UCL CENTRE FOR ADVANCED SPATIAL ANALYSIS

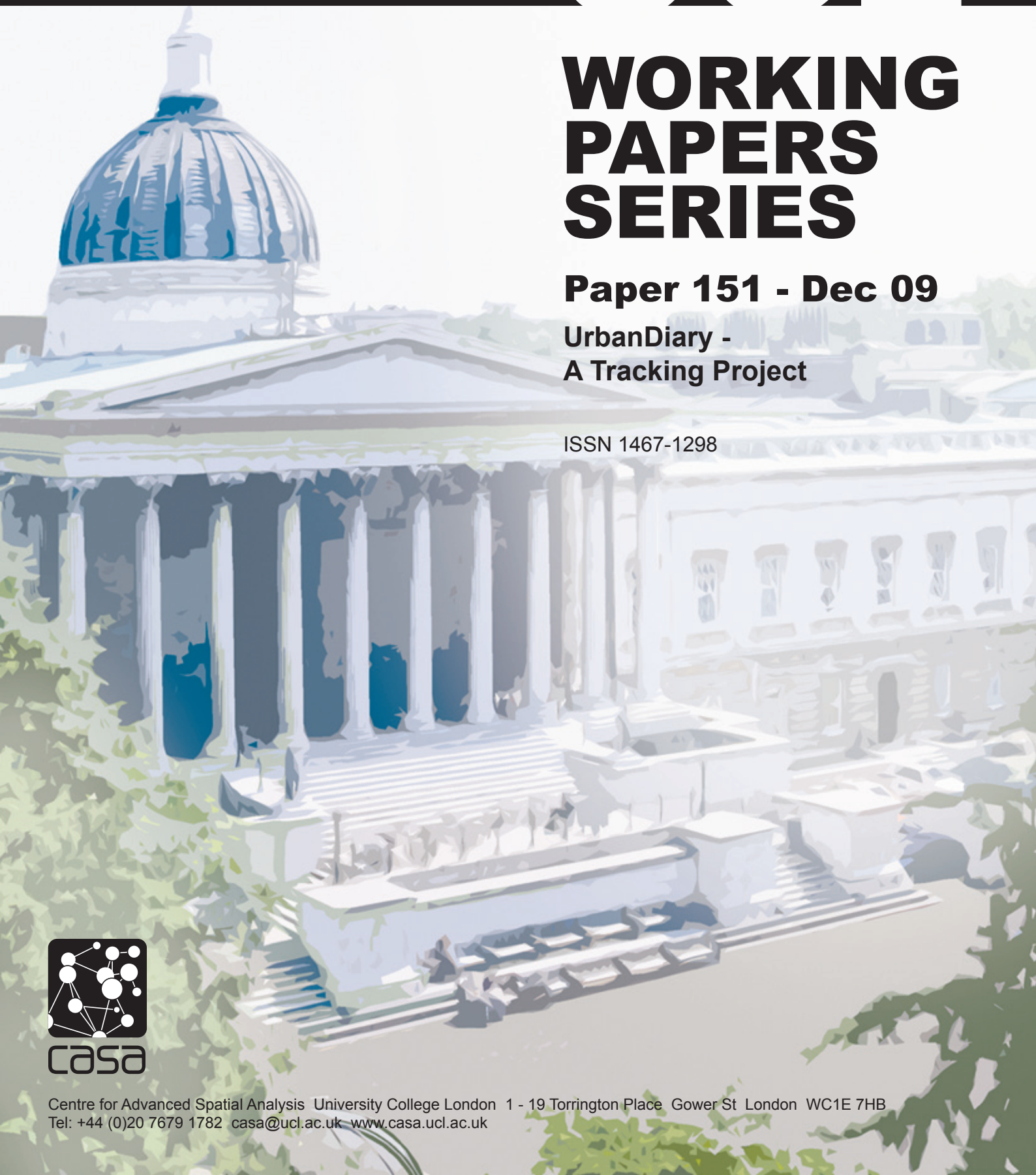
UCL

WORKING PAPERS SERIES

Paper 151 - Dec 09

UrbanDiary - A Tracking Project

ISSN 1467-1298



casa

Centre for Advanced Spatial Analysis University College London 1 - 19 Torrington Place Gower St London WC1E 7HB
Tel: +44 (0)20 7679 1782 casa@ucl.ac.uk www.casa.ucl.ac.uk

UrbanDiary - A Tracking Project

Fabian Neuhaus

PhD Researcher, Centre for Advanced Spatial Analysis (CASA), University College London,

1-19 Torrington Place, London, WC1E 7HB

fabian.neuhaus@ucl.ac.uk

http://urbantick.blogspot.com

December 2009

Abstract

This working paper investigates aspects of time in an urban environment, specifically the cycles and routines of everyday life in the city. As part of the UrbanDiary project (urbantick.blogspot.com), we explore a preliminary study to trace citizen's spatial habits in individual movement utilising GPS devices with the aim of capturing the beat and rhythm of the city. The data collected includes time and location, to visualise individual activity, along with a series of personal statements on how individuals "use" and experience the city. In this paper, the intent is to explore the context of the UrbanDiary project as well as examine the methodology and technical aspects of tracking with a focus on the comparison of different visualisation techniques. We conclude with a visualisation of the collected data, specifically where the aspect of time is developed and explored so that we might outline a new approach to visualising the city in the sense of a collective, constantly renewed space.

Introduction

Traditionally the city is mapped as a network of streets, buildings and blocks that form the space within, where this given space is generally taken as universal and true. Within this box-like construction of space-time, movement and change are placed attributes. They have no position as part of the general concept because they, unlike this general understanding of the city, have not one state but many. The UrbanDiary (UD) project at the Centre for Advanced Spatial Analysis, University College London, aims to address this problem of "many states at the same time" by examining techniques and methodologies to observe and map the change of movement and time directly, firstly from within the given and generally understood concept of space. Secondly, we combine aspects of process into the overall description of urban space by tracking activities to generate new perspectives on how to define and interpret the city as a collective product of patterns in time.

Unlike many studies in the field of traffic and movement surveillance dealing solely with the data of the locations of activities, this study is specifically looking at the route chosen between locations and the pattern of repetition occurring through rhythmic schedules over varying periods of time. As the first stage of data collection a number of volunteers were equipped with a GPS device in addition to which over a period of at least two months, participants recorded their personal spatial diary, mapping the extension of personal everyday life. In this way, the participant's routines were recorded allowing a space and time relation to be constructed and linked to a collection of habits and routines. The expressions 'everyday', 'everyday life' and 'routine' in this context are used in the sense of de Certaux (1984). The data collected and the terms of routines used are very much on an individual level, but combined as a collective map, this represents the spatial diary of the urban environment and ultimately represents the rhythm of the city which we seek to explore.

Context

The research focuses on the cycles and rhythms in the urban environment. Day and night, the rush hour, weekends, train timetables, paydays or a yearly celebration day are examples of repetitive patterns occurring in the city. Such patterns could theoretically be the result of spatial and social configurations, however, we view them as based around the organisation of the urban environment. In "The Social Logic

of Space" Hillier and Hanson (1984) collect a large set of examples demonstrating the connection between social configuration and morphology of the built form as a static setting.

As the hypothesis of this research, cycles are believed to be a third dynamic element within the system of objects (the first element) and their interrelationships (the second element). In any urban setting, these repetitive patterns are the main source of identity, provide orientation and are a main creator of memory. Barry Curtis regards memory even as: "Memory is one of the key ingredients in the creation of place…" (quoted in Borden 2001, p.63) and he reflects on this as: "Memory is rarely without contradictions, and it must be compromised in order to function". The UD project is an explorative project lead by two main research questions, firstly, do cycles participate in the shaping of cities, especially on the level of urban form? And secondly, how can cycles be integrated as a tool in the urban design and planning process? Distinguishing between three main groups of cycles, natural, activity and material cycles, the focus will lie on the activity group, daily rhythms and routines of individuals, living in the city and how these habits manifest in space (Neuhaus 2006). With both a theoretical and practical context, the UD project examines the spatial extension of an individual's routines in urban environments.

