speed transferred to the early italics developed from them. From an embodied realist perspective these letterforms provide cues from which we can construct links between these italicized characters on the one hand and our experiences of writing with a pen on the other. This embodied experience of writing includes the cause and effect relationships between the act of writing and the nature of the resulting strokes and letters; this understanding about writing letters is stored in our memory. The cog hypothesis also suggests ways in which we might mentally trace the movement of a pen as we study italics. A comparison of italics and roman letters by Baudin (1984/1989) demonstrates how much quicker and easier it is to conceptualize the construction of italics in comparison with their roman counterparts (*figure 3*).

The account of the kinetics of italicization advanced here therefore, is that it is this knowledge about the ways letters are written that contributes to our association of movement with italics rather than any independently existing quality inherent within the letters themselves. The idea that there is nothing contained within the form of an italic letter that means 'movement,' is hardly a novel one (see for example White, 2005, pp. 237-239). However, an advantage of the cognitive semantic perspective is that it offers a way to explain how we might unconsciously conceptualize movement using embodied experience, without the requirement that any quality of movement should be factual or inherent to the italics themselves.

The visual dynamics of oblique letterforms

Grandjean's romain du roi, is widely cited in the literature (Kinross, 1992; Massin, 1970; Tracy, 1986) as being the first attempt to design a roman and italic along rational lines using a grid. According to Kinross (p.18) this grid was impractical for the task of cutting punches although the system introduced principles that were to be explored later on. Among these was the idea of deforming roman characters by skewing the rectangular grid on which the characters are based to form a parallelogram. The resulting designs are known as 'sloped romans' or 'oblique' types. These types are inclined like traditional italics, but do not share

Figure 3 Comparison of the letter strokes that comprise the letter m in Bodoni Book and Garmond Italic.

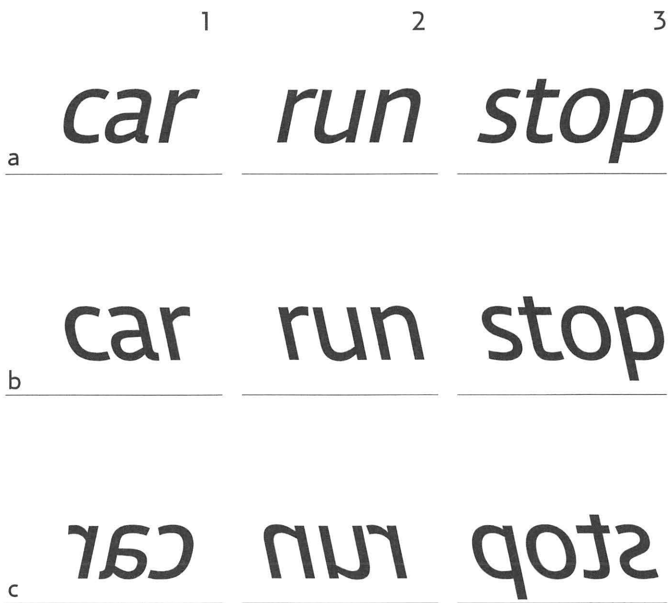


Figure 4 The words in each column are given the same typographical treatment: forward inclination in row 1, reversed inclination in row 2, and laterally reversed forward inclination in row 3. All appear well-formed except b2.

the simplified, cursive structure of italic letterforms. Rather than the single storey italic '*a*' for example, oblique types retain the more complex double storey structure of the roman '**a**.' Many of the cues that differentiate italic from roman and that prompt for the kinetic qualities of writing are therefore not to be found in oblique types. Yet according to Bellantoni and Woolman above, these types still 'possess a kinetic quality' and as they point out, this is associated with their inclination to the right. As Arnheim (1954/1974) also notes: "Oblique orientation is probably the most elementary and effective means of obtaining directed tension. Obliqueness is perceived spontaneously as a dynamic straining toward or away from the basic spatial framework of the vertical and horizontal." (p.424). This raises the question why should our basic spatial framework be vertical and horizontal? The answer from an embodied realist perspective is because of the upright posture of the human body. As humans, the vast majority of us experience the world from an upright position, perpendicular to the ground: walking, standing, sitting upright, etc. and this, according to conceptual metaphor theory (Lakoff and Johnson, 1980/2003), fundamentally influences our understanding, not only of the physical world, but (through metaphoric projection) our understanding of abstract concepts as well.

Texts involving metaphoric projections of movement

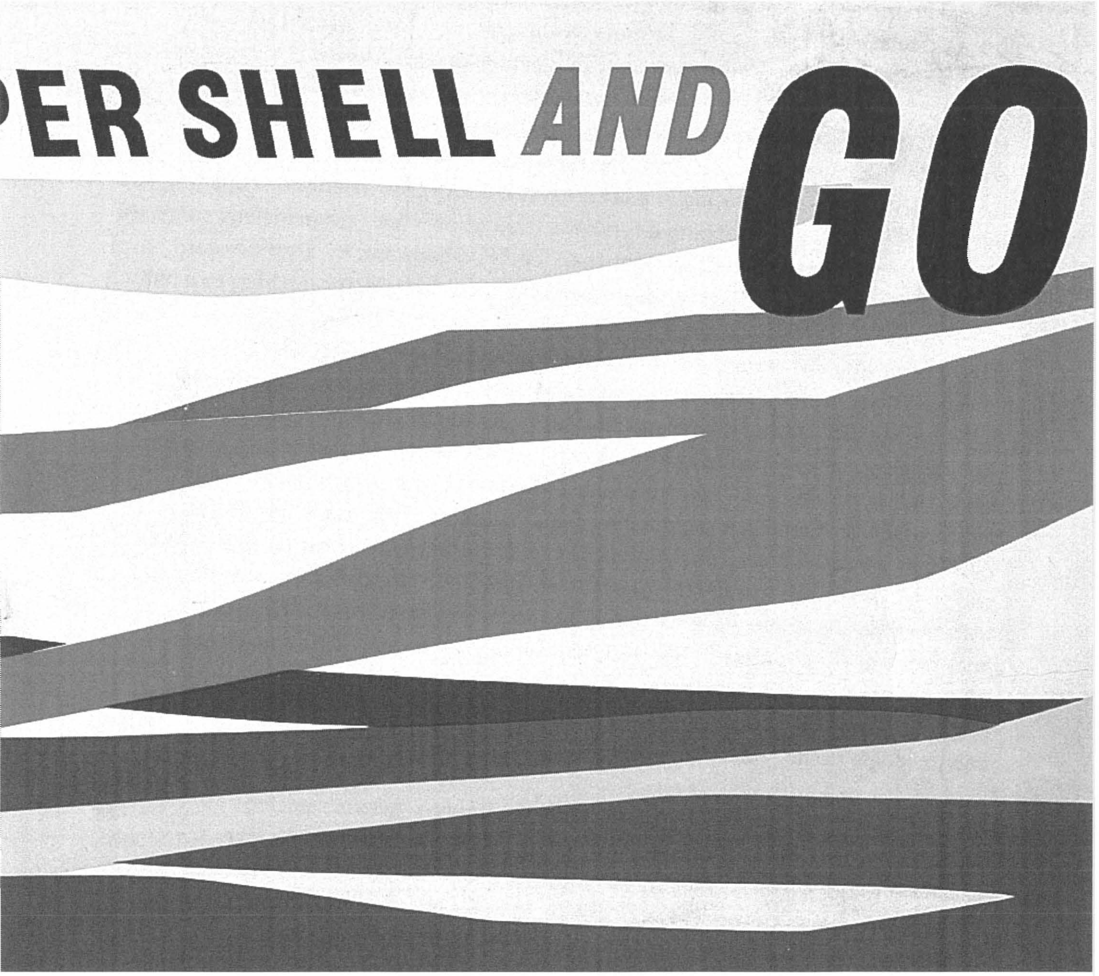
Two different kinds of projection are investigated below, those where:
a) embodied experiences of movement are projected onto letterforms and
b) those where movement suggested by letterforms is metaphorically projected onto a target domain related to the typeset words. The domain in question being *nonphysical:* that is, not directly related to the body.

Inclined letterforms and embodied experiences of movement

Part of the ongoing practice based project from which this paper derives explores the expressive use of italicization[1] to visualize *lexical concepts* (word meanings) associated with movement (such as ***'runner'*** and ***'car'***). As well as a sense of motion, these pieces of typography also seem to register an overall direction of movement (which we will call directionality). What seems clear from the examples in Figure 4 is that reading direction provides an overarching directionality, so that by laterally reversing the words the direction in which we feel the words are inclined to move is also reversed. Also, some words seem *well-formed*: by which I mean that the

1 Although 'italicization' is used here as shorthand, it is perhaps more accurate to use the term 'inclined letterforms' since forward and backward slanting italics and oblique type characters are all investigated.

Figure 5 Zero (Hans Schleger), Stop for Super Shell and Go, 1958, Poster, (50.8 x 121.9 cm). Reproduced with permission of Pat Schleger. Photography Heini Schneebeli.

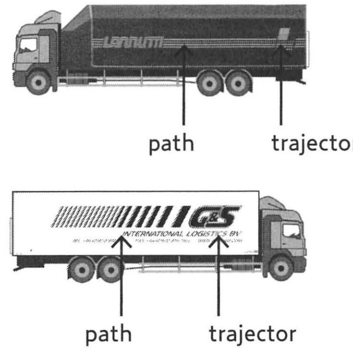

PER SHELL AND
GO

force dynamics suggested by the italicization synchronizes with the lexical concept concerned and the directionality imposed by reading. Consequently it is relatively easy to imagine the play of forces that would result in a particular type of movement in a particular direction. So, for example, *'run,'* **'car'** , *'car'* and ***'stop'*** seem well-formed, whereas other words such as **'run'** seem less well-formed. This reveals some apparent contradictions; for example, both **'car'** , and *'car'* are well formed and yet are slanted in opposite directions, while only **'run'** seems to be well-formed out of *'run'* and **'run'** . The use of italicization in the typographic statement *'car'* should be counter-intuitive, since accelerating in a car creates a backwards inclination (pushing you back into the seat) and stopping a forwards inclination— *'car'* nevertheless suggests a greater movement from left to right than **'car.'** Furthermore, in ***'stop'*** forward slanting letters can help to give the impression of some trajector lurching to a halt.

This diverse range of results can be explained by the idea that users creatively construct meaning from italics using the repertoire of bodily experiences, image schemas, conceptual metaphors and conventionalized structure available to them. Accordingly, cues provided by the entire communicative act enable users to actively blend elements until some relatively stable interpretation emerges (an account of processes such as this is provided by blending theory (Fauconnier and Turner, 2002). In the case of *'car',* or the classic Hans Schleger poster, *Stop for Super Shell and go* (*figure* 5), the image schemas that viewers select are chosen in accordance with the meaning of the word/s (that is, the lexical concepts), and their existing knowledge of the situation in question (in this case car travel). This knowledge is grounded in embodied experiences. The experiences related to *'car'* being those of pushing, walking and running, where the weight of the body is thrown forward and the angle to the ground (in some phases of movement at least) is oblique.

