SOME PROBLEMS ASSOCIATED WITH THE USE OF COLOR IN CARTOGRAPHIC DISPLAYS

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ABSTRACT

Cartography, having been spurred on by the relatively recent advances in Raster technology, has made a headlong plunge into the world of color graphics. Although cartographers have been involved in color production for centuries this recent digital innovation allows color to be used freely in an environment that lacks the restrictions generated by the time and expense of manual color preparation, color proofing and color printing. Unfortunately, the advances in technology have surpassed the available theory relating to the effective utilization of color in cartographic displays. In an attempt to provide some insights towards a utilitarian approach to color mapping several models are described that illustrate the human factors considerations in the communication of cartographic messages. From these models notions of an effective color theory are developed and illustrated by examples of color choropleth maps produced with the Decision Information Display System (DIDS).

KEYWORDS: Cartographic design, perceptual mechanisms, human performance, color coding, color design.

Cartographic messages are designed to serve one purpose: to provide a reader with information about the spatial behavior of a variable or set of variables. Since the mapped message is an information device we must suspect that its design is unique in respect to graphic messages whose purpose if to excite or persuade. This is meant to suggest that the map is neither an art form nor a piece of graphic propoganda. Rather, its structure requires a set of components tooled in an organized manner for the specific purposes of information transfer. Additionally, mapped messages have requirements somewhat unique in respect to other visual messages due to the constraints of representation involved in the cartographic process.

A model of the mapping situation must comprise at least seven functional message statements. (Figure 1) Three of these statements (crafting, timing and perceptible) are technical structures, three are semantic necessities (decodable, hierarchical and prepare decoder) and the remaining statement (integrity) is an effectiveness statement. Messages will not be successful if they fail at any one of these statement levels.

The effectiveness of messages, however, depends on the interfaces between the situation demanding the message and influencing its structure (in this case the mapping of the message,(see Figure 2) and the visual information processing capabilities of the human perceptual mechanism in respect to the performance of a specific task (in this case reading maps). Modelling these interactions in respect to cartographic information processing reveals several areas in which appropriate graphic design decisions will benefically effect the message transmission. Specifically, the temporal aspects of information processing require an image whose elements are highly conspicuous and spatially well defined (see Figure 3).

Issues related to image conspicuity and the degree to which display design can be enhanced by the use of color graphics are experiencing renewed examination, spurred on by the relatively recent developments in microprocessor and raster display technology. Although color maps have been common for centuries the expense of manual color plate preparation and printing have generally restricted the practical cartographic application of color displays in areas other than series mapping (atlas, topographic sheets, etc.). The more recent trend towards color computer graphics, however, has found application in the area of thematic mapping which is generally used as a graphic support in geographic information systems (the geographic version of the decision support system).

The utility and applicability of graphics in decision support systems is obvious since properly designed displays allow the organized presentation of a group of facts in such a way that the efficiency of information transfer is enhanced. It is equally obvious, however, that an improperly designed display can be misleading, perceptually inefficient or completely uninformative.

There is little question that the preparation of an informative and effective achromatic graphic display requires a considerable amount of skill. It appears that many vendors and users of graphics equipment feel that color is a panacea by which users can increase display effectiveness without the necessity of acquiring a significant body of knowledge concerning the design of graphic displays.

It is, however, somewhat naive to assume that color capability equates with design efficiency. Indeed, several examinations of color and achromatic presentations of the same data have revealed that color was no more effective (in terms of task performance) than achromatic displays although users did express a subjective preference for color displays (see for example the excellent reviews by Christ (1975), Teichner (1979) and a more recent article by Tullis (1981)).

The research cited should not be considered as suggesting that color is an ineffective display variable (i.e. one incapable of promoting conspicuity or spatial discrimination). Rather, these experiments should be taken as evidence that there are numerous graphic-perceptual aspects of color that require substantial research efforts before we can prepare color-effective cartographic displays. The facts that we know concerning the superiority of color for detection, recognition and the speed of search can easily be modelled in a general sense and provide strong indications of the task types that should use color as the prime graphic variable.

There are numerous questions, however, about the psychological, connotative and conventional aspects of color on maps that

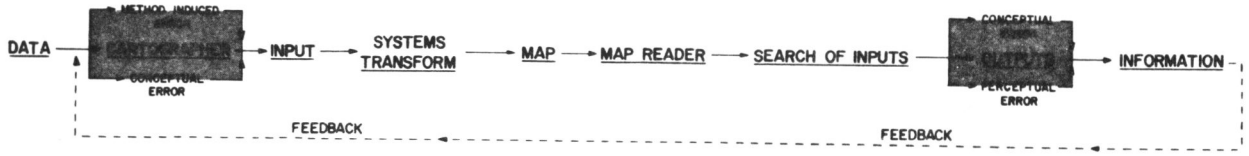

Figure 2. The Cartographic Information System. The generation of cartographic messages is typified by various translations that are required to convert tabular data to a spatial format. Systemic errors result from map compilation and map use.

