"THE EGOCENTRIC CITY"

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"This dissertation is submitted in partial fulfilment of the
requirements for the degree of Master of Science in Virtual Environments,
(Adaptive Architecture and Computation)
from the University of London"

Bartlett School of Graduate Studies
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15th, September 2005

ABSTRACT

This thesis is going to discus the advantages of the use of a GPS as a tool for surveying the pedestrian movements of individuals in an urban environment.
An experiment is going to take place that will try to evolve City designs specifically for the pedestrian movements of particular individuals whose tracks have been recorded with a GPS for this specific purpose. The aim is to see if the rest of participants' movement habits have been affected by this mutation in the city grid and if yes in what ways. As Cities can be considered as Emergent environment that are generated through the interaction of several factors it would be interesting to see how this different way of generating city plans would affect the outcome.

TABLE OF CONTENTS

INTRODUCTION

All cities have a very interesting characteristic; the fact that they all start from fluid and abstract ideas to be transformed into a rigid and solid city as time moves on. It is us, the inhabitants, who create in, and comprehend with our minds a series of plans, all unique and optimal, but somehow these perceptions are mutated into a single entity that gradually materialises into the form of a real breathing city. The living city is informed of its shape by the way the inhabitants are making use of these abstract ideas and, strangely enough, the more people share the same perceptions of a city, the more complicated patterns of traffic will emerge.

Thus, there has developed a relation of dependence between movement and the city's form; movement is what actually affects the form of every city, whereas the form of a city is always influenced by the movement of its inhabitants. And given their dependency one on the other, these two notions, movement and form can never be solid or stable, but they are always fluid and abstract.

A justification for the never-ending fluidity of the dependence relation between movement and the city's form might be the fact that cities never remain the same for long if they are meant to keep up the pace with the always-changing needs of their inhabitants. Therefore, the cities need to be flexible in order to adapt to the socio-cultural changes of their inhabitants.

However, in the long term, the mass movement patterns have "forced" most cities to develop in a compromised layout that sometimes lacks of individuality and become impersonal. The cities designed on a grid could be described as places where the planners had to compromise in order for the space to survive as an extension of a community.

As such, cities constitute an excellent example of emergent behaviour systems. In fact, as Holland (1960) notes, “cities have no central planning commissions that solve the problems purchasing and distributing supplies… How do these cities avoid the swings between shortage and glut, year after year, decade after decade? The mystery deepens when we observe the kaleidoscopic nature of large cities”. And as he continues, “Buyers, sellers, administrations, streets, bridges, and buildings are always chaining, so that a city’s coherence is somehow imposed on a perpetual flux of people and structures… a city is a pattern in time”.

In addition, according to Andrew Allan, professor in the University of South Australia, there is a notion about emergent behavioural systems that “there is a complex system to begin with and that they (cities) are self-organising”.

The same viewpoint is also supported by the scholar Steve Johnson, who suggests that the local system has an instinct intelligence with feedback loops that create new behaviours or what might be termed as “emergent behaviours”

A very good example to explain the operation of such a phenomenon is that of the ant colonies. In their search of food for the colony the worker ants leave a trail of pheromones for the other ants to detect and follow. These trails provide a feedback loop which indicates to other members of the colony where the optimum routes to a food supply are and this becomes a part of the colonies collective intelligence (or as previously mentioned mass perception of the city).

Another successful example of the concept emergent behaviour could be located in contemporary computer search engines, such as *Google.* Google is a good exemplar of computer software technology where collective knowledge is used to map the quickest and most direct pathway to a website of interest.

A simple way of explaining how Google works is that it moves around in the web and stores the local cache of the webpage's it finds and builds a lexicon of common words which it uses every time a user conducts a search. The clever part that Google does is to consider both the anchor text of links to a page as well as the text of the page itself, so it can look for images, audio, and video files at the same time. So this series of simple rules provide the user with an emergent outcome of thousand maybe millions of web pages (http://syn.cs.pdx.edu/~jsnow/google/google.html).

This is why the use of a computer simulated environment that somehow mimics reality can become so interesting; in such a reality, cities could constantly change and, consequently, retain their fluidity. Plans could be customised to a personal level, creating cities specifically designed for a particular person's choice of movement in a particular moment of time. Cities would have been able to change in so as to provide optimal use for their inhabitants, who would no longer have to bother about the evolution of the contemporary city map in the future. There will no longer be a need for the cities to be solid and rigid any longer, their grids could mutate constantly providing faster ways to the destinations this individual has chosen for that particular period in time.

In order to study such a phenomenon, one could hypothesise on what an individual's movements might be, or even create a computerised simulation of a pedestrian's walking patterns inside a city's limits. Nevertheless, this would not be the right way to approach such an experiment, as an individual's habits are very hard to predict and so much simpler to follow.
GPS is a global positioning satellite that is used to show the exact position of an individual or a location on earth. Thus, using a GPS receiver is the simplest and most efficient of ways so as to follow someone around with ease and be able to collect all sorts of detailed information about the way she / he acts within the city, without

influencing him/her in any way. To put it succinctly, GPS is easy to handle and unobtrusive at the same time. It provides its user with the range of routes that a person would follow in order to carry out his / her daily activities.

But the real question is *how* can something like this effect the rest of the users? Would this new "egocentric" city force an unpredicted emergent way of use by its inhabitants? And finally, will it mean that this new city works differently than the old one for each of its users or is it actually the same city as it was before with just a few improvements?

This research project sets down an extensive examination of the way people perceive the notion of the "city" and practically focuses on the way that the city "functions" for an individual. In other words, the project is going to study the way that people comprehend the city and how they actually use it in relation with their daily practices and how by changing the layout their daily practices would evolve.

Thus, the city is going to be divided into three main parts; (1) the theoretical overview, (2) the computer program and its application and (3) the experiments that fully justify the individuals' perception of the notion of the city.

THEORETICAL OVERVIEW

The theoretical overview is going to study the majority of theories developed about the interactive relation that has been constructed between the city and its citizen and is going to constitute the basis for the further development of the program and its application as well as the experiment. The work of scholars like Kevin Lynch, Donald Appleyard, John Douglas Hunt and many others have focused on the way that people think of their urban environments and their research can provide the basis for the theoretical overview of the project.

In order to have a better understanding of the individual's perception of the city, I am going to commence this part of the project with Kevin Lynch's theory, as developed in his book "The Image of the City" (1962). Lynch argues that people make use of mental maps and that city is a legible place. In short, he argues that each and every one of us has a distinct understanding of the surrounding urban environment, according to our needs and habits. I am going to make use of Lynch's theory in order to prove that there is such a thing as an individual city, given the fact that we all have our personal way of thinking and mapping out.

So as to fully support the argument mentioned above, Donald Appleyards "The Pluralist City" (1962) is going to enrich my project. According to Appleyard, there is not only a different way of thinking between the planners, there is a great division between them in two main categories; (1) the ordinary planners and (2) the planner-citizens. As Appleyard has proven this distinction of the two groups of people is an excellent example of the different perceptions people construct of the city; the one of the "user" of the city and the other of the city-expert. I am going to make use of the specific theory not only just to prove that the various city maps are in fact different, but primarily to introduce the reader to the way of thinking of an expert; information required for the sound comprehension of the practical part of this project.

Furthermore, Appleyard's theory on the construction of what he calls a "mental map" is going to be used in order to clarify the contrast between the perception of the ordinary citizen and that of the expert.

Y.M. Epstein's "Crowding Stress and Human Behavior" is the next resource on which the theoretical overview is going to keep developing. The theory developed in this book is the fact that people choose the follow the routes that stress them the less before reaching their destination. This part is purposefully shortly developed, given that it is only one of the parameters that influence the citizen's behavior. However, it is important to be mentioned since one needs the better possible theoretical background, so as to understand the aim of this project; the fact that there are indeed personal understandings of the city and the need for the construction of the individual city.