Alternatively, in the case of **'car'** , and ***'stop'*** the image schemas selected relate to the embodied experience of traveling inside a moving vehicle. The backward slanting **'run'** is more problematic in that we appear to be much less inclined to utilize our experiences of driving to make meaning from 'run.' Yet this discrepancy may well be accounted for by the basic and fundamental nature of running or walking to the human experience. If metaphor is "understanding and experiencing one kind of thing in terms of another" (Lakoff and Johnson, 1980/2003 p.5) it would make little sense to explain one well understood thing

←car



▲**Figure 6** Use of additional typographic elements to reverse directionality.
►**Figure 7** Image schematic elements utilised in pantechnicon designs.

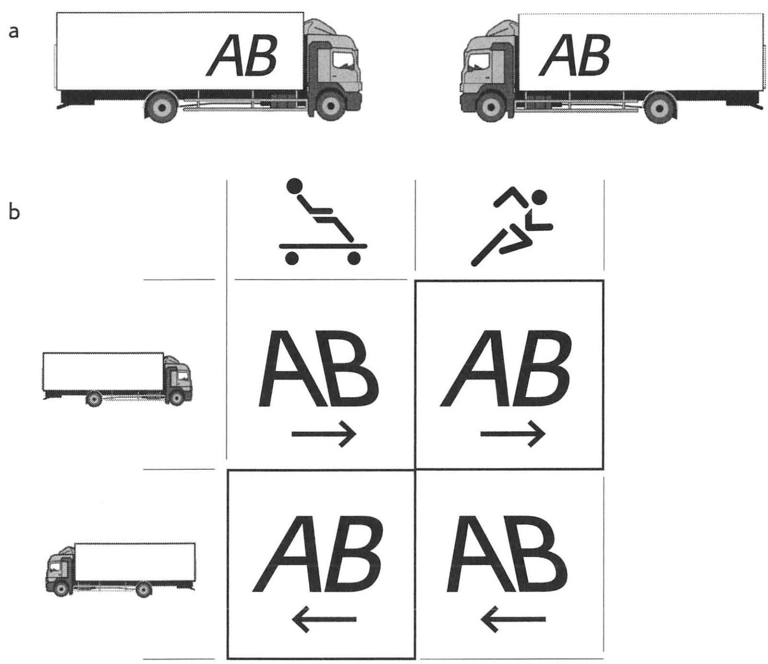


Figure 8 Diagram to show how the prevailing orthodoxy with regard to the uniform application of a logotype (a), can prompt for two different cognitive models, in this case based on bodily experiences of driving and running (the two columns in (b)). The arrows below the italic lettering refer to the direction of movement.

through the experience of something less well understood. The examples in Figure 4 all seem subject to the directionality imposed by the act of reading. This does not mean however that type will always appear to have a left to right directionality. By the addition of an arrow (*figure* 6), or by other typographic interventions type can easily be manipulated to suggest a right to left directionality. This underlines the complexity involved in communicative acts involving typographic modes of communication.

Pantechnicon designs that make use of italics provide further examples of issues of directionality and embodied experiences. As part of the project, thirty-eight pantechnicon designs incorporating italic or oblique typefaces were photographed and compared with the the SOURCE-PATH-GOAL-TRAJECTOR schema. The different designs prompted for one or more elements of the schema that were graphically represented on these pantechnicons in different ways (*figure* 7).

The boundaries of the communicative act in relation to pantechnicon trucks (tractor-trailer-trucks) includes the directionality imparted through the physical movement of these surfaces along our highways. Even when pantechnicons are parked there is still an implied direction of motion since the cab is located at the 'front' of the whole truck-pantechnicon ensemble. An asymmetry arises because of the relationship between the direction of movement of the truck to both the reading direction and direction of slant of the italics. On one side of the pantechnicon italics lean toward the direction of movement of the truck, on the other side they lean away from the direction in which the truck is traveling. Consequently, according to the explanation proposed here at least, each side of the pantechnicon is grounded in a different embodied experience (*figure* 8). These different experiences lead to a different handling of image schemas; primarily the compulsion schema which is concerned with the forces that compel movement. On one side of the pantechnicon the italics, grounded in the embodied experience of running, deliver the force; on the other side, the italics grounded in the experience of driving, are compelled by the force.[2]

The suggestion that visually, the same logotype is actively pushing, on the one hand, and passively being pushed, on the other, can provide potential for contrasting metaphors to be constructed. Mixed messages can therefore result; so that, for

2 See Talmy (2000, p.413) for an account of how similar force dynamic relationships occur in grammar.

example, there is a suggestion that, as an organization, a trucking company is dynamic or static, depending on which side of the pantechnicon is seen by the viewer.

Making metaphorical associations from inclined letterforms

An italic logotype seems to be a natural choice for a trucking company, in that the sense of visual movement derived from the letterforms, links to a core activity; the physical movement of the company's vehicles and the goods they contain. The same relationship however, does not exist between a company such as Microsoft and its italicized logotype; Microsoft's core activity is not centered on physical movement. Knowing a little about the kind of company Microsoft is, one reading of the logotype might be that it is a company moving toward the future. This movement is not literal but metaphorical. Furthermore, it is not inevitable, but requires effort, and this force dynamic is evoked by the use of italics. Consider this quote from the Microsoft (2003) website: "At Microsoft, we see a future full of potential. We're ... advancing our current products and embarking on fundamental research that paves the way for tomorrow's breakthroughs. ... Microsoft is working to push the state of the art forward in ways that benefit everyone." Here we can construct a scenario in which fundamental research 'paves the way' (the path) along which Microsoft (the trajector) pushes 'the state of the art forward' toward a perceptible future (the goal).

Admittedly viewers are unlikely to construct this scenario from the logotype alone. The more that is known about the company and its ethos however, the more potential there is to make meaning metaphorically from shared image schematic structure derived from the logotype and knowledge about Microsoft's view of itself.

Conclusion

Two different levels of metaphorical projections have been discussed in relation to italic and oblique types. The first kind is concerned with the use of image schemas (based on embodied experience), to metaphorically project qualities of movement onto the target domain of the letterform. This metaphoric projection provides an explanation for the conceptualization of movement in relation to slanted letterforms, and is entailed by metaphors such as FORM IS WEIGHT (Johnson, 1987) and OBLIQUE FORM IS MOVEMENT. The second level of metaphorical association, uses image schemas to project visual dynamics from the source domain of the letterform onto a nonphysical target domain relating to the words in the text concerned. These two levels of metaphorical projection seem consistent with Johnson's (1987, p.99) exploration of balance where, firstly "balance in visual perception ... involves a metaphorical projection of schematic structure from the realm of physical and gravitational forces and weights to a domain of visual forces and weights" and secondly, where there is "a metaphorical projection from an image schema generated in the experience of physical balance onto [a] nonphysical or less clearly structured domain."

The examples provided go some way toward describing how italics can be more than a way of labeling a particular hierarchical level in a text. Italics are salient because of the sense of movement they suggest and this sense of movement can be used to construct metaphoric associations in different ways. A consideration of the role of image schemas within the whole communicative act, suggests ways in which visual communication can be made more coherent by providing typographic designs that clearly and consistently represent image schematic structure.

In terms of implications for the support of the user in graphic design, cognitive linguistics approaches provide a different understanding of the visual; away from a fixation on the meanings of things on the page, meanings that are consumed by users, towards an understanding whereby it is the users who construct meaning through cognitive work. And this work undertaken by users, utilizes similar image schema, metaphors and metonyms that communities of users have individually developed through common experiences. This shared conceptual structure provides a focus for study for graphic design practitioners and theorists. Consequently, by identifying the conceptual metaphors that structure the thinking of particular groups of users, designers should be better able to communicate more effectively. Such communication might either re-present the users' conceptual metaphors visually or provide visual cues for alternative conceptual metaphors. These alternatives could help users to think about a particular situation or issue in different ways. Furthermore, by identifying the conceptual metaphors underlying their acts of visual communication, designers should have a better understanding of their own (often unconscious) thinking in relation to the design choices they make and whether such choices are appropriate for the users that they are addressing.

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The Method of Graphic Abstraction in Visual Metaphor

Regina W.Y. Wang and Chun Cheng Hsu

Abstract

In the design fields, graphics are often a medium of communication whose goal is to reach mutual understanding. The process of graphic abstraction is one of the most important methods in visual design. Designers often use it to enhance the recognition and impression of observers. This paper investigated abstraction methods through design software research and research of designer practices. The result showed that the major tools used in designer practice are paintbrushes (traditional hand-drawing medium) and software filters (computer media). Three abstraction methods were identified: a) shape simplification method, b) quantitative reduction and c) software-aided simplification. Designers used software programs mainly for simplification of overall image (plane) with comparatively little use to simplify 'points' or 'lines.' In addition, the design software cannot fulfill designers' needs for visual abstraction. The findings from this study can provide valuable references for user instructions, graphic design and computer-aided design applications.

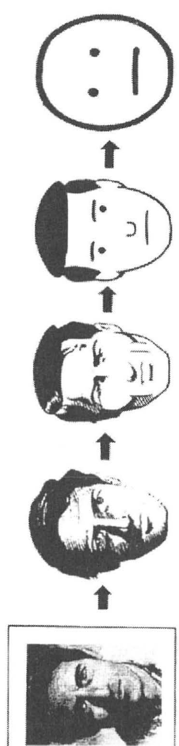


Figure 1 Five levels of 2D representation transferred from real object through graphic simplification (McCloud, 1994).

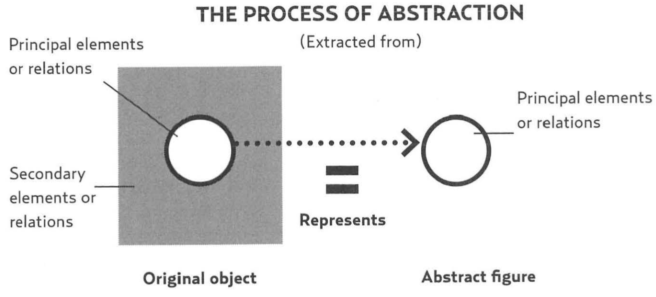
INTRODUCTION

To turn a real object (3D) into a 2D representation is an example of graphic-abstraction in visual design. (*see figure 1*; Arnheim, 1969; Langer, 1953; Yo, 1985; Hsu, 1993). The abstraction uses a strategy of simplification of detail, so designers often simplify the shape of the original object to enhance the recognition or impression of observers (Arnheim, 1969; Bell, 1913; Gombrich, 1982). Thus, abstraction is one of the most important methods in graphic design.

