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OUR DAILY DANCE IN TIME AND SPACE

BACKGROUND

It is possible to visualise the impact of the spatial design on people's time-use patterns. In the Netherlands, both Statistics Netherlands (CBS) and the Netherlands Institute for Spatial Research (RPB) research these effects and impacts. One conclusion is that more than half of the working population commute between 50 and 60 kilometres daily, totalling up to three hours per day. Our growing mobility in connection with work and leisure consumes an even greater part of our daily time budget. The need to make spatial planning more time-efficient is therefore an important item on the political agenda. In densely populated areas, accessibility and multi-functionality are vital factors thereby.

We consider user-oriented planning the right way to conduct spatial planning. It requires us to consider more than just the classic land-use patterns. Human time-space should also play a significant role in our deliberations on how to plan for the future. We can foresee that in the long run, demand-driven urban development will lead to time-conscious urban design. Tools to observe, map and analyse these changing patterns in human time-use are therefore in the process of being developed.

The patterns of human time-space use have been changing rapidly since the introduction of new modes of transportation. The accessibility of a location has become an important selling point. This has led to the multiple use of locations near highway crossings, train stations or airports. Here groups of people gather to shop, play sports, savour culture, meet other people, work or relax in public spaces such as squares, cafes, restaurants and hotels. New urban centres referred to as edge cities consolidate these optimal meetings in time and space. Changing patterns in the distribution of human activities in time and space moreover create a need for new types of information.

Various applications of geo-referenced information currently being developed are or will be both commercially and publicly available. These applications combine functions such as mobile communication, GPS, digital photography, e-mail, cartography, satellite imaging and internet access. One of the first applications of so-called 'location based services (LBS)' has been the tracking & tracing of convicts on parole and animal species in the wild. In the United States, web-based products are available that enable parents to trace the whereabouts of their children, so-called Child Monitoring Services. Locative media are also a powerful tool in the hands of urban investigators wishing to learn directly from users the specific routes they take and the locations or events they attend. Locative media can help to unveil the specific mental maps that an individual user has in his or her head. The experience and perception of a place or route can be reported by residents by means of short texts and photos. We decided to further develop geographical research techniques such as Hägerstrand's space-time path and diary analysis. In doing so we developed *Sense of the City* as a method of providing insight into the simultaneous but diverse patterns and experiences of people in regard to time and space.

DYNAMIC 3-D MAPS WITH LOCATIVE MEDIA

The online tool *Sense of the City* was developed and tested between 2005 and 2007. *Sense of the City* combines tracks of participants as a day-path in time and space, diaries, texts, images, maps, aerial and satellite photos on a real-time website. Through the use of GPS, *Sense of the City* is able to position the location of the participants in the project and to track their routes, velocity and distance as soon as they move. The participant can add significance to his or her route by uploading images and text messages. Uploading recorded sound and digital video to the website is also possible. All of these contributions add up to make dynamic maps. *Sense of the City* has published these maps online. They show how participants experience their individual time-space continuum. More in detail, they show the spatial choices participants make, as well as where they live, work, practice sports, meet up and recreate and relax. Even more interesting is the possibility of analysing the spatial behaviour of many people simultaneously. This will be possible as soon as common mobile phones include inbuilt geo-reference functions.

A promising research topic that can benefit from these new instruments is identifying those locations where the multi-functional use of time and space is the most desirable and the most promising. Other locations could be left open and designed as silent places in order to maintain or create nature areas. While designing new neighbourhoods, infrastructure, parks