"Concise Townscape" is the popular book written by Gordon Cullen, the scholar who suggests that the citizen-pedestrian is always making decisions in order to find his/her way in the city. Thus, it is another theorist's viewpoint that proves that the individual uses his brain in order to make decisions about his/her preferable way of circulation and, consequently, reinforces the notion that there is a personal way of moving around the city and that there is a thing such as an individual's city.

Professor John Zachariadis from the University of Concordia has conducted a study on the behavior of the people who first visit a city. Those findings are essential for the sound development of the theoretical arguments, given that through this study one has the opportunity to get acquainted with the parameters that affect one's decision-making. The Professor has divided the routes into ones of primary and others secondary importance and focuses on the individual's needs and wants for the shaping of these choices.

Hence, the theoretical overview is the part during which the reader has the opportunity to get an understanding of what is meant with the

term “egocentric city” or “egocentric perception of the city” and the significance of these terms so much in our daily lives, as in the specific project. And based on this understanding the reader will have the theoretical background for the conception of the other two main parts, programming and experimentation.

METHODOLOGY

Explaining what other people have said and done on the subject is of primal importance for someone to understand the basis of my argument. The theories and the terminology that are used as the platform of my experimentations on a city moulded on the pedestrian movement of an individual will be discussed and analysed before proceeding with the experimentations

Understanding the city from street level

The idea that we each construct our own dynamic city is an old one, but collecting maps sketches by individuals in order to communicate, study, and exploit our personal cities is an idea that was popularised by the city planner Kevin Lynch along with the joint centre in MIT that has sponsored path finding studies of urban perception and environmental cognition notably Kevin Lynches “the image of the city” and Appleyards the “pluralist city”

In 1960s and 70s, as a reaction to destructive impacts of Modernism on American cities and urban life Kevin Lynch, Jane Jacobs, Christopher Alexander and some others tried to make the city legible once again. To them this could be done by restoring the social and symbolic function of the street and other public spaces. They

criticized the loss of human dimension on modern cities. Thus their works derived from the view of city dweller. Among others Lynch saw the city as text and to “read” it he used scientific inquiry and **empirical** methods, interviews and questionnaires Lynches way of “reading” the city is followed by Appleyard, Thiel and some others afterward.

One of the first coherent analyzers of the urban scene in empirical terms is “*The Image of the City*” (1960)
In the book the image of the city Kevin Lynch gives an account of a research project carried out in three American cities (Los Angeles, Boston, and Jersey City with comparison to Florence and Venice). The project resulted in the evolution of the concept of legibility depending on peoples “**mental maps**”
Before Lynch the concepts of legibility have proved invaluable as an analytic and design tool. The image of the city helped give rise to a new science of human perception and behaviour in the city.

One of Lynch's innovations was the concept of **place legibility**, which is essentially the ease with which people understand the layout of a place. By introducing this idea, Lynch was able to isolate distinct features of a city, and see what specifically is making it so vibrant, and attractive to people.
To understand the layout of a city, people first and foremost create a mental map. Mental maps of a city are mental representations of what the city contains, and its layout according to the individual. These mental representations, along with the actual city, contain many unique elements, which are defined by Lynch as a network of **paths, edges, districts, nodes, and landmarks**. First, paths are channels by which people move along in their travels. Examples of paths are roads, trails, and sidewalks. The second element: edges are all other lines not included in the path group. Examples of edges include walls, and seashores.

Next, districts are sections of the city, usually relatively substantial in size, which have an identifying character about them. A wealthy neighbourhood such as Chelsea is one such example.

The fourth element: nodes are points or strategic spots where there is an extra focus, or added concentration of city features. Prime examples of nodes include a busy intersection or a popular city centre.

Finally, landmarks are external physical objects that act as reference points. Landmarks can be a store, mountain, school, or any other object that aids in orientation when way-finding.

Landmarks are an other type of point reference but in this case the observer does not enter within them, they are external. They are usually a rather simply defined physical object: building, sign store, or mountain.

The prominent visual features of the city are its landmarks, some landmarks are very large and seen in great distances, some others are very small and can only be seen from close up. Landmarks are an important element of urban form because they help people to orient themselves in the city and help identify an area

“The pluralist city” by Donald Appleyard

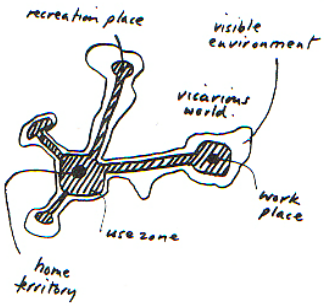
This book based on the experience of Ciudad Guayana in Venezuela, demonstrates that the deeper conflicts between planners and people are not only the result of clashes of values or intent but are as much reflections of basic differences in perception. The planner sees his model of the projected city as a totality from a completely different viewpoint than that of an inhabitant. This individual sees the present reality, from street level. “The planners map is a multicoloured physical reality”, the inhabitant constructs and constantly revises his mental map as “experience interacts with memory”.

What is a mental map and how can it be studied?

A person's perception of the world is known as a mental map. A mental map is an individuals own map of their known world. Appleyard tried to study these mental maps and in order to do that he devised a sort of survey that he tested out on the inhabitants of cities like Ciudad Guayana. First he chose people from different parts of the city with different social and economical backgrounds and then asked them directions to a landmark or an other location, he asked people to sketch maps of the areas of the city they were using or even describe it, and finally he asked people to name as many places as possible in a short period of time and determine how these places change with the passing of time.

With this the author determined that "Ciudad Guayana was many cities in one different people knew it in deferent ways. Their perceptions of its parts, their predictions of how it might grow varied from group to group and from person to person. Citizens viewed the city in different ways depending on their backgrounds, familiarity with the city patterns of use, educational level, and methods of transportation"

But in all cases the citizen's experience with the city takes a form of four concentric zones. First you have the "inner zone of personal territory", second you get a zone of regular use and travel, and thirdly you get a surrounding zone of visibility, finally you get a fourth zone of a "vicarious environment of indirect experience and inference".



According to Appleyard a typical inhabitants perception of the city is typically "home based", with "islands knowledge" around places of personal interest and use like markets, shopping centres, places of employment and previous residence.

In his book "The pluralist city" Appleyard suggests that urban knowledge has a form and either has the shape of a "star or a

constellation of known areas connected by tentacles of known territory along the circulation system".
It seems as though as people move further and further away from their "home base" it is more likely for them to depend more on "the worlds of vision and hearsay" to understand what is happening on the environment. But "the uneven and incongruent pattern of environmental form, visibility, use, and significance brakes up any neat spatial model of urban knowledge".

Professor John Douglas Hunt after research he carried out in the city of Calgary in Alberta Canada he mentions amongst other things that when people leave their homes in order to perform certain tasks, the number of tasks or even beater "scheduled stops" carried out in a single tour are either one or two before returning to their original location following almost always the same route. If these routes were then drawn on a map the pattern created would be surprisingly similar to the pattern described abode by Appleyard in his book "The pluralist city". This second remark made by Hunt only strengthens Appleyards approach to human understanding of urban space.

Emergent behaviour in pedestrian movement

What are the reasons that determine a person's movement in an urban environment?
According to Y.M. Epstein in his book "Crowding stress and human behaviour"
Pedestrian and Destination stress are two of the main factors that determine a persons movement in a city landscape.
Pedestrian receive a kind of mental stress from other pedestrians while walking, this kind of stress is called P-stress P deriving from Pedestrian. Moreover, each pedestrian whilst walking usually has a destination in his mind. If he/she can not walk along the shortest path towards that destination he/she receives an other kind of mental stress. This kind of stress is called D-stress D meaning Destination.

Pedestrians usually chose routes causing the minimum of both stress types.