The function of graphics is to communicate messages efficiently and accurately in human life. As a result, the rational analysis of graphics and their uses might help to enhance that efficiency and accuracy. Although an analysis of rules in the field of graphic design seems more challenging than in the fields of architecture or industrial design, as far back as in the Renaissance, Leonardo **Da Vinci proposed that painting should be approached with a scientific aspect. Mistakes are likely to occur, he suggested, if structures and outlines are drawn from impression, rather than using the tools of measurement.**

Modern-design methodology attempts to scrutinize design scientifically. Although there are still gray areas in which science cannot give an account, the methodology has a significant bearing on user instructions (Burden, 1996; Jones, 1992; Munari, 1989). With the development of digital technology, the application of design methods can be transformed into the computation that has also presented itself as an important research topic (Kirsch & Kirsch, 1988; Knight, 2003; Simon, 1981; Stiny & Mitchell, 1978). Therefore, discovery of the 'methods' behind design is beneficial to both user instruction and design computation.

Figure 2 Abstraction process model.



RESEARCH FRAMEWORK

This research is a case study that explores graphic abstraction in digital and traditional media.

This paper investigates abstraction methods through design software research and design practice research. First, in order to reflect the trend that modern design depends heavily on software, software that serves abstraction functions was examined in the design-software research section. Four of designers' favorite software are analyzed: Adobe Illustrator 10, Adobe Photoshop 7, Macromedia Fireworks MX, Macromedia Flash MX. Second, to understand the work of designers currently using graphic-abstraction methods, thirty-two Shih-Chien University sophomore and junior students, equipped with design expertise, were surveyed with regard to their practice.

LITERATURE REVIEW

Abstraction process model

'Abstraction' is widely discussed in philosophy, science and psychiatry. The Gestalt School is the earliest school of art to systematically carry out this type of study. They presented the law of Pragnanz, which states that the best form is the form that has been 'appropriately simplified.' This is because people's visual perception leans towards using the most economical method to receive information (Arnheim 1969, 1974). Illustrated by 'the abstraction model' in Figure 2, this concept shows that the abstract figure (that contains principle elements extracted from the original object) is able to represent the original.

Hsu & Wang (2004) proposed a definition for abstraction in art and design. They suggested

Table 1 Research approaches to abstraction in art and design (adapted from Hsu & Wang, 2004).

Research approach	Description	Scholars	Examples of application
Internal cognitive mechanism	The reification of the abstract internal	Arnheim, 1969; Langer, 1953; Osborne, 1988; Worringer, 1953	Abstractionism
External visual simplification	The abstraction of the concrete physical	Arnheim, 1974; Goodman, 1976; Hsu, 1993; Lee, 2003; Osborne, 1979	Primitive arts

Note: The table does not suggest a dichotomous summary of the scholars' researches, but rather the general direction of their viewpoints.

that 'abstraction in art/design' can be divided into two research approaches: one from an internal cognitive mechanism and the other from external visual simplification (*see table 1*).

From the perspective of visual simplification, an abstraction model is shown as Figure 3. On the left is the entire body of Chaplin, whose most representative elements are the hat and the moustache. The body is second in importance to the head in representing Chaplin. On the right is the abstracted figure. Although several elements have been taken out, the connection between the highly simplified picture and Chaplin still exists.

This abstraction process model may not be clear or detailed enough to guide design operations, but it helps to explain the general principles of abstraction methods.

The following discussion and investigation will focus on the dimension of 'external visual simplification.'

Abstraction methods in design

Abstraction methods in design are different from those in artistic expressions. Gombrich (1982) suggested that designers often use abstraction to make graphics clearer and easier to recall. Therefore it is important for designers to distinguish different abstraction methods between the art and design professions. We suggest that designers pay more attention to recognizability by observers.

In Figures 4 and 5, the trademark adopted by North Sea Gas in Britain combines the trident of the mythical figure Nepture and a gas burner. The earlier trademark was designed on the basis of realistic illustration (*figure 4*) and the later design simplified and abstracted the elements, preserving only the essentials (*figure 5*, both

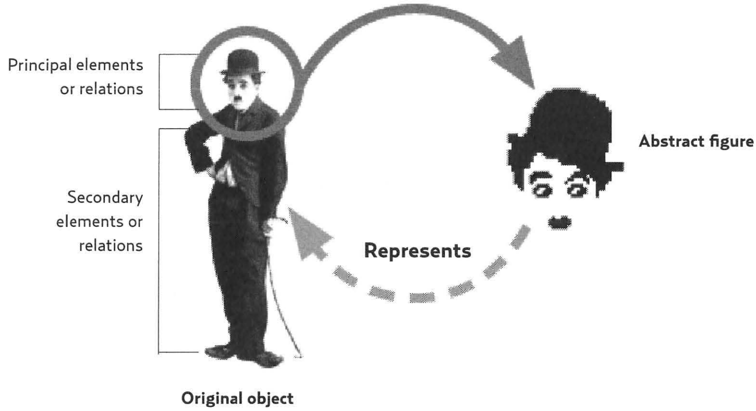


Figure 3 Art/design as an example for abstraction process model (from Hsu & Wang, 2004).

from Gombrich, 1982).

In the graphic design of traffic signs, trademarks and computer icons (see *figures* 6-8) designers convey complex ideas simply by using abstraction methods. Take Figure 6 for example, although the hands and other features are simplified, the two figures can still be identified as male and female. In Figure 7, we can only see the telephone receiver and mouthpiece, but this does not obstruct its representational meaning. In Figure 8, icons, based on visual metaphor, are used in painting software to represent the tools or actions.

In Figure 9, famous Japanese poster artist Tanaka Ikko simplifies the head of a Japanese woman, retaining very few characteristics. The lines of the ancient fish graphics in Figure 11 also use the same principles, retaining the major curvatures and linearizing and geometricizing the outlines.

DESIGN SOFTWARE REVIEW

In the digital design era, a majority of designers rely on the powerful functions of computer software to aid them in their work. Our focus is on a series of computer programs with abstraction functions, including Adobe Illustrator 10, Adobe Photoshop, Macromedia Fireworks MX and Macromedia Flash MX. Fuller descriptions will be given later. The analysis focuses on visual abstraction design. Other problems such as programming are irrelevant to the discussion of abstract design and are not considered.

Observing 'point,' 'line,' 'plane' from a design perspective

The basic visual elements of design software are points, lines and planes. Although these have proven to be appropriate in practice, they

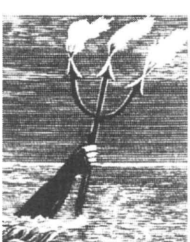


Figure 4 Trident trademark: realistic image.

Figure 5 Trident trademark: abstract image

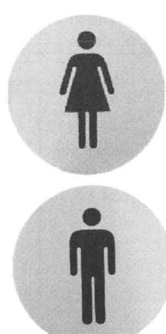


Figure 6 Icons for male and female.

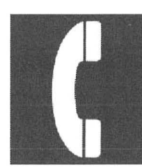


Figure 7 Icon representing a telephone.

do have some limitations in relation to the development of abstractions.
1) Point: none of the above-mentioned software enables the insertion of values to implement point simplification. The only alternative is to manually delete points by using vector illustration programs, such as Illustrator, Freehand, CorelDraw, etc.
2) Line: there are two interpretations of 'stroke' in vector software: outline and centerline. Centerline is more commonly used and is therefore the focus of the following discussions (*figure 10*).
3) Plane: adjusts the overall image's clarity and blurriness with different values, for example, the raster graphic program, Photoshop, has functions like 'mosaic' and 'Gaussian blur' under the pixelization menu.

Simplification of 'line'

There are several ways that points can be simplified. Adobe Illustrator, for example, can simplify vector images through the 'curve precision' and 'angle threshold' features. In these features, it is possible to reduce the number of points on a vector; this leads to a modified image.

Simplify path-Object/Path/Simplify: Simplify Path

1) Percentage 0 to 100 on 'curve precision' function determines the divergence between the new paths from the old ones. When the percentage is lowered, the number of points decreases. The divergence with the original is wider and the curve is less precise, but the positions of the beginning/ending points do not vary.
2) Table 2 demonstrates the process of the original 383-point image simplified with 'curve precision' value 100, 75, 50 25 and 0.

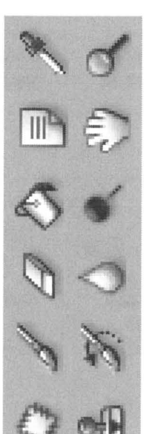


Figure 8 Computer icons.

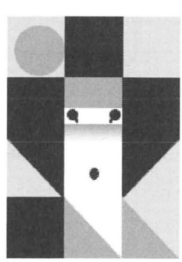


Figure 9 Poster design of Tanaka Ikko.

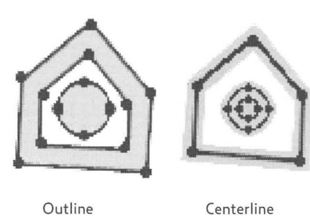


Figure 10 Two interpretations of 'stroke' in vector software.

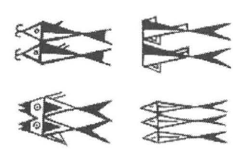


Figure 11 Fish graphics.