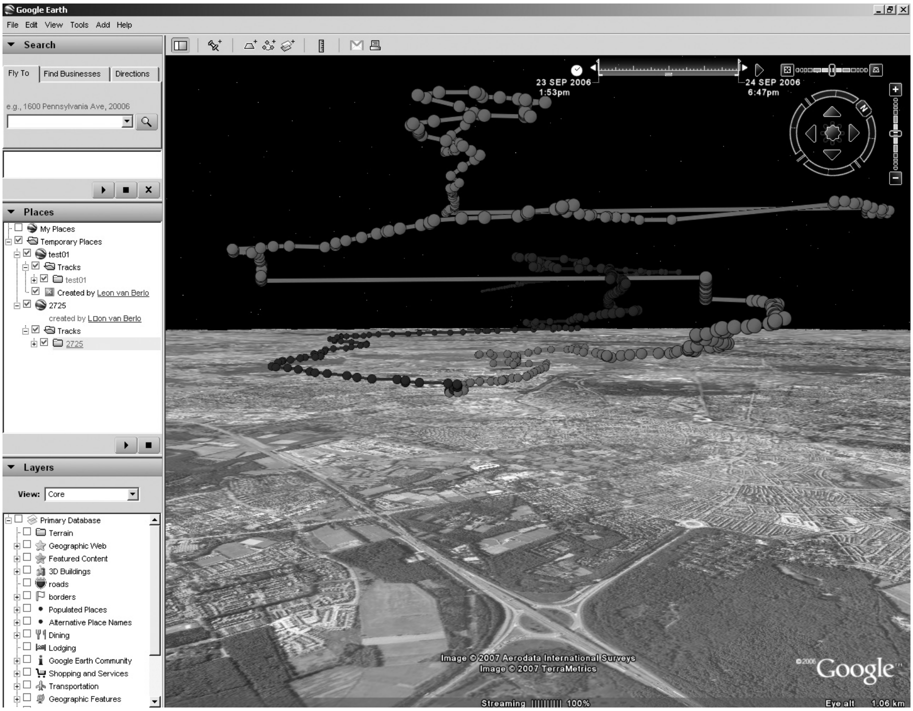


Illustration 9.1
Tracking routes in three dimensions

or city centres, it is possible to take the actual patterns in time and space use into account. Web 2.0 techniques can offer a bird eye's view of the human dance in time and space on aerial maps. A *Sense of the City*-project provides such an interactive website. It integrates real-time tracking of routes in three dimensions and user information, uploaded on to an aerial map (see **Illustration 9.1**). *Sense of the City* is a first example of the integrated use of technology that traces the complex unity of time, place, action and individual emotions with precision. This opens perspectives for quantitative space-time research and the qualitative investigation of perceptions of places and cities.

THE EINDHOVEN CASE

With new paradigms in Dutch spatial planning, municipalities will be increasingly just one example of many actors, and their role will shift from allowing towards enabling. As a result, municipal services will have to be well informed with regard to how residents and users perceive their surroundings. For seven days, the participants of the *Sense of the City* project in Eindhoven were asked to collect images and comments in connection with their daily routines in public space, coupled to certain social themes. In addition to housing and work, a link was made with the main themes of the Service for Social Development of the city of Eindhoven: Meeting, Developing, Recreation and Safety Nets. Participants were selected on the basis of their expected unique spatial patterns, forming a broad spectrum of possibilities of the spatial use of the city. *Sense of the City* aims to draw up an inventory of this use and analyse it for the benefit of municipal services. Qualitative data are consequently collected on prototypical use and the perception of public space and urban facilities.

Geo-tracing: from market vendor to policeman

In the case of Eindhoven, the *Sense of the City* website included the routes of all participants simultaneously, in real time, and the images they generated and sent by e-mail (see **Illustration 9.2**). *Sense of the City* displayed that information on three kinds of maps: satellite images of Google Earth, aerial photos of the city and maps of various scales. These maps were provided by the municipality, unlocking her intranet databank in *Geogids* software and projecting data onto this mapping material. Participants later wrote down their comments on their routes and the photographs taken. The images could be followed on three large led-screens displayed on strategic locations in the city. The scope of the project was somewhat limited. The sponsor PHC-Telecom supplied ten Nokia 6680 mobile phones. The participants were a real estate

Illustration 9.2
Tracing Eindhoven on www. senseofthecity.nl

agent, a pizza deliverer, a policeman, a first aid nurse, a marathon runner, a working mother, a secondary school pupil, a design academy student, a market vendor and a city cleaner. Their individual experiences were subsequently stored, replayed and analysed. The marathon runner, for instance, recounted how he didn't do his daily rounds on the city's training courses but on the bypass around the city, in the exhaust fumes, on the asphalt. This stretch is exactly 12 kilometres long, thus "forcing myself to run my daily distance without taking any shortcuts". The action radius of one participant differed greatly from the next. The school pupil uses only a limited amount of public space; she is either at home or at school or somewhere in-between. The working mother on the other hand has a large range; she cycles from the sports ground to shopping centre, to work, to school and home. It is no surprise that her weekend starts with "a relaxed Saturday morning at home".