In his popular book “Concise Townscape” Gordon Cullen proposes a serial approach to the design of public space in recognition to the constantly moving pedestrian’s viewpoint. His book is largely devoted to the linking of townscape experiences through controlled releases of visual information in the setting. Each visitor must make constant decisions to move through the environment based entirely on initial impressions and form a single moving observation point.
Professor John Zacharias from the University of Concordia has conducted a study on the exploratory behaviour of first-time visitors to an environment and specifically with importance of visual stimulus in path choice.
He suggests that an intention to move through an environment may not be accompanied by any predetermined prepuce.
In this case we are bound to assume whether consciously or not aspects of the environment beyond our present observable space affect our choices.
Assumptions about this future space are derived from the observed changes in use and meaning while we move through the environment. Information may trigger interpretations based on similar experience. Alternatively, information may be perceived without judgment or preconception about the outcome in preparedness for novelty or simply in passive acceptance.
In this study of visual stimuli in path choice, people were asked to explore freely in a novel environment without being directed to any particular features or qualities. Their itineraries tended to streets containing signs of human activity and especially other people. This tendency was confirmed when some of those people and other signs of human activity were moved to streets that initially contained few of those elements and had generally been passed by. Those ignored streets now apparently occupied by commercial activity were more

preferred than previously. In fact in most cases these streets became the most preferred choices amongst the available choices.
The unpredictability of pedestrian activity in city environments emerges partly from behavioural considerations such as why people make a trip at all and more importantly why they choose a particular route, and finally the fact that up until now it was almost impossible to measure and route how pedestrians are moving about the city in real time in the same way that is done for instance with vehicular traffic, with the use of traffic cameras for example.

But why do people choose particular routes for their journeys? According to traffic engineers and planners it seems as though the prediction of their movement eludes conventional traffic engineering methodologies.
Planners usually attempt to cater for pedestrians by creating people activity points and a general design strategy that calls for architecturally appealing structures and landscaped open spaces that draws people into or along certain areas of the city.
In the following paragraphs I will try to give a more detailed answer on the previous question.

“Route Choice” for pedestrians

“Route Choice indicates the process by which an individual selects a route from a set of known routes” (Bovy and Stern, 1990).
Route Choice also indicates that the pedestrian is in knowledge of his / her environment.
Pedestrians have the ability to walk in pedestrianised and non pedestrianised areas as long as it is possible to walk on them.
Interestingly pedestrian movement can be divided in certain categories relating to the purpose of every tour he is making, as well as how good is the pedestrian’s knowledge of the area he / she is travelling in.

Jon Gehl in his book “Life Between Buildings” he divides all travels in three different categories.

Necessary activities can be described as activities that basically compulsory, such as going to work, shopping, visiting the bank.

Because these activities are necessary “their incidence is only slightly influenced by the physical”, they take place in all weathers and in all conditions.

Optional activities are activities that “are pursued if time and place make it possible”, this category includes activities such as taking a walk just for the sake of it.

Social activities are activities that take place in the company of other people, like going to the cinema, or any other activity that is done by more than one individual.

All these categories have something in common they demand from traveller to have a very good knowledge of the grounds he is travelling in. but the thing that makes one different from the other is the amount of time the traveller allows for himself to travel from point A to point B, so for the situation when the pedestrian is travelling without a certain destination in his mind, the time he has to himself to complete his journey is rather long. In the second category when the pedestrian is undertaking a “recreational” tour time is of some importance but the person is not under a strict schedule so reaching the destination does not always mean that it has to be done in the shortest time possible.

And finally for the tours an individual describes as essential, time is of the most importance and usually in these cases the movement choices are governed by the cost of movement alone, that could also be defined as the “energy needed to overcome a spatial related friction constituted by a variety of parameters. The most important factor of the cost of movement is distance. The farther one point is from an other, the more effort you need to put in order to reach it. In these situations the geometrical distance between two points is not what is defined as “distance” but it is rather the length of the route selected to reach the destination from the origin (Zachariadis).

So in some cases being able to predict individual pedestrian movement is rather simple and can be duplicated easily just by figuring out what is the shortest way to a pre-selected destination. But this is not always the case as it is obvious from the previous paragraphs as people don't always have, reaching their destination fast high in their priority list. So in order to create a more realistic way of predicting human movement on the streets, there are several different ways of which most common is a multi agent simulation or an "emergent behaviour system". But even so these two systems can not really plot out individual's movements based on true facts they are just simulations, the thing is they work rather well.

For instance "Axial Mapping" is a program based on emergent behaviour systems the map created can provide graphs that are useful for defining pedestrian movement patterns and activities related to such movement (B. Hillier, J. Hanson, 1984).

The idea of such a map is to represent the longest lines of sight between any two intervisible building vertices; this can be generated automatically through software. Once the representation of morphology has been created, measures of spatial characteristics can be analysed. Hillier's theory of natural movement is that "the routes prioritised for pedestrians movement in such circumstances will be dependent on the morphological characteristics of the streets themselves" (A. Turner, A. Penn, B. Hillier, 2004).

In the experiment that is going to follow the axial map analysis for the area before and after the mutation of the grid, so as to mach the individual's use of the area, will be used as a visual aid to determine how the general flow of movement has shifted with the alterations implemented to the city.

As already explained this is a very helpful space syntax tool that can provide pedestrian movement patterns for the whole of the pedestrian users of the area.

Planning the egocentric city

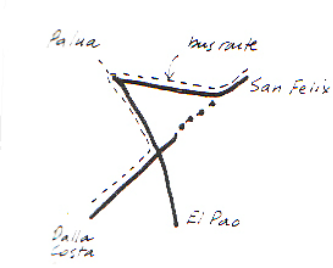
The planning authority in the city of Adelaide in Australia (Gehl, 2002) emphasised its need for improvement in the public areas of the city, in a way so as to make life easier for pedestrians and bring life back to the centre of the city. According to Gehl's suggestions in order for something like that to be achieved seatrain things had to be creates such as: good walking routes, pedestrianised streets, integrated pedestrian networks with a variety of pedestrian routes, as well as linking the squares in with pedestrian networks.

Appleyard as I talked about earlier has the ability to direct were the changes have to be made much easier. Because of the way he conducted his research in Ciudad Guayana he could easily pinpoint what needed to be done for the city to be "the best city in Venezuela" with the help of the people that took part in the Gallop he conducted.

While most changes were incremental additions to the size of the city or "gradual transformation of certain areas", structural changes produced sometimes disruptive changes in the perception of the city. The most evident of these were shifts in the use and form of the existing road system as superior channels were open to use.

The kinds of problems that were encountered after these changes are problems can be seen through this example.

For many years the road from San Felix to Dalla Costa travelled west to the entrance of the city of Palua were it negotiated a very sharp turn and took the El Pao road as far as the intersection with the road to Dala Costa. A route that can easily be descried as over complicated and improbable, surprisingly there was a direct route that connected Dala Costa with San Felix but because of the condition of the road no one seamed to prefer it.



The reality in Palua, the doted line shows the new road

When this road was later paved and in good condition people still were un able to adjust to the new more direct route into the city of Dalla Costa and that can be clearly seen from the sketches they did of the area in question, very few seamed to know were this new road

lead. Part of the problem in this case was the bus, in fear of losing its customers it continued o the old route wile the rest of the traffic moved to the new road.