Figure 1 - Garmin Forerunner 405 : The gadget use for tracking

Methodology

GPS technology has become widely available with relatively accurate devices. For this study the participants wore a watch-like GPS device on their wrist, which we illustrate in Figure 1. The specific technology and accuracy of GPS systems is explored further later in the paper. Wearing it on a daily basis ensured the capturing of routines with the required level of detail over the minimum duration of the study of two months, ensuring the inclusion of weekly patterns. The data record contains location and time information, which can be mapped using a variety of methods and tools. Participants were not specifically selected, but they were all adults of different ages with a mix of female and male candidates from different backgrounds, family and work statuses. Each participant was met weekly or biweekly to download the data. This ensured a close contact between researcher and participant and allowed for informal discussions about the collected data and personal routines. Towards the end of the recording period, a formal interview was carried out allowing the presence of routines or habits to be noted that may not be identifiable in the GPS data.

Technology

For the study, GPS was used to track participants as they move around the city going about their everyday business. In this section the technology as such behind this approach will be discussed to create a context for the data collected and the nature of the findings.

GPS stands for Global Positioning System and is a global navigation satellite system. Based on a signal sent from satellites orbiting the earth, a specialised receiver device can accurately define its location in the framework of the Cartesian system. “Current generation navigation systems … determine the user terminal position through the time of arrival. In general, this kind of ranging technique is based on the measurement of the time interval employed by a signal transmitted by an emitter (e.g. satellite, radio beacon) at a known location to arrive at the user receiver” (Prasad 2005, p.15). For pinpointing a location, theoretically three satellites (reference points) would be needed to triangulate the position. However, due to a constant unknown bias, usually differences in clock time, for an accurate location, the signal of at least four satellites is necessary (Tsui 2005, p.9), where the fourth one is used for time correction. Accuracy can be up to a few meters depending on the quality of the satellite signal. The location is determined as a latitude

longitude pair of coordinates and together with the time information stored as location points on the device's internal memory. With the time information, this data can, as a sequence, produce a track as a line of movement.

Initially developed for military use, the technology has, in the last few years become very popular in everyday culture. Today a large variety of digital gadgets are equipped with a GPS receiver, ranging from in car navigation systems to mobile phones and cameras. This was initiated by the former president Bill Clinton's decision to lift the imposed selective availability (SA) restriction in 2000 (Prasad 2005, p.7). The SA was initially imposed to prevent enemies from using the system in military action against the United States. Following the SA removal, civil and commercial GPS accuracy increased from around 100m to somewhere between 3m and 15m (Pendleton 2002 as cited in Spencer 2003, p.56).

Geocaching or geotagging of images are only two examples of the usage of GPS in everyday life. Unfortunately a large number of location-based service applications under development are mainly lead by the idea of sourcing new areas for advertisement. A key player is Google with its location based information services that developed from Google Maps. The main technological problem for the GPS device is battery life. Most mobile phones cannot support the energy consuming GPS receiver together with the energy consuming communication to cell phone towers over a longer period of time or even a day. Specialised GPS devices currently perform much better and can last for days depending on the settings. Latest handheld devices can be the size of a watch. For these reasons a specialised GPS device was used for this study.

The signal strength is dependent on a number of environmental factors such as weather and physical environment. Errors can be on the satellite side, as ephemeris errors, related to incorrectly transmitted position or time. Even though each satellite is based on four atomic clocks, errors occur due to instability and a deviation of 10^{-8} seconds results in around a 3.5 m error on the ground (Parkinson 1996b as cited in Spencer 2003, p.52). The atmosphere also creates errors as the signal passes through, resulting in 2m to 6m errors. The largest impact on errors however is called position dilution of precision (PDP) and describes the signal quality as a result of satellite position relative to one another. A good signal is received if the four necessary satellites are distributed at the same height in the sky, whereas a low quality signal

results from clustered satellite positions or satellites being very low on the horizon (Spencer 2003, p.28). With the help of the corrected satellite position, published some time after the event by the GPS Master Control Stations (MCS), a correction filter for the data can be calculated. Similarly the location for a survey can be pre-checked, if the time is known, regarding the satellite signal, and especially if the PDP takes into account the quality of signal that can be expected. On the ground the radio signal can be reflected by hard surfaces resulting in a multi path interference. Buildings or trees can, through this, have a significant impact on the signal quality. Here the resulting errors can vary between 2m to 15m from large, highly reflective surfaces such as water bodies. This is significant in the urban setting of the UD project as it is located largely in a dense urban environment. The combination of narrow streets and high buildings, plus a large amount of street furniture and signage, can make it difficult for the receiver to establish and maintain the satellite signal. An additional implication for the quality of the satellite signal is the mode of transport. In the context of London, the underground and the bus play a significant role in the daily migration of citizens. Underground on the tube, no satellite signal can be recorded. Similarly on the bus or on the train, it can be difficult for the device to register a proper signal. A window seat is notably better that an aisle seat and further away from the building facade towards the road centre will also improve the signal quality.

As we have noted, in the UD study, a Garmin Foretrex 201 is used. It is a simple handheld GPS device that can be worn around the wrist, like a watch. When it is turned on, it starts automatically to search for satellite signals and if the position is determined, starts recording. Approximately every two days, the participants are required to recharge the device over night. Reception of satellite signals on this device is quite good, but can be affected by errors as previously described due to the setting. Nevertheless, results have been determined as satisfactory so far. Garmin, the manufacturer of GPS devices, has kindly provided two of their new handheld GPS, Forerunner 405 (Figure 1), to be tested within the setting of this project. The new model delivered impressive results and notably improved data quality in the urban setting.

The data collected by the participant is stored locally on the device and downloaded manually by the researcher, usually on a weekly basis. For the older 201 models, some data cleaning is required due to random location points saved when the device loses signal or has a weak signal. A database stores the

location points together with contextual and anonymised personal information. For visualisation purposes, the data can be output in various table formats and processed further, for example as a Diary Map of London (Figure 2).

