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# User-Centred Approach in Visual and Spatial Reasoning: Design Research in Wayfinding Map Design.

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The term 'wayfinding' refers to the ways humans orientate and navigate within spatial environments. Wayfinding maps are maps designed and used for wayfinding purposes within specific environments and can be considered part of information and communication design as they provide visual forms to assist people in solving wayfinding tasks.

This paper will provide an overview of existing research methods commonly used in the process of designing maps for wayfinding. Most existing research focuses on the evaluation and testing of completed wayfinding map designs. Other research conducted involves artistic and aesthetic issues including the legibility of graphic elements such as shapes, colour contrast, format and layouts used in wayfinding map designs. These evaluation and investigation methods provide only minimal knowledge for generating appropriate designs in complex and rapidly developmental contexts. This paper will argue that it is vital to extend these views of wayfinding map design by applying user-centred approaches to the problem as a means of improving the effectiveness of wayfinding map design.

For the wider field of communication design Bruce Hanington has stated (in Design Issues vol. 19, no. 4, Autumn 2003) that user-centred research in communication design can be categorized into: (1) traditional methods (such as focus groups, surveys, questionnaires and interviews); (2) adapted methods (research methods borrowed from disciplines engaged in human research, such as sociology, anthropology and human-computer interaction research); (3) innovative methods (such as design workshops, cognitive mapping, visual diaries, camera studies, etc). This overview is also applicable to wayfinding map design. Following this categorization, existing research involving users in wayfinding map design can be categorized mostly within the traditional methods group. With the complexity presented by the recent development in map displays and human-spatial interaction, research for effective wayfinding map design requires sociological, anthropological and spatial cognitive knowledge. Therefore to move research in this area forward, adapted methods and innovative methods are critical for wayfinding map design.

The contribution to design research from cognitive psychology has been to study the ways humans interact and behave within specific environments. Studies of humans' cognitive mapping and mental images involves analysis and observation of people's reactions and drawings of the actual environment that they are interacting with as a means of understanding human-spatial interactions. It is proposed to build on these methods for design research into wayfinding in order to improve the usability of these maps.

The challenges for wayfinding map design and use are a result of the recent technological developments of map displays. The rapid development of computer technology allows wayfinding maps to be projected in a variety of ways, such as map interfaces on mobile devices, the displays of three-dimensional city models on touch-screen units and the applications of online maps. These developments complicate human-spatial interaction. It is with these communication systems that people are required to understand and 'navigate' within the cyberspace and information space before they can learn more about the actual environment. There is now greater complexity in the ways humans make connections with both cyberspace and actual space. The cognitive processes of people interacting with both cyberspace and actual space requires different forms of studies of user participation.

This paper will therefore: (1) identify existing problems in research conducted in wayfinding map design (from the information and communication design point of view); (2) identify the seriousness of these problems in relation to the technological developments in map displays and wayfinding devices; (3) propose the application of more explicit user-centred approaches to research for wayfinding map design.

## **Wayfinding map design: User-centred approaches for visual and spatial reasoning**

### **Introduction**

Designing effective wayfinding maps to assist people to navigate effectively within a specific environment has always been an issue. According to Wright, '[users] have responded negatively to map design in the past ...' (cited in Wood 1993). The aim of this paper is to address the importance of user-centred approaches in the design of wayfinding maps. In this paper I am proposing that graphic and information designers should emphasize the interaction processes between people and maps, people and the physical environment, and the relationship that people create between the map and the environment. This paper also suggests a speculative wayfinding map design process based on the mentioned human factors.

In general, the term 'wayfinding' refers to the interactions between human and spatial environments (Allen 1999, p. 47; Casakin et al. 2000, p. 55). Passini (2000) conceptualises the processes of wayfinding as:

- decision making and the development of a plan of action to reach a destination;
- decision execution, transforming the plan into behavior at the appropriate place(s) along a route; and
- perception and cognition (information processing), providing the necessary information to make and execute decisions (Passini 2000, p. 88).

Wayfinding maps therefore refer to the maps designed and used for wayfinding purposes within specific environments. Maps of these kinds must thus consider not only the interactions between people and the map but equal emphasis must be applied to the ways people perceive the environment. According to Correa de Jesus:

[w]ayfinding design involves a broad domain of knowledge, and represents concerns far beyond a mere combination of typographic and pictographic languages with architectural. It is an opportunity for efficiently choreographing human interactions with the built world, while affording independence, choice and motivation to users (1994, p. 36).