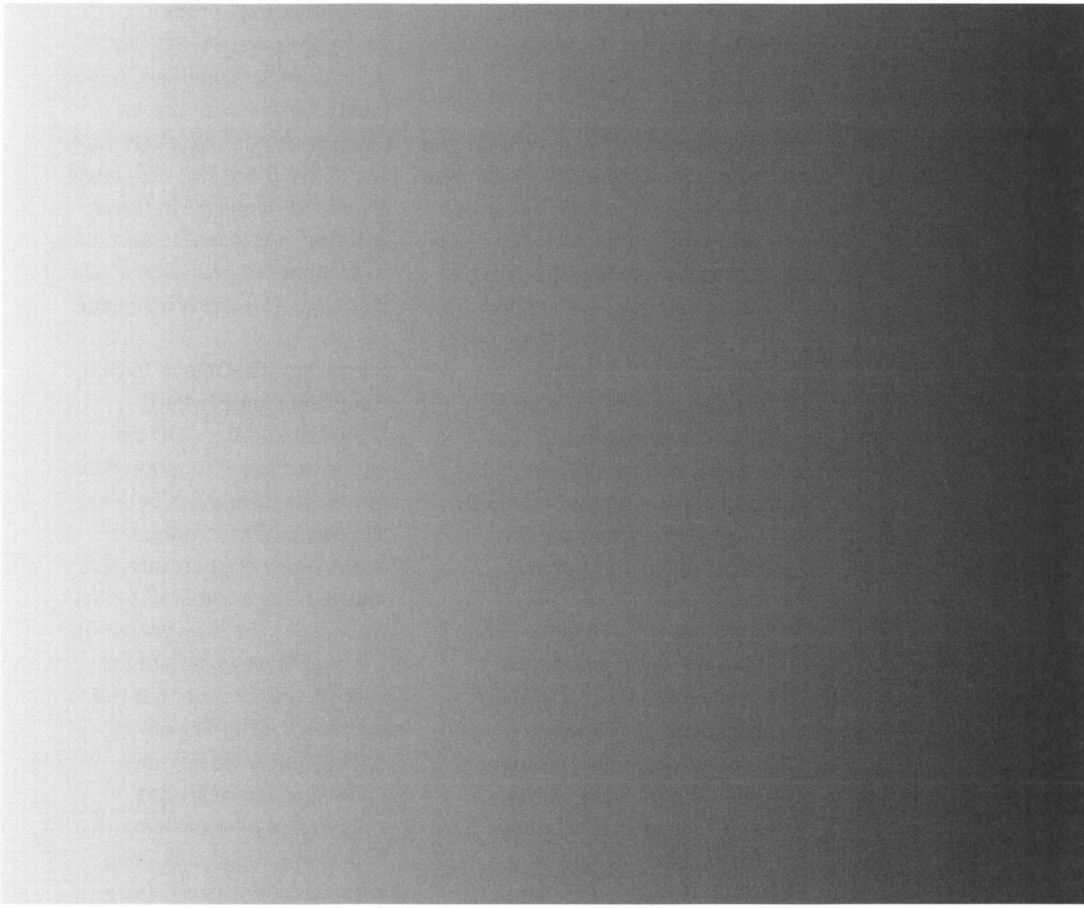
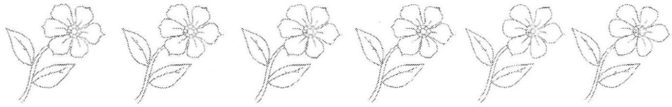
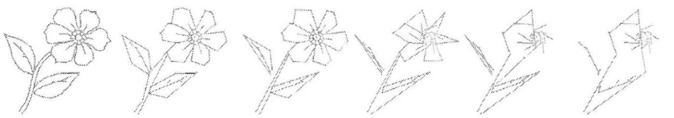


Table 2



Simplified level	**Original**	**level 1**	**level 2**	**level 3**	**level 4**	**level 4**
Curve Precision/Angle Threshold	**vector image**	**100**/180	**75**/180	**50**/180	**25**/180	**0**/180
Orginal/**Current points**	Orginal 383	383/**606**	383/**85**	383/**85**	383/**63**	383/**59**

Table 3



Simplified level	**Original**	**level 1**	**level 2**	**level 3**	**level 4**	**level 4**
Angle Threshold	**vector image**	**0**	**45**	**90**	**135**	**180**
Orginal/**Current points**	Orginal 142	142/**142**	142/**118**	142/**84**	142/**71**	142/**68**

Straight-Object/Path/Simplify: Simplify Path /straight

1) 'Angle threshold' determines the smoothness of corners. The lower the threshold value, the smoother the angle and also the fewer the number of points. When simplifying an image, increased threshold value will straighten the curve and sharpen the angle.

2) Table 3 is an example of the original 142-point image simplified with the 'angle threshold' value 0, 45, 90, 135 and 180.

Simplification of 'plane' (overall image)

'Mosaic' function of Adobe Photoshop

1) Major function: dissecting an image into grids with each grid represented by its average color to achieve the mosaic brick effect.

2) Simplification range is from cell size of 2 to 200 squares. The higher the value the greater the simplified level.

3) Table 4 divides the defaulted 2 to 200 squares into four ranks: 3, 12, 50 and 200.

4) The simplification function enlarges the pixels of the polygon. Photoshop has a comparatively smaller set of values of 'points' and 'strokes' than other vector software.

5) To reserve better 'formal/form' clues, the function is applicable to images of greater brightness or contrast.

'Gaussian blur' function of Adobe Photoshop

1) Major function: adjust the definition of 'polygon' blurring the entire image to a various extent. It gradually blurs the boundary and erases the details.

2) Simplification range is radius 0.1 to 250 pixels; the higher the value, the higher the simplified level.

Table 4

Simplified level	Original Image	**level 1**	**level 2**	**level 3**	**level 4**
cell size	- - -	**3** square	**12** square	**50** square	**200** square

Table 5

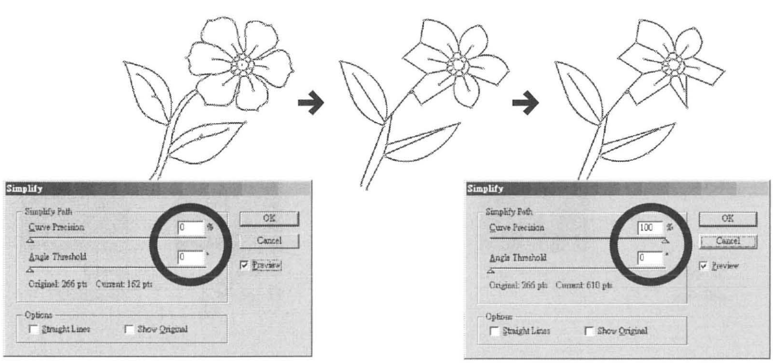
Simplified level	Original Image	**level 1**	**level 2**	**level 3**	**level 4**
radius	- - -	**3** pixel	**15** pixel	**62** pixel	**250** pixel

3) Table 5 divides the defaulted 0.1 to 250 pixels into four ranks: 3, 12, 50 and 200.

Summary

The design software reviewed explores the simplification function of software programs like Adobe Illustrator, Macromedia Flash and others. Internal commands in the software use numerical values to control the level of simplification, like the leftmost graphic of Figure 12 (original form of the flower) that has been adjusted to the simplified limit value of the rightmost graphic through the use of simplification numerical values, the changes in visual perception are not major. Correspond-

Figure 12 'Simplifying' the flower through computer-aided drawing.



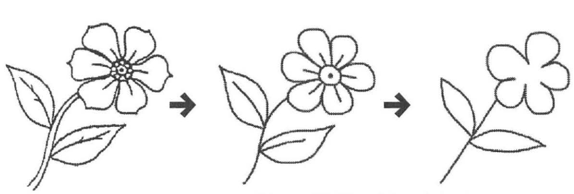


Figure 13 'Simplifying' the flower through the use of hand drawings.

ingly, in terms of the graphic simplification process of the traditional drawing in Figure 13, the 'simplification' command of the software's internal key is not satisfactory. Consequently, the study hopes that the rules it presents from a design point of view can help software program designers come up with better functional components to complement the professional graphic simplification operation.

DESIGNER PRACTICE RESEARCH SECTION

To probe into the ways in which designers deal with abstract images, thirty-two sophomore and junior students with design training from the Department of Communication Design, Shih-Chien University, Taiwan were selected. Students were required to perform 'four stages' of equidistant, average simplification with a concrete image they selected. Methods and tools were not limited, but a clear demonstration of design rules and steps was required.

The result shows that the major tools used were paintbrushes (traditional hand-drawing medium) and software filters (computer media). Three abstraction methods were identified: a) shape simplification, b) quantitative reduction and c) software-aided simplification.

Method one: shape simplification method

'Simple shape drawing' is commonly introduced to children or beginners studying drawing (*see figure 14*). The point of shape simplification

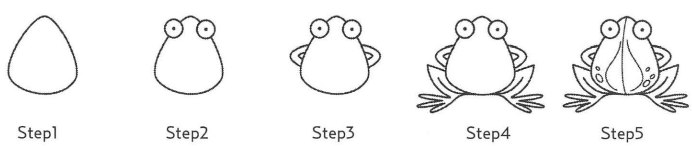


Figure 14 Simple shape drawing: introduced to children or beginners in drawing.

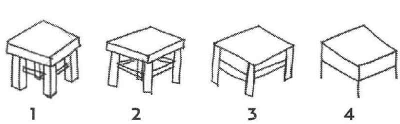


Figure 15 Simplified object: a table.

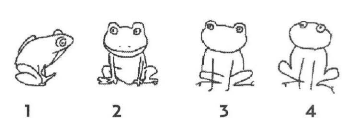


Figure 16 Simplified object: a frog.

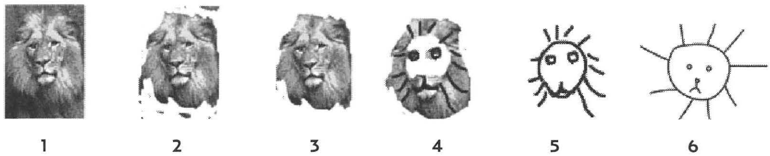


Figure 17 Simplified object: a lion.

method lies in reversing the procedure of simple shape drawing. Starting with a more complicated image, progressive deletion of strokes and lines results in a simple drawing. The final step is to outline the contours. Since the process and outcome for each student may vary, the simplification rules are not definite (*see figures 14-17*).

Method two:
quantitative reduction

According to the structure of the object, the image is dissected into individual parts. In the process of simplification, comparatively smaller blocks are removed. Compared with the 'shape simplification method' numeral reduction applies quantitative and regularization concepts in its graphic simplification (deleting smaller blocks), but graphic dissection and deletion order have not crystallized into definite rules (*see figures 18-20*).

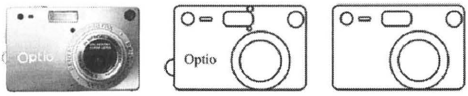


Figure 18 Simplified object: a camera.

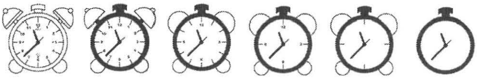


Figure 19 Simplified object: a clock.

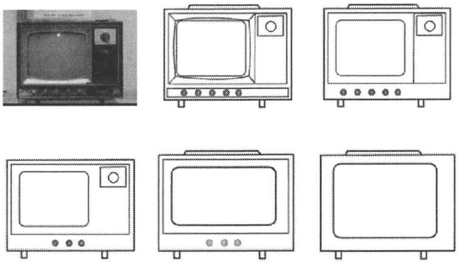


Figure 20 Simplified object: a television.

Method three: software-aided simplification

By using Adobe Photoshop functions such as 'patchwork,' 'blur' and 'mosaic' the details of an image are reduced. Only the form, color and positional relations are reserved as identifiable clues. However, when an image is overly simplified and when the form, color or positional relationship fails to be recognized, the simplification method is no longer effective. It has actually missed the essence and function of simplification (*see figures* 21- 23).

