

Diagrams as information design

Robert Waller

Although diagrams are very common, little is known about how they are understood. Designers can use a repertoire of patterns which exist within particular cultures. These patterns originate from two sources: special notations and visual metaphor. However, there are few grammatical rules for designing or interpreting diagrams. The lack of rules is both a weakness and a strength, depending on the creativity of the designer and his or her sensitivity to the readers' needs. In order to inform designers about how diagrams are read, the author describes research which investigates how simple sentences were diagrammed by non-designers using a limited set of symbols and connectives.

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Although diagrams are a common medium for communication, very little is known about how they work. For the engineer or the scientist they can be an everyday working tool (1), but the graphic designers have also turned them into an elegant visual art of the highest quality (2).

Although diagrams are sometimes assumed by their designers to be a more direct and motivating medium than text, research suggests that this is not always so. William Holliday, an educational researcher (3), found that although an experimental diagram proved to be as good as an equivalent text when presented on its own, when students had a choice - that is, they were given both the text and the diagram - they paid very little attention to the diagram and preferred to study the text. One conclusion was that they felt more secure with the more familiar and rule-bound medium.

Our own observations of readers using illustrated texts (using video and other techniques) seem to back this up (4). Readers become quickly cynical about the usefulness of all the illustrations if they discover one or two which are incomprehensible or trivial. Where does the problem lie? How can designers construct diagrams which communicate reliably? We do not have the space here to dig very deeply into such difficult questions, but I will attempt to summarise the problem and to describe the programme of research we have undertaken to explore it.

For centuries, diagrams have had a certain magical attraction. Although few modern diagram designers would be aware of their cabalistic use, nevertheless it is only too easy for us to seek symmetry for its own sake or to force connections where the diagram, not reason, suggests they should be: an elegant diagram suggests an elegant theory.

The visual quality of diagrams is at the same time their greatest strength and their greatest weakness. The search for symmetry, for surface pattern, for visual impact, has produced diagrams that are both memorable and motivating. But this

visual impact can be seductive, presenting arguments in a form that has no critical tradition. In contrast to verbal language, we have few rules by which to design, criticise or interpret diagrams. Diagram designers are free to mix graphic conventions to produce new creative solutions. As a result, however, unpredictable misunderstandings can arise between the designer and the reader.

For example, the well-known London Underground map combines cartographic conventions and the conventions of an organisational chart. Many visitors to London gain their knowledge of its geography from the Underground map, but the scale has been distorted in order to make the transport network clearer. The centre of the city is exaggerated in size because it contains a greater concentration of stations than the suburbs. As a result, visitors sometimes misjudge the time needed for journeys to the suburbs, and they change trains to reach the nearest underground station to their city centre destinations when it would be quicker to get out and walk. A similar example is illustrated by Figure 1. Although this works very well as a network diagram, considered as a map we find Zurich west of Paris, Jeddah north of London, and Paris north of Frankfurt.

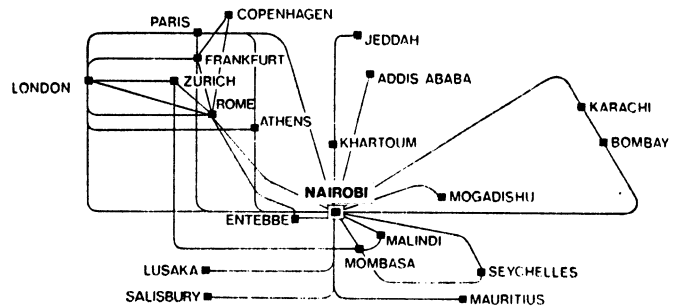
Examples like this are easy to find, but just

one more will suffice. Figure 2 is from a newspaper report of the Tour de France. The overall effect is quite satisfactory in many ways, but look at the symbols the designer has chosen to illustrate time trials. Wherever they appear on the map, the cyclists are riding the wrong way - towards the race's start in Frankfurt, not its finish in Paris. In this example there is a conflict between the symbolic and the pictorial use of the cyclist image.

Diagrams such as these are not the work of idiots, but are the inevitable consequence of not having a shared grammar of diagrams. However, it would be hard to arrive at such a grammar without losing the main advantage of diagrams - their flexibility and creativity. Moreover, taken to extremes we would no longer have a diagramming system but a notation, using that term in the strict sense of Nelson Goodman's theory of notation (5). His definition would almost certainly exclude diagrams which communicate not only through the meanings of individual components but also in a holistic way through their overall shape or pattern. For Goodman a notation is a system of distinct characters which are syntactically and semantically separable.

Most diagrams do have some notational characteristics - symbols, arrows, boxes and boundaries which have special denotations - but they also use connotative

Figure 1.



