



Digitizing the new image of the city: Towards an easier wayfinding

Abulnour, Adham Mohamed Hany¹

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Abstract A city's complex anatomy is hard to percept in today's world. The syntax of modern cities is argued to have become too enriched with various elements to the verge of being incapable of reflecting a clear and well defined image. This consequently reflects on the difficulty of wayfinding in modern cities.

Traditional methods of wayfinding whether cognitive (as in retrieving a certain trip path from the mind) or physical (such as sketch maps and signs) still prove their ability to throw an authentic and unified air upon cities. Nevertheless, the image reflected by such an authenticity and unification is not always necessarily up-to-date and heartily complete.

Cities evolve and accumulate strata of the built environment along with human activities over one another. This being said, and despite not being obsolete, traditional methods of wayfinding are strongly argued not to be fully capable of coping with the fast and overwhelming metamorphosis of the city's image in modern times.

To this end, the use of digital tools to complete the image of the city and accordingly enrich the process of wayfinding has become an imperative in our modern world. Such a use of digital tools reaches beyond the simplicity of dependence on computerized gadgets yet is optimally targeted to offer a better perception of the city and aid in formulating a clearer mental map of its complex and rich surroundings.

The aim and scope of this paper is to explore the use of digital techniques (with special reference to Virtual Reality) in providing a deeper perception of a modern city's anatomy that can be well carved in wayfinders' composed image of the city.

The paper follows a multidisciplinary methodology in examining the subject under study. Analytical and critical efforts are exerted with the aid of a literature review. The paper commences with the definition of wayfinding and navigation in order to set the ground for discussing the physical and cognitive aspects of the process. The paper then proceeds to discussing and critiquing the need for a new set of tools (digital devices) to complement the traditional physical and cognitive aspects of the wayfinding process. The discussion develops into a brief yet thorough analysis of the capabilities of a number of the major digital devices used for wayfinding in today's modern cities. The main aim behind this discussion is to clarify the role of digital devices in synthesizing a more thorough image of the city. The paper finally interprets its discussions and findings into a set of recommendation regarding the use of digital devices with Egypt as the case analyzed. This is intended to better demonstrate the various factors and considerations that govern the use of digital devices for wayfinding in todays' world.

1. Architectural and
Environmental design
Department, Arab
Academy for Science &
Technology, Alexandria,
Egypt

1. Definition of wayfinding

In a comprehensive sense, wayfinding can be defined as the process of determining a path or route between an origin and a destination, thus, it is considered a purposeful, directive and motivated act (Golledge, 1999, p. 6). This particular definition of the concept of wayfinding approximates it to the traditional definition of the concept of navigation. Navigation is concerned with orientation and locating positions. Throughout history, people have relied on various tools to navigate their way through unknown environments. Navigation tools evolved in time into signs, three dimensional models, maps with their wide variety of materials up to satellite images and most recently computer based tools in order to communicate spatial relations (Jacobson, 2008). The act of navigation usually indicates that the path followed is predetermined or previously experienced. In doing so, the path is usually restricted by specific criteria including finding the shortest distance within the general target of minimizing the cost, effort and time attributes.

A more differentiating definition of wayfinding identifies it as the cognitive element which strategically guides the navigation process. In similarity to getting references from a cartographic map, humans can cognitively draw maps in their minds. The term 'cognitive mapping' was first perceived in 20th century as a trial to define the human ability to construct a map within one's brain (metaphorically as a cartographic map in the mind) to help travelers find their way when needed (Tolman, 1948). When considered as a cognitive process, wayfinding is strongly argued to surpass the physicality of navigation guidance tools to become synonymous with the mental image of the city; i.e. image of the city. Wayfinding, as a cognitive issue, involves emotional and value considerations including for example the adventurous aspect of the travel experience without the necessity of a pre-planned journey that must be followed. At this point, the concept of navigation as the act of travelling from one point to the other is enlarged to become the summation of wayfinding as a cognitive issue and the 'motor' element of motion along a path.