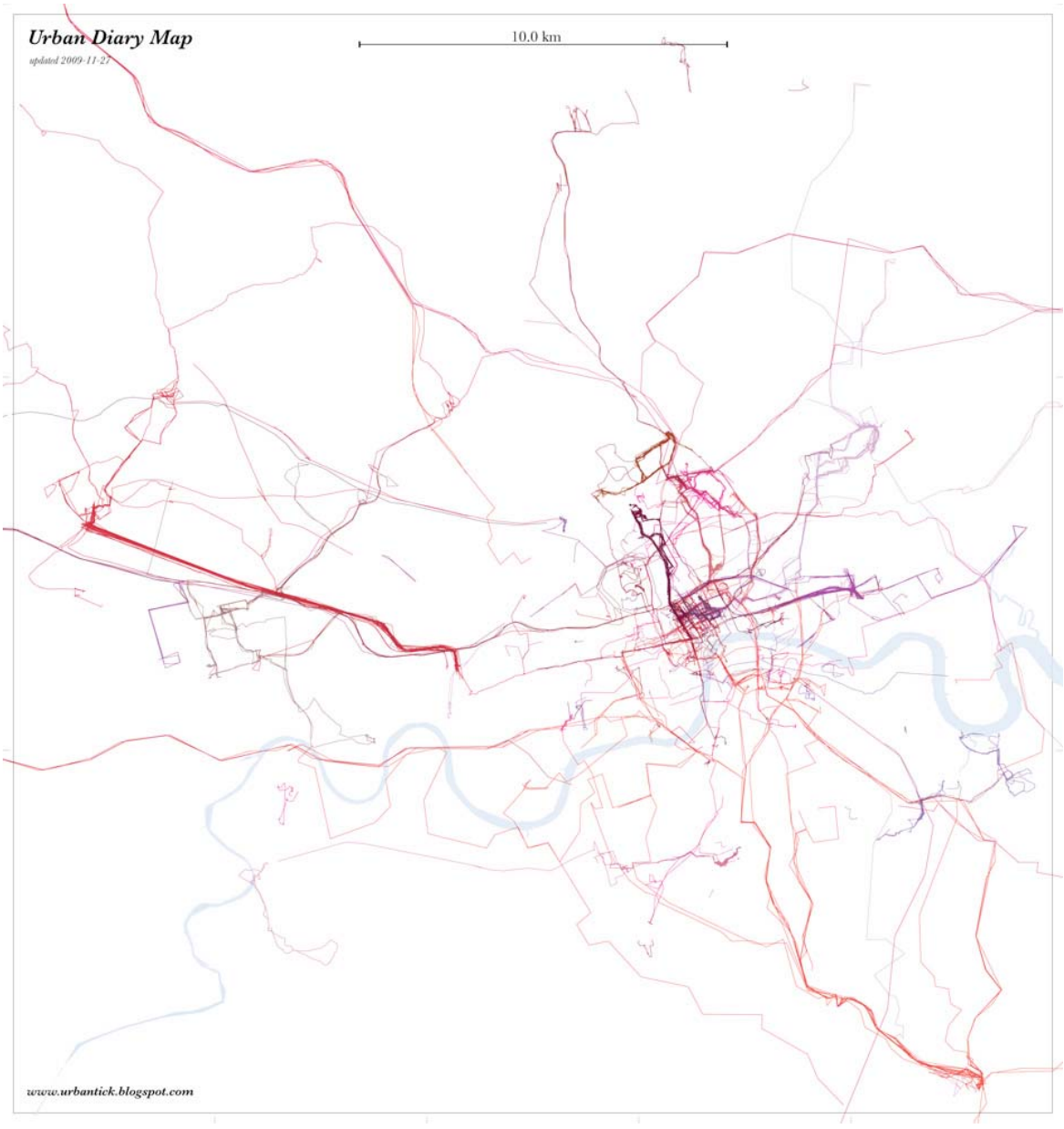


Figure 2 - UrbanDiary map showing twenty participants tracked over a period of two months.

Mental maps

During the UD interview, the participants were asked to sketch a mental map to allow participants to

express how they navigate the space in the city. In addition to the technical GPS record, this personal view has the focus on perception of space based on memory, experience, circumstances and current concerns. Through the comparison of the two different maps, new insights into people's motivations for choosing a route and individual methods of orientation can be explored. Participants were completely free on how to draw their 'map', the only rule was not to copy it from a street map or image. In addition they were asked to comment on what they had drawn, to record in depth information on perception and important factors beyond the sketch. Examples have been published on urbantick.blogspot.com together with an analysis of the drawings.

One of the most cited studies using mental maps is "The Image of the City" by Kevin Lynch. The study was carried out over five years and summarised in his 1960 book. Lynch states: "Every citizen has had long associations with some parts of his city, and his image is soaked in memories and meanings" (Lynch 1960, p.1). It is a fairly romantic description with a lot of implicit hints to society but expresses that there is some knowledge and meaning in each one of us about the environment we live in and navigate through. It is not about orientation, exact distance measurements or overarching, objective descriptions. Rather, it is about personal experience, judgment and what is physically and psychically important to the subject. Lynch states, "Most often our perception of the city is not sustained, but rather partial, fragmentary, mixed with other concerns. Nearly every sense is in operation, and the image is the composite of them all" (Lynch 1960).

As early as 1913 the pioneer of mental maps, as noted by Gould and White (1974, p.28), Charles Trowbridge, commented on how people have different senses of orientation. He concluded that there were two groups of navigators. Some people have imaginary maps in their heads centred upon the location of their homes. They are able to navigate a certain distance on familiar ground, but they would lose orientation in unfamiliar ground. The other group was more described as "egocentric" and orientated to their own position at the moment, with a better ability to navigate in unfamiliar territory.

The map is just one form of expression of these personal memories and descriptions. Although it is called a map, it has two fundamental differences. It has no scale and no objective direction assigned to it, the drawing of its elements may only stand in this personal context, e.g. there is no assumed north point unless

the author of the map assigns it. Nevertheless, some features of a map can be borrowed from conventional maps by the participant such as a top down view, symbols and so on. Other methods can be a description in words, both as a text or an interview. The business building block system Lego Serious Play is another creative way of expressing memories and perception in a hands-on sort of way. David Gauntlett from Westminster University is a researcher working with this method. He explains in his presentation clip "Representing Identities" on YouTube (Gauntlett 2008) that using these creative methods will get the brain working in a different way. He argues that we all have an embodied experience and that this experience is easier accessible through body gestures.

The instructions to draw a mental map are intentionally simple. The focus lies on the content and not the beauty of the sketch; there is no right or wrong. The key is that the sketch is not copied from a map or image but rather drawn from memory. Lynch introduces the mental map to the participants as follows: " We would like you to make a quick map of ... Make it just as if you were making a rapid description of the city to a stranger, covering all the main features. We don't expect an accurate drawing - just a rough sketch" (Lynch 1960, p.141). It is a quick exercise and does not require a lot of planning and thinking, and from our experience we can define three phases to the creation of the mental map. First is the skeleton phase, it contains most of the important information, objects, direction, names and paths. The second phase increases detail by linking between memories with information and description. This will often trigger some more memories and makes the map rich and representative. The third and last phase is the beautification process, where no more important information is added, but rather the sketch is adjusted and critiqued.

Mental maps have been used in a variety of spatial research. On one hand there are studies such as Lynch's with a focus on the physical environment. On the other hand there are studies to focus on the quality of the environment's perception through feelings like desire, stress, fear or happiness. Such a study has been carried out by David Ley in Philadelphia presented in "The black inner city as frontier outpost: images and behaviour of a Philadelphia neighbourhood" (Ley 1972) where participants responses have been processed to create an intensity topography. Sorin A. Matei develops a current similar project on fear in Los Angeles on www.mentalmap.info (Matei 2003). From participants responses, he was able to create a three dimensional digital surface to represent the amount of fear in the Los Angeles region. The colours red and

green are used to highlight areas of lesser or greater amount of fear.

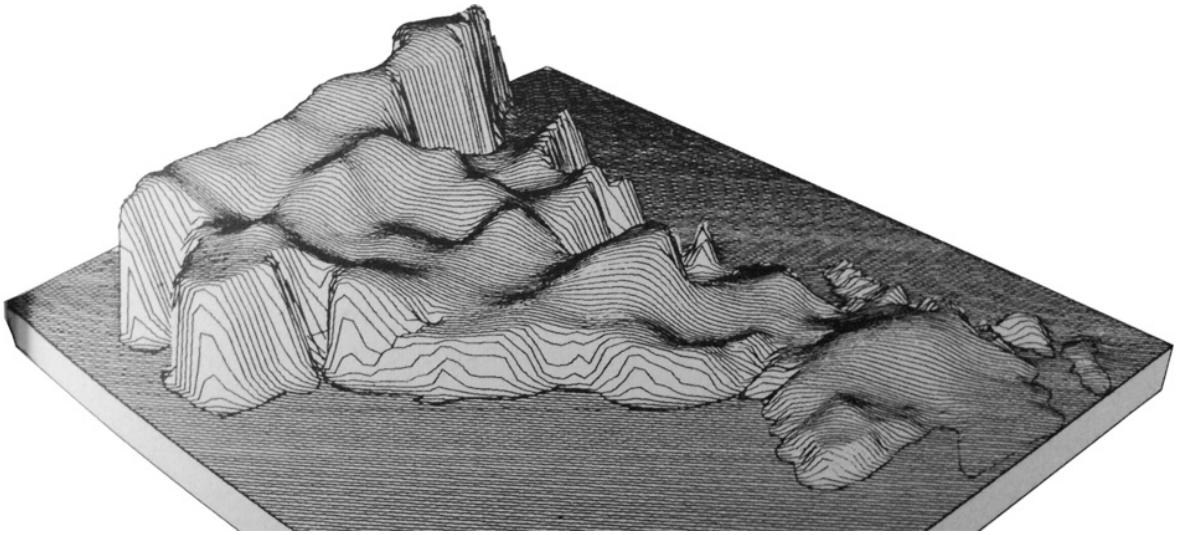


Figure 3 – A mental map of the desired locations of residency in the UK. Image by Peter Gould and Rodney White taken from Gould & White 1974

Peter Gould and Rodney White (1974) summarise an investigation into people's desires using mental maps in the book of the same name, they posed the following research question: "Suppose you were suddenly given the chance to choose where you would like to live - an entirely free choice that you could make quite independently of the usual constraints of income or job availability. Where would you choose to go?" (Gould & White 1974, p.15). From the responses, they generated a surface of desire for different areas in the world. In these early days, surfaces were visualised through contour maps, with each contour representing a change in value. In a very early 3d computer rendering of the data, they detail the UK by plotting the desired location of residents, as illustrated in Figure 3. Unsurprisingly, the taller peaks are in the southern part of the island. Those approaches do not actually work with mental maps as sketched by the participants but they use participant's responses to specific questions to generate them into a mental map that could be called collective.