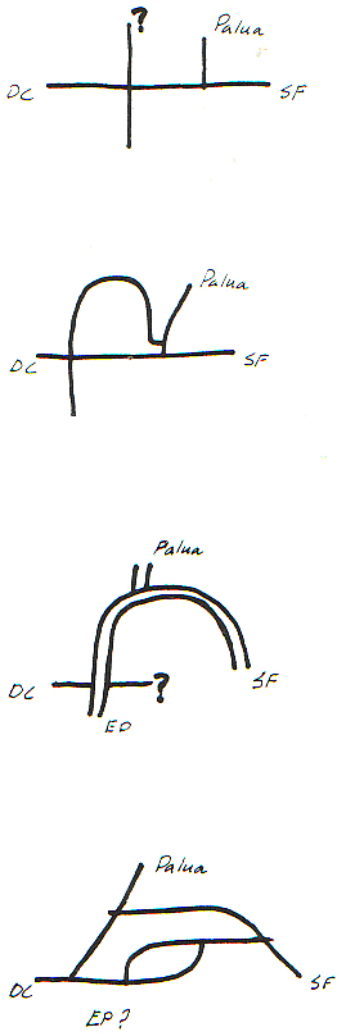
This change provided the community with two routes to a single destination splitting the community and creating confusion, there was a split of attention and use, a single route would have been enough. According to Appleyard “if the route changes had to be made, it should have been more define”.

This shows that people sometimes get comfortable with the way they have arranged their environment in their heads. Their mental maps of their town need time and stimuli to readjust to the new conditions.

In his research Appleyard states that as cities change people must correspondingly change the way they perceive the city around them if certain landmarks change or disappear people’s mental maps suddenly become more vague and primitive, they loose all the details they had managed to build through time. This raises a very important question which elements should survive the consecutive changes a city goes through in a period of time. If changes take place in the “social” and “functional” patterns of an individuals journeys through the city it is important for the individual to make it as easy for him as possible to readjust to the new conditions.

So for instance instead of adding new routes as in the case of Ciudad, altering the already existing ones would be a better idea, always maintaining as many of the old cities fixtures as possible, or maybe even better knowing which ones are considered important by the inhabitants and erasing the rest, thus creating a city with relates to its users as much as possible and obtaining a completely unique character.

So the best way to actually implement such structural changes to a city it would be to try and mutate the existing grid in order to fit in the new improved version without changing anything else, ending up with the exact same place as before only geographically realigned.



The “Mental Maps”of the local resident depicting the same roads in Palua

The use of GPS and Emergence

The satellite based global positioning system GPS permits its user to detract fairly accurate geographical positioning and the ability of tracking through the use of a GPS receiver on the ground. During the second half of the previous decade GPS receivers have gradually become smaller and cheaper also during the past five years most of them got the ability to be able to integrate and communicate with other electronic equipment like computers, palmtops, mobile phones and several other devises.

As an outcome of all this development GPS receivers are beginning to find uses in the field of surveys on the geographical allocation of activities for instance.

Early examples of GPS positioning in spatial surveys have been researches on the habits of several types of animals like for instance the blue wale. Were it was impossible for the researchers to actually follow this huge mammal around were ever it went without losing track of its exact position in order to get new ideas on their territories and geographical flexibility.

The use of a GPS for human surveys of a similar nature first took place in the mid nineties when the first transportation for vehicles took place in the United States (Schonefelder, 2002).

An example of a GPS based tracking system for pedestrians was developed by an Atlanta based company (Geostats) this company developed one of the first systems that could track individuals around discarding if they were travelling by foot or by car or as an actual mater of fact any other form of transportation. This system was used in part of a transportation and urban planning survey for the city of Atlanta (SMARTTRAQ) that mainly focused on the relationship between urban structure and physical training (Georgia Institute of Technology 2002).

But how does a GPS work? The GPS receiver provides the user with two types of data one is exact position on the planet and the other

time. The first series of data consist of longitude and latitude providing the coordinates, altitude is also provided, with the addition of time, direction and speed of travelling can be determined also with a simple calculation.

The GPS receiver positions itself by triangulating itself with at least three of the twenty four specific GPS satellites that orbit earth constantly over our heads on a predetermined route. Each of these satellites transmits an individual signal constantly over a predetermined cycle. The receiver then knowing every how often the satellite broadcasts this signal can easily figure out how far it is from that particular satellite, by doing the same processes with minimum three different satellites it can then calculate by adding these three distances from the satellites and find were the optimum position for it is so as all these distances meet in a single point in space thus providing the user with its specific longitude, latitude and height.

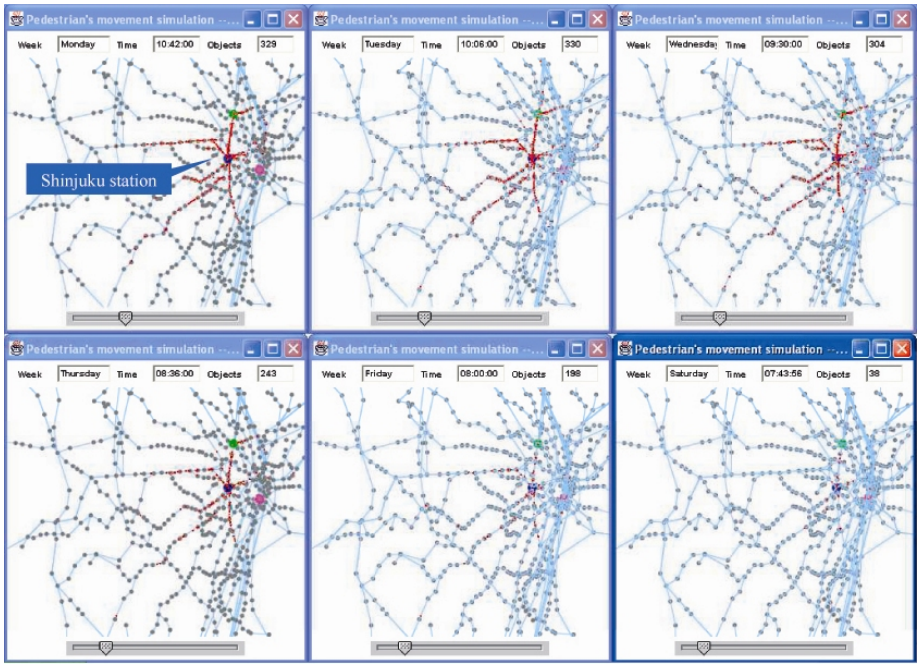
Accuracy depends on two things how good the antenna on the receiver is and how many satellites can this antenna detect at each one time on the sky, for instance the accuracy of the receiver would be greater if it could triangulate itself with four or five satellites at its one time than just three, the margin for error would decrease dramatically. In average a common receiver can have an accuracy of a couple of meters in the best of conditions (Scientific America, 2004).

But in build up areas it is not always so especially in situations were you get a lot of high rise buildings like in the centre of towns for instance were most of the population is concentrated and buildings tend to be higher, this usually effects the signals accuracy up to fifteen metres sometimes making a surveyors job harder. But buildings are not always the problem sometimes trees and bad weather could have the same effect on the GPS receiver compromising its accuracy.

Though the biggest drawback of the GPS is its disability to work inside buildings, especially when they are situated within high rise areas of the city blocking the signal from the satellite completely, it

would be rather interesting to actually be able to follow a persons movement were ever he went that being inside or outside a building, any way this is what surveying is all about. Unfortunately at the moment GPS technology can not provide us with a solution to this type of problem.

During the last couple of years GPS data taken from pedestrians, concerning route choice have been collected in order to be used as calibration data for “Emergent Behaviour Systems” in order to optimise pedestrian movement in big cities (A. Allan, T.G. Wyeld, 2005). Up until this point the only way to achieve something as realistic as this could be done by making the participants fill out schedules and constantly plan their routes on maps of the city they were occupying, something reminiscent of the techniques used by Appleyard and Lynch. Taking a lot of their time and defiantly most of the time done in approximation, thus never being really accurate.

