# ASSISTED LIVING: USING GPS TO DETERMINE DESIGN TASKS

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**ABSTRACT:** The enhancement of GPS technology enables the use of GPS devices as tools to capture travelled routes [1]. Activity Patterns in Public space investigates the use of GPS as instruments for analysis and design. In Rotterdam the instrument has been used to track elderly for an assisted-living project.
This paper will describe a motivation to deploy GPS tracking technology as one of the methods of Urban Analysis. GPS tracking adds an invaluable source of information to traditional methods, but doesn't replace these existing analysis methods. The paper investigates the potential of layering GIS data sources in GISweb. The method will be used in a design oriented approach leading to design tasks.
**KEYWORDS:** GPS; Tracking; People; Behavior; Mapping; Movement; Flows; Activity patterns; Urban Analysis, Public Space, Large Urban Project

## 1 ASSISTED LIVING

'*Assisted Living Areas'* is the central theme in the Urban Design elective course running in April-June 2009. The study area is located in Oud-Charlois, Rotterdam. The education is organized in cooperation with Veldacademie and SOZAWE (Municipality of Rotterdam). The motive for this Assisted Living project is the report 'Assisted Living Areas in Rotterdam': Drastic changes in the care system and the shifting demands for care due to a new generation of elderly requires new concepts of housing and new ways of offering facilities such as care. The actual design of the so-called assisted living areas requires detailed insight in activity patterns of elderly and their (future) needs. Based on the analysis of (actual) patterns of movement new and valuable solution for these areas can be developed and designed. [1]

A group of (inter-) national master students of TU Delft firstly developed projects for Oud-Charlois based on assumption of lifestyles and suggested activity patterns of elderly. As part of the urban analysis real patterns of use of elderly are investigated using GPS devices in combination with a questionnaire. The track logs collected with the GPS devices and the outcomes of the questionnaire were used to validate the assumptions made by the students regarding the spatial behavior of elderly in the district. [1]

## 2 GPS TRACKING TECHNOLOGY

GPS is a Global Navigation Satellite System (GNSS). GNSS is a system for location or position determination, or so called geopositioning. Using a special receiver, a geoposition in space and time can be calculated based on the reception of satellite signals. The United States' Global Positioning System (GPS) is the first available system using satellite Position Determination Technology (PDT) [3]. Other GNSSs are under development in Europe (Galileo) and Russia (Glonass). [2][3][4]

The availability of so-called geopositioning devices such as GPS (Global Positioning System) devices has grown enormously in the last decade and is still increasing. More and more people own a navigation system such as TomTom or Garmin, a GPS for outdoor uses, biking, geo-caching and photo tagging or a mobile phone such as iPHONE with built-in GPS for LBS (Location Based Services) [2][3][4]. These devices are mainly used for orientation (determining where you are), navigation (determining where to go) and communication (exchanging information with others or accessing information services). But the devices can also be used for *tracking*, i.e. *saving a travelled route into a track log*. This ability makes the technology useful to collect spatial-temporal data and thus as 'logger' for observing and measuring activities of people [1][3]. *In Urban Design, the data will be used to investigate and address urban issues* [5]. Examples of this type of research are the tracking experiments in Norwich, Rouen and Koblenz [6][7][8].

The GPS devices deliver gpx log files, called trajectories. These files consist of a location in space (x,y:

lat,lon) and time (t). The GPS device captures the location and time at a specific interval. In this case an interval of 2 seconds was used. Three types of GPS devices have been deployed: Garmin MAP60Cx (3), Qstarz BT-Q1000P (10) and Qstarz BT-Q1000X (2). There's a slight difference in the characteristics of the devices. This didn't influence the research experiment as the devices were used as blackbox: recording the traveled path at a specific interval.

## 3 METHOD

The collection of spatial-temporal data in a project like Assisted Living contains two main parts: data collection and data processing [2]. The collection can be split up in five main phases: project definition, approach and selection of participants, deploying devices, using devices and returning devices [2]. After this phase, the data processing starts. This part of the method also consists of five phases [2]: retrieval of data, validation, processing, conversion, analysis and visualization & interpretation.

For Assisted Living the project definition started in the beginning of May. Based on the proposal the students approached an elderly house were aged people still live on their own, but have assistance in the vicinity to rely on. The main building is a fully serviced high-rise complex. The inhabitants were informed by the administration. For a period of only three days the students posted in the lobby distributing a GPS device to all inhabitants leaving the building. On return, a questionnaire was taken. The questionnaire consists of questions related to personal characteristics and trip related characteristics. The questionnaires are used to profile the participant, investigate regular behavior and available modes of transportation.

