34 Wayfinding perspectives

Static and digital wayfinding systems: can a *wayfinding symbiosis* be achieved?

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Information design: research and practice, pages 509–526

Wayfinding is an activity that has been essential for the survival of animals and humans throughout history. It relies on a range of strategies aided by different sources of information. This chapter explains how people navigate through different environments and explores how information, both static and digital, influences human wayfinding behaviour.

Developments in digital technology have created new ways to access and use information and have led to new wayfinding strategies. Global navigation satellite systems provide positioning information in external environments and, when linked to an accurate map-base and wayfinding device, a journey can be made very easily. Inside buildings, however, where satellite signals are unreliable and detailed building plans are not openly available, effective digital wayfinding systems are less common. Indoors, static information remains the dominant source of information, but is this going to change?

The role of information designers in wayfinding has evolved as the uptake of digital technology has increased. Static information, whether printed, wall-mounted, or freestanding, still exists in most built environments, but will this information be replaced by digital solutions that provide personalized, journey-specific, inclusive information? Will digital system developers make wayfinding information designers redundant, or will they develop a mutually beneficial *wayfinding symbiosis*?

Humans explore unfamiliar places and have found ways to navigate through different environments – land, sea, sky, and more recently virtual worlds. Some people plan their journey in detail using information such as maps, journey planning websites, and spoken directions. Others rely on environmental features, landmarks, artworks, and their *sense of direction* to find their way. In unfamiliar environments, people are likely to pre-plan their journey and to use a combination of information sources in the environment to help them to navigate.

Human navigation or *wayfinding* is a multidisciplinary field of research. The use of information to guide, orientate, and inform people has been tested in multiple studies (Levine 1982; Butler et al. 1993; Hölscher et al. 2007; Porathe 2008; Willis et al. 2009; Meilinger et al. 2014a). Studies of brain function during navigation (Woollett and Maguire 2011) as well as the effect of brain injury on navigation and orientation have been published (Antonakos 2004; Head and Isom 2010; Spiers and Maguire 2007), and digital wayfinding systems have been studied and reviewed (Fallah et al. 2013; Taher et al. 2009; Willis et al. 2009).

This chapter focuses on human rather than animal navigation and considers three environments that humans commonly navigate through – natural environments, outdoor built environments, and inside buildings. Studies of human navigation in other environments include aircraft pilots experiencing spatial disorientation in the sky (Previc et al. 2004) and scuba divers using acoustics for underwater navigation (Hollien et al. 1982). Extensive research into animal wayfinding behaviour has been undertaken including many observation studies of rats (Benhamou & Poucet 1998; Frost and Mouritsen 2006; Dudchenko 2010), insects and bees (Von Frisch 1973; Judd et al. 1999; Collett and Collett 2000; Dyer et al. 2002; Cheeseman et al. 2014), and homing pigeons (Verbner et al. 2005). Research methods used for studying animals, such as *displacement* of honey bees (Dyer et al. 2002; Cheeseman et al. 2014) have been used for human navigation studies (Baker 1987).

Humans are unique in our ability to design information to aid navigation. To determine how humans use wayfinding information, both static and digital, it is first necessary to understand the process of wayfinding.

What is wayfinding?

Understanding how people find their way in natural and built environments enables designers to identify appropriate ways to provide information that is useful and in an appropriate format. Many books have been published on wayfinding, each with a slightly different definition of wayfinding, but all the authors agree that information is a key influencing factor affecting wayfinding success. In 1960, Kevin Lynch introduced the concept of 'way-finding' in his widely cited book *The image of the city* (1960). His study of three North American cities found that people's ability to interpret information and find their way was linked to an ability to create an *environmental image*:

> In the process of way-finding, the strategic link is the environmental image, the generalized mental picture of the exterior physical world that is held by an individual. This image is the product both of immediate sensation and of the memory of past experience, and it is used to interpret information and to guide action. (Lynch 1960, 4)

Most wayfinding books cite Lynch's book, and a review of his study fifty years after it was published found it is still 'highly topical and relevant', particularly for urban planners and people marketing a city (Hospers 2011, 2073).