Summary

In the designer practice research section, the exercise of the thirty-two students leads to three graphic abstraction methods: shape simplification, quantitative reduction and software-aided simplification. The first method relies on intuition and experience; it does not bring about a detailed description of a simplification rule. The second method initiates a description of the rules, dividing an image into patches and achieves quantitative reduction. The third method, assisted by computer programs, can precisely control the values. Its problem parallels that of the design software research section: the simplification value of software commands does not equal a visual simplification. In addition, research discovered that students used the programs mainly for the simplification of the overall image (plane) and comparatively little for simplifying 'points' or 'lines.'

CONCLUSION

When graphic abstraction is undertaken as a purely artistic behavior, rational discussion is insignificant. In the domain of design, however, rational analysis of design method is important because of its significance in user instructions and benefits for computer-aided design.

This research investigated graphic-abstraction methods via design software research

Figure 21 Simplified object: a lion.

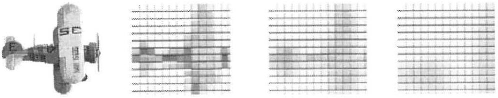


Figure 22 Simplified object: a light plane.

Figure 23 Simplified object: a helicopter.

and designer practice research. First, in design software research, although the built-in commands of design software can adjust the simplification level with its numerical functions, they can only control the value, but not the visual effect (see *figure 13*). This is a limitation of current design software. The function of simplification software was created by the programmers, but it sometimes doesn't fulfill the designers' visual requirements. It is helpful to figure out the graphic-abstraction program from the perspective of visual designers. Second, in designer practice, participants were requested to demonstrate in detail the process and methods they used while participating in an exercise about graphic abstraction. Three abstraction methods were identified:
a) shape simplification,
b) quantitative reduction and
c) software-aided simplification.

The discussion of graphic abstraction methods is important in the search for a better understanding of the rules that govern design operation. As previously mentioned, the chief meaning of method does not lie in 'innovation,' but in 'education' and 'computation.' Therefore, it may help novice designers to improve their graphic skills with some general guidelines in order to make graphic design more effective. In addition, the feasibility of each simplification rule in the application of computer-generated graphics is also worth attention through conducting experiments and assessments on their effectiveness. The authors look forward to exploring these directions in further work.

Regina W.Y. Wang received a research degree from University of Central England in Birmingham. Currently an Assistant Professor in the Department of Industrial and Commercial Design at the National Taiwan University of Science and Technology, her research interest is graphic communication and visual perception involving readability and emotion. She has published in design journals and international design symposium proceedings.

Chun Cheng Hsu is a Lecturer in the Department of Communications Design at Shih Chien University and a PhD candidate at National Taiwan University of Science and Technology. Inspired by interest in integrating theory into practice, his research is devoted to the application of design methodology and visual psychology in graphic/media design practices. He both practices design and writes about art and design.

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Abstract

The article proposes a five-part schema for analyzing the design process in constructing visual representations. Its purpose is to highlight the multiple ways in which the objectives of a design influence the final form: pictorial pragmatism, driven by the objectives, is taken to be the dominant force in determining that form. The schema is valuable when considering the relationship between aspects of the reality to be modelled and those of the designed representation. While accepting that a useful distinction is captured by the terms realistic and metaphorical, an argument is developed that this distinction cannot be strictly held. The notion of expressivity is examined and the pragmatic model of depiction is further explored, in which expressivity is shown to be often increased by mismatches between what is seen and its graphical representation. The aims of the article are: to question simplistic models of depiction; to provide a simple but robust framework for thinking about depiction and related forms of designing; and to act as a guide in the advanced education of designers, in particular making them aware of the extent of the choices open to them.

Stephen Boyd Davis runs the Lansdown Centre for Electronic Arts, a University Research Centre at Middlesex University dedicated to interdisciplinary work in digital media. He shares the Centre's commitment to continuous innovation—but also sets new media practices in wider historical contexts. His aim has always been to inquire radically into the possibilities of media and technologies, exploiting their special properties to the full. In addition to running the Research Centre and teaching, Stephen supervises PhD students who are developing new creative applications for technology. A Fellow of the Royal Society of Arts, he is a member of the Peer Review College of the UK Arts and Humanities Research Council, a referee on the Scientific Committee of the Design Research Society and on the management committee of the Computer Arts Society.

Stephen Boyd Davis

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A Schema for

Introduction

The article proposes a five-part schema of the design process in constructing visual representations. Rather than emphasizing the relationship of pictures to what they depict, emphasis is placed instead on the opportunities for *transformation*, at a number of conceptually distinct phases, between the observation (or imagining) of an object or scene and its final representation in a graphic. Thinking of depiction as some kind of matching to what we see is a widespread misconception. Instead we should think of depiction operationally and pragmatically.

Although the primary example used here is the familiar one of picturing a waste receptacle or trash-can which allows the computer-user to delete files, the schema is argued in relation to other forms of depiction created for other purposes and in different contexts, in order to demonstrate its usefulness and applicability. The schema is meant to be useful to the designer as well as the theorist, in particular by drawing attention to the freedom and range of choices available, and clarifying the purposes they can serve. Initially a simple five-step model of visual representation is set out, which is then refined through discussion of the issues raised.

Background

The term *schema* is used here in its general sense of a structured representation in the form of a diagram or plan. The schema proposed is intended to make it easier for designers and theorists, to think about the purposes of depiction and how those purposes influence—or should influence—the form of the picture.

In the author's experience, working with postgraduate students of design and with professional designers, there is a common tendency to think differently about two classes of graphic representation: on the one hand, figurative graphics (referred to here simply as *pictures*) and, on the other more obviously 'designed' representations such as diagrams. Picture-making has even been called *thoughtless imitation* when compared with thoughtful diagram design (Kazmierczak, 2001, p.179). When people learn to make pictures, there is a strong inclination to over-emphasize the relationship of the depiction to what it depicts and correspondingly to ignore or underestimate the relationship of the depiction to the purposes it serves. As a result, many opportunities for selection and transformation of the original object or scene, in order to serve the objectives of the representation, are ignored.

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Depiction

Part of the problem is that there is a lingering hope that pictures and other designs can somehow completely capture what they represent. Whether in figurative picture-making or in information design, a belief emerges that: representations can be complete; representations can be unambiguous; and that representations match something in the world. By contrast, **the pragmatic model offered here is one based,** to borrow Gombrich's phrase (1977, p.248), **on the dominance of *making* over *matching*.** The term *pragmatism* is used here to mean a focus on results—a concern with what a picture does to and for the user or viewer and with how the characteristics of depiction can be understood in those terms.

Conceiving representations as designed pragmatically, to inform and affect the user, their truth to something external becomes less vital than their effectiveness. This is not, of course, a cynical invitation to lie with graphics, but rather an acknowledgement that representations can not be complete, can not be unambiguous, that in sum, they are just as they are called—representations. This inadequacy of depiction might be conceived as rather depressing, but it will be argued here that the way in which representations fall short of matching what they represent, far from being a cause for regret, is a vital part of their expressivity. In fact this is an old idea. Descartes (1954. P.245) remarked: "very often the perfection of an image depends on its not resembling the object as much as it might." Rather than simply repeat this observation, the aim here is to construct a schema for the component processes by which pictures relate to what they depict and to the objectives they serve, in order to get a better grasp of what the picture-maker does.

An outline schema of visual representation

Consider the subject matter of a picture, which will be referred to here as the model, *M*. This model may be a directly observable object or scene in the world or one that is imagined based on recollection of how things look. The model *M* is to be represented in picture *P*. This picture *P* might be a picture of any kind. In principle, the schema offered here is applicable to all pictures, even to film and other dynamic images.

M, the model, itself represents something, an idea, *I*. This is most obviously the case where ostensive subject matter has a metaphorical or symbolic meaning so that, for example, a dove represents peace or a trash-can stands for the concept of deletion. But even a more literal picture, such as an illustration to enable a part in a furniture kit to be identified, is the carrier of an idea. While I is a generalized notion, *M* is a particular instantiation of that notion in an example. Some pictures are more particular than others: a road sign, a desktop icon or a way-finding symbol generalizes far more than a photograph, for example. But the need to choose some particular instance of the idea is always there to a certain extent.

The stages of representation from idea to picture can be set out in the form:

$$I \rightarrow M \rightarrow P$$

In the case of the familiar trashcan in the computer interface, the three phases can be laid out as in Table 1, where a general notion of a trash-can is instantiated in some particular model and this model is then rendered as a visible picture.

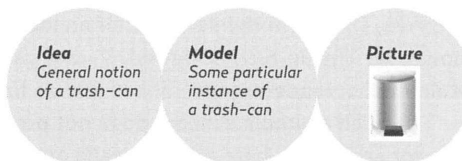


Table 1 A general notion of an object that has a particular instantiation that is pictured. (The trash-can picture is a public domain image by Andy Fitzsimon taken from Wikipedia, 4 March 2007.)

However, the idea, *I*, is selected to serve some objective, or set of objectives, O, requiring us to add another phase:

$$O \rightarrow I \rightarrow M \rightarrow P$$

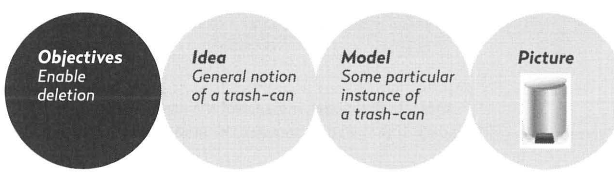


Table 2 All pictures serve purposes. The idea serves to further the objectives of the picture.

While Table 2 now shows the objectives, *O*, as motivating the idea, *I*, the schema needs still further augmentation, this time at the other 'end' of the process. We need to represent the fact that another representational process takes place between the model M and the picture *P*.

This is because the model *M* is pre-pictorial and probably three-dimensional, but the picture *P* is flat. Here it is useful, to some extent, to borrow from the pipeline metaphor of synthetic computer graphics (Foley et al 1995, p.334-5, 806-9), in which it is normal to separate conceptually two sets of decisions in the making of a picture: one involves the geometry and other attributes of the model *M*—whatever is to be depicted—while the other relates to the visualization of the model necessary to its display, including such factors as point of view, framing and so forth, denoted here as *V*. Each is of course essential. There cannot be a viewpoint onto nothing—the model is essential. And the model is useless for the purposes of depiction unless it is viewed.

The stages can now be redrawn as:

$$O \rightarrow I \rightarrow M \rightarrow V \rightarrow P$$

For the trashcan example, the five phases are shown in Table 3. This crudely represents how the objectives, *O*, inform the selection of an idea, *I*, which is instantiated in some particular model, *M*. This in turn is viewed, *V*, in a particular way and finally pictured, *P*, using certain media, rendering techniques and so forth.

Such a simple schema does not pretend to capture the subtleties of real depiction. For example, where exactly would one place the choosing of a projection system, such as a choice between three-point and axonometric perspective? Is this best accounted for as an aspect of the viewpoint or of the final picturing process? Provided the coarseness of the diagram is borne in mind, it may nevertheless be useful.