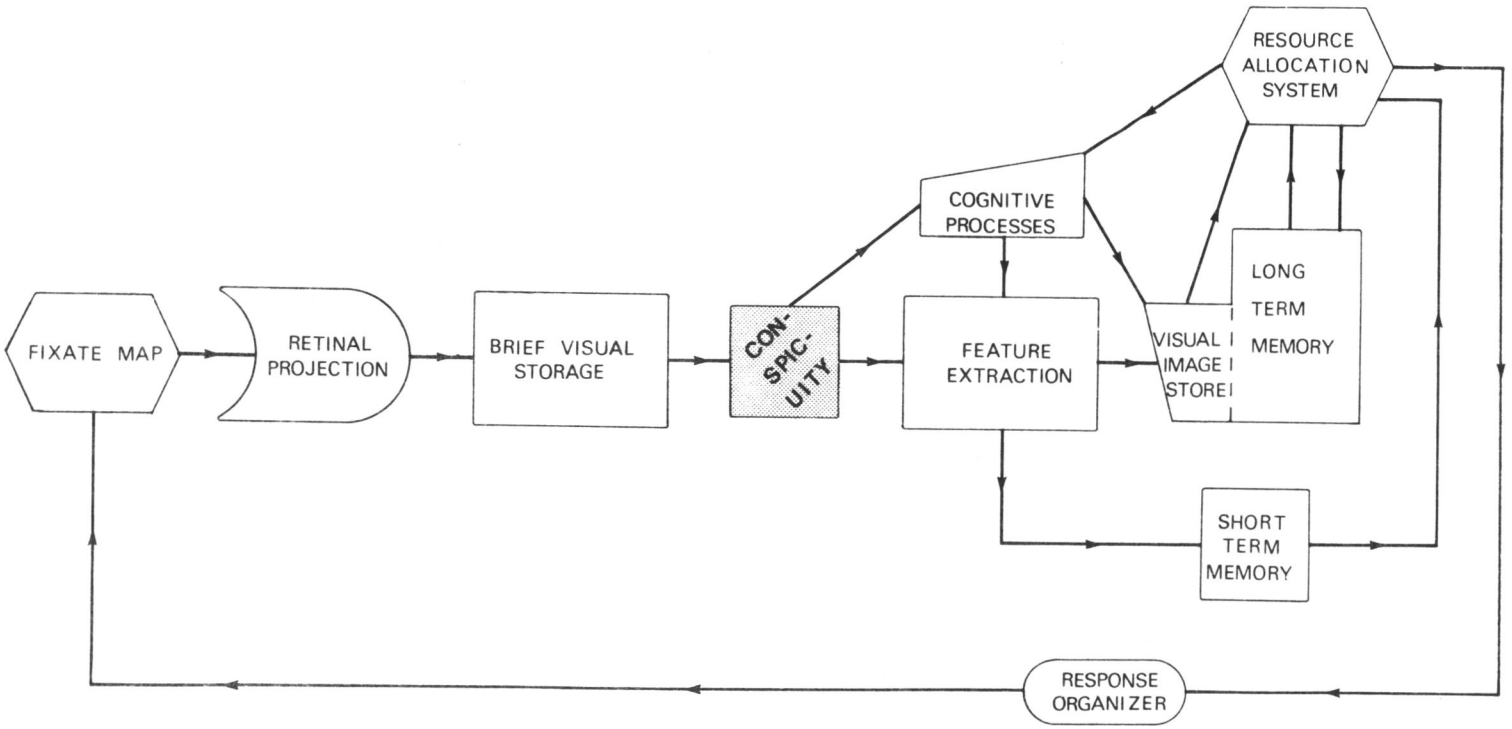

Figure 3. A Model of Visual Information Processing During Map Reading. The processing of a cartographic display is based on a series of perceptual processes that transform, store and analyze fixated image elements. These processes generally restrict the utility of the incomming message.