In *Wayfinding: people, signs and architecture* (Arthur and Passini 1992, 25), the authors describe wayfinding as a three-stage, spatial problem-solving process: *decision-making, decision executing,* and *information processing*. In 'Towards a taxonomy of human wayfinding tasks' (Wiener et al. 2009, 6), four different processes linked to successful wayfinding are defined: decision-making processes, memory processes, learning processes, and planning processes. In *Design that cares* (Carpman and Grant 1993) with its emphasis on hospitals, five simple wayfinding stages are described:

> Wayfinding involves five deceptively simple factors: knowing where you are, knowing your destination, knowing and following the best route to your destination, recognizing your destination upon arrival and finding your way back out. (p. 66)

In *Wayshowing > wayfinding* (Mollerup 2013, 27) the author describes a different three-stage process: to seek, to decide, and to move – or *search, decision, and motion*. Mollerup also introduces the concept of 'wayshowing' as the 'professional activity of planning and implementing orientation systems in buildings and outdoor areas' (Mollerup 2013, 6).

> Wayfinding and wayshowing relate to each other as do writing and reading ... or cooking and eating. One activity deals with sending, the other with receiving. The purpose of wayshowing is to facilitate wayfinding. (Mollerup 2005, 71)

Mollerup's definition and distinction makes perfect sense, and the term *wayshowing* defines the activity of designing information to help the activity of wayfinding, but the term has not yet been adopted extensively either in the UK or globally – *wayfinding* is commonly used to describe both activities.

In *Wayfinding: effective wayfinding and signing systems: guidance for healthcare facilities* (Miller and Lewis 1999, 16), the authors studied wayfinding systems in nineteen UK hospitals and eight other built environments including three international transport terminals, three conference and art centres, and two shopping centres. Their study identified three key factors that influence wayfinding: *personal or people factors, environmental factors,* and *the understandability of information*. The book was first published in 1999 and there is no mention of digital information at any of the study sites. Digital technology was costly and connections were slow and unreliable. Twelve years later, the author published a study of wayfinding systems at three UK hospitals (Jeffrey 2011). The study found that sites were not using digital technology in any cohesive or effective way for wayfinding purposes. Information such as site maps and building diagrams, designed to be printed in colour, on standard sized paper were being used on hospital websites as static, low resolution, small-sized images, or as poor quality photocopies.

The interaction of people and information in physical and virtual environments is dynamic, interactive, and evolving at a rapid rate. The information design boundaries are expanding and blurring and effective information planning and design is central to the success of digital wayfinding solutions. Figure 1 shows how information content and design is central to both static and dynamic wayfinding systems.

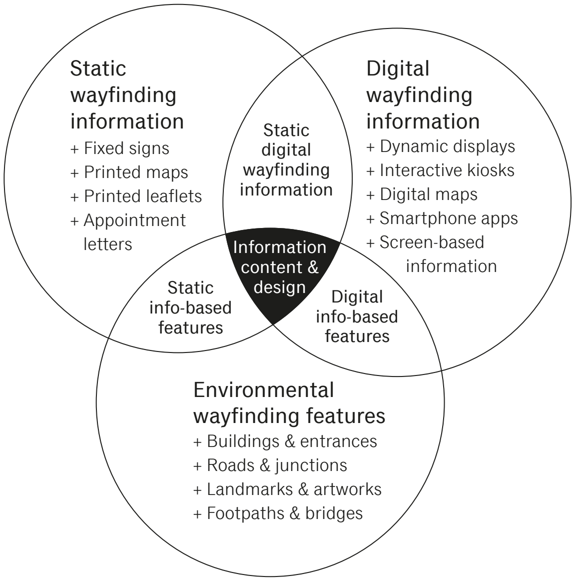


Figure 1
Information content and design is central to both static and dynamic wayfinding systems.
Image: Colette Jeffrey 2016.

Wayfinding strategies and behaviour

In 1999, a group of academics from around the world met to discuss *human and non-human wayfinding behaviour,* and specifically the role of *cognitive maps* in navigation. Speakers included a number of psychologists, but also a biologist, a neuro-scientist, a cognitive scientist, a computer scientist, and a geographer, and resulted in a collection of research papers published as *Wayfinding behaviour* (Golledge 1999). The conference brought together two previously disconnected research areas – human and animal wayfinding behaviour – that until then had not shared ideas or literature so closely or comprehensively. They discussed whether the creation of a *cognitive map* was central to wayfinding behaviour in rats, insects, birds, and humans. Kitchin (1994) found twenty-two different phrases used in literature that relate to the concept of *cognitive maps*, including *spatial memory, spatial representations,* and *mental maps*, highlighting both the difficulty of defining cognitive maps and the complexity of wayfinding behaviour research.