Elaborating more on the subject, the process of cognitive mapping can be defined as the *"construct which encompasses those cognitive processes which enable people to acquire, code, store, recall, and manipulate information about the nature of their spatial environment. This information refers to the attribute and relative locations of people and objects in the environment, and is an essential component of the adapted process of spatial decision making"* (Downs & Stea, 1973). The synthesis of the cognitive map is based on combining the perception of a certain path and places with the traveler's preferences within a spatial matrix. Such a matrix clearly recognizes that the space within the cognitive map surpasses its physical boundaries and *"would not exist if minds did not exist...In contrast, physical space is any space attributed to the external world independent of minds"* (Lieben et al, 1981). This in turn helps people to identify *"the conceptual manifestations of place-based experience and reasoning that allow one to determine where one is at any moment and what place-related objects occur in that vicinity or in the surrounding space"* (Golledge, 1999, p. 12). In synthesizing a cognitive map, the brain uses basic geometric components such as points, lines areas and surfaces (Lynch, 1960). These geometric components are associated with objects and features of the physical environment such as:

- landmarks: anchor points, destinations, special objects in the built environment
- zones: areas of congregating activities
- Paths: routes and streets.

2. The rise of a new set of tools for wayfinding

Cities, like living organism, grow in size. The result can be chaotic and unpleasant due to the overcrowding of cityscapes where a myriad of activities meet together and different elements such as buildings, streets, signs and landscape elements are located. The amount of data generated by this growth process is also gigantic and complex. In consequence, modern cities are strongly argued to have created themselves quite a complex character. All of this generates concerns regarding the capability of traditional wayfinding tools (whether physical or cognitive) to commute a clear wayfinding process for the modern city traveler. Whenever a traveler in a

modern city is executing a wayfinding process, he is faced with a myriad of decision making/influencing alternatives concerning (Reichenbacher, 2004):

- Orientation: questions asked include where am I? The operation undertaken is concerned with location.
- Navigation: questions asked include how do I get to a certain place? The operation undertaken is concerned with navigating through space and planning a route
- Search: questions asked include where is the nearest and/or most relevant object? The operation undertaken is concerned with searching for objects.
- Identification: questions asked include what/who/how much is there in a certain place? The operation undertaken is concerned with identifying/ recognizing persons or objects.
- Event checking: questions asked include what is happening at a certain place? The operation undertaken is concerned with checking for events and objects state.

Most traditional (physical) wayfinding tools reflect an unmistakable static nature since they are deployed in a place in attendance to the traveler's arrival to this particular place to be guided along the trip. This static nature can represent a major disadvantage because the question to ask at this point is how to arrive to the place where the signs are located in the first place. Another major disadvantage of such systems is the language problems or illiteracy of the travelers. Faced with these problems, it would be simpler for a traveler to ask for direction rather than using the wayfinding tools present. Another disadvantage is represented in the high cost and efforts needed to update and maintain them overtime.

On a similar note, the traditional cognitive aspect of wayfinding might also prove itself to be inadequate in commuting a clear wayfinding process for the modern city traveler. In modern cities, the amount of data faced by a traveler are argued to be huge in number and complicated in nature to the verge of not being process-able into an image of clear identity. On a similar note, the continual growth and change in the urban structure due to urban regeneration and development also narrows the probability of perceiving a clear mental image of the urban structure with all its components including the hierarchy and distribution of buildings, the orientation and directionality of streets and the whereabouts of landmarks and zones of congregating activities.

This paper argues that the trial to differentiate between the concepts of navigation and wayfinding is not totally effective in today's complex cities. The logic behind this is that if seen only as a cognitive process, the complex image of modern cities might prove to be of difficulty in helping travelers carry out the wayfinding process. This is why the need of tools is strongly argued to still be of importance. Nevertheless, the set of tools needed in the modern city should be able to record, illustrate and help recall the complexity of elements constituting the cognitive experience acquired by a traveler in cityscapes. The required new *"wayfinding systems must respond with speed and sensitivity to changes, or else they become more than outdated: they become liabilities"* (Innovation Oakland, 1989). Under this umbrella, new digital tools based on information, telecommunication and computer technologies can commute a successful way finding process using different languages and present visual and audio data for the user (Endicott, 2007). The following section of this paper discusses the attributes of some of the fundamental as well as recently developed tools related to information, telecommunication and computer technologies used for wayfinding in modern cities.

3. The World Wide Web and the wayfinidng process

With the widespread of the internet World Wide Web all over the globe, a considerable percentage of the world population rely on websites to plan their trips, retrieve relevant information as well as consult spaces and places on the computer screen even before starting the trip itself. Different services provided by the internet websites help carry out these endeavors. To start with, travel planning websites are commonly consulted for setting up trips especially by travelers who are not familiar with their destination. On a similar note, the wide widespread of

online mapping and 3D interface websites such as MapQuest (www.mapquest.com), Google maps (<http://maps.google.com>) and Google earth (<http://earth.google.com>) allows travelers to consult a certain route from origin to destination prior to their visit .