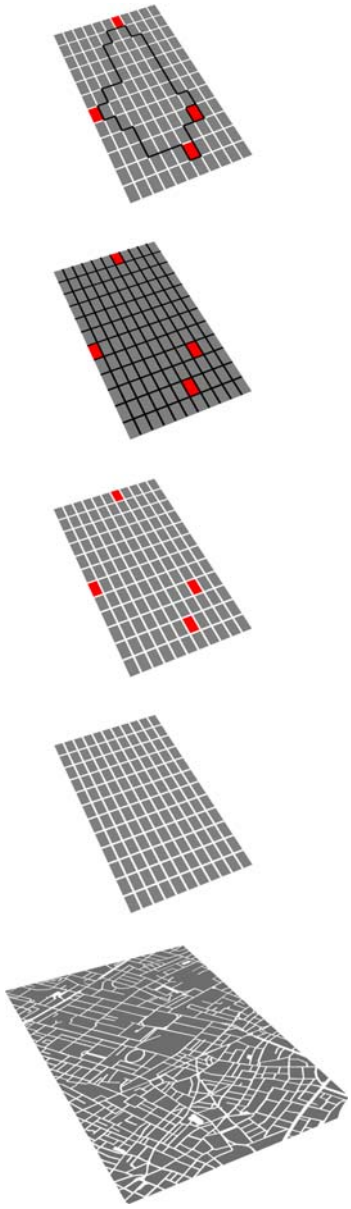


A. Allans
“Emergent Behaviour System”
for the city of Calgary

THE EXPERIMENT

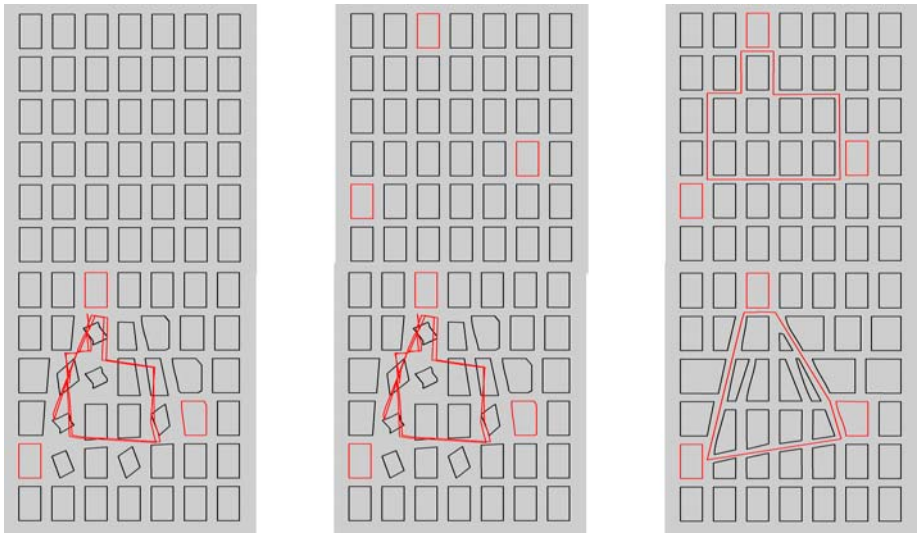
As already argued, there is a range of parameters that influence one's choice of how to circulate. Issues such as time, physical strength and urban spatial morphology are of prime importance.
In this part of the experiment, I am going to elaborate on the importance of routes and their relation with the grids that I would have to construct in order to build the egocentric city

According to Zachariadis pedestrian travellers when travelling from point A to point B; the route chosen most of the times is the shortest possible route (the shortest distance from point A to point B).
This as it already has been mentioned means that time is of the essence in most travelling situations even more so when we are walking, this being a physical and energy consuming process.
So if we were to optimise the journey one has to make to go from point A to point B, this would mean to make the route he follows even shorter, thus turning it into a straight line.
The reason for not creating a new direct route from point A to point B is rather simple, if something like that was done it would mean that the places legibility would change and as Appleyard explains in his example this would create confusion amongst the users so we would not be certain that the pedestrian how's movement we studied in the first place would choose the new direct route or the route he was following previously.
So by adding a new route the outcome would be a new city with none of the characteristics of the old one. Though a modified city does not offer something different than the old one it just proposes a new grid that has emerged out of one person's movement, increasing our chances of suggesting that the pedestrian will follow this same route again.
It is also quite important for the surface of the new blocks that create this alternate grid not to have a different surface area than the old

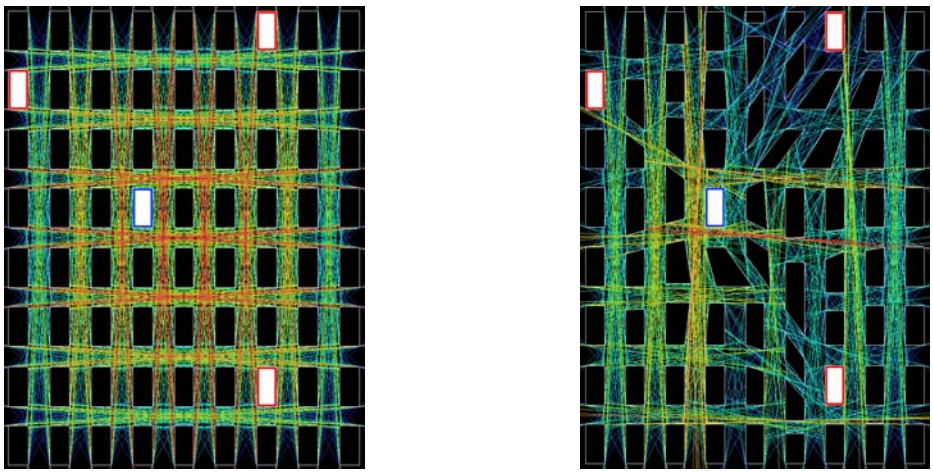


These images give an example of how an "Egocentric City" can be formed

ones so that the façades of the buildings that are on these blocks remain the same. And if an alteration is needed then it should be spread out as evenly as possible so as the change will be very subtle. So at the end by looking at the axial map outcome one might see how the rest of the pedestrians reacted before and after the changes. Also it will be possible to see how the walking patterns of the rest of the people that took part in the research have evolved, is it now easier for them to navigate around that particular area or not?



These images give an example of how an "Egocentric City" can be formed

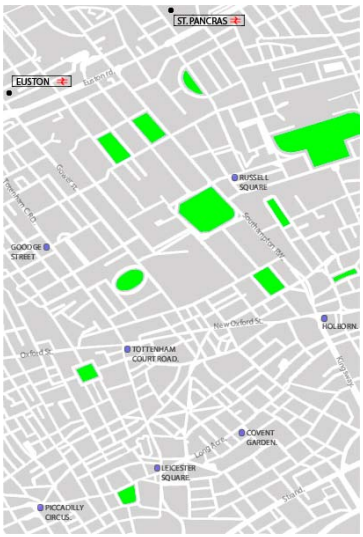


An example of how an "Egocentric City" can alter pedestrian movement using "Axial Mapping"

Introducing the area

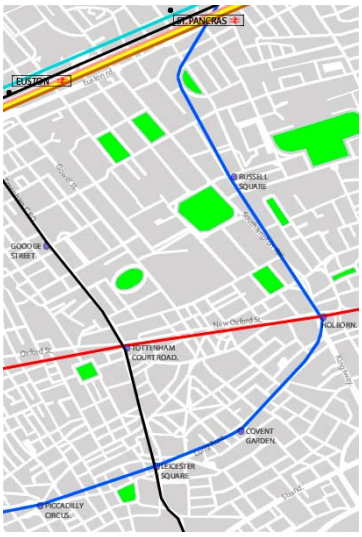
The experiment took place in an area of London belonging to the Camden council, this area is situated between Euston station on the north, Charring Cross station and the river Thames on the south, the east boundaries are marked by Coram's Fields and Holborn, as for the west boundaries, they are just west of Charlotte Street, creating a rectangle within which some very interesting effects take place.