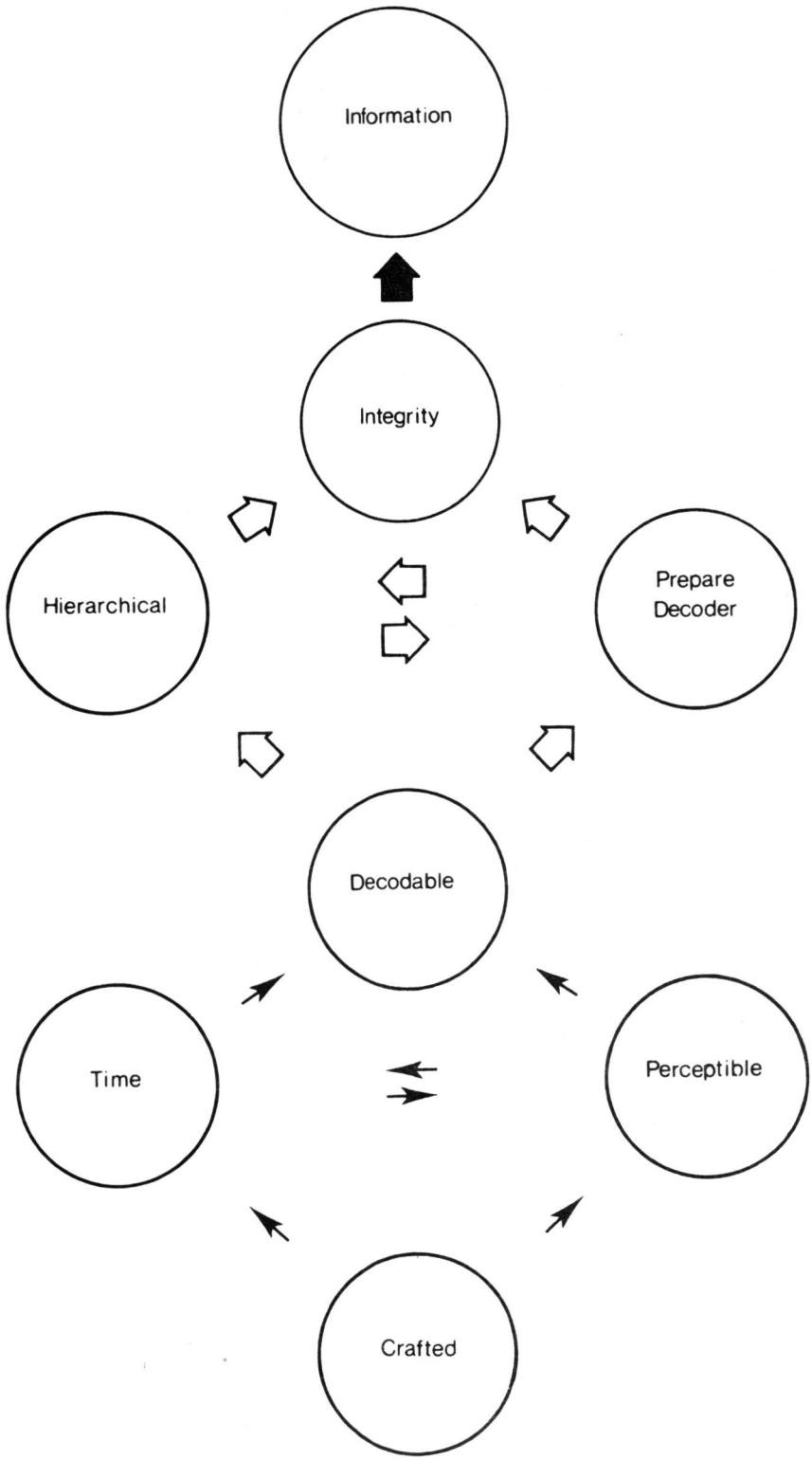

FIGURE 1. Funtional Requirements for Nontextual Messages (after Doblin, 1980). These message statements indicate the complexities and interlinkages that typify the compilation of a cartographic display.

bear further investigation. On the psychological front we must deal with the confounding aspects of simultaneous color contrast when color is used to identify thematic data, geographic data and background areas. In the subjective/connotative aspects of color use we must seriously question existing assumptions. In the area of the conventional aspects of color we must investigate questions of hue preference in general and the role of the individuality of color preference in particular.

The few principles of color design that exist (color harmony, color contrast, color constancy, the appropriateness of colors and color preference) are not well documented and provide only thought for further research. It seems obvious, however, that these guidelines will find eruition only in the context of their effect on task performance. In a sense, the affective use of color requires defining a performance task first and then taking a backwards walk through the interrelationship of design principles (i.e. harmony, contrast, etc.) and message requirements (i.e. decodable, hierarchical, etc.) in order to render a message that will enhance task performance. Since the objectives of map use are well defined (the map must be used either as an areal table (item analysis) or as a source of distributive pattern (image analysis)) the potential linkages of the design principles and message requirements are reasonably obvious but not experimentally documented. Without substantial research relating task performance to color coding the utility of color will remain unclear and the application of color will be regarded as yet another toy but not as an effective design tool.

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