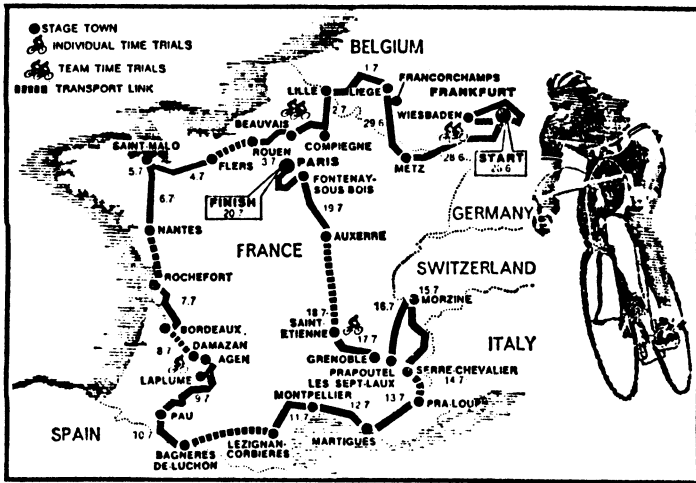


Figure 2.

or metaphorical techniques. Diagrams use metaphor whenever they use an aspect of our shared cultural experience to make an otherwise abstract point. Visual metaphors are usually very explicit when they first appear, but become more abstract as time passes. Early tree diagrams were pictures of trees with labels pinned to the branches. Modern tree diagrams need no instructions to tell us that the logical flow is from the 'trunk' to the 'branches' - both represented by simple lines. Arrows, too, have become more abstract over the years.

In practice, most diagrams seem to use patterns which have their origins in abstract notation or visual metaphor, but which have become part of our shared visual culture, a culture which is constantly changing. It is for this reason that diagrams are so hard to analyse or to classify - as students of semiology will be aware, it is necessary to analyse not only the visual marks but the whole of the culture that produced them.

It would be unrealistic for us to seek a completely reliable system for diagram design. A better solution may lie in our design philosophy. In college we should be teaching students to design diagrams which are not only aesthetically pleasing but

diagrams which anticipate misunderstandings before they arise, which show an appreciation for the users' needs. But, as David Sless (6) has shown, we first have to replace the overconfidence of the typical designer with a proper respect for his or her audience. Images which seem completely obvious to the person who designed them can mean something quite different to another. This has often been demonstrated with different cultural groups (7) but also happens within a single culture.

We recently started a small programme of research to find out how non-designers think about diagrams. The purpose of this programme (which is still continuing) is to find out how people cope with the problem of diagramming in the absence of a systematic grammar of diagrams.

The experiment had two stages: first, we asked a small group of people (Open University staff) to create simple diagrams: then we asked other people (polytechnic students) to interpret them.

The 'designers' were given eight sentences to convert into diagrams. Each of the sentences proposed a different type of relationship between two points, A and B.

They were given a set of diagrammatic components to use, both connectives and end-points. These are illustrated in Figure 3. Using these components, they designed eight simple diagrams and gave an estimate of their confidence that others would be able to interpret their design correctly.

The 'interpreters' were then given the same eight sentences and four sets of these diagrams, each set being in random order. They had to decide which diagram represented which sentence. We have not space here to present the results in full (a report will be available from the author), but two points in particular deserve a mention here.

The first point concerns the use of visual metaphor in the design task. In spite of the rather abstract symbols, the designers frequently came up with quite expressive designs, and their designs were easier for other people to interpret. Some of these are shown and discussed in Figure 4.

Second, the ability of the interpreters to correctly identify a diagram correlated with the confidence of the diagram's designer. Three sentences seemed particularly easy to diagram: 'A speaks to B', 'A controls B', and 'a continuous flow of movement between A and B'. Just one sentence, 'A is changed into B', proved hard to diagram and to recognise. This result may not seem very remarkable, but it becomes more interesting when one considers that the actual diagrams produced by the different designers were often quite different (see Figure 5). Interpreters were able to recognise other people's diagrams even though they were different from the one they designed themselves when given the same task. The conclusion may be that the interpreters were seeking and finding a unique visual syntax within each set of diagrams.

These results are interesting enough to encourage us to continue the programme. This diagrams study is now being repeated with the use of a microcomputer to ensure that the sentences and the diagram components are presented in random order (on the computer's screen). This prevents

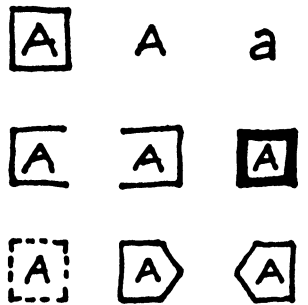
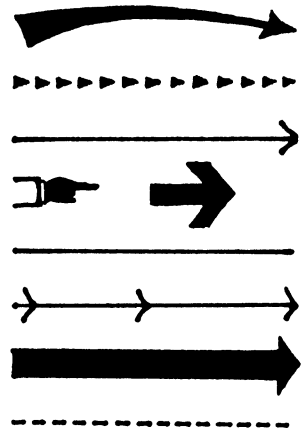


Figure 3. Diagrams are often used to show relationships between things, people or places.