The interesting thing with this area is that it can easily be divided in four very distinct zones, on the north you have the "academic zone" that is basically dominated by university buildings and halls of residence accommodating thousands of students attending the six major universities that are in the area.



Park space in the study area

The second zone is dominated mainly by hotels and museums, this area is very popular with tourists and it is situated exactly underneath the university zone. Although these two zones are not completely separated from each other, the are quite integrated, it is still possible to distinguish one from the other as the whole feel of the place shifts from one type of use to the other as you gradually move from north to south.



Underground and train station network

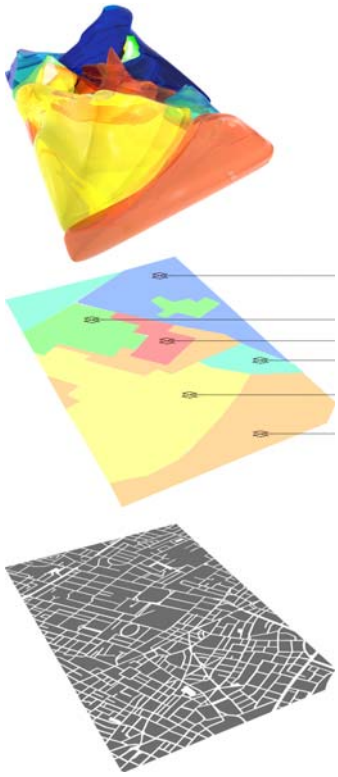
Underneath the "tourist zone" at the south part of these rectangle is a an area that can be described easily as a "recreational zone" full of pubs, bars, clubs, and shops both appealing to tourists, students as well as any other person using this area. Covent Garden can be described as a magnet for attracting people all over London.

The final zone is the "commercial zone" it is at the west of this rectangle and is situated along side the rest of these zones creating a narrow strip travelling from north to south.

The way that this area is divided up like that gives a hint of how the flow of people would be. Most people would be travelling towards the "entertainment" and "commercial" zones thus creating a movement from north to south and from east to west

The two main reasons for choosing this area are, the fact that it is situated in the centre of a big city people are very well aware that walking is the best solution for navigating around this area.
The area can provide its occupants with a lot of “necessary” destinations such as supermarkets, banks, post offices and laundrettes for instance within walk-able distance one from the other. Also the strong policy of the mayor of London against cars as well as the very dense network of public transportation ensure that most of the people for their day to day needs at least are all walking to their destinations.

But the main reason for all these people choosing to walk is the density of the population (number of people in the area they occupy). This is what makes car use impossible because of the traffic, this is what makes it possible for a lot of small businesses to flourish although one is so close to the other, and this is what makes this area different from a suburb were abundance of space has made distances so big.

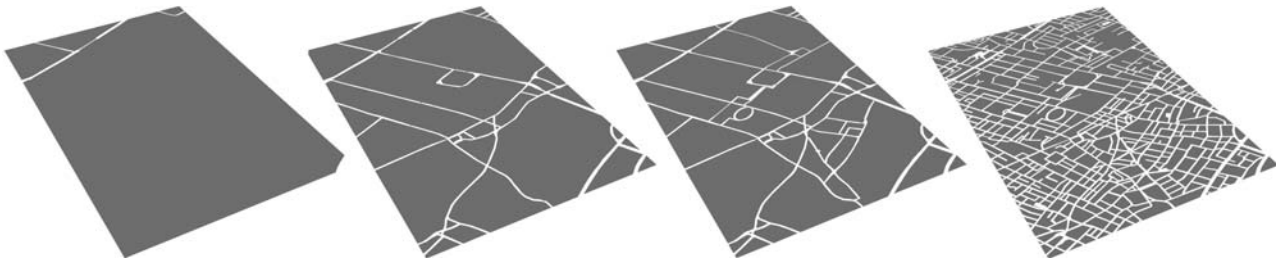


Dividing the area according to the different uses

The second reason for choosing this area is the mixed users that inhabit it. The combination of permanent and not permanent users makes this area more diverse and more interesting for study.
As I have mentioned previously local users (people with very good knowledge of the area have a very particular way of using it, time is of more essence to them and they do not use visual stimuli so much in order to navigate in their “home territory”,
They usually define a single objective and almost always follow a certain route in order to fulfil that objective regardless of what is around them the reason for that is the reason they travel in the first place, it is usually for necessity something they need or something they have to do.
In contrast to newcomers “tourists” for instance who rely completely on what they see around them and try to collect as many information as possible, establishing new “land marks” and routes every time

they travel through an area. But their objectives are hugely different these people travel in order to travel for them the journey is of more impotence to destination or time.

Red marks were most of the shops are situated



Main road network (A roads) (B roads) (C roads)

The subjects

Choosing the subjects seamed to be a rather important part of the attempt to design a customised “egocentric” city, the reasons for that were very simple, coherence and simplicity would have to play a very important role if I was to make this experiment more understandable and get a more effective outcome at the end.

At the end I chose to select four subjects and conduct my research around the way these four people used the city.

The three of the subjects were all students around the age of twenty five they all leaved in the area for the past five years and they all had developed a very detailed mental map of their surrounding environment.

Being all students and around the same age meant that they would all have a very similar way of viewing the city according to Appleyard,

Starting points for the four subjects

the fact that they all leaved around the same area also meant that some of the co-centric circles that form their mental map of the area would blend together, and in particular the first two, “the inner zone of personal territory and the zone of regular use and travel”.

It also seamed logical that they would all have the same sort of habits meaning that all their journeys would have the same type of goals, they would all go to their universities every so often, they would all go shopping, and they would all at some point go out for a drink or a stroll around their area. The difference between student and any other professionals is that their programmes are more flexible and are not so much sucked into a routine as the last, student do not really plan so forward in the future like the rest of the people, so I expected for them in that short period of time that they were tracked to do more tours than other people.

These three subjects all leave in different parts of the of study area, one is close to the top, the other is positioned in the middle and the final one leaves at the south of this rectangle. This means that by studying these people I can see what types of journeys coincide and which are separate. Seeing at the end how one persons modifications on the city grid effect the others movements.

As I have already mentioned different types of pedestrians use the city in different ways and most importantly read it differently than others a tourist as I said before is guided more by visual stimuli than a permanent resident, he also tries to stay more in routes that are more walked by other people as explained by (xxxxxxxxs) experiment, and finally the way their tours are organised is completely different than the rest of the people. Tourists when navigating do not usually have a single primary destination or goal on their tour so the way they use the city rather different to a permanent resident for example, they usually cover much bigger distances, they visit three or four different destinations before returning home and most of the time they return through a different route forming a circle. Finally their goals constantly change every day, conducting different tours every day.

Different routes followed by three of the subjects and their destinations

The program

The GPS tracing system can be described as the most important part of this thesis, it is what provides the operator with all the information he needs on were has the subject been all day. It is something that can not really be done any other way.

The antenna used for this experiment is a 12 channel Garmin GPS receiver very small and very durable but most importantly very cheap. All these characteristics make it the ideal tool for the job in hand.

In the beginning the aim was to design all the software needed for a simple antenna to work, from the GPS protocol, to the visualisation part of the project, but this idea was soon abandoned for two main reasons, first it was impossibly hard to design the software needed for a USB satellite antenna to be transformed into a GPS in the amount of time given and secondly if there was possibility for something like this to happen it would imply that the subjects would have to walk around with a laptop on their backs at all times (not very practical).

So this is were the Garmin GPS came into play, this device can communicate with a computer via a “Parallel” port something almost none of the modern computers have today so a conversion cable had to be found that would connect the “Parallel” port to a “Universal Serial Port” (USB) making it compatible.

