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Urban ergonomics: an ongoing study of city signs and maps

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Abstract. The purpose of this study is to assess whether the existing signals in three European cities were developed according usability principles and ergonomic aspects for the citizen. City maps and signals will be tested using efficiency, effectiveness and user's satisfaction criteria. Among the urban areas are the center of Paris-FR, assumed to be well signalized, the historical center of Guimarães-PT and Chorweiler, Cologne-DE, a residential neighborhood of modern urbanism characterized by the extensive use of vegetation, the landscape homogeneity, and, consequently, by the difficult navigation.

Keywords: urban signage, wayfinding assistance, schematic maps, spatial context

Introduction

Kohlsdorf [7], have expressed the idea that cities are talking entities that tell us where and how we can go from one place to another; some speak fluently, others confusedly. The ease or difficulty in understanding them depends mainly on their shapes and they unique configurations, able to highlight its unique identity.

Nowadays, the constant technological development has more and more consequences on the interaction between humans and cities. Urban Ergonomics is a concept that was proposed to adjust the scale, material, function and form of urban components to humans promoting self-localization and the corresponding wellbeing.

Providing localization guidance within an urban context is the first step for exploring the potential of cities. Ergonomics has the challenge to mediate the information exchange among planners, designers and pedestrian users. This dialogue should allow expansion of the citizen's cognitive attributes for understanding and performance in urban space. Moreover, it aims at providing guidelines for the development of city signals, planning and designing urban spaces efficiently and more suitable for its users.

At the first contact with an unknown urban space, the search for signals and maps promotes an interaction between the user and a wide complex system, rich in stimulations and with many threats, usually experienced in many metropolises. This reality often leads then to quit or limit their operation in a sea of urban possibilities. The urban traits instead of promoting civility and interactivity among users, often becomes a stage for oddities and insecurities. Thus, it is justified the importance of studying the urban signals, as the set of elements and resources used for the orientation in physical space, such as maps, interactive or non-interactive panels, outdoors and other indicative signals.

According to Hopkin and Taylor [16], there are a few ergonomics principles related to city maps on the literature, but in general they are not used. Many psychological principles, such as the perceptual structure, the process of information and coding, are clearly relevant to the design of maps. Many standard procedures, like as the task analysis and the development of quantitative measurements, are relevant to the design being suitable to the work environment. For instance, the visual organization of the map is important both for practical and aesthetic purposes. Therefore, ergonomic data resulting from a specific research of maps studies can help to reduce the distance between those who produce maps and those who use it [16].

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By using a literature review; we will explain the design of a methodology to investigate signs and maps of three cities. The main idea underlying this research is to highlight the difficulties found by citizens while navigating and the main aspects that can contribute to the effectiveness, efficiency and satisfaction of the urban signs within the pedestrian overview. We will discuss the concepts, methods and approaches used to study the urban morphology and then we will demonstrate which parameters, showed in Table 1, will be used to collect data from pedestrian users.

The third part includes specific aspects to justify the choice of the selected cities, areas, and paths to be used in this research.

The fourth part is the consideration about the foreseen results for this study.

2. Theoretical development and methodological formulation

2.1. Concepts and methods about the study of urban morphology

The city shape results from the social dynamics that happened over time affecting the creation and development of the urban space. Capturing and understanding the processes of setting up each city involves reading not only the physical measurable aspects, but also its perception and cognition [4].

There are several forms of perception and analysis of urban spaces with different approaches, but they all seek the comprehension of the whole studying the parts involved [4].

The apprehension of places occurs in physical form, with architectural and geographical approaches, and studies related to cognitive mechanisms. Apprehension here is assumed to be the assimilation of the psychological meaning and to be able to understand and use that knowledge [7].

Thus, we must consider both the ability to use urban space as well as the potential of information transmission through interpretation of existing signals encoded in urban territory [7].