The ability to create a mental map or cognitive map of an environment has been identified as an influencing factor in the wayfinding process (Allen 1999; Kozlowski and Bryant 1977; Maguire and O'Keefe 1999). A study of indoor wayfinding found:

> The maps that human geographers design are enduring, geocentric and all embracing in their scope and flexibility, [but] the internal representations that

> guide human navigation have none of these properties … Humans navigate primarily by representations that are momentary rather than enduring, egocentric rather than geocentric, and limited in the environmental information that they capture. (Wang and Spelke 2002, 376–380)

In 1960, Kevin Lynch had identified the *environmental image* as crucial in wayfinding and believed it was used to interpret information. He identified five distinct elements in people's mental maps:

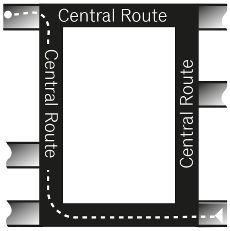
- *paths*: the distinctiveness or pattern of different routes along which people move, e.g. streets, rail tracks, forest trails, and other channels people move along.
- *edges*: boundaries between two areas and breaks in continuity.
- *districts*: areas with common characteristics and neighbourhoods.
- *nodes*: strategic focus points for orientation, like a town square or a distinctive road or corridor junction.
- *landmarks*: a point of orientation or reference, usually an easily identifiable physical object that may be distant such as a spire or tower.

More recent studies have identified the same elements in other cities (Nasar 1990; Šiđanin 2007; Carmona et al. 2003; Dijksterhuis 2008), and in *The wayfinding handbook* (2009), David Gibson describes the 'hidden logic' of wayfinding systems and explains four wayfinding strategy models that reflect Lynch's thinking: *the connector model, the district model, the landmark model, and the street model*:

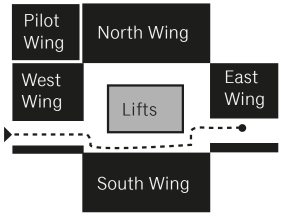
> Designers use these frameworks to structure a system of signs that will help people navigate, depending on the strategy, from district to district, along streets or corridors, or between landmarks. (Gibson 2009, 44)

A recent study (Meilinger et al. 2014b) describes the wayfinding strategy 'when in doubt follow your nose' (first proposed by Dalton 2003). People follow a visible path, street, or corridor and only memorize decision points, turns, or nodes. Otherwise they walk straight, reducing *working memory load* and the amount of information they need to remember. This approach is seen in vehicle satellite navigation systems (satnavs), in which the driver assumes they should travel straight on unless a turn is indicated either visually on screen, or through spoken directions. Research into whether the use of satnavs has affected human wayfinding ability, particularly when digital information unexpectedly becomes unavailable is difficult to find but Meilinger, who has studied the effects of maps on navigation, states in a newspaper interview 'if somebody doesn't care to learn the environment, that's fine but they shouldn't complain if their mobile is not working and they are completely lost' (Oliver 2012).

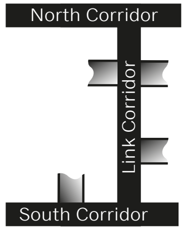
The need for wayfinding information strategies arises in complex built environments with multiple floors, entrances, and destinations that cannot all be listed on every static sign. Strategies aim to reduce the amount of text on signs, help people understand the 'hidden logic' of the environment, and enable people to create a mental map to help them navigate. Often a few of these strategies will be applied in one environment. Examples of Gibson's four models being applied to complex sites in the UK, and an example of a nodes model, are shown in Figure 2.



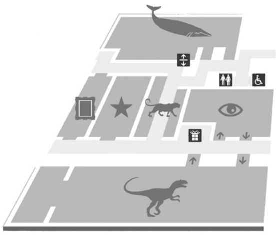
Connector model
The 'connector' is called the Central Route at QMC, Nottingham.



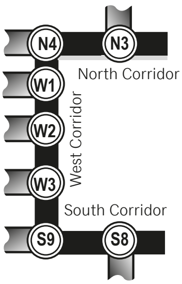
District model
The 'districts' are called Wings at Charing Cross Hospital, London.



Street model
The 'streets' are named Corridors at Hammersmith Hospital, London.



Landmark model
'Landmark' exhibits are used on maps and signs at the Natural History Museum, London.



Node model
Junction numbers/letters at 'nodes' link to corridor names at Nottingham City Hospital.

Figure 2
Wayfinding strategy models for complex buildings in the UK, with a new Nodes model.
Image : Colette Jeffrey 2016 (derived from Gibson 2009, 45).