This perspective indicates that effective design of wayfinding maps require cross-disciplinary knowledge on human factors that is relevant to human-map interactions and human-spatial interactions. Suggesting a more holistic approach, this paper also considers the relationships and representation issues that people make between wayfinding map interfaces and physical space. These human factors will be discussed as important aspects of user-centred approaches to wayfinding map design.

The notion of user-centred approaches in design is not a new concept. It is to focus the design process onto the needs of users in relation to the intended design products (Alexander 2003 [Online]). Various disciplines have discussed and are developing user-centred methods in order to improve the usability of designs for end users. The studies on human-computer interaction (HCI) have been focusing on the emotional issues of computer users (Klien et al. 2002), web usability (Marsico & Levialdi 2004; Troyer & Leune 1998; Garrett 2000) and computer software/system design (Olsson 2004; Maguire 2001). These notions share the same objective of formulating design and research methods in response to the user's needs and experience.

For the wider field of communication design, Hanington (2003) has stated that user-centred research in communication design can be categorized into: (1) *traditional methods* (such as focus groups, surveys, questionnaires and interviews); (2) *adapted methods* (research methods borrowed from disciplines engaged in human research, such as sociology, anthropology and human-computer interaction research); (3) *innovative methods* (such as design workshops, cognitive mapping, visual diaries, camera studies, etc). This overview is also applicable to wayfinding map design. Having looked at these areas in detail, this paper suggests possible ways for graphic and information designers

to adapt appropriate user-centred approaches to the research process and design of wayfinding maps.

The following discussion commences by stating the issues involved in current research and design methods in wayfinding map design. This will show the necessity of more appropriate research methods that focus on users. This will be followed by a consideration of possible applications on user-centred research in the design process.

### **Research issues in wayfinding map design**

The main issues in wayfinding map design and research are identified as: (1) *research conducted has been too specific and lacks of cross-disciplinary knowledge that is essential to the functionality of the design outcomes;* (2) *the involvement of rapid technological developments in map displays changes the ways people interact with maps and therefore requires more effective research methods.* These together suggest the necessity of new methods of research and design to be applied to the design of wayfinding maps. The following sections address these issues in detail.

#### *Lack of cross-disciplinary research*

The involvement of only evaluation and testing methods in wayfinding maps are somehow limited in providing adequate information on people's reaction towards the map. The applications of holistic approaches in gaining cross-disciplinary knowledge are critical in order to contribute to the effectiveness of wayfinding maps. Research conducted by graphic and information designers have mostly been testing of completed wayfinding maps for built environment such as hospital (Wright et al. 1990) and museum (Marino 1997). Case studies have also being conducted on the effects of figure-ground contrast (Barker et al. 1986), the use of graphic conventions between rail and bus network diagrams in London (Burke & McLaren 1981) and analysis of guidebooks used in London (Lasky & Kahn 1995). Although these study outcomes had suggested improvements to the completed designs, they did not focus on the understanding of the ways human interact directly with the built environment. It is important to consider people's direct reactions towards the physical space as wayfinding maps are representations of people's understanding of the actual environment. More

experimental research in search of people's direct reactions with the actual environment are therefore required before a map prototype can be successfully constructed.

### *The impact of technological shift*

New and rapid developments in computer technology have caused changes in the projection methods of maps. These call for new and more appropriate design research to be involved in the design process of wayfinding maps in order to produce effective design outcomes. The advancement of computer technology allows maps to be displayed in two- and three-dimensional methods on mobile and fixed wayfinding devices (Takase et al., [Online]; Kray et al. 2003, [Online]). Apart from that, maps are available in real-time communication systems (Haraguchi et al. 2003). By allowing users to interact with each other, the system provides not only visual representations of physical environments but also serves as a communication tool that provides more relevant information on the particular environment.

These changes in wayfinding map displays have not only complicated the interaction processes between people and the map interfaces but have also added complexity to the perceptions of actual and abstract space. For example, interactivity between users and maps are heightened by the way that users are able to select their desired angles and sections of the displayed map. The projection of wayfinding maps on the Internet and other computer systems require map users to understand the structure of virtual and information space involved in the map displays in order to effectively use them. This kind of user participation requires appropriate consideration in order to incorporate the user's needs in the design process and use of maps. These new elements introduced in human-map interactions thus impose the necessity of focusing wayfinding map design research and methods on the user.