After the first part collecting spatial-temporal data and background statistics, the data was processed: cleaning and filtering of trajectories, selection of valid tracking data. The background data was analyzed in SPSS and linked to the trajectories in ArcGIS. In ArcGIS spatial analysis was carried out on individual tracks and on collective use of space, e.g. by using the density tool (see Figure 1: cumulative use in time).

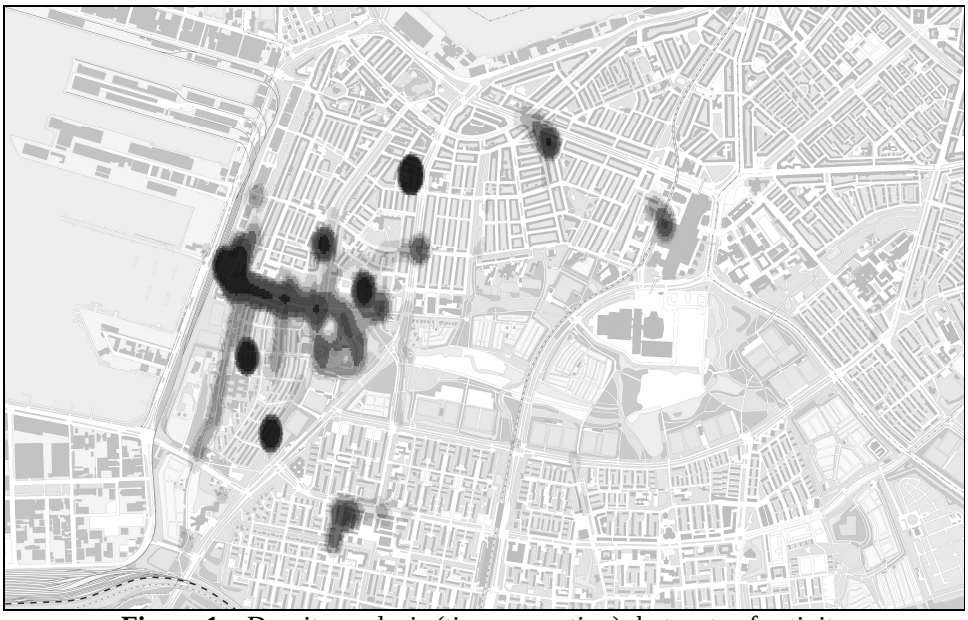

**Figure 1** Density analysis (time correction): hotspots of activity

In the next phase the data was visualized in Adobe CS. The result is a series of images showing track specifications such as speed, duration, destination(s), mode of transportation, but also distance and radius. The *distance* represents the *trip length:* total length of the travelled path. The *radius* represents the maximum distance from the origin. For this paper, we mainly take into account the distance, radius, duration, purpose and mode of transportation. Figure 2 shows the trajectories organized by purpose.