The physical organization of the space is governed by certain laws. Thereby, we hypothesized that the concept of knowledge and the genesis of their development have some universal features that help the apprehension of the shape of places.

Kohlsdorf [7] developed procedures for studies on the evaluation of urban spaces, which she called "topoceptive performance". In these studies the researcher sought to decode the formal codes assimilated consciously or unconsciously by the population with the mental maps technique devised by Lynch [9].

The comparison between the approaches of the different authors, Kohlsdorf, Lynch, Passini, Kato & Takeuchi, Xia et al, Lamas, Cullen, Sorrows &Hirtle, Trieb &Schmidt (*apud* Kohlsdorf), Taylor & Hopkin [7, 9, 12, 6, 17, 8, 2, 15, 7, 16] allows us to observe three basic influences of how urban space can be perceived and memorized: 1) aesthetic perceptions; 2) psychosocial expectations and 3) information expectations.

The first category is structured on the intrinsic characteristics to the design of spaces and therefore is beyond the scope intended herein. These must be properly assessed by architects and urban planners.

The psychosocial category takes into account the individual characteristics or those from a certain group. Therefore, they will not be the object of this research study, but the conclusions of other previous research in this direction will be relevant for this.

The present study will focus on the expectations of information, although taking into account the influence of the other two categories. It is important to detect when the aesthetic and psychosocial expectations will interfere positively or negatively on the information expectations. Then, they will be presented in the parameters of research, sometimes as assumptions, cause or effect of a situation/problem susceptible to intervention.

2.2. Wayfinding researches and the map resources

Many technological resources are available in certain areas of knowledge, but they are not fully accessible. For instance, the internet tool called Google Earth has a range of information to facilitate the location, route and ways, and it should be widely used for pedestrian orientation.

It is necessary to give good signals for pedestrian, including children, tourists (domestic and foreign), the elderly and those with special needs. With this purpose, information should be worked by experts and available for all pedestrians.

In a study involving tourists in a park located in Victoria, Australia, Xia et al. [17] concluded that people followed certain behavioral rules during the process of wayfinding based on the spatial relationships between objects. These relationships include: proximity, separation, order and inclusion.

In order to better understand the notion of comfort, belonging and commitment of the city users, Fenster [5] introduced the method of using temporal cognitive maps (TC maps) and concluded that fear affects significantly the use of public spaces.

Duckham [3] studied the incorporation of landmarks, which are widely used in human wayfinding, in particular in navigation instructions generated by computer. Although the landmarks constitute the first level of knowledge in a spatial interaction with a new environment, the author noticed that the information systems and mapping services spaces available on the web rarely uses such feature. Duckham [3] attributed such failure to the absence of available data about the landmarks of cities.

Schmid et al. [14] proposed the route aware maps (RAM), a map-based wayfinding assistance that inserts in the select route information about its surrounding environment, i.e., the global spatial context. RAMs provides an easy information extraction by focusing on the route as the crucial piece of information and, at the same time, it contributes to the efficient and safe navigation feeling by keeping the wayfinder in global context. Next to the actual route from origin to destination, RAMs present the area around origin and destination in more detail to keep the wayfinders oriented at these crucial spots. The maps also integrate alternative routes at those points along the route where wayfinding errors were likely occur due to the (local or global) ambiguity in the environmental structure. Furthermore, RAMs embed the route in its global spatial context. For such purpose, those regions relevant for the routes are identified and displayed allowing approximate navigation using region information in case the route has been accidentally left; key local landmarks are shown as well as the anchoring of the route within the environment. Schmid et al. [14] argue that providing a global context decreases the risks of making wayfinding errors and helps to overcome a major problem of actual assistance systems, which is that users don't really understand the spatial situation once they hardly remember anything of the route after reaching the destination.