These strategies inevitably introduce another layer of information to be remembered and processed. The wayfinding problems caused by *information overload* are especially prevalent in large hospitals. The following hospital journey scenario is typical: Instead of simply seeing the Foot Clinic sign from a parking space outside the entrance, a person will have to find a car park, find an empty parking space, find a building entrance, and then look for a sign saying Foot Clinic. If a Foot Clinic sign is not present, she shows her hospital admission letter or email printout to a receptionist. It says go to the Department of Podiatry. At this stage of her journey she is told the clinic is on level 5, in the South Wing, and that the nearest site entrance is the South Entrance, but that she has entered through the North Entrance. Her journey will therefore be long and complicated. When she eventually hobbles her way to the South Wing, she can't find the lift. And the signs don't say Foot Clinic, they say Podiatry, or Bluebell Clinic, or South Clinic 5. Looking at the signs with a confused expression, someone passing by reassures her it is the right place. Still unsure, she arrives at the clinic tired, anxious, and late. In this complex but very common hospital journey scenario, the benefits are clear for having a personalized, journey-specific, digital wayfinding information system, providing visual and audio directions straight to a handheld or worn device. If the indoor system is linked with an external navigation system people could have a seamless journey from home, along the most direct external and internal routes to their destination inside a building. So why aren't indoor digital wayfinding system widely available? To answer this question, it is necessary to understand the differences in wayfinding through natural and built environments.

Wayfinding in natural environments

Wayfinding has always been an essential skill for human and animal survival in natural environments. Finding a safe place to shelter, finding good hunting grounds and sources of food, and safely finding the way back home, has historically relied on natural features with some human intervention. Man-made wayfinding solutions including arrows created from twigs or stones, trail marker trees (Downes 2011), stiles and gaps in walls, and footbridges are shown in Figure 3. Sign systems, you-are-here maps and information boards have more recently been installed in some natural environments to give people information about which way to go, or to mark a route.

Figure 3
Examples of man-made wayfinding solutions, in natural environments.

Stone arrows temporarily indicates which route to take.

Trail marker trees trained to indicate a particular direction (Downes 2011).

Stiles and gaps in stonewalls indicate where a route continues.

Footbridges indicate routes across rivers and signs provide information.

These natural wayfinding solutions are simple but effective in indicating a particular route, direction, or crossing, where only a few directions and destinations exist. Planning and making more complex journeys through natural environments requires more detailed information. Traditionally a printed map has been used and is still used (and preferred) by many people, but the navigator must know where she is on the map for it to be of use for navigation. Digital technology offers alternative ways to access information and maps and has the distinct benefit of knowing a person's location if the use of a global navigation satellite systems (GNSS) is possible, and then using her position to provide location-specific digital information. A constellation of twenty-four satellites have provided global positioning information for armed forces since 1995, and for civilian and commercial use since 2000 when the USA government decided their Global Positioning System (GPS) would be made freely available. Other countries have satellite systems that are planned or partially operational including Russia, the Europe Union, Indian, Japan, and China. Mobile devices using interactive mapping and positioning technologies, accessed on-the-go using a smartphone, or a computer at home, show accurate route options, travel times, distances, and other real-time information used for navigation. However, maintaining a global navigation satellite signal in mountainous, heavily wooded, or densely built up environment can prove very difficult, making digital devices unreliable and requiring the use of other navigational information such as a printed map and natural features to support digital navigation systems.

Wayfinding in built environments

Wayfinding in towns and cities can be a complex task because there are often many alternative routes through built up areas, with multi-entrance buildings and an intricate network of roads, pathways, and green spaces. 54% of the world's population lives in urban areas but this is expected to grow to 66% by 2050 (United Nations 2014). These figures are much higher for England and Wales where 81.5% of the population lived in an urban area in 2011 (Office of National Statistics 2013). Wayfinding solutions for built or urban environments have evolved from hand-painted banners, flags, and signs identifying shops, pubs, and other public services, to integrated city wayfinding systems for both vehicles and pedestrians. Figure 4 shows examples of man-made wayfinding solutions consistently used in built environments.

Figure 4
Examples of man-made wayfinding solutions, in built environments.

Painted arrows on roads indicate the direction of trafiic, and which lane to take.

Road signs indicate a particular direction.

Pedestrian crossings indicate a safe place to cross a road.

Footbridges indicate where people can cross a road safely.

