*This article considers the similarities and differences between maps and other types of graphic information such as graphs and diagrams. It is argued that all types of graphic information are different solutions to a common problem: the brain's limited capacity to store unprocessed information.*

# Are maps different from other kinds of graphic information?

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Maps, graphs, diagrams, histograms and similar displays are sometimes collectively referred to as "graphic information". They all communicate information in a way that is primarily visual or spatial, rather than verbal or symbolic. But maps are often regarded as rather different from other forms of graphic information.

One way in which this is reflected is the clear division of labour between creating maps and designing other forms of graphic information. In many countries, cartographers, on the one hand, and graphic designers, on the other, are quite separate professions with different approaches to training and a mutual reluctance to encroach into each others' domain.

Another difference is historical. Maps have been with us a lot longer than most other forms of graphic information. Maps have been used for more than 5,000 years whereas most other forms of graphic information date from the eighteenth century – graphs are a surprisingly modern discovery (Tufte, 1983). The earliest use of pictures is, of course, long before the first map, but perhaps we should exclude pictures from our definition of graphic information: pictures do not seem to share the geometrical or conceptual structure of maps and graphs.

As often happens, the sequence of historical development is crudely echoed in human development. Very young children can interpret simple pictures, children of kindergarten age can interpret simple large scale maps (Stea and Blaut, 1973), but it is several years later before children can make sense of other forms of graphic information.

Perhaps one basis for distinguishing maps from other types of graphic information is that maps depict *spatial* information. But this distinction does not seem to be a sharp one: distance-time graphs, electrical wiring diagrams, knitting patterns and chess boards all depict some spatial information but none of these are usually called maps.

One reason for posing the question "Are maps special?" is to ask whether research on the design of maps has any relevance to the design of other graphic information, and vice versa. Taylor and Hopkin (1975) looked at the feasibility of applying general ergonomic principles to map design. They took published guidelines on the design of visual displays and incorporated these in an experimental map. The map they produced was inferior to a more conventional map in a number of respects and they concluded it was unwise to apply general graphic design principles to maps. However, other research has sometimes found quite close similarities between human factors in map design and the design of other graphic information. For example, Phillips *et al.'s* (1977) experiments on map typography arrived at very similar recommendations to those for type in other contexts. It would be valuable to establish principles for whether research results are likely to generalise or not.

There are also educational questions. Balchin (1972) and others have stressed the importance of teaching children "graphicacy", by which they mean a fluency in using graphic information of various kinds including maps. But if maps are fundamentally different from other forms of graphic information, should we expect any kind of transfer or generalisation between map reading skills and skills in using other types of graphic information, for example, graph interpretation (Bell *et al.* 1987)?

## WHY DO WE USE GRAPHIC INFORMATION?

It is helpful to begin by asking why we use graphic information at all. Almost all human communication is through words and symbols: it is nearly all listening, writing, reading and talking, so why do we sometimes change and switch to such a radically different means of communication? Perhaps, from time to time, do we simply grow tired of words? Or perhaps can graphics achieve a kind of emphasis or emotional loading which we cannot produce with words? Neither of these can be the principal reason as the occasions we choose to employ information graphics are much less haphazard than these explanations would suggest.

Perhaps the real reason is that we have little or no choice in the matter. From time to time we are forced to abandon words and adopt graphical means of communication because of our own mental limitations.

This argument brings in some psychological ideas and draws an analogy between the way our brains function and the way a digital computer carries out similar tasks.

## GRAPHICS AS A MEMORY AID

Ask somebody to repeat back to you exactly what you say. Begin by giving them five random digits (e.g. 37954). They should have little difficulty in repeating them. They give them six random digits, and then seven, and so on. Surprisingly, most adults will have made a mistake before you get to ten digits.

There is a simple explanation for this: our capacity to remember raw, unprocessed information is very limited. A computer will happily read thousands of numbers into its memory before beginning to process them but people simply cannot do this. The problem is not limited to numbers. We have the same limitation with any verbal information, but we are less aware of it with words than with numbers. This is because the limitation only applies to *unprocessed* information. When somebody talks to you, you immediately start processing their words into meaning, and because you can also turn meaning back into words, you can usually recall quite long sequences of words.

Various names are given to this limited memory store inside our heads. It is sometimes called short-term memory or primary memory, but perhaps the best name for it is *working memory* (Baddeley and Hitch, 1974) because it plays a part in how we think, as well as in how we remember.

It is no disadvantage to have a working memory of small capacity as long as information can be processed as it is received. But some types of thinking are very difficult to do in this step-by-step manner, and these include many of the tasks we do with graphical displays like graphs and maps. Here are some examples.

> The annual consumption of potatoes in a canteen was 2,853, 3,791, 4,445 and 2,473 Kg in 1972, 1973, 1974 and 1975 respectively. The corresponding figures for carrots are 1,549, 2,071, 2,843, 1,341 Kg, and for onions, they are 1,085, 1,841, 2,283 and 863 Kg. Which figure does not fit the overall pattern?
>
> During a game of chess, there are white pawns at a4, b4, g4 and h2, a white rook at h5, and the white king at h3. There are black pawns at a7, b7, f5, g5 and h6, there are black rooks at c3 and d2, a black bishop at e5, and the black king at g6. Tell me whether either king is in check.
>
> Tell me the most direct route from Mount Park Road, Ealing to Nelson Road, Crouch End. Here is a complete list of roads in London with their co-ordinates. . . .

These problems are posed in a verbal form, using words, numbers and symbols. A computer program would happily receive the information in this form, but human beings would find the problems much easier if they were translated into a graphical form, such as a graph, a chess diagram, or a street map.

The important common feature of these three problems is that the information cannot easily be processed in a step-by-step fashion. It is necessary to have access to the whole body of information simultaneously, before the problem can be solved. Because of the limitations of working memory, we cannot store large amounts of raw information before we begin to process it. But computers, on the other hand, can do this easily.

Why does it help us to present the information in a graphical form? When the information is spread out in front of us in a map or a diagram, there is no longer any need to store the raw information inside our heads. The limited capacity of working memory ceases to be limitation. The graphical image itself becomes a kind of memory store for as long as our eyes continue to look at it.

Computers are unable to process information in this way because they do not normally have the capacity to process information in parallel. A computer program tackles a route finding task in a very different way from a human being, partly because it has something that brains do not have (the capacity to store large amounts of raw information), and partly because it lacks something that brains have (a visual system that processes in parallel).

The structure of brains and computers limits the kind of information processing which can occur, and hence the kinds of thinking. In people, this type of limitation is universal. No amount of teaching or experience will have any significant effect on the capacity of working memory, any more than a computer programmer can write a program to rebuild a computer's hardware.

But this discussion has been limited to the early stages of human information processing, soon after information enters the brain through our eyes or ears. As information passes on to higher levels of cognitive processing, these simple, universal types of limitation seem no longer to exist. Here the limitations are in thinking itself. Our age, our experience, or education, and our culture will all affect the way we can handle information at this level. There is no doubt that we have to *learn* to read maps and other graphic displays and that there are many facets to this learning.

## DIFFERENT SOLUTIONS TO A COMMON PROBLEM?

Perhaps then, the differences between maps and other forms of graphic information are not as great as they appear. All types of graphic information are different solutions to a common problem: our limited capacity to remember unprocessed information. By removing the limitations of short term memory, graphic information allows us to do kinds of thinking which are difficult or impossible in other ways.


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