4. Mobile wayfinding devices

Personalized devices which are handheld by travelers while being mobile on foot or in auto vehicles (commonly known as mobile devices) have recently become a rapidly evolving wayfinding tool. The following discussions explore the subject more in depth.

4.1. Global Positioning System (GPS)

Global Positioning System (GPS) is a dynamic wayfinding service allowing constant update of direction with reference to the traveler location. In doing so, GPS enables the traveler to perceive all paths while processing other data concerning his route prior to as well as simultaneously while executing the trip. GPS proves to be mostly useful for people encountering an unfamiliar environment (Kaasinen, 2003). Conventional GPS takes the form of a physical handheld device which receives data regarding location and paths to destinations from satellites. The receiver enables the overlay of the real time experience of the traveler onto the graphical representation of the city in the device (Chalmers et al, 2004).

In the concrete jungles of modern cities, telecommunicational signal weakening can hinder GPS functions. The issue worsens in buildings indoors where GPS signals might be totally lost. Several multi-national corporations are paying significant attention to the concept of 'Indoor positioning' ushering that it is the next step in wayfinding. 'Indoor positioning' is all about the wayfinding experiences inside the gigantic buildings of today's cities. A related revolutionary new technology known as 'Locata' depends on chronologically synchronizing a radio signal generated by a positioning-unit device at a known location with a reference positioning signal generated by a reference transmitter at a known geometric distance. According to the technology inventors: *"a network of terrestrially-based ... transceivers transmit extremely well-synchronized signals, which creates a ground-based local replica of GPS. These signals form a positioning network ... that operates in combination with GPS ...or operates totally independent of GPS (e.g. indoors or in urban areas)"* (<http://locata.com/technology/locata-tech-explained/>).

4.2. Geographic Information System (GIS) and Location Based Service (LBS)

Geographic Information System (GIS) is a professional service for experienced users which has been developed along decades for professional geographic data applications. On another hand, Location Based Service (LBS) is a more recent technology which appeared with the evolution of the development of cellular phones. In comparison to GIS, LBS is a more limited service dedicated for non -professional user groups. The common ground between GIS and LBS is the handling of data with regards to positional reference or in simpler terms the location of the traveler. This paper focuses on LBS systems rather than GIS due to the former's direct relationship with the wayfinding process.

One definition of LBS narrows it to an information service accessible with cellular phone in order to pinpoint the location of the device and consecutively its handler (Viraranta et al, 2001). A more elaborate definition adopted by the international Open Geospatial Consortium (OGC) identifies LBS as *"a wireless..service that uses geographic information to serve a mobile user"* (OGC, 2005). The later definition recognizes the LBS capacity to cover a wide set of information related to the wayfinding process. The different types of wayfinding information and covered by LBS technology include:

- Comprehensive static information: such as the information available in yellow pages and cartographic static maps. This type of information remains static (without updating) for long periods of time long time and is retrievable through other tools such as the television and newspapers.

- Topical information: relating to certain issues, which intrinsically change with the passage of time. Such issues include weather forecast and traffic status. An additional service of the LBS would be providing guidance to the user in order to carry out his wayfinding process in light of changing issues.
- Safety information: such as providing news update on any emergencies occurring on the road such as roadblocks and accidents.

LBS technology can provide travelers with all of these types of information in different formats including graphics, texts and voices. This is intended to diversify the range of inputs and outputs that are used by LBS in order to reach the most effective and efficient way to deliver information to the traveler. For instance, LBS technology can provide wayfinding instructions using speech via phonetic transcriptions of city and street names through the cellular phone.

In providing such information, LBS depends on a number of tools and technologies. Firstly, New Information and Communication Technologies (NICTS) taking the form of handheld tools (such as cellular phones, Personal Digital Assistants (PDA)s, laptops, smart pads or a navigation unit in a vehicle) are used as input devices for user's data and service requests. Consecutively, the user data and service requests are transferred forward and backward between the handheld device and the service provider through Communication Networks. The service provider then proceeds to processing and responding to the travelers' different services requests. These include searching specific information on objects of travelers' interest, calculating the position of the traveler, finding a route, and searching the 'yellow pages'. In doing so, the service provider uses different technologies such as (GPS) or through WAN (wide area network) stations.