While working with children, mental maps are often used as a method of expression, as for example, in "Environmental fears and dislikes of children in Berlin and Paris" by Olga N. Nikitina-Den Besten (2008). Besten's paper examines the absence of children in today's cities and investigates the highly specialised urban environment from a child's perspective of safety, fear and joy. Drawing is often associated with something for children or something that one does at school. For research with children, the method seems

appropriate but not for adults? As Gauntlett demonstrated in his workshops, there is a lot of potential using creative methods. The aspect of drawing should not be underestimated. It appears that adults often have more difficulties, compared with children, to draw even a simple sketch. Drawing is not something adults necessarily do very often.

There is a lot of information contained within the mental maps on how people perceive space, use space and ultimately how people create their space. As a very abstract concept, it could be compared to the technical creation of space in the virtual world as an orbit around the subject in time and space. The engine only renders a certain area or distance in a game scene and not the world, city or house as a whole. In a similar manner, the temporary space people create in the real world could be described as a bubble. Space as in social space or individual space is probably not the same as Euclidean space, which is the way we think about space generally. If we describe space from personal perception and a temporal point of view, the concept of space might be something very different from the space-in-a-box concept. The creation of space could be something very personal and through mental maps can be recorded as a very dynamic concept of temporal perception based on mood, concerns and circumstances.

Participants

This project is by definition looking at the urban area and participants all located within the Greater London Region. A secondary criterion for participants is that they are over the age of eighteen. To date, twenty different people's data has been collected through the UD project. We note that while this is a small sample and not statistically representative, partlydue to limitations in the availably of GPS units, it nevertheless allows several different types of characteristics to be represented. The study contained nine female and eleven male participants, nine participants, of whom six have dependent children, co-habit with a partner and eleven are currently single or live in a distant relationship. Looking at their occupation, ten are classed as students, eight employed and one is self-employed. All except one student and one employed participant work full-time.

With the GPS devices participants recorded their movement automatically, and they are not required to have a manual diary. For detailed trip information, participants are interviewed at a later stage of their data

collection. The interview was designed as a semi-structured interview with the main topics based on their personal schedule, transport and movement, experience of the city, orientation and memory. The two additional tasks are, firstly, to write down a rough personal schedule on a daily, weekly and yearly basis and secondly, the drawing of a mental map. The schedule helps with the interpretation of the data regarding patterns that are not in sync with the normal routine. It is also interesting to learn more about an individual's organisation, both in time and space. The mental map on the other hand is directly related to space and visualises an individual perspective. Both elements are regarded as important to the spatial narrative of everyday life in the city. In addition, this information is believed to be essential to understand the GPS information. The contact between researcher and participant during the two-month period is relatively close. Meetings take place on a weekly or biweekly base to download the collected data from the device through the researcher. This also allows for informal chats. As mentioned earlier, the personal routines and habits are the main topic of these discussions. Very often participants suddenly become aware of a number of routines they follow without having noticed beforehand.

Usually participants have a different perception of their spatial habits and will describe them at the beginning of the tracking as diverse and spread over a large area of the city. The first few times they see the collected data, it can be disappointing for them to see a rather strong routine. Routine seems to be negatively perceived and participants often would describe themselves as active, flexible and spontaneous implying a widely spread range of activities with a diverse movement pattern. Of course one does not necessarily exclude the other but the usual interpretation of a strong pattern tends to be this way. This phenomenon might have its origin in the modernist ideal conceptualisation of space and movement. It could be a late descendent of the illusion of the automised freedom that played an important part in modernist spatial concepts. The beauty of the machine and the associated freedom newly inherited by the middle class. As Alistair Bonnett puts it "Thus 'ordinariness' and 'everydayness' are maintained as the provinces of the working class, …" (2000, p.28).

To describe the personal routine, participants often refer to someone they think is very flexible or very inflexible; just to provide an example for comparison, it appears to be more convenient to define it via metaphor or characters. It is a personal subject where people prefer to make assumptions and live with stereotypes. The aim of the interview is to collect information on how the participants actually perceive

the activities and how they would describe these routines. From the GPS data, a schedule can be generated, but this might not reflect the intended plans of the individual.

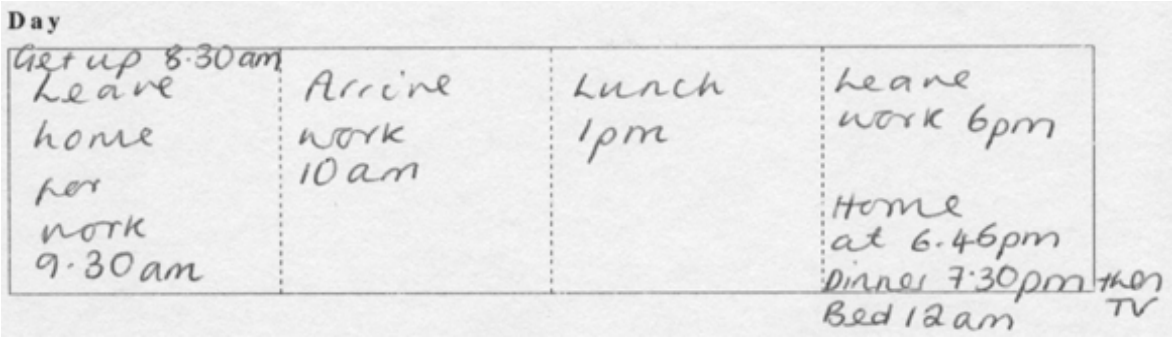


Figure 4 – Participant's schedule for a day

The participants were then asked to write down details about their schedule, focusing on important structuring events. Three scales were of interest, the day, the week and the year. It turned out that discussing participant's individual schedules is the longest and most complicated part of the interview. It seems to be not as simple to explain one's daily schedule. There are a lot of ifs, ands, ors together with 'thens and woulds'. In short it is presented as a dynamic string of decisions with numerous dependencies. Nevertheless, there are strong elements of directory within this pool of fluent decision making. Again the major element is the working week versus the weekend and then there are the clear western standards for a daily structure both on weekdays, illustrated in Figure 4 and weekends as illustrated in Figure 5. The focus does represent the personal situation. There are big differences between participants that have dependent children and those that have none.

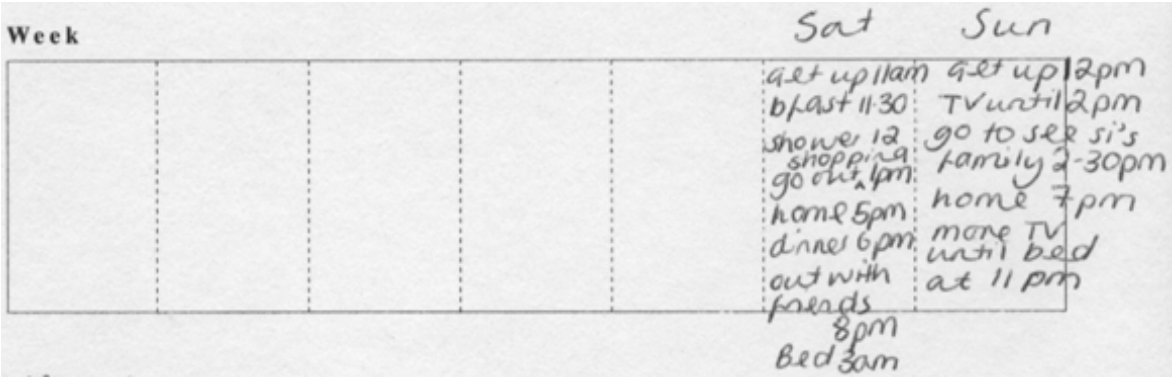


Figure 5 - Participant's schedule for one week

Taking the two time frames together, these represent the participants "mind map" of weekly activities. Regarding the information, one might expect large gaps between plans and activities, however the two are largely similar. The "mental picture" of our routines is strong, and comparing this to participants' perception of their spatial activities, this is surprising. In spatial terms people often think their activities are much more flexible and they are traveling more than they actually are, as explained above.