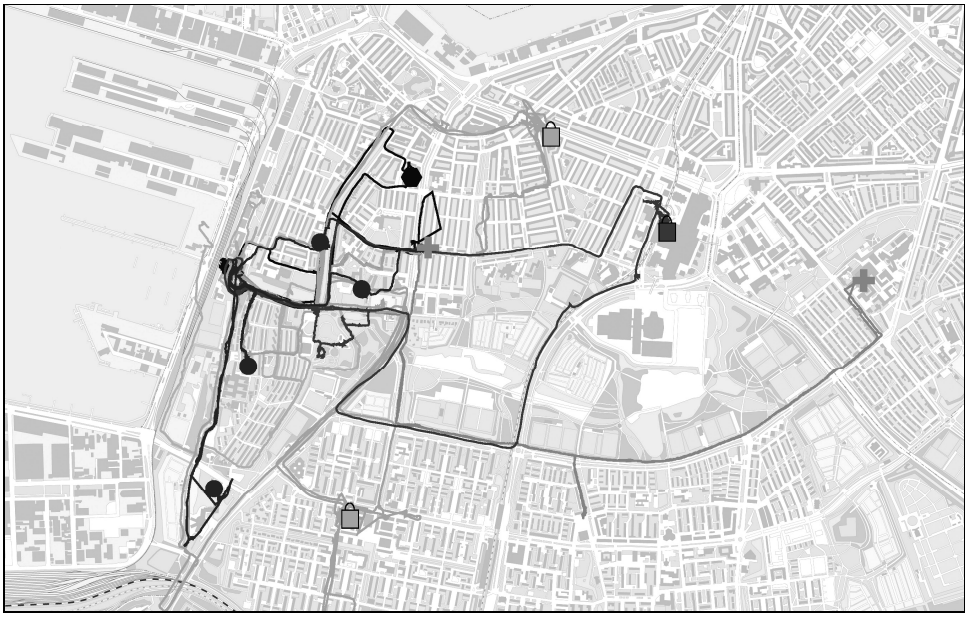

**Figure 2** Trajectories organized by PURPOSE: social, recreation, shopping and care.

Finally conclusions were drawn and the outcomes were compared with other layers of information to explain the outcomes. In this part GISWeb played an important role (see Figure 3 and Figure 4). GISweb is an online GIS-application of dS+V. The collected tracks were uploaded in this system enabling the comparison with geo referenced statistical data, such as social, economic and demographic information, but also information representing local conditions, eg functions, traffic intensity, air quality, crime rate.


**Figure 3** GISWeb (©dS+V): layering of trajectories with local databases such as crime rate, violence, vacancy, land value, occupation, income level, education,…etc

## 4 RESULTS/OUTCOMES

The experiment was restricted to three days of data collection. Due to weather conditions elderly left the building only during two out of three days. In total 26 tracks were collected which limits the project to an experiment, an exploration. Nevertheless, the results lead to some remarkable outcomes and discoveries and were very useful for the students. Table 1 shows the valid tracks. To make the data anonymous a number replaces the participants' name. Per participant the distance, radius, duration, purpose and mode is shown.

External activities are the main reason to leave the building. The elderly mainly left the building for recreation: walking outside for a short while with family or friends. Walking mostly appeared to be around the building and to the park as expected. Surprisingly walks are short and the main road in east direction is not crossed.

A second major reason is shopping. Although the basic requirements are available in or directly near the building, people travelled to shops further away as well. But, the destination for shopping was surprising: the wide variety of shops along the Wolphaertsbochts is NOT visited. Moreover, the whole area up north from the complex is NOT visited at all. An explanation can be found using GISweb: crime rate and violence is rather high in this area, preventing the elderly to pass the area (Figure 3).

**Table 1 Trajectory specifications**

| Trip ID | DISTANCE (km) | RADIUS (km) | DURATION (hrs:min) | PURPOSE | MODE |
|---|---|---|---|---|---|
| **001** | 1,40 | 0,50 | 1:50 | social | walk |
| **002** | 1,70 | 0,60 | 0:30 | recreation | wheelchair |
| **004** | 10,00 | 3,00 | 2:00 | care | scooter |
| **005** | 11,00 | 2,00 | 1:10 | shopping | car |
| **006** | 1,50 | 0,30 | 1:25 | recreation | walk/d |
| **008** | 1,20 | 0,45 | 0:45 | recreation | walk/d |
| **009** | 1,20 | 0,25 | 0:40 | recreation | walk/d |
| **010** | 4,20 | 0,45 | 5:10 | recreation | scooter |
| **011** | 9,80 | 1,00 | 7:25 | other | call |
| **012** | 6,30 | 1,50 | 1:30 | shopping | car |
| **013** | 3,40 | 1,50 | 2:15 | social | public |
| **014** | 2,60 | 0,75 | 1:10 | recreation | walk/d |
| **016** | 10,20 | 2,25 | 1:15 | shopping | public |
| **017** | 7,50 | 1,60 | 1:15 | shopping | scooter |
| **019** | 2,50 | 1,00 | 0:25 | recreation | walk |
| **020** | 5,30 | 1,60 | 1:00 | shopping | public |
| **021** | 10,90 | 2,10 | 3:05 | shopping | car |
| **022** | 2,70 | 0,70 | 0:50 | recreation | walk |
| **023** | 6,10 | 1,00 | 2:05 | care | bike |
| **024** | 3,90 | 1,00 | 1:00 | other | call |
| **025** | 2,20 | 1,00 | 0:25 | recreation | scooter |


**Figure 4** GISWeb (©dS+V): layering of trajectories and pollution

An important outcome of the project is the use and requirement of other modes of transportation for elderly. Although the sample is rather small, a large number of modes is included. Some exceptional modes are wheelchair, walking with device, electric scooter (scoot mobile) and elderly buses. The scooter surprised by the distance covered and continues speed. People drive from the building into the destination, eg a hospital. The range covered up to three kilometers! The elderly bus is a bus on demand, but unfortunately NOT flexible: people have to make a reservation at least one week in advance. All trips with this bus are planned for or regular, weekly trips.