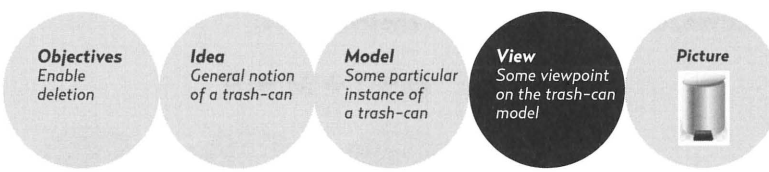


Table 3 The model, instance of the idea, cannot be depicted without a point of view. The selection of viewpoint is a vital aspect of the relation between the model and the picture.

Other simplifications in the diagram include the fact that it shows each of the stages as singular, whereas in practice many stages will have multiple aspects: for example, the objectives, as already noted, are likely to be many for a single picture. Similarly a single model may yield innumerable views and pictures and so forth. Another important point is that the process shown in Table 3 appears to be linear and uni-directional. As discussed later, such an impression would be misleading.

So far, the left-to-right arrows in the sequence have been left undefined. They might be taken to suggest a logical implication or inevitability, but that is not at all what is intended here. Every one of the conceptually distinct phases is an opportunity for intervention. Macdonald-Ross and Waller suggested in 1974 the idea of the designer as transformer, who takes another person's knowledge or message and finds the means to convey it to the intended audience (Macdonald-Ross and Waller

2000). Similarly, the argument here is that, even in the case of pictures, **each transition should be conceived as a transformation, an opportunity for interpretation and expression, not as a mechanical, inevitable mapping.** In particular, the transformations from the model to the view and to the picture require examination.

Model to view to picture: processes of transformation

While it is obvious that diagrams need not visually resemble anything which they represent, it is equally clear that for pictures—by definition—some resemblance is involved. There have been many discussions of just how these two graphic modes may be assimilated or differentiated, on a variety of grounds (Norman, 2000; Kazmierczak, 2001). In his *Schema for a Graphic Language* (1987, p.204), Twyman uses a dotted rather than a solid line between the categories *pictorial and schematic* to suggest some continuity between the two. Engelhardt's *Language of Graphics* (2002) usefully integrates terminologies and concepts from many graphic modes including both diagramming and depicting (but does not deal with the transformations of view and picture described here).

In grappling with these problems, the term *automorphism,* as introduced by Currie (1995, p.97), is useful: it names the match between a property of the thing to be represented and a corresponding property in the representation. Normally in a picture, *a* being to the left of *b* maps the fact that *A* is to the left of *B* in the scene. Of course, automorphism is not an absolute: degrees of automorphism are common, as when the widths of roads on a map approximate to, but do not arithmetically scale to, the widths of the roads represented. In the London Underground map, there is some automorphism between locations in the city and locations on the map, but the colors of the lines are arbitrary—there is nothing red about the Central line itself.

Some degree of visual automorphism is definitional for all pictures, and if a picture could be a perfect representation of a scene then it would be completely automorphic. However, we shall see that no such perfect representation is possible. There are two fundamental difficulties. The first is deciding what constitutes the *depingendum*—the thing to be depicted (this term has been adopted in order to avoid the too-specific implications of words like *object or scene,* and clumsy repetition of lengthy phrases like 'the thing to be depicted'). The other difficulty is in deciding on the relation between this depingendum and the depiction. We need to establish the limits of what can be done, and by this means to work towards a useful concept of expressivity—the ability of a representation to communicate effectively.

Pinning down the depingendum. It is often assumed that what is 'out there' to be captured is uncontroversial but, even in a strictly practical way, it is easy to demonstrate that the status of the depingendum is problematic, simply because it is not 'out there': it is inextricably involved with active, constructive perception. It is often pointed out that no picture is neutral towards its subject, as for example Kress and van Leeuwen do when they say, 'Pictorial structures do not simply reproduce the structure of reality. On the contrary, they *produce* images of reality' (1996, p.45). But the additional point here is that, even prior to picturemaking, **perception itself is a constructive, selective process.** It has frequently been suggested that a picture can imitate reality by presenting the same stimulus to the eye as the scene itself (something that the special case of *trompe l'oeil* images really attempt to do). Though he subsequently renounced it, Gibson (1954) originally offered just such an idea of a 'faithful picture': "A delimited surface is so processed that it yields a sheaf of light-rays to a given point which is the same as would be the sheaf of rays from the original scene to a given point."

A fatal problem with this conception, as Gibson later realized, is that perception *is not* the sum of a series of flat pictures, but the result of an active negotiation with the world in depth. Whereas it used to be thought that, in natural vision, the entire visual field is in focus at once—and the history of pictures is dominated by images which are entirely focused both in depth and breadth—it is now known that this is far from the case. For one thing, the eyeball itself changes shape as it surveys the scene, in order to alter the focusing distance (accommodation). And in addition, only that portion of the scene which is opposite the fovea is clearly resolved, so through saccadic movements of the eyeball the fovea is exposed to different parts of the scene. So, both in depth and across the scene, it is impossible for all parts of the scene to be equally resolved. However, there is a profound complication to this simple truth. Since we are not generally conscious of the eye's altering focus (and never of the saccadic movements) it could be argued that a representation which is in focus across its whole surface is true to our *experience*. We have therefore *two valid claims* to realism. Similar mismatches of what have been called *logical* and *psychological* truth also arise in relation to perspective geometry and scale, as noted in very different contexts by Klee (1968, p.41) and Gregory (1977, p.174).

This problem of truth-value arises even in the case of photographs, often still regarded as the benchmark of perfect representation (*figure 1*). Prince (1996:28) notes that C.S. Peirce conceived photographs as indexical traces that 'correspond point by point to nature.' Barthes considered them as operating without a code (Barthes, 1977, p.17). Such a conception underpins the views of film theorists like Bazin (1967, p.46) who often suggest that realism has an unproblematic relation to the scene: we know what scenes look like and film should look the same. As indicated above, the disturbing but exciting fact is that we *don't* know what scenes look like—so we have no way of making pictures, or even films, look the same. Even photographs themselves must be designed—through the selection of lens, aperture, film stock, mechanical form of the camera and so forth—to favor one of several competing truths.

Figure 1 The apparent truth-value of photography is misleading.

Why does any of this matter? The key point is that we are constrained and at the same time liberated, by the impossibility of making a perfect picture, even when using a camera. The emphasis must instead be on pragmatics, on pictures which serve the objectives for which they are made, not on any supposed truth to an objective original. This is largely at odds with the way we are taught to make pictures, where achieving some 'match' between the scene and the picture is normally considered the primary goal. Novice designers are particularly prone to imitating aspects of the real world without considering whether or not this enhances the effectiveness of the design. Visual characteristics then appear in the representation on the grounds that this is the way the world looks, not on the grounds of fit with the objectives.

(Part of an artwork by Andrew Kearney at Middlesex University, London, UK. Used with permission.)

Pictures as representations —towards a definition of expressivity

In the transformations from model to view and to picture, distortion, attenuation and omission are all common. A particularly interesting case is that of what might be termed *illicit marks*—marks with no corresponding presence in the scene. Probably the commonest is the drawn outline. So ubiquitous is it in pictures that we can easily forget it has no basis in the observed world. Marr's model of vision (1982, p.37) proposed that mental constructs equivalent to outlines are a primary means of segmenting the scene at a very basic level, but this does not alter the fact that the lines are post-optical: they are not present in the scene. Outline in a picture stands for an aspect of the world after it has been perceived, after the scene has been processed by the visual system. Instead of imitating the external stimulus of the scene—the optical depingendum—it evokes the cognized, meaningful *experience* of looking at a scene, rather as we saw in relation to uniform focus.

Outline is a significant example of the ways in which the weaknesses of representational technologies are turned to strengths. For example, in some cartoon drawings, a shape outlined in black can be additionally separated from the background by a white outline (Kurlander, Skelly and Salesin 1996, p.229). It is also used in graphical user interfaces to make the cursor 'float' over all other displayed elements. These are informational advantages. Richards, in a celebration of outline from Leonardo to modern technical illustration (Richard, 2006, p.103), highlights its superiority over purely tonal rendering when the structure of complex objects must be conveyed. Through suitable use of line, the image can also be expressive in other ways. Often lines are inscribed onto the surfaces of objects in drawings, which tell us what it would be like to trace one's finger across the surface of the object rather than merely to see it. It is not true to suggest that pictures are limited to what we can see: the picture-maker is entirely free to embed tactile and other knowledge into the visual representation, and arguably, the finest picture-makers do just that.

Importantly, picture-makers do not adopt a rigorous logic in their use of illicit marks. This is another aspect of pragmatism: such marks are usually combined with purer optical data in an *ad hoc* way, which may be driven as much by the ongoing solution of pictorial problems as by any preconceived system. Wollheim refers to the picture-maker building up *analogies* between the medium and the object of representation, seeking an 'ever more intimate rapport between the two experiences' (Wollheim, 1980, p.224), and Podro remarks how 'line connects shape to movement as they can be connected only in drawing. Shape and movement become projected onto each other, so that while making recognition more replete the image takes on a structure which *has no equivalent outside depiction.*' (Podro, 1998, p.9 emphasis added).

Figure 2 Pragmatic picturemaking. The picture-maker's marks operate in a multitude of relations to the scene. (Page from an early nineteenth-century sketchbook, detail. Author's collection.)

In Figure 2, **marks have many functions in a pragmatic evocation of experience.** They operate in a multitude of relations to the scene: now delineating the contour of an object, now creating shadow; indicating a surface retreating in depth; caressing the cylindrical shape of the foreground logs; selecting telling details such as the keyhole, hinges and nails of the barn; making a dramatic contrast between the angled stakes and the rectilinear barn wall; evoking the exuberant wildness of the creeping plants in full leaf straggling over the building. *V* and *P* are therefore representational transformations, not transmissions. They make it possible for the picture-maker to 'tell' about the scene graphically not simply to 'show' it. To quote Richards on the art of technical illustration: "The question is not: is this what the component looks like? Rather it is: **does this collection of graphic marks provide the viewer with the appropriate information to 'read' the illustration?"** (Richards, 2006, p.103).

Expressivity and information

It is time to be more exact about the nature of expressivity in pictorial representation. Initially the discussion will concentrate on those aspects of depiction that are primarily informational. Subsequently, the affective aspects of expressivity will be tackled.

In the context of information visualization, Mackinlay (1986, p.114-6) proposes a strict test of expressivity, that representations must 'encode all the facts in the set and encode only the facts in the set.' This definition harks back to the idea of perfect and complete representation which was rejected above. It might be characterized in Table 4, where facts in the source are mapped to features in the representation, each with its direct counterpart.