While working with these schedules it occurred to us that the time spent interacting with the urban morphology, as moving in the city, is rather restricted. There are clearly defined timeframes, for each individual of course, but time spent in the city is limited and certainly not random. From the examples in Figure 4 and Figure 5, activity that involves spatial interaction on weekdays is basically during the rush hour in the morning and the evening. Other than this there is little activity. The weekend pattern is different in that there is afternoon and evening activity, with Saturday being the most active day.

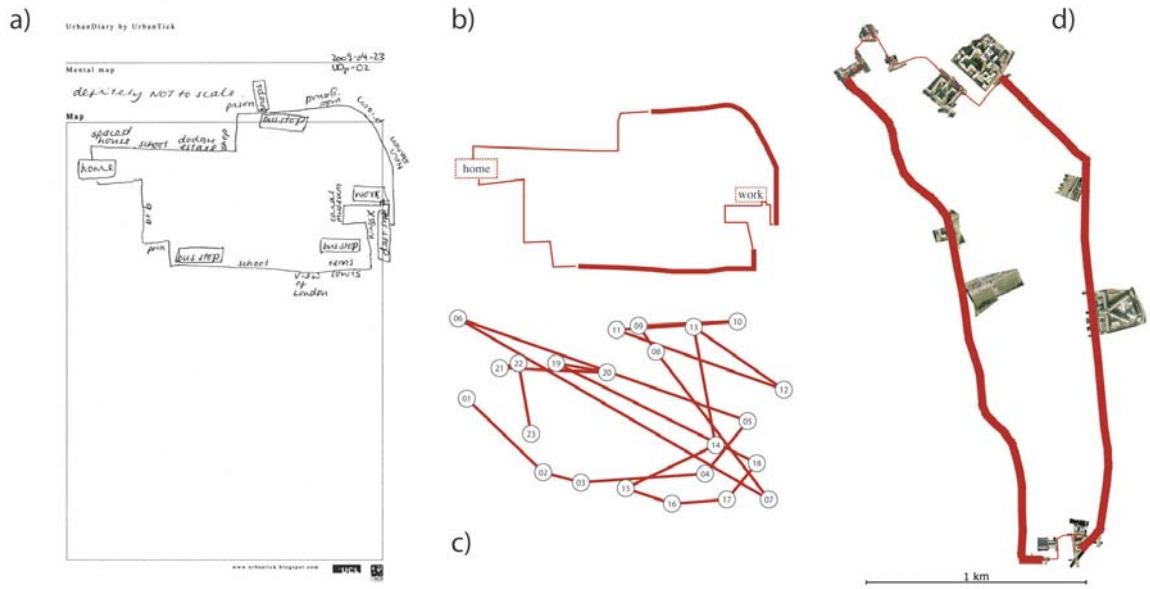


Figure 6 - UDp-02 mental map a) compaired to GPS record d).

The information about yearly events has not generated much valid data, as for most of the participants, this category was too broad. It seems not to be a unit that people plan or even live in, even though in professional life, this is definitely an important time frame. In terms of personal activity few have had planned activities other than the expected Christmas and Easter breaks. Birthdays and holiday were among

the other named activities on a yearly scale. Regarding the city and spatial morphology longer timeframes are of course interesting, but the connections have probably to be found elsewhere. It is assumed at this point that urban events such as festivals, memorial days or concerts are beyond the everyday life of individual people.

The topics space and movement look into how participants use the space on a daily basis and how it is perceived in connection to the routines. It is of interest to see how they are able to connect the spaces they frequently visit regarding their mental map. This is especially notable in the context of London, as for example, traveling by tube might leave the traveler unable to connect start and end location spatially. Movement on the other hand is directed towards how participants travel and how this is part of the routine. Again, it is interesting to hear from the participants how they see themselves and how much they think they travel. Most of the participants have clear preferences regarding the mode of transport. Some mainly travel by tube, because it is easier to navigate with clear destinations, whereas others would only very reluctantly go in to the tube, because it is narrow, underground, or busy. Instead, they prefer the buses and describe them as flexible and close to their destination.

For the spatial experience and memory, the participants were asked to draw the mental map of one journey in the sense described above in the section mental map. For this setting the focus was specifically on the commute, the journey from home to work and back. To draw the map they are asked to include not only the direction they travel, but also additional elements, things they use for navigation, orientation or simply reminders. Those can be street names, buildings or urban settings even views or atmospheres can play an important role here. The paper for the mental map is prepared with a frame/box to further limit the space. Experience has shown that this additional boundary line helps navigating on the “white paper” for “inexperienced sketchers”. Participants tend do draw towards the edge, then realising that there is no more space to draw the second half of the journey. The additional space outside the frame can accommodate some of this information which is otherwise lost or drawn in a disconnected way. In the example illustrated in Figure 6a, only the very top of the sheet was used. Participants are asked to comment on what they draw and the transcript of this helps to interpret the drawing later, for example regarding the sequence. Comments they have made about their feelings in connection with a certain element or configuration can also be traced back. A frequent phrase for example is “This is not to scale” pointing out

that there is an uncertainty about actual distances.

In the example pictured, Figure 6a, contains the mental map as drawn by the participant where Figure 6d, is a reference map generated from the same participants GPS record. In the middle, the two analysis diagrams look at relationship of mode of transport (Figure 6b) and the sequence of the map creation (Figure 6c) as a dot-to-dot doodle. Both are based on the participant's mental map.

Modes of transport in this example are a bus journeys (bold lines) and walking (thin lines) to and from the bus stop. Comparing the length of both modes to the GPS record, it is clearly visible that the length of the bus journey is different in the mental map and the GPS reference. Similarly the walked part is represented in more detail in the mental map than the bus journey. This suggests that the perception of space changes with time and especially speed. Less detail is registered by some commuters on the bus as they "know" the route and focus on the destination. Some of the participants have explicitly stated in the interview that on the bus they ignore the route and concentrate on a book, the music playing through their headphones or simply just look out the window without registering anything. This leaves them with little knowledge that could be used to describe the journey.

During the interview, aspects of daily activities come up, much are of note. Many participants feel the need to explain their activities and excuse for them. This seems to be related to the amount of movement, flexibility or distance, and routine is viewed as negative, whereas flexible and independent is deemed positive. This experiment has been insightful in this respect, as the recorded movement unveiled routines that seemed to be much stronger than the participants have so far realised.

Visualisation and Findings

The GPS tracks have been used to map the participant's activities. The data recorded by the device is in effect only locations, as a series of points. The trajectory map results from connecting these points with lines. These trajectory lines represent what is assumed to be the line of movement. If the recorded points are close together recorded on a frequent interval this is believed to be representative of the participant's movement.

