Should Cartographic Design Be Context-Aware?

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ABSTRACT

In this paper I examine the absence of a systematic understanding of context. Although context is an indispensable element of cartographic communication, its importance is not reflected in our design strategies. Through a brief examination of context and context-aware computing, I suggest we develop a "context-aware" design model for interactive maps.

Author Keywords

Context; context-aware; cartographic design; interactive map;

ACM Classification Keywords

H.5.2. User Interfaces: User-centered design.

INTRODUCTION

To initiate a conversation on designing across human abilities and map use contexts, I touch on two topics that have considerable bearing on emerging map design and map use developments: the shifting, often vaguely qualified concept of "context," and context-aware computing. I also examine the status of context in relation to current ICA research agendas, briefly introduce and discuss the relevance of each topic, and then suggest that each can be incorporated to produce a "context-aware" design methodology.

For purpose of this paper, I limit my discussion to interactive maps (here meaning digital maps or mapping applications that can be manipulated by the user); additionally, I use the term *cartographic interaction* to mean "the dialogue between a human and a map mediated through a computing device" [11].

CONTEXT AND THE ICA RESEARCH AGENDA

In a 2009 paper contributed to the ICA Commission on Theoretical Cartography [15], Hansgeorg Schlichtmann identified "the contexts in which signs and sign processes are embedded" as one of five major themes of cartosemiotics. He proposed that this theme is constituted by a set of (at least) seven contextual factors, all relating to the participants involved in cartographic communication and the territory being mapped [16]. Although *cartosemiotics* was discussed in the 2009 ICA research agenda on usability (as were *users* and *design*), *context* was not [18]. If we consider context equally critical to successful cartographic communication, then this omission is surprising.

THE RELEVANCE OF CONTEXT

The sensible approach to framing context is to define it. One oft-cited definition states, "Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves" [1]. Context is viewed as a dynamic and interactive construct, at once predictable and unpredictable, containing myriad static and dynamic components (e.g., virtual and physical locations, time, social interactions, activities, objects) [4, 7, 9], and highly variable according to the goals, abilities, and affective states of the involved individuals and groups [2, 3]. These components are also highly interdependent and overlapping, and only when combined can they begin to capture what we perceive as "context."

Other conceptualizations emphasize individuals, and how their actions and interactions are what create context. One approach adheres to the "five W's" [2] as a minimal set of factors necessary for defining context: *who* (the user and the presence of other users), *what* (human activity), *where* (spatial and behavioral), *when* (temporal and behavioral), and *why* (user's purpose and affective state). Another identifies as many as ten contextual factors [4].

These definitions also share three additional, valuable, characteristics: first, to recognize the limitless variety of contexts, each is purposely generalized in order to provide a wide amount of applicability; second, each permits a taxonomical and hierarchical structure to support standardized and easier implementation [5, 17]; third, by enumerating context, one can better define or anticipate a particular context a priori rather than rely on ad hoc methods [2].

Context is a weak link in cartographic design frameworks. Presumably, cartographers are well aware of the mutual relationships between maps, their users, and their contexts of use. User-centered design (UCD) approaches to map design is in part predicated on this awareness: from our understanding of user abilities come appropriate design decisions, typically grounded in pre-conceived notions of appropriate contexts of use. Compared to user abilities and design decisions, however, we lack effective strategies for enumerating and implementing context components. This is

particularly troublesome as interactive maps continue to supplant traditional forms of cartographic communication, but our design frameworks fail to keep pace with this shift. To address this deficiency, I suggest we look to context-aware computing for effective applications in both applications and design processes.

CONTEXT-AWARE COMPUTING

Context-awareness has been a principal feature of and established area of research in ubiquitous computing since the early 1990s [3, 5, 6, 14]. Although the applications of context-aware computing have advanced significantly in the past two decades, its basic purpose has not: context-aware applications are conceived as systems "that can adapt their behavior based on aspects of the context of use, such as a user's activity, location, social relations, gestures, posture, environment, or affective state" [3]. The contextual information itself is determined by the goals of the particular activities for which the system is designed (e.g., location-based services typically require information such as location, time, and identities of nearby people, places, and objects). These systems provide "eyes and ears" [17], often using external sensors, which enable them to respond or adapt to the different settings in which they're used.

To create a successful contextually-aware map, users must be able to interact with each contextual input and understand how the map uses those inputs to adapt to new situations [17]. The current utility of context-awareness in mapping is fairly obvious (e.g., GPS, geo-tagging), and many, if not most, interactive maps are already to some degree context-aware (e.g., Google Maps can locate your position and orientation on demand). However, our existing design frameworks are ill-prepared to determine our threshold for contextual information, or to ensure maps with large amounts of context match what the map user is experiencing.

Chen suggests a context-aware application be "adaptive, reactive, responsive, situated, context-sensitive and environment-directed" [4]. This description is equally applicable to any map developed to be reactive to contextual changes that occur as users move from one setting or situation to another. Presuming that maps' context-awareness will only increase (along with the variety and quality of sensorial inputs used), we should consider either modifying existing UI/UX design strategies to become more adaptive and responsive, or adopt new design strategies altogether. [9, 10, 12, 13].

CONTEXT-AWARE CARTOGRAPHIC DESIGN

If current cartographic design strategies are capable of handling only limited amounts of contextual information (and often insufficiently at that) how can we expect to cope with more? Context-aware applications are capable of gathering an immense amount of data using a vast network of sensors, and before long these data will be used to add additional contextual information into our interactive maps. We need good representations of context on our maps. So

moving forward, I suggest we adopt a "context-aware" design methodology to address the emergence of context-aware maps, one that builds on and enhances existing UCD and UI/UX practices.

CONCLUSION

While there have been no concerted efforts to formalize or implement Schlichtmann's specific contextual factors, there are many examples of cartographers contextualizing map usage [8] and incorporating context into design processes, particularly those pertaining to mobile applications, location-based services, and UI/UX design [10, 12, 13]. Even so, from a broader design perspective, standardized models specifically addressing contextual issues rarely seem to gain traction. One thing is clear: context is too complex a concept, and often too illusive, to be limited to a single definition, taxonomy, or structure. Preceding the development of a CA framework, however, requires arrival at a systematic understanding of context, one that defines the appropriate canonical contextual states, the information necessary to infer those states, and the appropriate map (and user) response to any sensed context. This information is crucial to good cartographic interaction design, and essential to keep pace with innovations in context-aware interactive maps.

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