It is reasonable to say, as Tufte (1983, p.55-77) and Wainer (1997, p.22-25) do, that for instance, three-dimensional visual representations should not be made when only two dimensions of data are available. In this limited sense, it is quite acceptable that Mackinlay does not want a representation to introduce unwarranted additions to the source facts. At heart, however, Mackinlay's expressivity is defined on the basis that 'the facts' can be established unequivocally; that all that ends up in the representation was found within the facts; and by implication, that the design should act as a channel transmitting these pre-existent facts to the viewer. It is a quite widespread supposition that source data has immanent structure, and that design can or should transmit this straightforwardly. For example, Card et al (1999, p,10-11) present a model of data visualization described in a linear fashion with no apparent place for the design process to alter the conceptualization of the data. Designers sometimes subscribe to a similar view. The designer of a three-dimensional timeline claims, "The information being visualized has its own intrinsic multi-dimensional semantic structure" (Kullberg, 1995, p.22 emphasis added). This view of information sees representation as transparent to content, and content as self-evident in the world. By contrast, March and

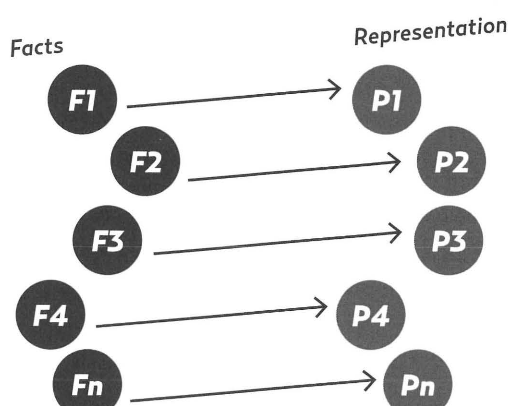


Table 4 A model of representation based on Mackinlay's definition of expressivity. Facts in the source are mapped in the representation.

Steadman (1971, p.29) emphasise the multiple patterns accessible in a data set—and the importance of questioning the pattern that most readily comes to the fore—while Kazmierczak (2003, p.46) passionately argues that "Data per se is meaningless. It merely is a collection of symbols/interfaces, which have been acquired as a result of an inquiry. To answer specific queries and become meaningful information, data must be organised," so that the design does not act as a transparent channel for the data, it makes the data into information. This takes still further Macdonald-Ross and Waller's concept of the transformer cited above.

Not surprisingly, the lack of a perfect fit between the facts and the representation is a source of disappointment to some. In the well-named essay "The Problem of Representing Knowledge" (1972) the same Macdonald-Ross earlier regretted the ambiguities and slippage that visual representations of knowledge bring with them. Nardi and Zarmer (1993) attacked metaphorical representations in the interface on the grounds of their ambiguity and lack of precision, but failed to notice that all representations are more or less subject to these 'failings'—because they are representations.

A preferable overall model of visual representation is presented in Table 5. **If the 'facts in the set' are considered to be the ideas for which the model stands, then a picture can represent more than the set of facts, for instance by having both a simple pictorial and a metaphorical relation to its subject.** A picture also adds to the source facts through reference to common knowledge, including knowledge of other pictures. And a fact in the set, such as the curvature of a surface, may, as we have seen, be transformed into an analogous mark in the representation, instead of being represented directly. In addition, any picture also presents *less* than the facts, since no representation can show all aspects of the model, particularly when a three-dimensional world must be mapped to the plane. Mackinlay's definition of expressivity – the facts in the set and only the facts in the set – is clearly wrong.

The alternative model favored here is a view of design as a form of

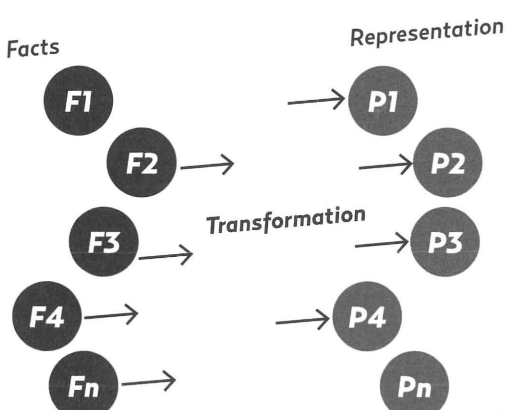


Table 5 A modified model of representation based on the ideas presented in this article. Selective observations from the source pass through a process of transformation into the representation, which will usually both fall short of *and* exceed the mere data.

rhetoric (Poggenpohl, 1998) which places the transformation from content into form in a setting of human-human purposive communication. It is design as described by design semantics, in which 'making sense of things' (Krippendorff 1989) really is considered as *making,* not matching something which exists and awaits expression. **Pictures are created through a series of transformative interventions, just as diagrams or other graphics which are more obviously 'designed'.**

1. Expressivity refined: information and affect

So much for informational expressivity. However, a vital aspect of communication, in addition to the conveying of information, is *affect*. Here this is taken to include anything which alters the viewer's relationship to the depicted.
It is not concerned only with the emotional aspects, as discussed in relation to design for example by Norman (2004). While *informational expressivity* denotes how much the user comes to know about the depicted scene, *affective expressivity* denotes any changes to the relation between the scene and the user. Though the two aspects are often closely intermingled, it is useful, initially at least, to tease them apart. In each case the location in the schema will be indicated.

Consider the case of selecting a point of view (*V*) on an object, initially in relation to informational expressivity. Some views are more significant than others, probably because they differentiate the object with greater efficiency (Bruce, Green and Georgeson, 1996, p.224)—they are preferable in terms of their ability to convey information. Particularly for icons and similar graphics, what is generally needed is a canonical view, providing simple object identity without attention to momentary appearances (Hagen, 1980, p.13). To offer an extreme case, if the trashcan discussed here were pictured as in Figure 3, it would be a poor representation, inexpressive in informational terms. Holmes (2001, p.140) tells how, in his practical design experience, he tries "to find the most representative view of an object." For instance "a true side-on view, or profile, of a pair of spectacles does not remind you of spectacles, it's just a capital letter J on its side." The inexpressivity of some views has been exploited in visual riddles such as Figure 4.

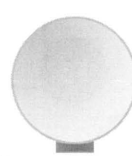


Figure 3 An inexpressive view of the trashcan. Some views are more expressive than others.

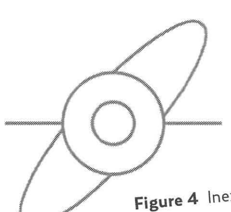


Figure 4 Inexpressive views as a source of visual humor, a traditional visual riddle for children, representing a man in a sombrero paddling a canoe.

Blanz, Tarr and Bülthoff (1999) have measured the angles at which subjects elect to view a three-dimensional model and produced a persuasive illustration of the clustering around the particular angles that provide canonical views (*figure* 5). All are views in which the defining characteristics—the overall shape, the spout, the handle and the knob of the lid—are visible. Almost every viewpoint chosen is above the horizontal. Recalling the trashcans depicted in the history of the desktop metaphor, each has either been viewed in simple elevation (as in the early Macintosh operating systems) or from slightly above.

But in addition to the informational expressivity of such a view, is there an additional, affective, aspect to this choice of viewpoint? Users should feel in control of the systems they use—this has long been one of the claimed benefits of well chosen interface metaphors (Carroll and Thomas 1982, p. 112), and to look down on an object is to feel empowered in relation to it. The downward view on the trashcan fulfils this affective requirement as well as the informational need.

If we turn to the rendering of a picture (*P*), the drop-shadows 'cast' by interface widgets in many operating systems perhaps serve some slight informational purpose in enabling the user to more easily locate the boundaries of discrete screen segments, but they also make the objects seem 'more real' in an affective sense. Their arrival in the interface seems to have been contemporary with a particular style of book decoration by the publishers Dorling Kindersley, which used a similar device to make objects on the page seem more object-like and less like traditional book illustrations. It is a device that conveys almost no information but makes users feel different about what they are looking at.

While, conceptually, information and affect deserve separate consideration, in pictorial practice, as the examples given already suggest, they often work in collaboration.

Film demonstrates remarkably how informational and affective aspects can become inextricably bound up in a single device. A close-up (*V*) allows us to see the nuances of a character's expressions (it adds information) but is also affective—it forces a closeness that produces effects similar to being near an actual person (Reeves and Nass, 1998). Similarly, moving the focal plane to alter which part of a scene in depth

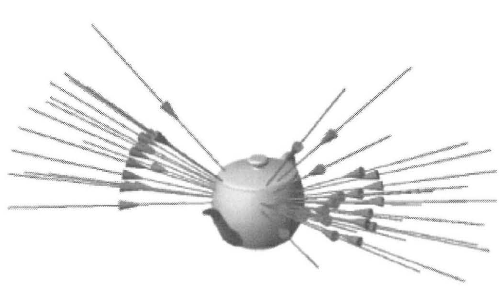


Figure 5 The clustering around a limited set of viewpoints, chosen by experimental subjects, onto a three-dimensional object. These viewpoints favor canonical views. (Blanz, Tarr and Bülthoff, 1999. Reproduced with permission.)

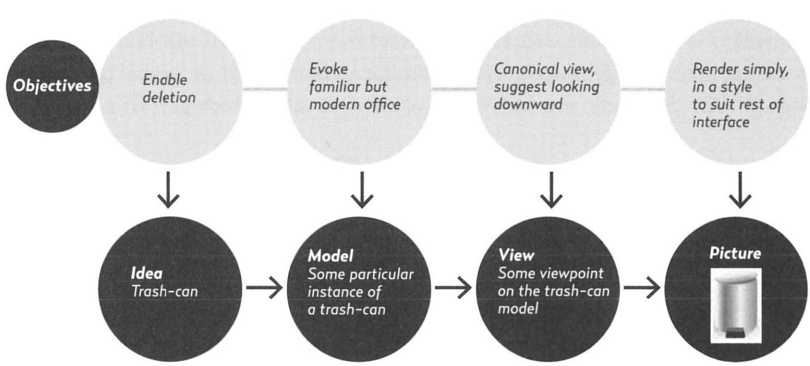
is in focus (*P*) is informational, since it allows something else in the scene to be more clearly observed, but it also has a strong effect on the viewer-subject relationship—it effectively compels the viewer to relate to a particular part of the depiction.

Angle of shot (*V*) is yet another technique which combines informational and affective expressivity. For example a view upwards to a person in a high window may be followed by a view through a window down into the street: the spatial relation between them is constructed by the viewer on the basis of the coherence of these angles. Shot angle here is used an informational device. But, in addition, shot angle has a relation to the film-viewer: it is this that causes an upward view of a character to imbue that character with authority. This is the affective aspect. As Harrington puts it (1973, p.77) the filmmaker "tells the viewer how to feel about a character or an action by a shot angle." This use of viewpoint and other aspects of the transformation to "tell the view how to feel" is fundamental to the effective aspect in all classes of depiction. **Every aspect of the depiction is influenced by the objectives.**

Refining the schema

Returning to Table 3, some weaknesses can now be identified in the draft schema. It was noted earlier that there is an implication of linearity. It might seem that the objectives O influence the selection of the idea I, but no other aspect. Nothing could be further from the truth: in fact, as has been shown, they influence every representational transformation.