### **User-centred approaches in wayfinding map design**

Three aspects of human factors have to be taken into account in order to embark upon user-centred approaches in wayfinding map design. They are namely: (1) *human-map interaction*; (2) *human-spatial interactions*; and (3) *the relationship (that people make) between map and the actual environment*. The relationships

of these three aspects are depicted in the diagram below. Research relevant to these aspects have not been evident to the field of graphic and information design but have been established in other disciplines. Cartographers, psychologist and cognitive scientists have looked into each aspect very specifically but not many discussions are available on the relationships of these three aspects in relevant to the usability and design of wayfinding maps. There is much potential for graphic and information designers to adapt these studies and research methods into the design process of wayfinding maps.

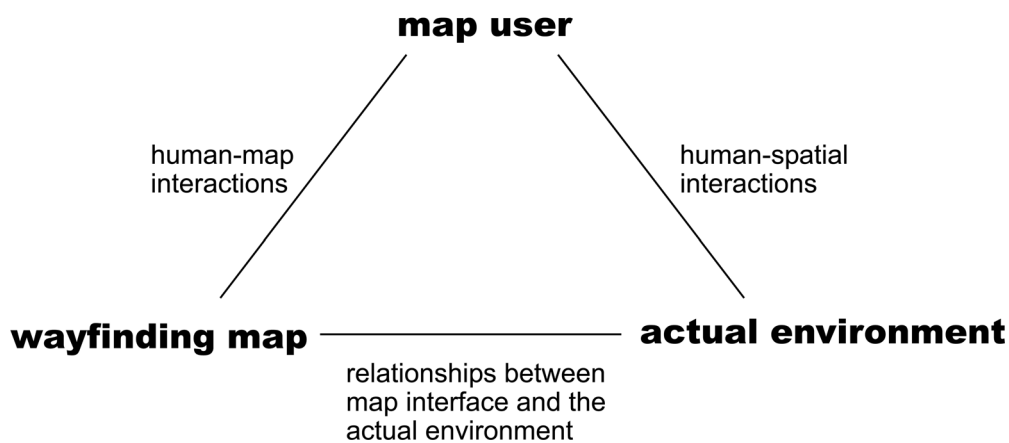


Figure 1: The depiction of the connections between map user, wayfinding map and the actual environment.

This diagram shows that consideration and understanding of the environment, users and the designed communication devices need to be brought together to increase the effectiveness of the design of wayfinding aids. It is therefore necessary to discuss the roles of each interaction and relevant research methods that have been developed in different disciplines.

### *Human-spatial interactions*

Knowledge of the ways people perceive, understand and function in physical space is important to the design of wayfinding maps. Since the major task in wayfinding map design is to clarify the structure of the given environment in a visual form, designers must therefore first understand the processes of people making impression of the space. In order to do so, designers must therefore acquire basic theories that explain the interaction between people and space.

Tolman (1948) conceptualised that humans structure the image of the spatial environment in the mind as a 'cognitive map'. Down and Stea (1977) further define the process of cognitive mapping as '... a process of doing: it is an activity that we engage in rather than an object that we have. It is the way in which we come to grips with and comprehend the world around us' (p. 6). This indicates that people's impressions of the environment change according to experience, aim of the journey and other human activities carried out within the physical space. This should alert designers to the fact that wayfinding maps must be capable of contributing substantial input into people's learning processes in the given environment.

The complexity of human-spatial interactions becomes obvious when considering Tversky's argument that 'cognitive collage' is a better explanation of the ways human represents the spatial environment in the mind (cited in Hirtle 2000, p.32). According to this notion, spatial knowledge is rather 'a collection of partial bits of multimedia knowledge that is combined into a collage or mosaic'. This concept suggests that people learn about the environment by remembering important parts of the environment separately. It explains that certain spatial information is redundant in a person's spatial learning (Hirtle 2000, p. 33). This notion contributes to the design of maps by emphasizing that some spatial information is redundant in visual representation. The basic conceptions of 'cognitive map' and 'cognitive collage' explain that people function in the physical environment by engaging complex cognitive processes.