Schmid et al. [14] believe that route aware maps are a promising approach for solving two related problems in map-based navigation assistance: (1) provision of focused, easy to access assistance that still allows for error recovery; (2) the key-hole problem, which is to present local information in its global context is crucial for the small displays of mobile devices. Schmid et al. [14] plans to test the performance of RAMs in empirical wayfinding studies comparing the wayfinding performance of human subjects using route aware maps in real world navigation tasks with participants using 'classical' streetmaps, as well as to explore scale-dependent construction of RAMs and check whether additional important objects should be included in the maps, for example, major roads, such as highways, which may provide additional global orientation.

2.3. The construction of the methodology

The concept of usability, from the Cognitive Ergonomics, valued within the criteria of efficiency, effectiveness and satisfaction will be used to guide the evaluation of navigation maps proposed in this study. According to Carroll [1], Human Computer Interaction (HCI) provides a model for a mutual relationship between science and practice that are unprecedented. It is responsible for developing synergies between cognitive science and cognitive engineering.

For pedestrian usage, city utilization means the ability to understand and explore functions and uses of a particular urban space. Then, the existing system will be tested by user's ability to provide effectiveness (the ability to perform tasks associated with the using of urban space), efficiency (intelligence that governs the creation and implementation of an action plan in this space), and satisfaction (positive reaction in accomplishing the intended task).

The research question is: Are city signs and maps doing their job efficiently, effectively and satisfactorily? To establish knowledge about this matter, the strategy will be to verify the user's perception of the city and the usability of the available tools.

The usability of the maps and signs can be evaluated in its easiness to learn, effectiveness in use of the specific object, easiness to remember, subjectiveness to please, and finally should promote fewer mistakes [10]. According to Norman [11], the draft design for people must obey two principles: (1) provide a good conceptual model and (2) make things visible. For this author, the majority of accidents are attributed to human error, but in most cases human error is a direct result of poor design quality. The principles that guide a quality design, human-centered, are not only relevant to a more pleasant and enjoyable life but they can save lives [11].

In terms of wayfinding communication, designers must answer three main questions: which information should be submitted, where and in which form. Dur-

ing wayfinding, people will choose the information that is relevant to their task. The criterion of relevance is contextual and it must be taken into account that perception is selective [12].

This work will try to investigate the difficulties achieved by users in their pedestrian routes through urban spaces. Thus, epistemologically, the work will have a research phase with a critical realism approach, interpretive, and under the ontological aspect, subjectivist. In a second phase, it will also focus on measurable aspects in order to contribute with information to support pragmatic actions for interventions on design of urban equipments and also those for individual use. Thus, from the epistemological point of view this study will have a functionalist approach and ontologically it will be also objectivist. Such paradigms are consistent with the regulatory desired intention, as shown in the matrix of the four paradigms for the analysis of social theory, developed by Burrell & Morgen (*cited in* Saunders) [13].

Thereby, the chosen strategy is the study of case with investigations to be conducted in three different and specific urban fragments. Interviews will be conducted, exploring mental and existing maps and during wayfinding. All steps will be recorded for later analysis.

The parameters for investigation were constructed upon the study of different urban morphology approaches, previous maps and wayfinding researches. Table 1 summarizes the criteria for the investigation of each parameter as well as the specific strategy is being used in each case.

3. The proposition for the case study

The study urban areas are the center of Paris, in France, which is assumed to be well signalized, the historical center of Guimarães, in Portugal and Chorweiler, Cologne, Germany, which is a residential neighborhood of modern urbanism, characterized by the extensive use of vegetation, the homogeneity of the landscape and, consequently, by the difficult navigation.

3.1. First case study: Chatelet-Les_Halles district, the center of Paris, France.

Among the characteristics that justify the choice of this area is the fact of being an urban center with an intensive use and a very detailed use of signs. There are different types of maps at the bus stops, subway stations and billboards along roads and intersections.

