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Perception, cognition and technology in the reading of digital cartography

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Summary
Some problems related to the readability of originally analogical maps when transformed into digital copies and the relevant 'screen-views' are discussed with respect to the technological and social complexities of the issue involving at last the dominant question of the human perception and cognition in approaching the study of maps. The subject meets its modern justification in approaching the process of digitalisation of maps as historical documents, which is now a challenging task for all institutions safeguarding cultural heritage.

Criteria and conventions

What criteria come into play when we read a digital rendition of an analogical work of cartography (which in most cases is a map drawn on paper)? The answer to this question brings into focus the full complexity of an issue that involves technology (the resources used in producing, distributing and employing the map), legal and administrative matters (the protection of intellectual copyright), cultural/political questions (how to define access and decide possible limitations to access) and finally the very processes of human perception and cognition (how are the document and its contents perceived as a source of information?).

Let us start by looking at how a work of cartography renders certain items of information regarding a specific area of territory - its size, physical characteristics, etc. Look, for example, at the map of Italy in any atlas. Our ability to understand it rests in part upon recognition of a form that complies with a learnt abstract model - that is, the well-known definition of Italy as "a boot-shaped peninsula" (Fig. 1). A series of graphical conventions (colour, line, symbol, etc.) then describe the contents of that outline in a rather simple manner; the orientation is given in relation to the cardinal points of the compass; distance and area by scale; altitude by colour and/or contour lines, and so forth. In effect, therefore, the perceptive and cognitive procedures that comes into play in reading the map make it possible for us to recognise the form before us and then go on to read it in detail. But - and this is a fundamentally important point - the fact that such a possibility is open to us rests largely on what Gombrich (1960) defined as a process of 'trial and error', which here involves moving backwards and forwards from a view of the whole to a view of a detailed section in order to establish the relations between the part and the whole and

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between the individual parts themselves. In effect, what one does is create a sort of perceptual scaffolding that makes cognitive reading possible.

Figure 1. The boot-shaped peninsula.

As the psychology of perception puts it (Arnheim 1967) *"in representation in general, form and outline are a preliminary and indispensable requisite for perception to establish the character of the contents of that representation"*. This means that the absence of an outline form (be it concrete or abstract) hinders, when it does not entirely prevent, the organisation of visual perception as a cognitive experience.

The map outline

Let us now go back to the map of Italy. As long as the page in the atlas shows it in its entirety, we can associate that specific form - the boot - with a range of contents of varying complexity that go to make up our shared notion of Italy as a geographical entity. But if we cover that page with a sheet, which contains a square opening, so that only a small part of the map is visible, will we be able to recognise the visual image in the same way? Will it be the basis for the same cognitive process? Clearly, it will not. And this is even more the case when the territory represented is some unknown region of the world and not an area as familiar to us as Italy.

Everyone has had the experience of being a first-time visitor to a new city and having to use a map in order to get his or her bearings. The maps sold at newspaper kiosks or distributed in tourist offices are generally printed on folded sheets, so if one wants to get from the station to a particular hotel in the centre of the city, one has first to locate both places on the map and then establish a spatial relation between those two points. In other words, to get my bearings, I have to transfer my framework of corporeal orientation - based on such elementary notions as left/right, up/down - to within the space of the map. However, to do this, I have to unfold that map so that I have a single image comprising my point of departure and my (desired) point of arrival. If I try to get my bearings by looking at only one section of the map at a time, it will be very difficult - if not impossible - for me to establish a relation between the two points; I will not have been able to

project my corporeal schema of orientation upon a image of the city as a whole but only upon individual sections of it. It is only by repeated shifts from detail to whole - the process of 'trial and error' - that I will be able to create the conditions required for my visual examination of the map to supply the necessary cognitive experience.
In most cases, cartographical representations are not recognisable thanks to a previously acquired model or form. Even if the shape or outline can be recognised without much difficulty (although even here there are significant exceptions, especially when one considers the history of cartography), the contents - or, if one prefers, the topography - of a particular geographical area do not have their own innate form; one might compare them to an expanse of brick wall, which gives no idea of the appearance of the building to which it belongs. What we have is a complex of (conventional) signs that appear to have no significance outside their relation with the whole and, in the second place, with each other. As in a sort of hypertext, each detail is low in significance, yielding information above all through its individual and general relations to other signs.

From analogical to digital

If one now moves from analogical to digital cartographical images - that is, to those, which appear on a computer screen - one has first to consider some technical points. To return to our initial question: when can one define the geographical map on a computer screen as 'legible'? The simple answer is: solely when we can read all that is written upon it (place-names, captions, legends, etc.). But here we encounter our first difficulties - admittedly, largely technical difficulties that may well be overcome by technological developments in the instruments at our disposal.

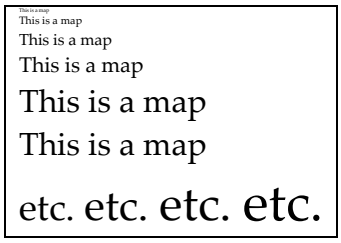

Figure 2. The readability of the inscriptions.

Even if printed in very small type, all the inscriptions on a map must be readable if that document is to provide the highest possible quantity of information (obviously the problem here with manuscript maps is even greater). This means that when the map is reproduced digitally, the degree of resolution within the image must be high; in effect, the bigger the size of the original on paper, the larger must be the computer files necessary to maintain parity of resolution. Given the limited variations in the size of monitors and the degree of resolution in video images, this has the rather interesting result that the portion of the image one can examine on the screen is in inverse proportion to the size of the original. In other words, the larger and more detailed the map, the smaller the portion of it that one can call up on the monitor. This creates the situation described above, when a sheet with a window was placed over the map of Italy, and hence reduces our ability to perceive and cognitively organise the image before us.

On the available technology

To obviate this difficulty, at least in part, software such as the MrSId (and its numerous derivatives) was developed to enable one to 'navigate' within the image. The mechanism is simple: within a small window on the screen is a visualisation of total document of which the main image forms a part, and by giving such instructions as "further north" one then moves to the next portion of the document, and so on. As we have already seen, however, such procedures make it rather difficult to initiate that process of 'trial and error', which, in the case of geographical maps, rests on the back-and-forth co-ordination of the whole and its details. This is mainly due to the above-mentioned fact that the 'contents' of a geographical map have no form as such.

Significantly, MrSid technologies are much more efficient when applied to other types of image - for example, works of art[1]. Within certain limits it makes little difference whether these works are figurative or abstract, Picassos or Michelangelos - because both the details and the image as a whole respond to those 'simple' and 'universal' (Arnheim 1967) elementary forms, which define the fundamental patterns of cognitive visual experience. In a cartographical representation, on the other hand, there are no such 'simple' and 'universal' forms.

In short, parathetical viewing of portions of an image - that is, in sequence rather than simultaneous juxtaposition - proves to be ineffective at providing visual perception, which can serve as the basis for cognitive experience. As further proof of this one need only think of the digital reproduction of manuscript or printed pages of text, in which the direction of writing rather than the meaning of the text already lays down a uniform model of development; the very sequence of the lines establishes 'meaning' even before other perceptual operations come into play. What is true of written texts and artistic images is not, however, true of maps, where cognitive experience relies on a variety of specific procedures which take into account the special characteristics of the cartographical image.

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[1] See for instance the DADDI Project at the site www.uffizi.firenze.it/Dta/daddi-ita.html