In order to understand the ways people construct 'images' of the physical environment, Lynch (1960) conducted studies on three American cities (Los Angeles, Jersey City and Boston) that investigated the image that city dwellers made out of the given cityscapes. By asking people to sketch rough maps of the cities, Lynch found out that people identify a city by recognizing five main elements. They are respectively paths, landmarks, nodes, edges and districts. These findings are important as they depict the recognition of these spatial elements (in city and town environments) that are of help in constructing the impression, or the 'image', of the built environment. People's interaction with the actual environment involves much interpretation and recognition of spatial elements. In-depth understanding of these ideas are critical for the design of functional maps. Lynch's approach can form the basis of an appropriate



research method that graphic and information designers can adapt to the design process for wayfinding maps.

### *Human-map interactions*

This aspect of interaction requires equal attention to *scientific* and *philosophical* reasoning towards the ways people perceive and understand elements of map such as map symbols, colours and shapes. Scientific approaches provide designers with an understanding of how people perceive different kinds of map signs while philosophical approaches focus on the construction of meanings in map signs. In respect to scientific research in map design, psychologists and cognitive scientists have conducted studies on the effective schematisations of geographical information in map representation (Barkowsky et al. 2000, pp. 41-53; Casakin et al. 2000, pp. 54-71; Freksa 1999 [Online]). Hopkin (1973) discussed issues of human factors in map design. Referring to maps as complex information displays, Hopkin emphasised the ergonomic concerns of symbolic and pictorial information, typographic legibility and the use of colour on maps. Designers should conduct similar research in order to acquire the knowledge on the ergonomic and readability of map signs. The application of these findings to wayfinding map design is thus critical in improving the interaction process between people and the map interface.

MacEachren (1995) approaches human-map interactions with a more philosophical viewpoint. He suggests that the functional way to achieve effective map design is by investigating the representation value of maps and map signs. According to him, the meanings of maps are 'meanings about space, about time, and about attributes in space-time (p. 312)'. This notion shows that the understandings of the ways people interpret and associate meanings in maps requires broad aspects of knowledge. This also calls for designers to be conscious on social, cultural and anthropological issues in map-use. Designers can obtain this understanding by applying techniques used in semiotic analysis (Berger 1998).

### *Relationship between human-map interactions and human-spatial interactions*

This is a critical aspect as the functionality of a wayfinding map depends on the ways people make connections between the map interface and the actual environment. Discussions made in this aspect have been about the

representative value of maps. Benelli et al. (2001) conceptualises maps as second level artifacts that mediate between people and primary artifacts (such as path, routes and road signs) in the environment. This notion derives from cognitive that states that human cognition is mediated by primary and secondary artifacts. Primary artifacts mediate between human and the physical world while secondary artifacts mediate between human and primary artifacts (Wartofsky cited in Benelli et al. 2001, pp. 22-23). In light of this, Benelli et al. concluded that people function in the existing spaces by making relationships between path-based learning (as primary artifact), landmark-based learning (as primary artifact) and survey learning (the use of map as secondary artifact). This depicts the way people make connections between map learning and the actual environment. It is essential for designers to gain similar knowledge while designing wayfinding maps that function as representations of the actual environment. This level of understanding can be achieved by adapting cognitive, communication and representation theories and research methods (Sirken et al. 1999; Elias 1991).

The consideration of these human factors provide graphic and information designers with cross-disciplinary knowledge on the ways people use wayfinding maps as visual aids that assist them in solving wayfinding problems within a given actual space. The integration of this knowledge in the design process of wayfinding maps will thus be beneficial in producing effective design outcomes.

### **Implications**

Taking the human factors mentioned as guidelines, designers can employ appropriate user-centred research methods that integrate cognitive science, sociological and anthropological research methods. This section suggests a speculative wayfinding map design process that incorporates user-centred research.