An audit of signs to guide pedestrians in London found there are many conflicting systems:

> [There are] at least 32 separate wayfinding systems for pedestrians in the central Congestion Charging Zone alone. These systems come with sharp differences in information, design and quality. Destination names are inconsistent. So are indications of distance. Designs vary in colour, shape, typeface, materials and branding. Some aren't maintained properly, leading to graffiti and vandalism. There is no common standard for the positioning of street signs. By contrast, our road signage for motor vehicles is consistent, clear and accepted right across the country – it tackled these issues decades ago. (Transport for London 2007, 13)

Designed by Jock Kinneir and Margaret Calvert from 1957 to 1967, the road sign system in the UK has been consistently installed across the country, with standardized signs, pictograms, and road markings. On motorways, Kinneir's original static directional signs are supplemented with digital dot matrix signs displaying temporary messages, often giving real-time traffic information. Changeable digital advertising displays positioned next to city centre roads promote products and services. Satnav displays show digital mapping and give auditory instructions for drivers. Such devices have dramatically changed the wayfinding behaviour of some drivers (Axon et al. 2012; Dalton et al. 2013). Mapping apps, accessed using a smartphone, are increasingly being used for wayfinding on foot and by vehicle. But these apps can only guide people to building entrances, not to a destination inside the building.

Bristol was the first UK city to fully embrace the concept of being a *legible city* with a consistent on-street system. The city council worked with a team of designers to create innovative wayfinding information and products. The approach to pedestrian signage and mapping has been applied to many cities in the UK and globally. In a review of the *Bristol legible city* project, the influence of Kevin Lynch's study in 1960 is directly acknowledged:

> Successful cities will be those that connect people, movement and places efficiently.
>
> They will be engaging, welcoming, accessible and easily understood (Kelly 2001, 7).
>
> Cities generate a fog of content overload – tourist books, timetables, maps, road signs, pedestrian guides and advertisements. Too much and too much that is inappropriate, out of date and inaccurate. (Kelly 2001, 18)

Legible London built on the knowledge gained from the Bristol project and the city audit identified two types of navigator – a *strider* and a *stroller* (Transport for London 2007, 4). A *stroller* seeks memorable experiences by drifting and wandering through a new city focusing on the environment, not on the information (Figure 5, overleaf).

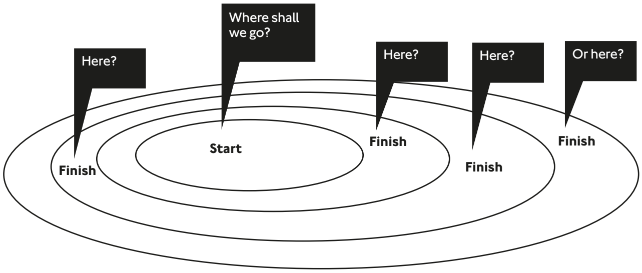


Figure 5
A stroller needs information that allows them to drift, wander, and have the confidence to get lost. Their journey is conceptually like 'ripples in a pond'.
Image: Applied Wayfinding (in Transport for London 2007, 26).

A *strider* wants to get to their destination as quickly and efficiently as possible and their strategy is often to get near, then use information and the environmental cues to find their destination (Figure 6).

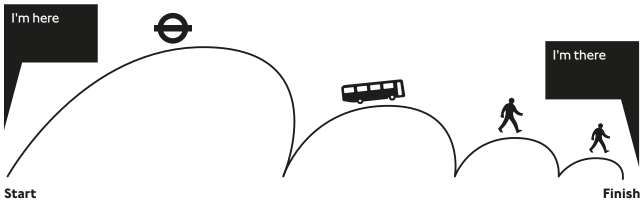


Figure 6
A strider's strategy is to get near, then find wayfinding information. Their journey is conceptually like 'stones skimming across a pond.
Image: Applied Wayfinding (in Transport for London 2007, 26).

The Legible London system provides information for both striders and strollers, using digital and static platforms for wayfinding and transport information with the aim of creating a seamless journey (Transport for London 2007, 4). The different static and digital information provided at a typical decision point are shown in Figure 7 (Transport for London 2007, 24). Transport for London are currently trialling a touchscreen map and information panel at a bus stop in Piccadilly Circus to provide real-time travel information and access to Legible London maps, but it has taken eight years to develop this interactive display since the first static signs were installed. A key issue that delayed digital solutions being launched was the use of Ordinance Survey (OS) data for creating the base map. At the time of the launch, OS would not allow the maps to be used for on-screen applications. Other cities have avoided this digital data usage problem by using aerial photography to create base-maps, but even though the cost of digital hardware and software has reduced, there is still a need to find funding for the installation and ongoing maintenance of the signs and the information. Transport for London commissioned an evaluation of the Legible London scheme in 2013 and responses highlight interesting changes in human wayfinding behaviour, users' perceptions, and the interrelationship between digital and static information:

> *User comment 1*: I'm a lot happier knowing [the signs] are there – in case my phone died or something.
>
> *User comment 2*: I would assume that I would have to rely on my smartphone or ask for directions [if the signs weren't there] – I would feel reticent about having to do that.