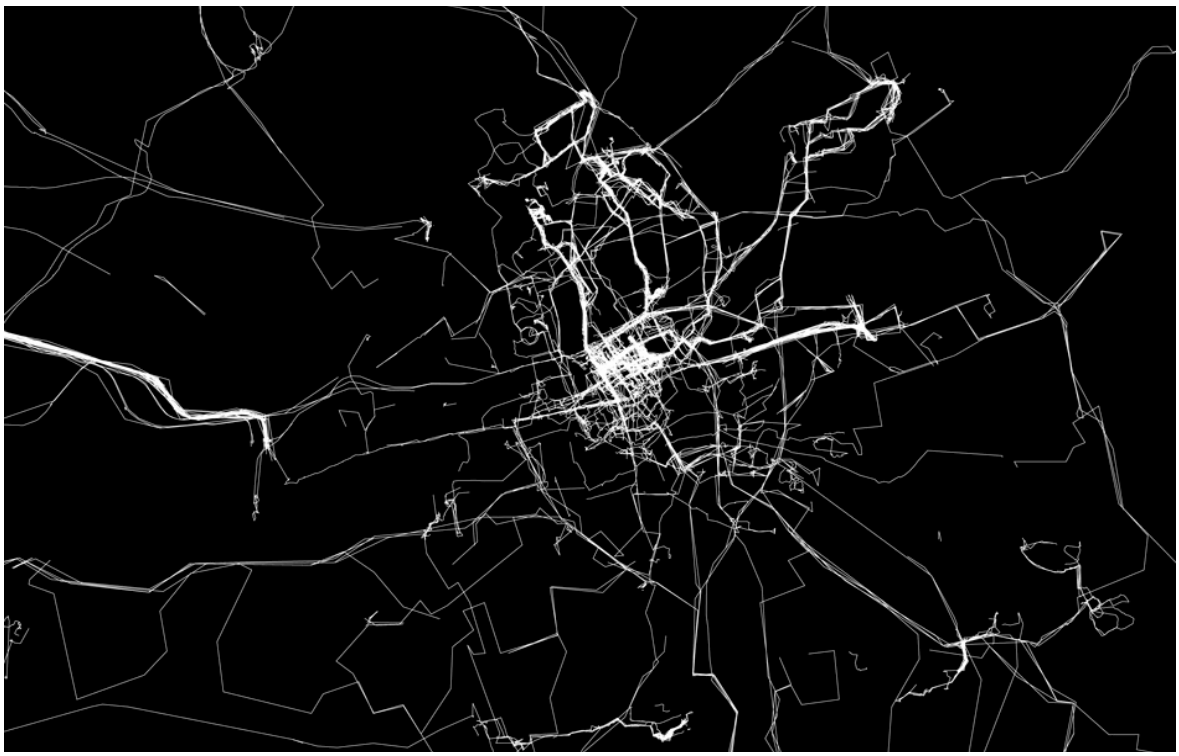


Figure 7 - London as drawn from the twenty participants' movement path.

Over the period of the tracking, the map that built up started to show patterns which mainly represent the occurring repetition in the participant's behaviour. Thick lines start to accumulate on the daily routes and draw out the very personal arteries of the city. Most of the participants rely on the public transport network and therefore are channeled into the routes simultaneously used by thousands of fellow travellers. These personal arteries become collective arteries and start to represent transport corridors. The major overall pattern that starts to show up from early on is the very London like characteristic of a centralistic radial structure (Figure 7). The trajectory map starts to look like a star, with the majority of the traces drawn from an outside location into the centre and back out again. Based on the Transport for London zone plan, most participants lived in zone two or three, but traveled into zone one for work. This traveling is generally in a predominantly straight line pointing at a virtual centre. This radial pattern is directly related to the structure of the London infrastructure layout. Compared to records of other cities (Figure 8), this characteristic is individual to each city and is determined mainly by the morphology, transport network and citizen behaviour.

Although the raw data is only point information, for visualisation, mainly 2D mapping purposes, the

recorded location points are used to render a line representing the movement. The reason for this is the better sense of continuity and sequence this provides. There are cases where the device has lost signal over a longer period due to environmental factors as explained above in the technology section. Lost signals are however generally picked up at a later time. This is the case if participants are traveling underground, using the tube. In this case the tube station is the point of disappearance and another tube station the point of reappearance. In Figure 9 we represent these as dotted lines to give an idea of how movement and places are connected. This allows making sense of a number of islands of activities to be tied into the overall picture. Currently no data is added to the journey data, e.g. tube lines.

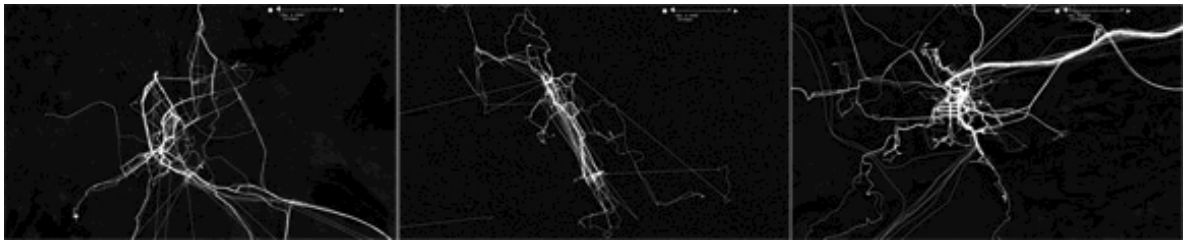


Figure 8 - Track structure comparison between Basel Ch (left), London UK (middle) and Plymouth UK (right)

Depending on the participant's transport preferences, the emerging pattern of activity draws a continuous track or starts to build up isolated and spatially disconnected areas. Guy Debord examined and defined this phenomenon in his Naked City text and challenged traditional ideas of mapping with the map of the same name (Sadler 1999, p.60). One major factor to influence this pattern of detached locations is of course the mode of transport, in the case of London the tube. However from the experience through this project this pattern is also connected to people's personal preferences. Some of the participants would not use the tube for personal reasons and other would solely use the tube for the same reasons. Often the argument is the sense of orientation participants associate with the mode of transport, e.g. simplicity of the London tube map.

As mentioned before, not all patterns end up as a collection of disconnected locations. There is another group of participants that maintains a record of continuous traces of movement. Two of the participants happen to be a couple and their individual movement pattern represents one group each. She mainly uses the bus, whereas he mainly uses the tube, which we illustrate in Figure 9. Their record strongly illustrates

the characteristics of both modes.

Figure 9 - City islands, the impact of mode of transport on personal psychogeography of the city

The aspect of time in this kind of mapping is not represented as such. To visualise this part of the information, other techniques have to be used. One method is to apply colours according to the time. This method has its limitation as the colours often are used to distinguish between different individuals. But it was successfully tested in a single participant environment.

Another method to represent time and location simultaneously was developed in the 1970's by Torsten Hagerstrand (1978). The model produces a 3D visualisation of the data, using the x- and y-dimension to refer to the spatial location and the vertical z-dimension to plot the time. This space-time aquarium (Carlstein et al. 2001) comfortably merges the two different types of information. It was also implemented successfully in work done by Kwan summarised in GIS Methods In Time-Geographic Research (2004). Although the readability of the object can be tricky, it works well in an interactive 3D environment but can be confusing when used as a static 2D print with a lot of contextual information. Patterns of repeated

activities do emerge as obvious with this method, which we illustrate in Figure 10.

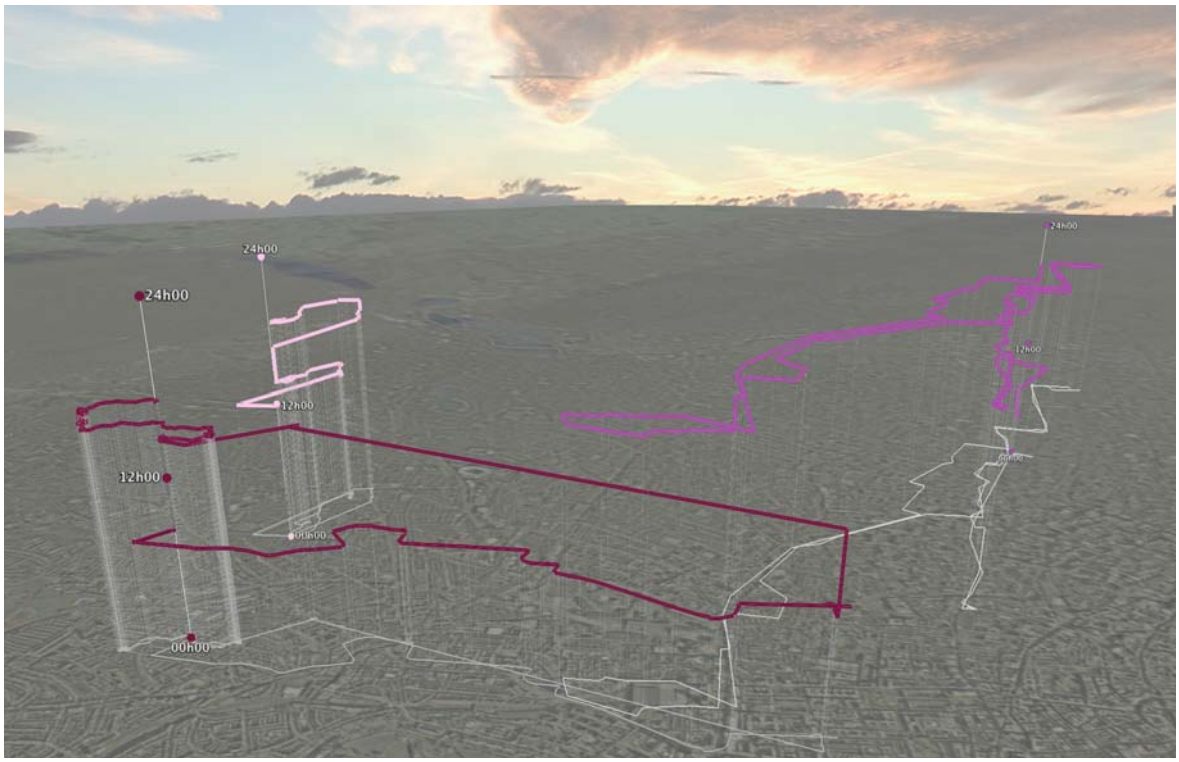


Figure 10 - Space-Time aquarium after Hagerstrand plotting three participants in the UrbanDiary data