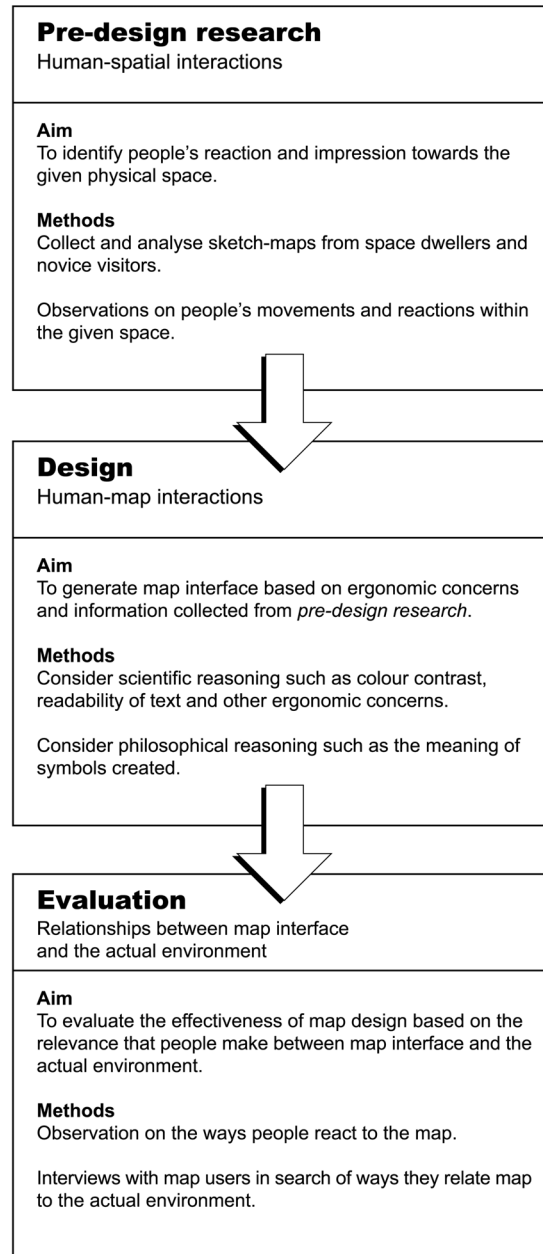


Figure 2: The speculative wayfinding map design process that focuses on human factors in map use.

The design process consists of three main stages: *Pre-design research*; *Design* and *Evaluation* (see Figure 2). The purpose of *Pre-design research* is to investigate the ways people perceive, understand and function in the actual environment. Designers can adapt sociological research methods in order to achieve this aim. Such an approach can be achieved by collecting and analyzing sketch-maps produced by people who are familiar with the environment and those who are new to it. This will provide designers with an in depth

understanding of the spatial elements that people commonly construct about the environment. These elements such as landmarks and pathways will be the primary information to be included in the map to be designed. Observations can also be beneficial in collecting information on the ways people function in a specific environment. By observing routes that people commonly use, designers will be able to identify the primary routes that are important for people to navigate the given space.

The second stage of the design process is aimed at designing a map interface based on the information collected from first stage. Human-map interaction is the main consideration in this part of the design process. The primary focus is on the scientific and philosophical issues involved. In respect of scientific reasoning in map design, designers must consider aspects such as colour contrast and text readability. Philosophical concerns such as the meaning of symbols used in map are important at this stage. The emphasis of these aspects will contribute to the functionality of the design outcome.

The third and final stage of the design process is the evaluation process of the design prototype. The aim of this is to test the effectiveness of the designed map based on the relationships that people make between map interface and the actual environment. Possible methods include observations and interviews focusing on the ways people use the map and function within the environment.

These three stages of design process are aimed at providing designers with holistic knowledge on people, map and the actual space. It must be emphasised that this process must not be a limitation to creativity and flexibility in design. Designers are urged to adapt these stages as guidelines that focus on human factors in order to contribute to the creative process. This process takes into account for the technological development of map displays on both paper printed media and digital applications on computer devices.

## **Conclusion**

The current development of wayfinding maps requires more appropriate research and design methods in addition to the evaluation of design outcomes. This paper presents user-centred approaches by taking into account the three aspects of

human factors involved in the design and use of wayfinding map. Graphic and information designers are urged to look at the ways people interact with maps, the given physical space and the relationships that people make between the map and the actual environment. This triadic relationship provides cross-disciplinary knowledge for designers and assists them in designing more effective wayfinding maps.

The importance of these aspects is emphasised by the speculative design process suggested. The three stages suggested are *Pre-design research*, *Design* and *Evaluation*. *Pre-design research* stage incorporates sociological research investigating people's impressions of the actual environment in which contribute substantial information for the design of wayfinding map. The *Design* stage thus focuses on scientific and philosophical reasoning of human-map interactions in generating appropriate map interface. Final stage of the process evaluates the prototype design outcome based on the ways map users relate the map interface to the actual environment. These together integrate holistic and discursive design and research methods in the practice of wayfinding map design.

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