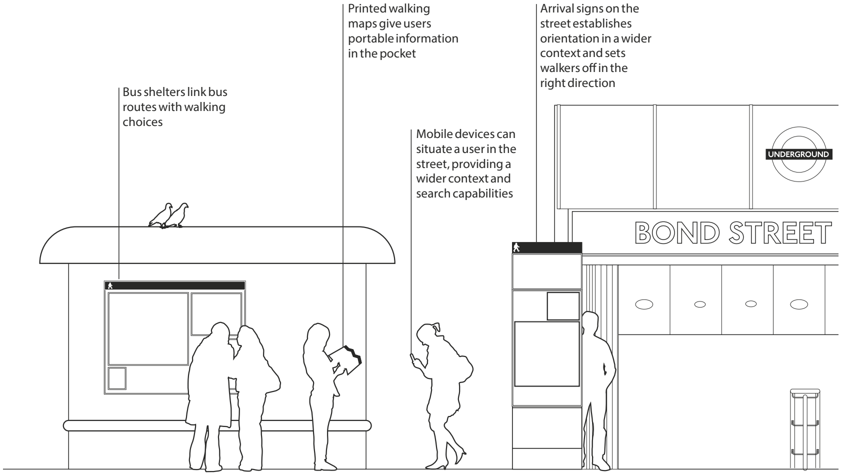


Figure 7 Legible London aims to provide continuity of information, for pre-planning and information on-the-go connected to on-street signs.
Image: Applied Wayfinding (in Transport for London 2007, 52).

> *User comment 3*: The signs are not in every neighbourhood so you can't rely on them to always be there.
>
> *User comment 4*: Sometimes the Legible London maps give you more detail than Google Maps and sometimes Google tells you that you are in the wrong place if you have a poor signal. (Steer Davies Gleave 2014, iv–v)

In Brighton, royalty-free aerial photography was used to create the map-base, enabling the design company to develop a more integrated system, with downloadable maps and a smartphone app, as well as the on-street signs and maps, right from the launch. The city has the Royal National Institute for Blind People's REACT radio frequency identification (RFID) digital system, providing real-time public transport information installed at bus stops. However, REACT requires people to have obtained a fob to trigger the information messages, significantly reducing the accessibility of the system, and it also provides a limited range of information. The WalkBrighton app used a smartphone to receive information and the phone's inbuilt compass and GPS to enable the app to be location aware, telling people where they are in the city and indicating where they need to go, similar to an in-vehicle satnav. It used the same base map as the static signs and maps for consistency in the content, style, and detail of information. The WalkBrighton app is included as an example of digital wayfinding in *Wayshowing > wayfinding* (Mollerup 2013, 161). However, a different app using different mapping is now being promoted by Visit Brighton, highlighting the problem of keeping digital information and apps up-to-date, and venues wanting their apps to offer more than just wayfinding information. Mollerup describes the burdens and benefits of wayfinding apps for venues and visitors:

- *venue benefits*: self-service, branding, experience economy, hidden advertising.
- *venue burdens*: initial costs, updating costs.

- *visitor benefits*: portable information, often updated, treasure hunt.
- *visitor burdens*: download takes time, updating takes time, must be watched all the time, hinders studying the environment, hinders creation of cognitive map, small type may demand use of two pairs of glasses. (Mollerup 2013, 161)

Despite these burdens, it cannot be ignored that mobile phones are ubiquitous in many countries, with phones grasped firmly in hand as people walk through streets, travel on buses, and enter buildings. It makes sense to explore how best to use mobile phones as an information provider, trigger, and receiver for digital wayfinding in outdoor urban environments.

Wayfinding inside buildings

Wayfinding inside buildings, especially multilevel, interconnected buildings can be difficult and designing wayfinding information is often challenging. Studies of wayfinding in hospitals (Carpman and Grant 1993; Miller and Lewis 2000; Mollerup 2008), airports (Fewings 2001; Kishnani 1999), exhibitions (Peponis et al. 2004), and museums (Passini 1999), highlight a variety of wayfinding information issues:

> Signs are a last minute thought . . . a necessary evil to be watched so as not to disfigure a building. (Arthur and Passini 1999, 241)

> The standard cure for wayfinding problems is more signage. Signs are used as medicine to solve wayfinding problems. Sometimes, however, it pays to take a look behind the apparent problems before prescribing more signs. (Mollerup 2008, 112)

An *Architect's Journal* article supports these opinions:

> Wayfinding, one of the more charming neologisms to enter architectural discourse in recent years, is a topic which sits comfortably with floors, stairs and lifts and, as it's a newcomer, we'll discuss it first. Although many architects regard signage as an admission that a building has failed to communicate by architectural means. (Mara 2012).