Program stills

Then it was time for the hardest part of this project to start making data actually travel from the GPS receiver to the computer some way or an other, at this point a decision was made on what type of programming language was to be used, Processing seamed as an easy choice. But what exactly was this program supposed to be doing?

The program can be divided up in four different parts, the first part is getting the data from the receiver and converting it into a readable

format, (longitude:, latitude:, altitude:), the second step is placing this data into a file and saving them so that they can be played back if necessary, the third step is translating longitude and latitude into x and y coordinates so they well be projected on the computer screen accurately. And finally the design of a visual interface showing the individuals movement on screen.

The whole process seamed to be rather logical and simple although some points were rather difficult to do and caused a lot of problems on the long run, the most difficult seamed to be calibrating the GPS's protocol to mach processing's requirements in order for the second to start receiving data. It took a very long time figuring out what needed chaining in order for the program to work.

The main part of the program meaning the part that would convert the data received from the GPS to something more readable like, Longitude, Latitude, and Altitude was taken from a code written by (xxxxxxxxx), the rest was then developed in time.

The communication between the serial port and the GPS is done through a simple command: begin Serial (rate) though it depends on what Processing realise you are using, in this case only 069 works, and what java platform is installed on the machine.

A small example of the program that receives the data and coverts it into a readable format:

Program stills

Program stills

Program stills

```
void serialEvent() {
  gps.processNMEA((char)serial);
}

class P5gps {
  private boolean locked = false;
  private boolean available = false;
  private String latitude; // ddmm.mmmm
  private String longitude; // ddmm.mmmm
  private int north;
  private int east;
  private String altitude; // metres

  private String nmea;
  private String nmeaType;

  P5gps(int rate, String nmeaTypeIn) {
    beginSerial(rate);
    nmeaType = nmeaTypeIn;
  }
void processNMEA(char nmeaIn) {
    nmea += nmeaIn;
    if(nmeaIn == '\n') {
      String[] dataBlock = splitStrings(nmea,',');//check this
split method!
      //println(nmea);
      if(dataBlock[0].equals(nmeaType)) {
        if (nmeaType.equals("$GPGGA")) {
          latitude = dataBlock[2];
          north = (dataBlock[3].equals("N")) ? 1 : -1;
          longitude = dataBlock[4];
          east = (dataBlock[5].equals("E")) ? 1 : -1;
          locked = (Integer.valueOf(dataBlock[6]).intValue() >
0) ? true : false;
          altitude = dataBlock[9];
        }
available = true;
      }
      nmea = "";
    }
  }
  float minutesToDegrees(float dm) {
    return (int)(dm / 100) + (dm - ( (int)(dm/100) ) * 100) / 60;
  }
  float latitude() {
    if(!available) return 0;
    // convert from ddmm.mmmm to dd.dddddd
    return
minutesToDegrees(Float.valueOf(latitude).floatValue()) *
north;
  }
  float longitude() {
    if(!available) return 0;
    // convert from ddmm.mmmm to dd.dddddd
    return
minutesToDegrees(Float.valueOf(longitude).floatValue()) *
east;
  }
  float altitude() {
    if(!available) return 0;
    return Float.valueOf(altitude).floatValue();
  }

  boolean locked() {
    return locked;
  }
}
```

An other very important part of this project was to align the map so as all the data that came in from the GPS could be translated into “x” and “y”. to do that one has to pinpoint a certain location on the map and the same location in real life. he then has to figure out that positions location on the map by finding its “x” and “y” position and then do the same thing with the GPS and find its longitude and latitude, then its just simple mathematics to calculate the next “x” and “y” by following the argument:

$x_1 = mX_1 + C \quad \Rightarrow$

$\Rightarrow \quad C = mX_1 + x_1$

$x_2 = mX_2 + C \quad \Rightarrow$

$\Rightarrow \quad x_2 = mX_2 + (mX_1 + X_1)$

$\Rightarrow \quad x_2 + x_1 = m(X_2 + X_1)$

$\Rightarrow m = (x_2 - x_1) / (X_2 + X_1)$

If

$x_2 = 274$

longitude1 = -0.12365

$x_1 = 364$

longitude2 = -0.12058

then

m = 29363.78

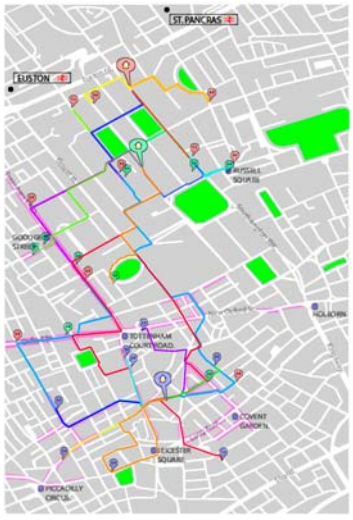
c = 3904.68378

So: pixelx = 29363.78* longitude + 3904.685

And the same follows for the y coordinates

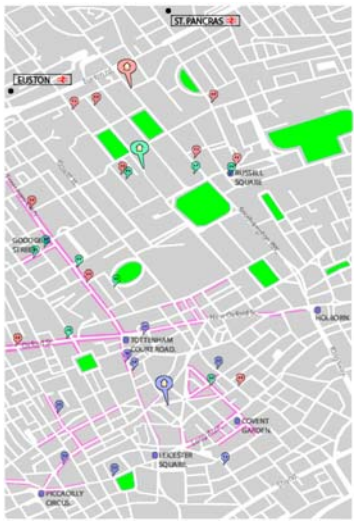
Results

Each of the subjects was instructed that every time he left his house, "flat" he was supposed to empty the memory of the GPS as it could only store a certain amount of information, end every time he returned he had to run the processing program and store the map using as a file name a, name or a description of his stops during that tour. If experiment was conducted with a more expensive GPS that would not have been necessary, but in this situation it was the best way in order to avoid any mistakes resulting in the loss of valuable information, it also made it easier to isolate each journey and pinpoint the end destination straight away.



The collection of these saved tours in the duration of the experiment resulted in this following diagram that depicts the number of trips each individual conducted as well as the reason he made the each trip.

	Activities	A	B	C	D
1	Laundry	●	●		
2	Off-licence	●●	●●●	●	●
3	University	●●●●●	●●	●●●●●	
4	Shopping	●	●●		●●●
5	Cinema	●		●	
6	Video rental		●		
7	Night out		●	●	●
8	Window shopping	●	●●	●	●●●●●
9	Strolling	●●		●	●●●●●
10	Gym	●		●	
		subject 1	subject 2	subject 3	subject 4



All starting and ending point of all three subjects during the experimentation period

The image next to the activity schedule depicts the exact same information but straight on the map.

So let's start with each of participants and se if we can define the way they perceive the city around them by identifying their personal territory and their zone of regular use and travel.

In order to do that we have to collect all the tours of each individual and place them on the map, this will at least show us a part of this individuals habits and his city for that time period.

The first subject is the one how's residence is situated the furthest to the north; it is marked in red as well as all of his destinations during the experiment. During this time he has visited his university five times, he went for laundry once, he went for a walk twice and so forth as it can be seen from the schedule. Interestingly if we place his routes on an axial map of the area we will see that his choice of route does not really depend on the popularity of the route meaning that according to the axial map program although most of his destinations are placed on rather busy streets the way he gets there seems to be focusing on finding the shortest route to the destination and interestingly enough if a travel is to be repeated the route followed by the subject is identical. Is this surprising?

Axial map of the area before the mutations

According to the reasons that I talked about before it seems rather logical for this person to be concentrating on reaching his destination on the shortest time possible. Also being rather familiar with the area, visual stimuli is of no importance to him but then why is he in more than one occasions choosing to follow the exact same route instead of an other one that could offer him the same length of travel?

Maybe this is just a routine that he has made himself follow, or it just has to do with the fact that during the research period he just chose this particular route.