Analysing data on 3-D maps

While analysing the data, we realised that we had to develop a possibility of visualising the 3-D component of the times of the data on the maps. Mei-Po Kwan's 3-D mapping of behaviour in Franklin County inspired us to look for a way to map the third dimension in a similar way (**Illustration 9.3**). In this illustration, the vertical axis represents the temporal progression

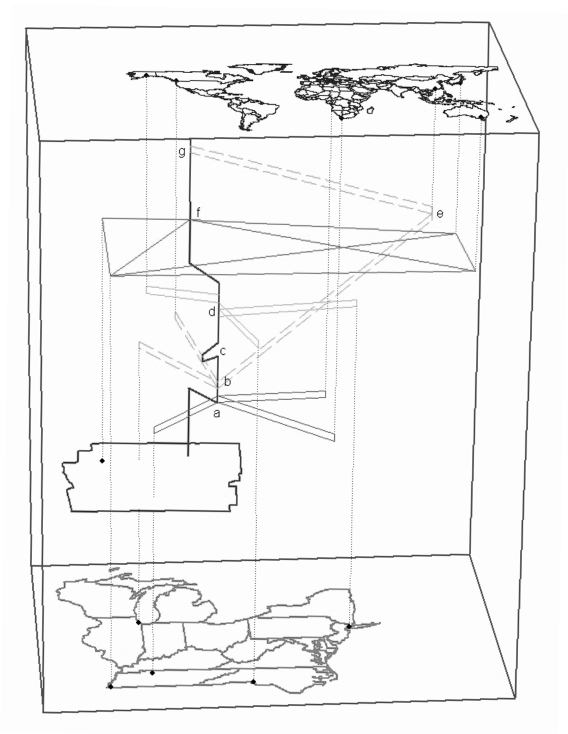


Illustration 9.3 The 3-D aquarium of Franklin County, Ohio by Mei-Po Kwan. Source: http://geog-www.sbs.ohio-state.edu/faculty/mkwan/Gallery/STPaths.htm, accessed 11 May 2008

Illustration 9.4
The website shows the daily pattern of a captain of industry on the satellite map of the Eindhoven region

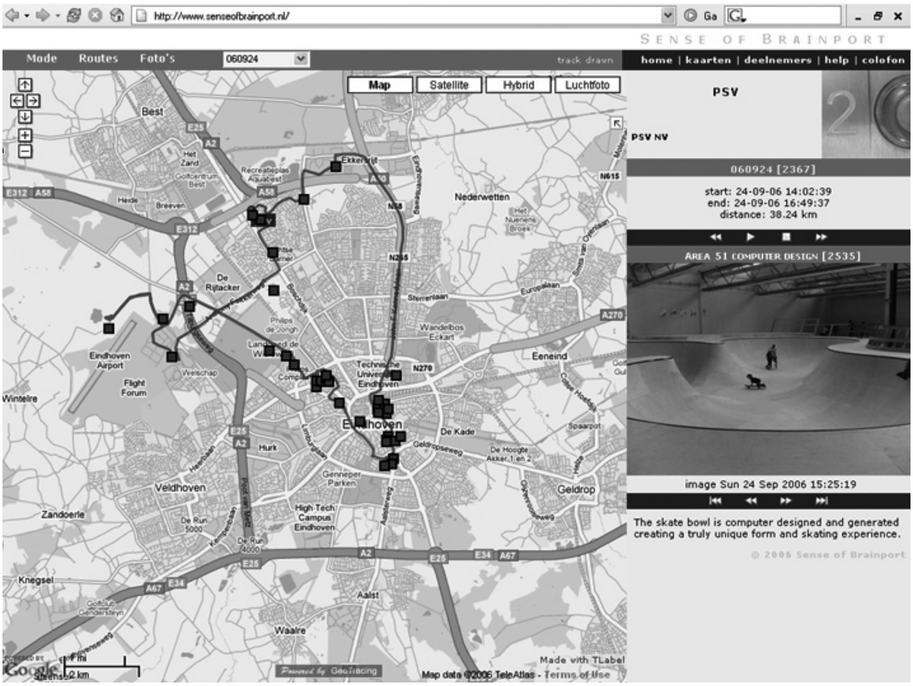


Illustration 9.5
The website shows the daily pattern of a captain of industry on the street map of the Eindhoven region

of movement in space. Multiple individuals can be analysed simultaneously for an easier comparison of their activity patterns. We developed a tool to automatically visualise GPS data in mobile phones on Google Earth (see box 1). Using this technique, we can fill a 3-D aquarium at a specific place and use it as a chrono-geographic model to analyse a group of participants and their use and perception of time and space in order to design a place for future needs.