There are many excellent examples of imaginative static signage and environmental graphics inside buildings, particularly successful where architects have clearly worked collaboratively with information designers. Recently published books (Victionary 2013; Graphic Design Group 2012; Mollerup 2013) present hundreds of photographs of creative static information with text, pictograms, images, and three-dimensional solutions creating fascinating signage inside buildings, but there are still very few examples of effective, innovative digital-only wayfinding solutions.

A key problem for digital wayfinding inside buildings is that satellite signals do not work – so providing accurate positioning information for indoor or underground environments is difficult. A comprehensive review of indoor navigation systems (Fallah et al. 2013) provides details of technique and describes the advantages and problems with each. The study concludes:

> Indoor navigation systems have not achieved large-scale deployment due to issues pertaining to cost, accuracy and usability ... Future navigation systems need to primarily lower the installation cost, by minimizing the amount of infrastructure augmentation that is required for localizing the user, or by using low-cost sensors. (Fallah et al. 2013, 30)

Creating a seamless outdoor to indoor wayfinding journey using digital technology is therefore not going to be straightforward. It is important that digital wayfinding solutions are the result of people who understand the wayfinding process and who are able to identify information needed at each stage of the journey, and able to create solutions fitting these needs – i.e. not solutions primarily prescribed by technical developers limited by current technology.

Miller and Lewis (1999, 17) identified four key journey stages when travelling to a new destination. A summary of the information needed at each stage, showing where static wayfinding information or digital information is most appropriate is illustrated in Figure 8.

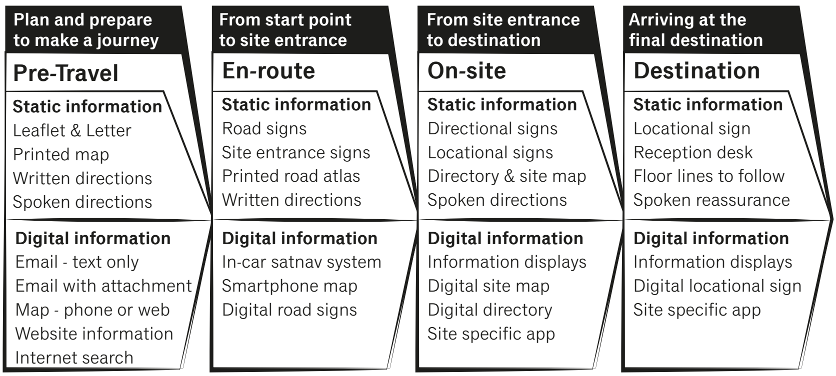


Figure 8
Four key journey stages with four information types – static and digital.
After Miller and Lewis 1999, 17.

Many studies of wayfinding behaviour inside buildings have tried to determine what information is used and how it is used (Levine 1982; Butler et al. 1993; Hölscher et al. 2007, 2006; Kishnani 1999; Passini 1999; Dogu and Erkip 2000; Miller and Lewis 2000; Fewings 2001; Willis et al. 2009; Rui and Klippel 2010; Carlson et al. 2010; Fallah et al. 2013). These and other wayfinding studies give interesting insights, but do not provide consistent, definitive findings as to how static information should be designed. There is no agreement on how digital information should be developed, what indoor positioning system is the most effective, how people navigate through unfamiliar buildings and what they do and feel when they get lost. Research in this field continues to develop new knowledge that will inform the design of combined digital and static indoor wayfinding systems in the future.

Digital wayfinding information: is wayfinding symbiosis the future?

Wearable information and navigation devices such as smart glasses (e.g. Google Glass), smart watches (e.g. from Apple, Sony, or Samsung) and even smart shoes (cf. Lechal) are being prototyped. If the devices are linked to a digital map base and a positioning system they can provide personalized wayfinding information, but none have been universally adopted for navigation yet. People are still relying on their phones or in vehicle satnavs that are *portable* rather than *wearable* devices:

> There is an important distinction between *wearable* devices and those that are merely *portable*, the classic examples being the pocket watch and the wrist watch. You have to pull out the pocket watch and open it to see the time, while the wristwatch enables you to see the time instantly, even while working with both hands. (Pentland 2001, 12).