The region of Île-de-France has now approximately 13 million inhabitants, 6 million in Paris and the other part distributed in its neighborhoods. The RER, the suburban train, is responsible for the mobility of passengers between Paris and the suburbs (zones 3,4,5 and 6), while underground lines are responsible for distribution in the inner zone (zone 1 and 2). The Chatelet-Les Halles Station is located in the first "arrondissement", located in the heart of Paris. It is a railway station and the largest underground metro station of the world, both in number of trains and passengers moving through it daily. It is a "node" of the central common transportation network of the Île-de France, responsible for the intersection of three lines of the suburban train (RER) and connection with five other subway lines. With more than 1,500 trains/day, it is the most important transport hub in the region, with more than 520,000 passengers each day. The station is served by trains from lines A, B and D of the RER and metro lines 1,4,7,11,14. It is therefore easily accessed by all train stations in the national and international transport, in addition to airports and is the connection point to all of Paris and environs.

The Chatelet district is the second oldest and most full of stories of the capital, only after the Île de la Cité, which was the birthplace of the city.

The first subway line was opened in Paris in 1900 and since there Chatelet is considered the main station. Its main features are location and dynamism.

It constitutes the largest complex of underground stations of Europe. The station is under the Forum des Halles shopping center, which is the largest underground shopping in Europe.

Given its accessibility and their architectural conditions, it is highly frequented during all periods of the year, even during the winter when people usually avoid leaving their houses.

Strategy and target audience: The interviews will be conducted individually with foreign students from a French language school.

Step 1: global context and description of a route.

In this task will be asked the user to draw a sketch of Paris and indicate where is the station Chatelet-Les Halles.

Then using the map, we will ask them to explain:

- which path she/he would make to go from the school to the Chatelet station.
- how she/he instruct a visitor to make this stretch.

Table 1
Parameters considered in the research and corresponding criteria.

RESEARCH PARAMETERS	CRITERIA AND INDICATORS			STRATEGY
	EFFICIENCY (Active item)	**EFFECTIVENESS** (hit rate or occurrences)	**SATISFACTION** (User opinion)	
GLOBAL SPATIAL CONTEXT	Whether maps show particular places inserted into the whole	Whether more than one area was referenced	Assigned rating for each type of map	1, 2, 3
ORIENTATION: CARDINAL POINTS	Whether map indicate the geographic north. Is it aligned?	Whether the respondent use the map orientation	Assigned rating for this item (map orientation)	4, 7
ZONING (FLOOR PLAN): neighborhood, boundaries	Whether the item appeared in the mental map. Was it stated?	Whether zoning guided the user	Assigned rating for this item	1, 5
LAND SUBDIVISION (FLOOR PLAN): fragmentation, full/ empty	Did the item appear in the mental map?	Hit rate	Assigned rating for this item	6
DISTANCE: in floor plain and on-site	Was it possible to calculate the distance?	Hit rate	Assigned rating for this item	5
REFERENCES: landmarks, visual information and street equipment	Does map show landmarks? Have landmarks been mentioned by the user?	Numbers of landmarks and how many times they were mentioned	Assigned rating for this item	5, 7
ROUTES – routes and means of transportation Possibility to repair the route	Whether course corrections were made and were they easy to remember.	Numbers of decision points and landmarks Alternative corrections	Numbers of errors Time spent	5
EXISTING SIGNALS AND MAPS	Are there maps and signals along the route for orientation?	Numbers of visit to maps and signals	Assigned rating for this item	5
URBAN LAND USE	Are there any information about the urban land use?	Whether the user utilized land use information	Assigned rating for this item	5, 7
NODAL POINTS	Whether they were correct and clearly showed on the maps	Whether they promoted errors and delays along the route	Assigned rating for this item	5, 7
PHYSICAL SITE: topography, geography, landscape, vegetation, river, atmosphere	Were they mentioned? What were they?	Numbers of times they were mentioned	Record any observation about this aspect	5, 7
ARCHITECTURAL AND URBAN BARRIERS	Were they mentioned? What were they?	Numbers of times they were mentioned	Record any observation about this aspect	5, 7
VERTICAL PLANES: crowning, punctuation, rhythm, proportions	Were they mentioned? What were they?	Numbers of times they were mentioned	Record any observation about this aspect	4, 5
QUALITATIVE INFORMATION: sound, lighting, flooring, scale	Were they mentioned? What were they?	Numbers of times they were mentioned	Record any observation about this aspect	5, 7
SEMANTIC INFORMATION: nip/enlargement, enhancement, involvement, amplitude, direction	Were they mentioned? What were they?	Numbers of times they were mentioned	Record any observation about this aspect	5, 7
PSYCHOSOCIAL INFORMATION: emotional security, freedom, social interaction	Were they mentioned? What were they?	Numbers of times they were mentioned	Record any observation about this aspect	5, 7
GRAPHIC PRESENTATION OF MAPS AND SIGNALS	Were they visible? Were the resources adequate? Did it allow comprehension of the conceptual model?	Whether the information was correct and clearly communicated	Assigned rating for this item	8