GeoTime has turned this method of representation into a functioning software program including a user interface (Kapler & Wright 2004). From a point data set, it can build the space-time aquarium and offers a set of tools for analysis. During all processes, the software keeps the representation of the aquarium flexible and the representation can be altered at all times. This maintains a very welcome flexibility and helps with the reading of the data. GeoTime has been used to run analysis on the UD data set. Specifically the "Meeting Finder" proved very interesting. With this tool, points, where trajectories of movement meet criteria of distance and time, can be identified. It turned out that participants of the project have been in the same location without knowing each other, suggesting that London is perceptually not so big after all.

A further method to map time-based information is by employing animation techniques. With this method, the passing time can be represented through sequential frames. A number of clips have been produced and continuously updated as the UD data log grows. Usually Google Earth has been used as the visualisation platform. The built-in functionality to replay time tagged location information is simple to use and powerfull. To achieve more clarity in pattern representation, the recording period was usually compressed

and represented as a single day. This means superimposing all the days onto a 24-hour period. Reoccurring events show up as accumulated activities, whereas one-off activities are represented as single lines. The Virtual London Model, developed by Michael Batty and Andrew Hudson-Smith at CASA (Batty & Hudson-Smith 2005), has been used to set the recorded locations into a spatial context. This setting is regarded as a first step to combine the time-based information with the morphological space of the city.

The graph visualisation focuses on the quantitative aspect of the data. The idea is to look at the schedule information contained in the record. This is of interest as the project aims to enhance knowledge on personal, spatial routines. The graphs are visualising the amount of activity over a specific time period. The periods are one day, one week and one month. Using these units of general time frames helps to establish an appropriate framework for the data. Participants are all understood to use these time frames. More specific units could relate to religion, culture, job or specific responsibility. These will be represented on a more individual level of analysis. In the graphs, the x-axis represents time whereas the y-axis refers to amount of activity drawn directly from the GPS log; this is measured by the number of log points the GPS device has stored for the time period in question. The graphs do not provide information about time spent in one location for they solely focus on travel time between destinations.

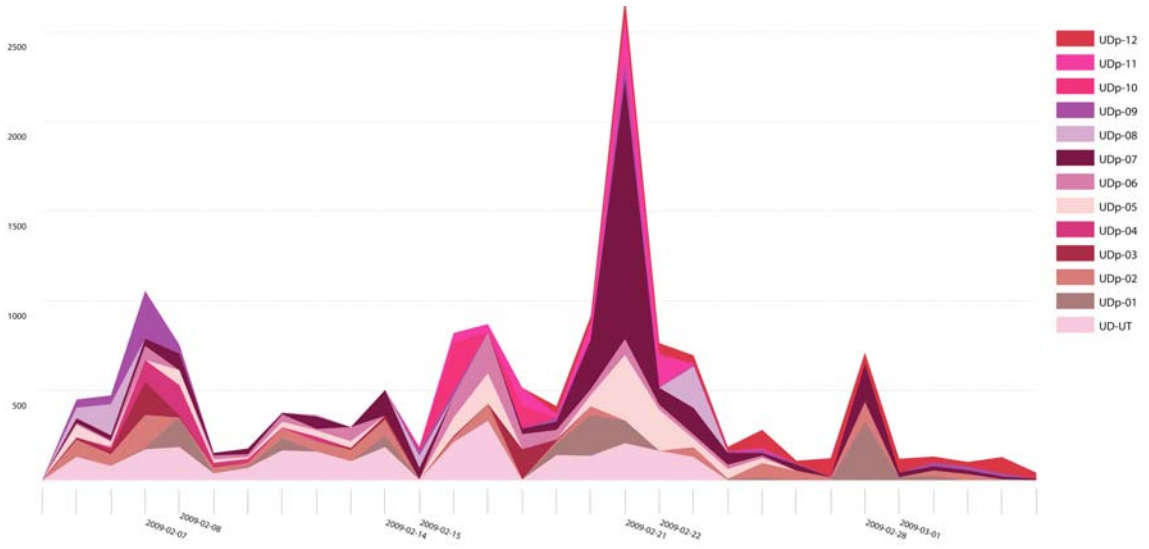


Figure 11 - Diary graph over the period of two month.

If we look closer at the graph illustrated in Figure 11, the following can be observed. One month analysed by day and participant shows the weekly pattern, with four peaks over four weekends. They generally do

match, although one peak has slightly moved into week three. This was the UK school midterm week, a holiday break. Participants who have children or work in a school have spent more time traveling during the normal weekdays. Surprisingly, the Sunday at the start of this mid term week is very low. All of the participants have recorded little activity. This may have been due to inclement weather conditions, resulting in the participants more likely to stay indoors. On the contrary, one Saturday stands out intensively. One of the participants had an intensive outdoor sports day, during which he generated a large number of points. Activities seem to accumulate on Saturdays. This shows up in particular in the week's graph. Saturday has more than double the amount of points over other days of the week. Not only this one participant who is doing intense sports activity on Saturday but also all of the participants tend to have significantly more activity on Saturdays. Other than that, the weekdays are fairly even in terms of activity with a tendency to lower activity midweek.

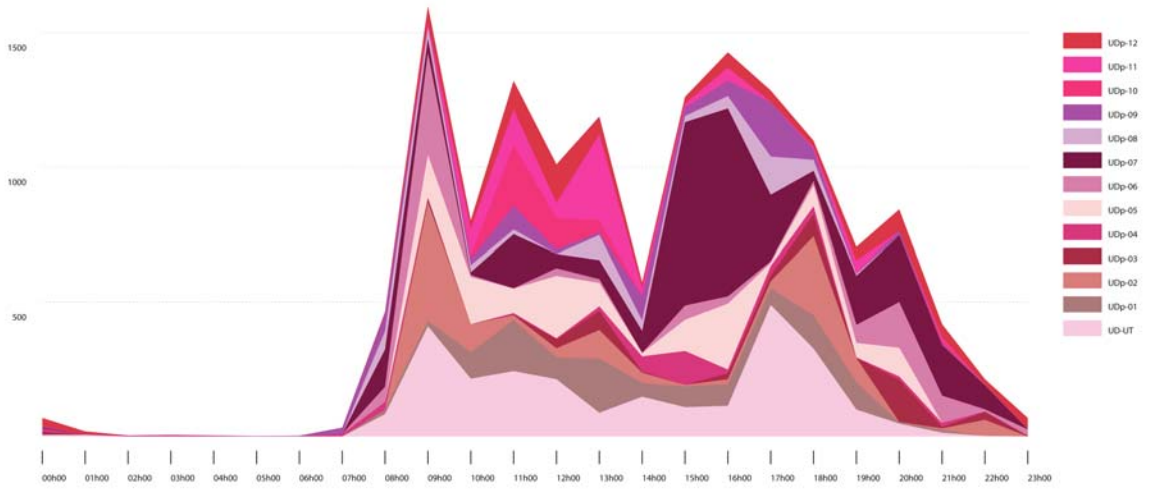


Figure 12 - Graph plotting GPS records of sixteen participants superimposed on to 24 hours - one day

Compared to the regularity of the week, the 24-hour graph, illustrated in Figure 12, details a number of peaks. The graph starts at midnight with an expected flat portion representing few activities. In the first hours of the day, there is some activity but it reduces to virtually zero in the early hours of the morning. The day then starts with a first peak of the morning rush hour. After seven o'clock, participants start leaving the house, but the recorded activity takes off from eight, peaking around nine and coming to a first low point around ten. By looking closely at the participants involved in these first two peaks, one can see

that actually there are two groups, one generating the first “rush hour peak” and the second group creating the second similar peak about one hour later. The second peak has a twin peak with a first high point around 10h00 and a second one just before lunch around 13h00. This second group turns out to be mainly participants with small children, not yet school age, to undertake morning activities. After lunch, around two o’clock, there is the low point of the day with the least activity during this 24-hour day apart from the early morning hours.