> The technology has evolved to a point where it can now be synthesized with clothing … it will be mind-blowing five years from now … you'll go to the store and buy a shirt or an undergarment and you'll expect it to be a connected object. (Walker 2015)

The following extract from a fictional story describes a concept of mobile, wearable footwear for wayfinding, but what happens when there are five different directions and a change of level on the route:

> His left shoe started vibrating, so he turned left. As he walked to the restaurant for the first time in his life, he thought funny how quickly you get used to this stuff. Three months ago, when my shoes first started vibrating, my first impulse was to kick them off. Now I'm not even aware of them. I just turn left or right because that's where I need to go … both his shoes vibrated indicating he had arrived at the restaurant, just as planned. (Van Der Drift 2009)

The vibrating insole concept has been prototyped as a *shoe-integrated tactile display* (Velázquez et al. 2009) and tested by twenty undergraduate students aged between 18 and 25, to see if they could determine direction (north, south, east, or west, fourteen times in a varying sequence) using sixteen vibrating sensors in their shoes. The study found the success rate ranged from 64% identifying south and 83% identifying east correctly. Six of the participants performed almost perfectly but four performed very poorly suggesting performance may be unreliable. Vibrating insoles and other wearable and haptic devices are becoming commercially available each year (Coxworth 2014), but will people buy them and use them? Using haptic navigation devices could enable people to focus on seeing and listening to an unfamiliar city or building whilst wayfinding, without being distracted by visual or auditory wayfinding information. The devices could enable people with visual impairments to navigate without needing to see the environment clearly or read or listen to information. Digital technology could provide individualized wayfinding information, specific to a person's journey, but currently wayfinding information, positioning, and mapping systems are not always standardized, reliable, or compatible, so connecting an outdoor and indoor journey seamlessly is proving difficult. The Society of Environmental Graphic Design (SEGD) says the advantages of a digital wayfinding system are obvious:

> Rather than display one layer of information, a digital wayfinding system can display multiple layers with almost limitless flexibility in how and when it can be displayed. (Reising 2008, 44)

Montello and Sas believe digital technology can potentially provide flexibility if wayfinding information is displayed in different forms, and the systems enable people to access only the information they need:

> Effective wayfinding requires this information to be sufficiently accurate, precise, complete, and up-to-date. Furthermore, we must be able to access this information and reason with it appropriately, according to the situation we are in … It is important that the information is sufficient but not more than sufficient … the form and modality of the information is often important to the success of wayfinding. (Montello and Sas 2006, p. 2004)

A member of the design team involved in an award winning digital wayfinding system at the Smithsonian National Museum of Natural History in Washington DC suggests a static and digital wayfinding symbiosis may develop, and Mollerup agrees:

> There's definitely a misconception that digital wayfinding will replace traditional media … I believe it is meant to be complimentary, add value, and improve the experience. (Reising 2009, 46)

> The new technologies primarily work in outdoor areas while a fair part of our wayfinding problems happens indoors … not all of us carry a digital wayfinding assistant all the time … it is a safe prediction that we will not dump the traditional wayfinding media including signage in a foreseeable future. (Mollerup 2014)

Digital technology relies on the navigator having a way of *receiving* the information and the information provider a way of *sending* information in a reliable, accessible format appropriate to the journey and journey stage. Kiosks and wall mounted digital displays are often accessible but are static, i.e. not portable digital information systems. Mobile, wearable devices are portable but expensive, and therefore the information system becomes exclusive rather than inclusive. It is likely that the first people to experience integrated digital and static wayfinding information systems inside buildings will be shoppers because retail companies want to combine wayfinding and product finding with advertising, special promotions, and marketing messages. They are already managing complex customer information databases, are motivated to keep the product and customer information up-to-date and they want to influence customer wayfinding and purchasing behaviour.

Innovative modes of communication, transport, and navigation often first appear in futuristic movies. In *Back to the future part II* (1989) the actors travel 'back to the future' to 2015. Innovations that film viewers see include a huge multichannel television, personally targeted digital advertising, controller-free computer games, and flying cars. All predictions except the flying cars have become ubiquitous. Future wayfinding systems are difficult to predict but they will hopefully be personalized, journey-specific, accessible, inclusive, accurate, and reliable.

People trying to find the way to a clinic at a complex hospital, the right gate at an international airport, or a specific exhibit in a large museum will be elated when there is a seamless, intuitive digital information journey from home, using the best mode of transport and most direct route to their destination. Until digital technology develops and standardizes further, and information systems become consistent and cohesive, and everyone has access to personal digital devices, a static and digital *wayfinding symbiosis* is inevitable.

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