(1) mental sketch map
(2) location of landmarks
(3) comparison of different maps of the same city
(4) request to indicate on the map
(5) investigation along the description of the route and consulting the map
(6) comparing similar maps of different cities
(7) Wayfinding
(8) analysis of map

- in her/his opinion, which are the possible difficulties encountered by tourists, which mistakes can be made; which precautions should be taken to prevent mistakes, and how to repair them, if they happen.
- which route guidance she/he would give to a cyclist having these same references as the source and destination.
- if there are signals in this stretch that can help orientation.

Step 2: cross-referencing of maps.

Paris and Rouen maps with no street names or locations will be showed to the interviewed, and we will request she/he to identify which is the Paris map and to justify their answer. The cities selected have very similar physical sites, both are cut by the river Seine, forming two islands; what differs them is the floor plan layout of the urban area.

Several other maps of Paris will also be shown, selected specifically for this activity, and they will be asked to indicate which ones they like. They will be asked to justify their responses and to indicate on map the Chatelet-French School path and to estimate the distance between these two points.

3.2. Second case study: Historical Centre of Guimarães, Portugal.

The characteristics that justify the choice of this area includes the fact that it is a fragment of the medieval urban area, very well maintained, frequented by locals and tourists, and rich in stimuli.

Strategy and target audience: request the mental map and indication of landmarks.

The respondent should indicate how to instruct a foreigner, for example a tourist, to move from the train station to the University of Minho, which is located in the opposite side of the city, passing by the Historic Center. Later, tests will be performed in the course indicated wayfinding, with new students in the city. During this step, will be collected metrics of time and numbers of errors. Observations will be registered and will be used as indicator of subjective satisfaction.

3.3. Third case study: neighborhood – Seeberg/ Chorweiler in Cologne, Germany.

Among the characteristics that were considered for selecting this area was the fact that this is a typical residential area of modern urbanism, occupied, mostly, by Turkish immigrants. The monotony of the landscape, due to the similarity of the buildings blocks and plenty of green areas, hinders the visitor's orientation in the neighborhood. The difficulty is reinforced by a poor use of signs, without icons and with texts in German. The urban area with irregular configuration and characteristics of labyrinth is another factor that hinders the orientation.

The research will be conducted with residents of the area, which prompted the appointment of a route for visitors, where the source and destination will be from the central station (Bahnhof) to the respondent residence. A route should be given for hikers and for visitors driving a vehicle.

4. Considerations

The three cities utilized in this study will provide different but complementary information. In Paris, we will evaluate the usability of existing signals. In Guimarães, we expect to detect difficulties concerning locomotion within a medieval-like environment; and Seeberg/Chorweiler will be useful to evaluate to what extend the signals available on internet supply and/or replace signals available though out the neighborhood. Finally, we expect to provide valuable information guiding the construction of signals necessary to minimize the pedestrian difficulties during the use of urban space.

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