The relationships are sometimes shown with lines or arrows of various kinds, while the names of the things or people can be put in boxes, put next to symbols, or just printed on their own.

Below is a collection of different kinds of line, and a collection of different ways of showing the people or things. Choose a style of line and style of box or point to illustrate the relationships listed. You can choose the same style for both A and B or a different one for each. A is on the left of the diagram and B is on the right, as shown here.

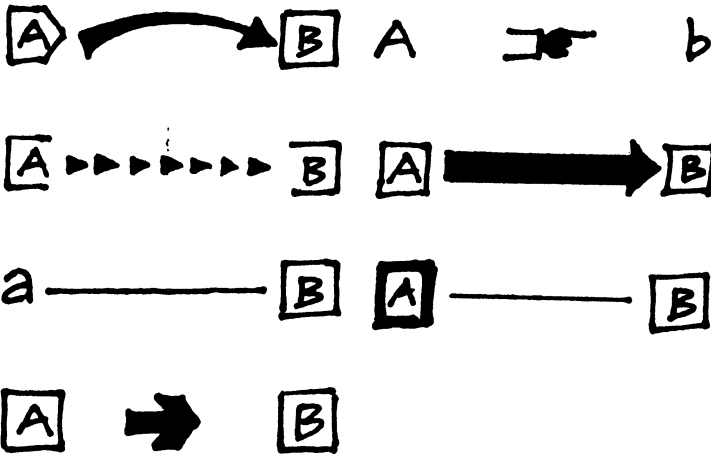


Figure 4. The first diagram, representing 'A gives something to B', uses the curved arrow to suggest the picking up and putting down of an object. A problem with arrows is that the reader does not know who has initiated the transfer or flow: this subject has solved the problem by using the pointed box for 'A'.

The second diagram represents a continuous flow between two points. The repeated arrows were the most popular way of representing flow, and the open boxes suggest exit and entry points.

The third diagram represents the linking of a caption to an illustration. The absence of the box around 'a' draws attention to the box around 'B' which may suggest a picture frame.

The fourth diagram represents 'A goes to point B'. It is possible that this arrow was chosen to designate travel because it looks like the arrows used on British road signs.

Figure 5. These three diagrams all represent 'A controls B'. The first one uses the old-fashioned fist symbol in a very literal way, to represent the giving of orders. It also represents the lower status of 'b' by printing it in lower-case. The second diagram relies on a dominating arrow, while the third uses a neutral connective and relies on the different status of the boxes to communicate its meaning. Although quite different, these diagrams were successfully interpreted when seen alongside other diagrams by the same designer.

order effects from distorting the data. The computer has other advantages, too. First, it allows subjects to try out diagrams on the screen before making up their minds: the computer is recording the false attempts as well as the final decision, giving us information on the process of designing as well as the product. Second, the computer program is available to other researchers, who can then replicate the experiment with identical conditions - only a few lines would need to be translated into another language, if necessary. It is available (for an Apple II computer) from the author.

The study of these individual preferences has a further implication for graphic design in the future. As more information becomes available in an online form (through computer databases or computer-assisted learning systems) the potential now exists for the same data to be presented in a variety of ways according to the needs of the user. For example, the same statistical data can be presented in a table or in a graphic form according to the interpretation required by the user. An organisational chart might be redrawn with a different focus, or to highlight only certain types of relationship. The user might then become also the designer, setting up an individual notation to be used whenever he or she accesses the program, aided by the 'designer inside the machine'.

(1) *Tools for Thought*: C.H.Waddington, Jonathan Cape, London, 1977.

(2) *Graphis Diagrams*: Walter Herdeg (Editor). The Graphis Press, Zurich, 1974.

(3) Teaching verbal chains using flow diagrams and text: William Holliday, *Audio-Visual Communication Review*, Vol. 24, No. 1, 1976.

(4) Testing design alternatives: Gary S. Schumacher and Robert Waller, *Designing Usable Texts* (edited by Thomas Duffy and Robert Waller), Academic Press, New York, forthcoming.

(5) *Languages of Art*: Nelson Goodman, Hackett Publishing Company, Indianapolis, 1976 (Second edition).

(6) Image design and modification: an experimental project in transforming: David Sless, *Information design journal*, Vol. 1, No. 2, 1979.

(7) Cultural differences in the perception of image and color in pictures: Rune Pettersson, *Educational Communication and Technology Journal*, Vol. 30, No. 1, 1982.