After the lunch break, there is a notable afternoon / evening peak. This is the result of a combination of weekend and weekday activities such as work and outdoor sports mentioned above. Included into this peak are a first evening rush hour high point between five and six and a smaller second peak around eight, possibly pointing to the visit of the pub after work. Generally this resembles the expected daily routine pattern of a western city. More surprising is the accuracy the pattern shows, rather than any unexpected results. Although the sample is not representative, we did not expected to find such regularity.

Conclusion

Through the above visualisation of the data, some preliminary findings can be drawn. There are two main levels of interest; one is at the level of the individual and the context of the personal routine and activity. The other one is at the collective level looking at overall patterns and rhythms that point towards a spatial society and urban morphology. The first one is ultimately present for the participants and mainly the context they each perceive themselves in. The second, collective level is something that is to be constructed from the individual activities. The present research was particularly designed to capture individual data and not collective data to gain insight into the routine of the basic unit. This will help to understand how the two levels interact.

Timewise there are big differences between work time and personal time. The pattern of this almost universal division is an extreme determent of what all participants do. In addition there is the pattern of the week with weekdays and weekends that structures the time over this period. The workdays are represented as a back and forward movement between the home location and the work place. The London morphological characteristic here loosely resembles a star shape; as discussed above, people live outside

and travel linearly into the centre and back out. To some extent this might depend on the data sample and the pattern observed here might not apply for all configurations. However, the routine in movement between a few fixed destinations shows up clearly throughout. Over time each routine defined location builds up a sub local area. Depending on the activity and the time spent in this location, the area grows while the creating individual becomes familiar with the location.

The way the different destinations are connected spatially depends on the mode of transport and personal preferences. For some participants, the workweek tracks are two islands on the map, as most of the traveling happens underground, where as other participants travel to work by means of over ground transport and the map shows an intense continuous collection of tracks. The weekend travel pattern on the other hand is mainly focused around the home location or tends to be directed outwards, away from the city. Very often this is directed by the location of friends and family, also the location of shops and amenities such as markets, parks or playgrounds play a major role as attractors.

By looking at a neighbourhood area where participants live, the local pattern becomes more obvious. The weekend pattern shows activities within the neighbourhood and local streets rather than the main routes. Not only, but more intense is the local activity of participants with dependent children. Local amenities and activities play a major role in the weekend planning. Especially if the weather is poor, the local activities are popular. For all the participants, visiting friends and family is another major during the weekend days. Their home location creates another set of destinations with clear directions.

Figure 13 - What shape are you? Track records show distinct individual pattern of four participants over the same timeperiod and represented at the same scale.

What shape are you? It emerged from the recorded data, that each participant has her/his unique pattern of tracks, which we illustrate in Figure 13. Almost like an individual fingerprint, the shape created by daily

movement is unique. The shape is determined by a number of factors such as the spatial relationship of destinations, the distances traveled, the amount of travel and the intensity of repetition. The first point, the relationship of destinations, makes for the overall shape and the last point, the intensity of repetition, makes for the character of the shape.

This preliminary study, to trace citizen's spatial habits, has provided the study with a lot of valuable data and a number of possibilities for mapping the data have been explored. Findings so far, have shown that people in the city seem to live along rhythms that appear to be largely congruent, more so than we expected. The small sample of twenty participants is definitely not representative, but enough to show that there are patterns on the level of collective activity. The sample will need to be carefully chosen once the study shall grows to include a larger set of observations.

In terms of technology, GPS tracking has been successful and proved to be a good method for collecting data on individual movement. The involvement of participants by wearing a special device and "being in charge" of the collection could in this respect be positive. This will show in the next stage of semi-structured interviews with the participants. Having said that, there will be some next steps of investigation with the UD project. This will continue on the individual level and will be interviews directed towards understanding participant's perception and memory using mental maps.

The analysis of the project data so far has been very much personal and individual. Another step will be to look at ways to combine the data, to move towards the analysis of the collective level. This will be closely connected to the body, both of the participants but also the city, looking at morphology as a product of rhythmic processes.

Aknowledgement

The author would like to thank Garmin, who supplied Forerunner 405 devices and the UCL Transport Department, who supplied the Foretrex 201 devices, that have been used. The author would also like to thank the participants of this study.

References

Batty, M. & Hudson-Smith, A., 2005. Urban Simulacra: London. *Architectural Design*, 75(6), 42-47.

Besten, O.N.N., 2008. Cars, Dogs and Mean People: Environmental Fears and Dislikes of Children in Berlin and Paris. In *Urban Trends In Berlin And Amsterdam.* Berliner Geographische Arbeiten. Geographisches Inst. der Humboldt-Univ., pp. 116-125.

Bonnett, A., 2000. Buses. In *City A-Z.* London: Routledge, pp. 26-28.

Borden, I. ed., 2001. *The Unknown City: Contesting Architecture and Social Space: A Strangely Familiar Project*, Cambridge, Mass: MIT Press.

Carlstein, T., Parkes, D. & Thrift, N.J. eds., 1978. *Timing Space and Spacing Time*, London: Edward Arnold.

Certeau, M.D., 1984. *The Practice of Everyday Life*, Berkeley, CA: University of California Press.

Gauntlett, D., 2008. *Representing Identities (Part 1: Method)*, Available at: http://www.youtube.com/watch?v=LtS24lqluq0&feature=youtube_gdata [Accessed September 16, 2009].

Gould, P. & White, R., 1974. *Mental Maps*, Harmondsworth: Penguin.

Hagerstrand, T., 1978. Survival and Arena. In *Timing Space and Spacing Time - Human Activity and Time Geography.* London: Edward Arnold.

Hillier, B. & Hanson, J., 1984. *The Social Logic of Space,* Cambridge: Cambridge University Press.

T. Kapler and W. Wright, 2004. *GeoTime Information Visualization,* IEEE InfoVis 2004.

Kwan, M., 2004. GIS Methods In Time-Geographic Research: Geocomputation And Geovisualization Of Human Activity Patterns. *Geografiska Annaler Series A-Physical Geography,* 86 B(4), 267-280.

Ley, D., 1972. The black inner city as frontier outpost : images and behavior of a Philadelphia neighborhood /. Available at: http://worldcat.org/oclc/6643324 [Accessed September 16, 2009].

Lynch, K., 1960. *The Image of the City*, Cambridge, MA: MIT Press.

Matei, S., 2003. Mental Maps: Social and spatial research on emotional and affective implications of maps and space. Available at: http://www.mentalmaps.info/ [Accessed September 16, 2009].

Neuhaus, F., 2006. *Cycles in Urban Environments*. MSc Urban Design Thesis. University College London, the Bartlett School of Architecture. Available at: http://cyclesinurbanenvironments.blogspot.com/.

Prasad, R., 2005. *Applied Satellite Navigation Using GPS, GALILEO, and Augmentation Systems*, Boston, MA: Artech House.

Sadler, S., 1999. *The Situationist City*, Cambridge, MA: MIT Press.

Spencer, J., 2003. *Global Positioning System: A Field Guide for the Social Sciences*, Malden, MA: Blackwell Pub.

Tsui, J.B., 2005. *Fundamentals of Global Positioning System Receivers: A Software Approach* 2nd ed., Hoboken, NJ: John Wiley & Sons Inc.

urbanTick, 2009. City islands - on the linkage of everyday locations. *UrbanTick*. Available at: http://urbantick.blogspot.com/2009/03/city-islands-on-linkage-of-everyday.html.

urbanTick, 2008. Comparison. *UrbanTick*. Available at: http://urbantick.blogspot.com/2008/12/comparison.html.

urbanTick, 2009a. London Diary Week Three. *UrbanTick*. Available at: http://urbantick.blogspot.com/2009/03/london-diary-week-three.html.

urbanTick, 2009b. the linkT. *UrbanTick*. Available at: http://urbantick.blogspot.com/2009/01/link-t.html.