EVALUATION AND FURTHER TESTING: TOWARDS A WIKI-ATLAS OF CITIES

Most research meets with less than 40 percent response and intensive follow-ups are required to persuade people to participate in qualitative research. However, *Sense of the City* met with an enthusiastic and intensive response on the part of all participants. Data collection was a playful affair and was carried out by the participants exclusively. They were curious and enthusiastic about using new technologies, and fascinated to see their own routes and perceptions charted. *Sense of the City* produced the tracks of ten people in a period of one week. This collection of individual day-paths shows the beginning of a pattern of prototypical users moving through their city. It will be even more interesting to see how individual patterns coincide. Who will meet who, where and when? This will help us identify the collective nodal points of the city, and could indicate where the municipality should plan facilities in connection with its four main themes (Meeting, Development, Recreation and Safety Nets). It does however require larger data sets, and we will therefore have to wait until everybody owns 'smart phones' with high resolution cameras, GPS navigation and fast internet access. Mobile phone service providers can already locate the exact whereabouts of their subscribers. This data is currently used by the police to trace missing or wanted persons. In the future, we hope to use these data as quantitative input for qualitative research on perceptions of the city.

A second test within the framework of *Sense of the City* was conducted in the wider region of Eindhoven, a region which is planned to be developed as a high-tech cluster referred to as Brainport. The time-space continuum of the Brainport region is built up by means of data on the daily patterns and perception of fifty captains of industry. Their dreams and wishes for the future moreover shape the framework of the Brainport Region 2020. Their factual traces and perceptions are documented on www.senseofbrainport.nl (see **illustrations 9.4 and 9.5**).

A more general application of the *Sense of the City* principle enables participants to make their own contributions, as is in the process of taking place with collective web 2.0 projects such as Wikipedia. Cities or regions could provide information on the web through residents who allow themselves to be traced. In this way, a Wiki-atlas of the city is produced. Large companies such as building societies or networks of industry could also manifest themselves on a Wiki-

Box 1 Visualisation of the temporal dimension of tracing data on aerial photos

How should the temporal dimension of tracing data on aerial photographs such as Google maps be plotted? Data collected through the mobile phones, used in Sense of the City project is exported to a database that is placed online. The structure of the data is the well-known GPS Exchange Format or GPX. GPX is a light-weight XML data format for the interchange of GPS data (waypoints, routes, and tracks). This GPX data can easily be imported in Google Earth. This project did not follow that procedure. We first transformed the GPX data to Keyhole Markup Language or KML. KML is a file format used to display geographic data on Google Earth, Google Maps, and Google Maps for mobile. KML uses a tag-based structure with nested elements and attributes and is based on the XML standard. The translation of data from GPX to KML takes place using a XSLT stylesheet. XSLT is a language for transforming XML documents into other XML documents. XSLT is designed for use as part of XSL, which is a stylesheet language for XML. In addition to XSLT, XSL includes an XML vocabulary for specifying formatting. XSL specifies the styling of an XML document by using XSLT to describe how the document is transformed into another XML document that uses the formatting vocabulary. XSLT is also designed to be used independently of XSL. However, XSLT is not intended as a completely general-purpose XML transformation language. Rather, it is designed primarily for the kinds of transformations that are needed when XSLT is used as part of XSL. The KML file that was given by the translation is a 'flat' file. The polygons do not rise from the ground as we want in a time-space aquarium. This is because the original GPS data also naturally lack raising data that is useful for this application. All the previous steps are taken merely to transform the GPS data from mobile phones to KML files that Google Earth uses natively. This is mainly done due to the fact that Google Earth has not fully implemented support for GPX data.

The next part is the part in which an algorithm changes the height of the waypoints in the KML files. This is the fun part of this project as the changes are clearly visible. The changing of the waypoints in the KML files is a tricky business. It does not 'just' entail the changing of the height variable of the waypoints. First, the oldest timestamp has to be found in all the KML files. This oldest timestamp is the 'start-point'. Then the latest timestamp has to be found, also in all of the KML files. The waypoint that contains the latest time is set to the 'end-point'. Now the z-value of the 'start-point' is set to 13. This is the height of Eindhoven, so the start-point is set to the ground. Now the z-value of the 'end-point' is set to 3500. This is the top of the time-space aquarium. 3500 is a nice number for the aquarium because it is not too high, nor to low (so the lines are much too compact to see them differentiate). The next step is to calculate the seconds between the end-point and the start-point. Now the number of 3487 (derived from 3500-13) is divided by the number of seconds between the start-point and the end-point. Next, the time is connected to the height (z-value) of a waypoint. The final step is to adjust the z-value of the waypoints, corresponding to the time. Of course this is done for all the KML files. A piece of the code to do this is given in Illustration 9.6.