5. Virtual Reality (VR) technology and wayfinding

The term Virtual Reality (abbreviated to VR) is commonly used since 1980s in description of applications and technologies through which people can interact with spatial data in non-real life experience (Whyte, 2002). The word 'virtual' itself applies to *"...something that can be done or seen using a computer and therefore without going anywhere or talking to anyone ..."* (Cambridge University Press, 2006). When used with wayfinding, VR applications and technologies are based on the use of systems to create a virtual media (or store an already created one) which users can use to consult with their trips. A VR system is mainly composed of computer hardware and software, input and output devices, data and users. The term 'VR media' refers to the virtual (unreal) environment and the model created (or stored) using the system. VR systems and media allow an easy communication with users. This can be done verbally or non-verbally without the barriers of languages or illiteracy. Moreover, VR systems and media can be updated easily and quickly without huge costs providing an easy tool to guide people within an inexperienced environment.

VR applications and technologies used with wayfinding can have different uses. To start with, various VR applications are used nowadays in assessing and valuating the performance of urban wayfinding systems. This is much encouraged by the hypothesis that *"If the wayfinding behavior and navigation in virtual and real environments was shown to be similar, one could conclude that the virtual environment can be used for assessing the future cities' wayfinding system."* (Skorupka, 2009). In addition to this, VR applications and technologies can be used as tools for guidance while carrying out the wayfinding process. In doing so, VR applications and technologies can assume a number of formats. Following is a brief survey of some of the most imminent ones.

5.1. Interactive kiosks

Interactive kiosks are composed of a series of computer devices that are networked together and located in different designated destination within the cityscape. A software is added to the computer devices depending on the nature of the place whether indoor or outdoor containing all

information that can be needed by the traveler. The devices can be networked using different services such as local area network (LAN), wide area network (WAN), and metropolitan area network (MAN) or public switch telephone network (PSTN) (Endicott, 2007). Through the network and the software, the computers are capable of receiving both video and audio inputs and outputs while providing information about the traveler destination. The kiosks identify their location within the cityscape within the target of presenting the most accurate route to the required destination. The software used with the computer devices is commonly consulted through touch screens allowing the user to interact with the system. The used software can also resolve to the use of vocal instructions as well as graphic interface and virtual directional tours allowing blind and illiterate people to be able to use it with ease. The VR media presented by the kiosks is modifiable according to the circumstances and changes in the urban structure.

5.2. Immersive and Non- Immersive VR devices

Immersive VR devices use special hardware tools that absorb the user totally (and hence the name immersive) into a VR media. Immersive VR devices can assume different formats. One format is personalized immersive devices which include Head mounted Devices (HDM). HDMs allow travelers to be totally immersed in a virtually created media while performing walkthrough and panoramically exploring this virtual media. The coordinate position of the user's head (and accordingly direction of view) is continually updated within the system using a motion tracker allowing the HDM media images to update themselves according to the user's position. Similar technologies include the BOOM (Binocular Omni Orientation Monitor) which is a head-coupled stereoscopic display device and optical system that are housed in a box attached to a multi-link arm. The use of the BOOM is based on the user looking into the two holes of the box in order to panoramically explore the virtual media. The user's head coordinate position is determined via sensors located in the links of the arm that holds the box. Users guide the BOOM wayfinding system verbally using their voices. On a similar note to personalized devices, immersive VR devices can also assume the format of three dimensional displays. This includes the CAVE (Cave Automatic Virtual Environment) systems where the virtual media is projected on the floor, walls and ceiling of a cube. Working as a screen display of the virtual media, the cube provides the illusion of total immersion within the environment (Schreer et al, 2005).

On a significantly different note, non-Immersive VR devices do not totally absorb the travelers into the virtual media. A software technique similar to that in application with immersive devices is used but the devices projects the virtual media onto a computer screen. On another front, Augmented Reality (AR) can be seen as a middle ground between real and virtual media (Miligram & Kishimo, 1994). One way of achieving AR is to mix videos and computer images. This surely reduces the amount of modeling in the virtual environment. AR technologies allow the traveler to visualize the real media (the surrounding environment) with virtual objects superimposed upon it. Together, the real and virtual media are projected over one another creating a single sensorial experience.