We can actually see the area he is using and we can in a way identify the zone that defines his area of constant use and it is just a small circular are around his departure base "home". His everyday journeys that fall on the category of essential do not really exceed the four hounded metres radius, actually much sorter journeys than it was expected. It is only when you start looking at his recreational journeys that you see a longer average in travelling distance.

The rest of the non essential journeys focus towards the south of the selected area of study, Covent Garden to be more precise.

But how would this place change if it was modified to mach this individuals perceptions?
For this first individual the changes were done one route at a time and the results that came from the axial map program were not hat significant, until that is the longer journeys were taken in to account.
Then the changes that occurred were significant and a very large part of the area was distorted cousin a lot of the very popular roads to loose their appeal.

Subject 1 Pedestrian movement patterns before and after the mutation

The second subject had a similar movement pattern to the first individual; he to when it came to essential journeys had a travelling radius of approximately four hounded metres from his place of residence. And him also when it came to recreational journeys was also choosing to go towards Covent Garden, selecting for even longer journeys to use public transportation, (tube, buses).

Though leaving very close to the first participant and taking very similar tours in distance and destination to him the effect he had on the axial map after the modifications took place were very different to him. This was very surprising, not only had he not affected the main traffic arteries like Tottenham Court Road but his movement had created even more.

Subject 2 Pedestrian movement patterns before and after the mutation

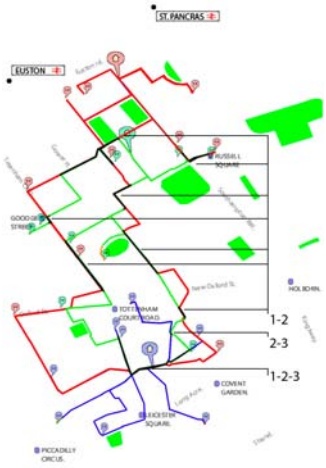
The third individual that leaved inside the Covent Garden area had also a similar radius from his starting destination to all of his essential journeys like the rest. But because of his starting location none of his journeys, which he made on foot at least, averaged as much as the other two subjects.

And so not surprisingly the effect he had on the axial mapping program after the changes took place was not that impressive as the first two.

Subject 3 Pedestrian movement patterns before and after the mutation

Interestingly what actually played a vary big role, along with the distance of the journeys the participants made, and their starting location on the map there was a third factor that effected the changes that took place in the pedestrian flow after the modifications for each of the individuals was implemented on the plan.

The size of the grid where the movement took place plays a very important role on the flow alterations. So the essential journeys the first individual made although averaged the same distance as the thirds the effect they caused on the fist city plan were much grater than what the third individual's movements did, simply because the ripple the first individual made was much grater.



The overlapping of the subjects movement is drawn in grey

The effects of the "egocentric city"

Surprisingly although the outcome of the axial map analysis has shown big changes in the way pedestrians would respond to the changes in the city grid, when it comes down to studying the movement patterns of our three subjects there is a very big chance that we will see no changes.

These seems very strange because, for example when the city was modified to mach the first of the subjects the changes that emerged were very big, traffic flows changed completely, roads that before were deserted now look like they are gathering all the traffic, and others that used to be full of pedestrians now seem to be full of people.
Holland suggests that "cities are excellent examples of emergent environments" (Holland 1992)
So every change in a city would evoke an emergent behaviour from its pedestrian inhabitants, as a whole and as individuals.
"It has been known for a long time that urban spatial morphology exerts a powerful effect on pedestrian movement patterns". (Hillier 1993)

But if changes are implemented in that city and although the pedestrian flow changes significantly how is it possible for the individual's movement no alteration is occurring.

The explanation for such an outcome is simple, it all has to do with the way the city was morphed in the first place when it was turned to match the needs of one individuals pedestrian movement.
As it was explained previously pedestrianised movement can be divided in three tour categories, necessary, optional, and social.
Necessary travels seem to dominate our daily lives and rightfully most of the tours taken by our three students at least, fall in the

categories of necessary. This means that these journeys were conducted with speed and efficiency in mind, in areas that the subjects knew extremely well, so if distances between start and end points of their journeys stays the same and the relative surface of the blocks stays the same, then the routes they follow will not change, their mental maps of their area of everyday travel will be recalibrated almost immediately.
But even the optional tours they conduct they are not that long and in most cases they too if repeated are along the same route so the same outcome can be expected from such tours as well. And that is because these tours are still conducted within an area of the city that is very well known to all three subjects.

So despite the dramatic changes in the whole of the environment and the very big improvement on the travels of the particular person for hum the changes have been made the other two subjects will not bee affected by the changes that took place.

One person whose pedestrian use of the city is expected to change is the tourist that took part in the experiment.
This person had a very basic sense of the area and his levels of “P” and “D” stress were much higher than the levels of the other subjects, so most of his movement dependent on finding the simplest route to his destination, the one with the list number of turns, and the largest number of fellow travellers.
So when the changes take place it is expected from him to change the way he is using the city and readjust to the new way of travelling. What would be interesting is to see how this new city would react to the passing of time as a real city is expected to.
As it was stated in the beginning of this thesis a city is an emergent environment that evolves out of two interacting factors, human movement and spatial morphology. One is constantly informing the other and both at the end produce an emergent amalgam of form and function.

The city that was designed does not obey to these rules movement is the dominant factor in the evolution of this new “Egocentric City”.
And movement constantly changes but cities as it was explained do change so although this city was never meant to be real, it is not that much different than any other city.

Conclusion

This thesis began by focusing on how a city evolves from an idea into a form, how different elements interact with each other in order to create something solid.
Each inhabitant of this city has a different perception of his surrounding environment; mental maps between inhabitants differ enormously even if this people use the same parts of the city.
A very important part of this dissertation was to understand how people actually navigate around a city, what are the factors that make someone choose one route over an other.
If it was possible to understand what makes someone to choose a particular route to reach a destination, then it would be easier to find a way that would help to convert this city into an egocentric one and it would be easier to predict how the rest of the pedestrians would react to this mutated alternate environment.
The idea of using a GPS antenna in order to survey the way one navigates around a city is not very old and it is much more accurate than generating a simulation based on estimations and hypotheses.
This actual real data in combination with the theories that exist on pedestrian movement have helped in developing several “Egocentric Cities” and understanding how they would affect individuals’ tours as well as the whole of the population.
Surprisingly although the simulation program used showed very big differences in circulation in some cases the subjects that were

followed with the GPS seemed as though their route choices will not be affected according to the theories that were investigated previously.
This generates a very interesting question on the design of this "Egocentric City". Does this over simplification of ones individual city help to expand his knowledge of the rest of the city around him or will it have the exact opposite effect isolating him more from the bigger picture?
This settle shift from one Leigh-out to an other can give the opportunity to all the pedestrians to revaluate their mental maps and reposition themselves on this modified reality, providing a breath to the city and maybe a change to something better.

The interesting part of this new individualised planning of the city is that according to the axial mapping analyses in some cases traffic in not relating to the roads that the shops are now on. This new turnout could be both good and bad at the same time
Will the shop owners have to move to a new location or can this new change in traffic bring more people in he shops? This is only something time could tell.

Further work

The problems that were faced during the conduct of the experiment revealed two very interesting facts about the technology used.
Firstly that this particular GPS struggled to achieve satisfactory levels of accuracy in pinpointing the exact position of the person under study because of the crowded skyline of this inner urban area
And secondly although being small and unobtrusive it steel had to he held by the subject hand and always in clear view of the sky.
If it was economically and timely feasible the best solution would be to use a devise like a mobile phone or a PDA with Blue-Tooth

technology connected whit a GPS Blue-Tooth enabled antenna, much more accurate and much smaller.

Finally the development of a program that could generate an Egocentric City by itself modifying the grid automatically out of the GPS data would be the ultimate goal.

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