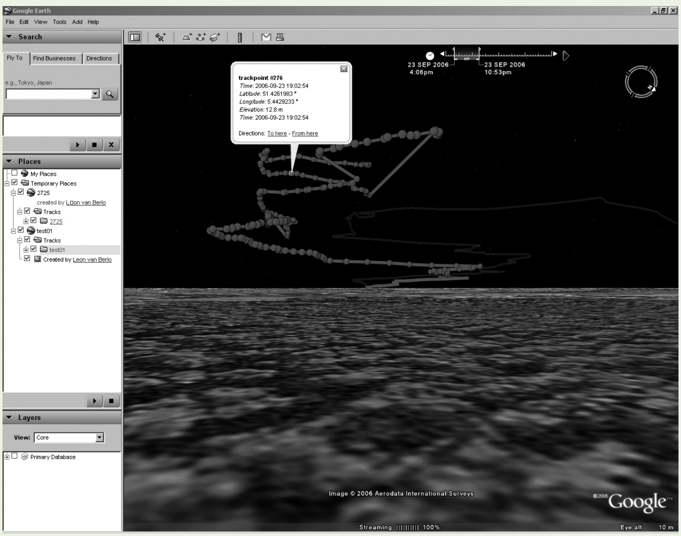
A complete time-space-aquarium is given in a bunch of KML files. The final step is to read the KML files in Google Earth (see Illustration 9.7). While constructing time-space-aquariums with this tool, one has to consider the following: when the GPS data has too many 'leaks' (open places), the rendered aquarium has open spots. This does not help in representing the use of the space. Also, the different users (lines) should use about the same space in about the same time. If this is not the case, the time-space paths can also be represented separately. The advantages of using Google Earth for the representation of time-space-aquariums are obvious. A model is given instead of a static picture. Each user can walk around and through the model, which is a great experience. The use of Google Earth is wide-spread, so it is a very generic tool. For the time being, it is therefore an open source tool. The KML files can be put online. In this case they will be open to the public. The next step in the development of this tool is to make it fully automatic. The data from mobile phones will be sent directly to a web-server where the data is stored. This web-server will analyse the data and render the time-space-aquariums on the fly (this means it will render on command of the user). The server has the native data which means that it can also render other types of models which represent time-space use.

Illustration 9.6 - Piece of the code to create 3-D aquariums of time-space paths

```
NodeList nl = d.getElementsByTagName("Placemark");
for (int i = 0; i < nl.getLength(); i++) {
     Node cn = nl.item(i);

     if (cn instanceof Element) {
          Element e = (Element) cn;
          NodeList cl = e.getElementsByTagName("Point");
          Element point = (Element) cl.item(0);
          if (point == null) continue;
          NodeList am = point.getElementsByTagName("altitudeMode");
          Element altitudemode = (Element) am.item(0);
          altitudemode.setTextContent("absolute");
          NodeList pl = point.getElementsByTagName("coordinates");
          coordinates = (Element) pl.item(0);
          NodeList wl = e.getElementsByTagName("TimeStamp");
          Element timeStamp = (Element) wl.item(0);
          NodeList tl = timeStamp.getElementsByTagName("when");
          when = (Element) tl.item(0);
          transform(coordinates, when, i);   // this is where the transformation takes place
          lineString = lineString + coordinates.getTextContent() + " ";
     }
```

Illustration 9.7 - Reading the 3-D kml files in Google Earth



atlas. The region Brainport is an example in this respect; this network of high-tech industry in the region of Eindhoven aims to present itself on, and investigate by using the internet. It will position itself through *Sense of Brainport*. Brainport is thus the first candidate for the Wiki-atlas.

Amersfoort is the second candidate. The city plans to present itself on the occasion of its 750th birthday by means of a new interactive map of the city, a 3-D-atlas containing the lives and experiences of its inhabitants, using various means of modern information and communication technology.

CONCLUSION

The need for time-specific and place-specific information on the human daily dance has been clearly articulated. The technologies to be used to gather this data and store it in such way that it can be analysed within a reasonable timeframe have recently become available. By testing these techniques (web 2.0, aerial photos, mobile phones with GPS, GIS and spatial databases), it has became obvious that they should be integrated into one tool. Analysing the data gathered and stored by means of such a tool requires a 3-D visualisation in a chrono-geographic model, a description of which has been given (see box). The next step is to present a full analysis of the chrono-geographic datasets on people's daily dance in time and space. This is foreseeable in 2008.

Sense of the City is a product of CityWorks, an office for spatial planning and of Just van den Broecke, De Waag Society. Sense of the City was developed using a subsidy granted by Ruimte voor GeoInformatie and an 'InnovatieVoucher' granted by SenterNovum. The 3-D time-space aquariums were developed by Léon van Berlo from the Netherlands Organisation for Applied Scientific Research (TNO).