In Table 6, the schema is restructured to indicate this. In the case of the example given, the trash-can is chosen to facilitate deletion of files; a particular instance of this idea is chosen to evoke a familiar but modern office; the instance is viewed from a canonical viewpoint, which also happens to be a downward view, suiting



▲**Table 6** Reconstructing the draft schema allows the influence of the objectives on every aspect to be identified.

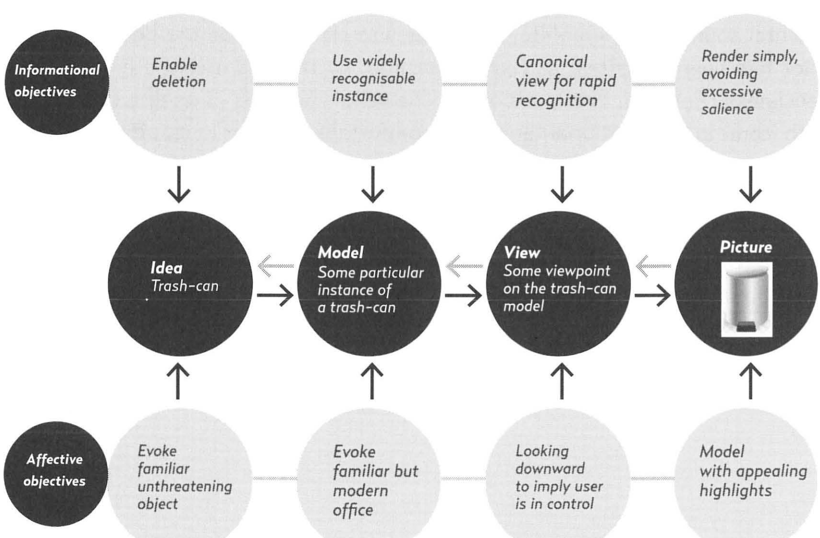
►**Table 7** Finally the schema is restructured so that the role of both information and affective objectives can be identified. In addition, the possibility of 'reverse flow' is indicated, for those cases where considerations concerning the 'output' alter decisions about the 'input.'

the need to suggest that the user is in control; and finally the image is rendered in a simple, unadorned way, one that will sit well with the other elements of the interface.

In the final version (*table 7*) the informational and affective objectives have been separated, not—as already indicated—because they really operate independently, but simply to make clear that both kinds of objectives potentially act on every transformation.

In Table 7, another final weakness of the original ***O → I → M → V → P*** characterization has also been addressed. **In the pragmatic business of depiction, the flow is not always one way. Frequently for example the model *M* is contrived in order to produce the desired picture *P*, so the demands of the picture propagate back to the characteristics of the model.** In the early days of linear perspective, Uccello, in his Battle of San Romano (c1450), contrived particular subject matter—and placed it in somewhat improbable positions—so as to provide plenty of orthogonals projecting dramatically at the point of convergence in the center of the painting. An eighteenth-century painter might order everything in a picture around the S-shaped line of beauty—again working back from the composition to the contents. The filmmaker who wants a low-angle shot, up to the face of a powerful character, will position the character high up in the scene, so 'necessitating' an upward view. Even the humble trash-can may show traces of this 'reverse engineering': once it is decided that the icon will appear low down on the screen, this is probably a third factor in deciding that the downward view onto the object is the most appropriate. Having a trash-can on a desktop may be strange, but at least the point of view is roughly the right one.

To reflect these ways in which objectives may propagate 'backwards' through the representational phases, additional reverse arrows now flow upward through the schema.



The schema applied

Using the schema we can begin to anatomize the transformations employed in the design of another icon. The trash can was a simple icon in which an object stood for an action, but often it is necessary to combine more than one element to suggest a more specific meaning. In Table 8 an icon is presented where two objects are juxtaposed, to represent the action of saving data to long-term storage. One element of the idea *I* is in some ways a fairly literal depiction of the storage medium itself: a disk. The other element is, like the trashcan, an object that stands for an action, a pencil to picture the act of writing. It exploits the metaphor of writing, since no actual pencil is involved in storing data to the disk. Because pencil marks are easily erased it has the advantage of suggesting a recording operation that can later be undone. These are all informational benefits.

What, in terms of information, would be lost by using either element alone? Clearly the disk alone suffers from the ambiguity that it might denote any of a range of disk operations. The pencil alone might be a tool for drawing or for making annotations. Together, the meaning is more clear. **The combination of a literal and a metaphorical element seems quite effective,** though it raises an interesting problem of viewpoint, dealt with below.

In affective terms, the comfortable familiarity of the pencil, the writing tool of childhood, can be thought of as tempering the relative 'foreignness' of the digital technology represented by the disk.

An idea having been chosen, particular models *M* for each element are required. The storage medium appears as a 3.5-inch floppy disk, perhaps because it is the most recognizable instance of this class of objects, even though the icon also denotes writing to other storage media.

The yellow pencil in itself is a rich sign. Approximately three-quarters of all the pencils sold in the US are painted yellow. It has been suggested that the Viennese Hardtmuth Company in the 1890s adopted yellow for its finest pencil to connote the Oriental source of its graphite, since this was claimed to be the best in the world. The color has been described as having become, by the mid-twentieth century, a sign of pencilness (Petroski, 1990, p.163). So the yellow pencil is in itself a canonical instance, both iconic in informational terms and comfortably familiar in its affective aspect.

The idea instantiated as a particular model must be viewed *V* and, when using multiple elements, this also means the elements must be composed as a visual whole. In this case a tricky problem arises from the literal/metaphorical mix. It is necessary to avoid the pencil seeming to write on the label of the floppy disk: this could be misleading. So the pencil seems to write, if anywhere, on the part of the disk

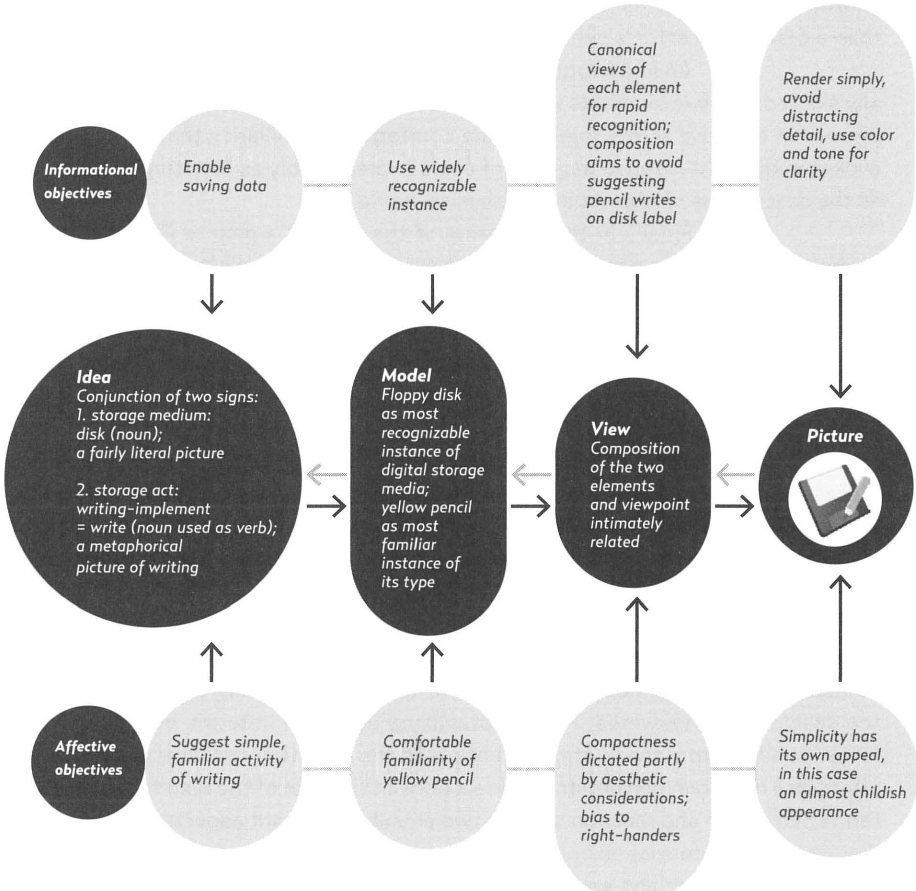


Table 8 From the *iSimple System Icons* set by Dirceu Veiga, May 2006. (Downloaded under GPL licence from Wikimedia May 2007.)

where the read-write head of the disk-drive will operate. There are of course also a host of aesthetic considerations, including the need for the entire icon to be reasonably compact. The pencil depicted is therefore a short one, another example of the backwards propagation of objectives, in this case from the viewpoint to the model. Perhaps the shortness also reinforces the sense of a comfortable everyday household object, rather than a brand-new artist's pencil.

An important issue in terms of affect, is that the composition is laterally skewed: the two elements would only be used in these positions by a right-handed person. In affective terms therefore the comfortable familiarity that the composition evokes in the right-handed majority of users is presumably as irritating to left-handers as the dextral bias of objects in the physical world.

Finally in the rendering of the view as a picture *P*, in informational terms the color of the pencil is an advantage in differentiating it clearly through both tone and hue, while in affective terms it makes a pleasing splash of color on an otherwise monochrome object. As before, a modest style of rendering is chosen: it has a simplicity that is almost childlike, a characteristic of this icon set as a whole.

Summary conclusion

The schema as finally presented is grounded in three key issues discussed above: the impossibility of making perfect representations and the inevitability of mismatch between the scene and its picture; the complex nature of expressivity arising from this mismatch; and the richness of the resulting transformational opportunities available to the designer or picture-maker.

Picture-making has been conceived here as making an artifact that in some way (or ways) makes equivalences for selected aspects of human experience—not as matching anything neutrally existent in the world. Viewing depiction in this way, the designer is empowered. Reconceptualizing depiction in terms of expressivity, the focus is shifted from the relationship between the depiction and what it depicts, to the affordance of certain perceptions and reactions in the user of the resulting image. These terms perception and *reaction* sum up two equally important aspects of expressivity as discussed here: information and affect. The picture both carries information about visual and other experience and promotes a certain relationship between the user and what is depicted. **The notion of carrying information is not—as we have seen—a simple channelling of data from the source to the user. On the contrary, at each stage, from the objectives to the idea, from model to view and from view to picture, subtle processes of transformation are at work. The proposed schema captures some of the richness and complexity of this pragmatic activity.**

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Hung Hom, Kowloon
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