Discussions and findings

In depicting the different types of digital tools used for wayfinding in modern cities, the dynamic essence of these tools is quite identifiable. To start with, digital wayfinding tools have the ability to update their information with the changes occurring in the urban structure. Through this, the information offered by digital wayfinding tools are far from being obsolete or out-dated. The dynamic essence of the digital tools is also evident in many devices which can be handheld and consulted while executing the wayfinding process. Mobile personalized devices with LBS integrated allow the easy consultation of spaces prior to as well as during a trip. Services like the internet also increase the dynamic essence of digital wayfinding tools as such services offer a panoramic experience of cityscapes without the necessity of being physically present. Digital wayfinding tools can also be consulted to offer a wide range of information concerning the

traveler (like routes, current incidents occurring on these routes, weather conditions, etc) in different formats including graphics and voices in different languages. These different formats surely help overcome the blindness and illiteracy difficulties facing a traveler depending on traditional physical wayfinding systems. All of this comes in contrast to the static nature of physical wayfinding systems like signs and maps which are deployed in certain places in order to offer a limited amount and types of non-updated information.

Another advantage of digital tools is their ability to efficiently receive the huge amount of data projected by cities onto their travelers and process these data into a coherent wayfinding process; the thing which is argued to be difficult to execute through traditional cognitive mapping. In addition, the use of this new set of tools enables travelers to search information based on their personal criteria and interests. In other words, the new set of tools helps the individual differences in preferences to be practiced in the wayfinding process. Digital wayfinding tools are also strongly argued to diversify the modes in which cityscapes are identified and memorized. The diverse visual and auditory inputs/outputs of digital devices allow the recording and retrieval of views and voices. One could argue that the use of digital tools has added new components to the elements forming the image of the city. In contrast to the static geometric components of cognitive maps, the new components added by digital tools are characterized by being dynamic, changing and 'alive'. This includes for example the events organized in a certain cityscape, the incidents occurring in it as well as the particular weather conditions of this particular cityscape. Digital tools also help evade the difficulty of having to memorize a complete and thorough mental image of the city. This can be quite useful in overly complex and continually growing cities where it is difficult to mentally keep track of the city features into a coherent mental map.

Recommendations: Digital wayfinding tools in Egypt

In Egypt, the use of mobile devices for wayfinding is common due to the proliferation of the telecommunication networks and service providers in the country. Educated Egyptians are familiar with Location Based Services (LBS) and Global Positioning Systems (GPS) offered by cellular phone devices and companies. GPS devices for autovehicles are also becoming a common scene nowadays in Egypt. It would be relevant to mention in this context that the Egyptian government allows solely the use of GPS and LBS equipped devices for private usage. That is to say, individuals can only track their own location using their privately owned personal devices. The Egyptian NTRA (National Telecommunication Regulation Authority) forbids the use of GPS devices and services that allow people to monitor the location of other individuals or even autovehicles. In similarity to mobile wayfinding devices, the use of the internet for wayfinding is common in Egypt. Egyptians surf the internet for travel planning and tips. Internet website and services like Google Earth and Google Maps are commonly consulted in Egypt. In contrast to this, the use of Virtual Reality (VR) technologies and applications for wayfinding (such as interactive kiosks, Immersive and non-immersive devices) is quite rare (if not totally absent) in the country. One reason behind this is the cost. VR technologies and applications are considerably high in price. To this end, private possession of such tools is highly uncommon in Egypt. Moreover, the deployment of VR devices by the government for public use in cityscapes across the country would necessitate initial investments in the hardware and in instructing city travelers on how to use these devices. Additionally there would be the extra costs of maintaining and updating these devices overtime. Mobile wayfinding devices do not face similar problems as they are considerably more economic (cheaper to buy, maintain and update) and easier to use in comparison to VR devices. If VR technologies and applications for wayfinding are to be deployed by the government for public use in Egypt, the following points have to be considered:

1. The initial investments and running costs (maintenance and updating) of the devices should be weighed against the financial revenues expected from using these devices. The revenue of VR devices can be direct (as in collecting fees from travelers to use the devices) or indirect

(as in the financial benefits attributed to the role of the devices in encouraging tourism through easier wayfinding).

2. The devices should be easy to use and consult. Their software interface should also come in different languages (Arabic being the formal language of the country).
3. The inputs and outputs of these devices should be equipped with audio capabilities as a considerable majority of Egyptians is illiterate and would consult the devices vocally.
4. The devices should be well protected against vandalism and theft; the thing which would add more to the overall cost of the devices.
5. Instructions on how to use the devices should be made available to the public. This can be done through different media like the television or special training courses.

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