In general we can conclude that elderly hardly leave the building. From the main building, NO tracks were collected. During the rainy day, only one person left the building (planned trip). On the other days in average only 12 trips a day were collected. The relation between space and activities has to be addressed very careful. It is no use to bring all facilities to the assisted living complexes, as the elderly hardly use them. But, today's distribution makes the facilities hardly accessible. An intermediate form needs to be developed. The students have come up with several proposals. The solutions involve the integration of the assisted living complexes in neighborhoods leading to hybrid buildings or hybrid blocks (see Figure 5: proposal Back to the City by Rafael Alencar-Saraiva and Figure 6: Hybrid Living Unit by Kangnin) [1].

Alternative modes of transportation offering flexibility and on demand transportation could solve a part as well. Further, the amenities in public space need to be designed and build well. The comparison between tracks and pollution (air, noise, traffic intensity) shows that attractive public space is required to pull people out of their complex (Figure 4). Ana Duarte's research focused on "The Interaction Between Public Space and Building Typologies". All recreational activities take place in the greener, quieter and saver area. Therefore a masterplan consisting of a special, barrier-free network for elderly was developed (see Figure 7)[1]. An important project herefore is "Taking Care of Public Space: Selective Interventions to Heal the Heart of Society" by Eline Oort [1].

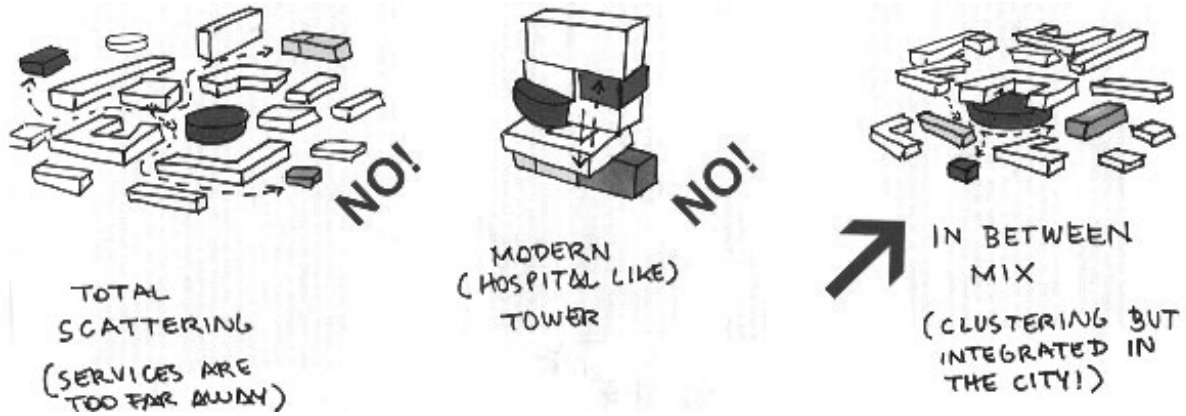


**Figure 5** Proposal "Back to the City" by Rafael Alencar-Saraiva

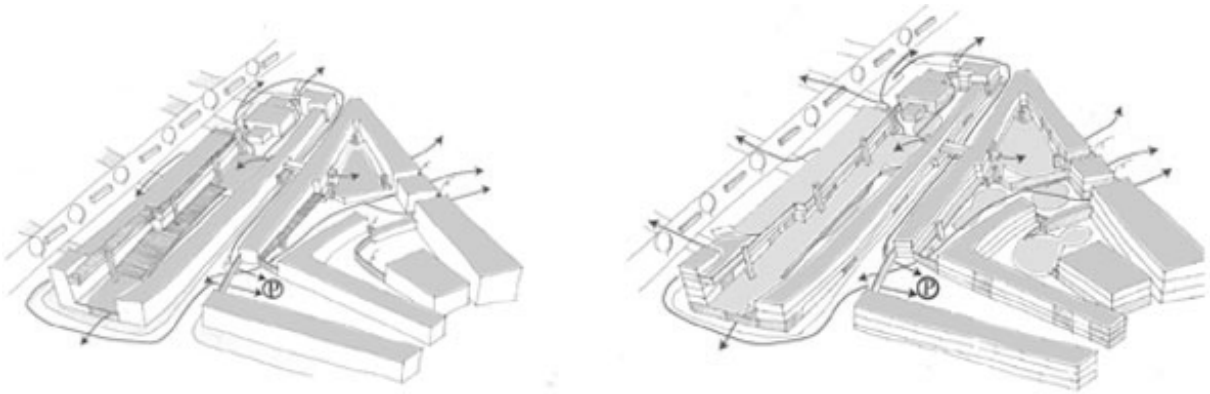

**Figure 6** Proposal "Hybrid Living Unit" by Kangnin

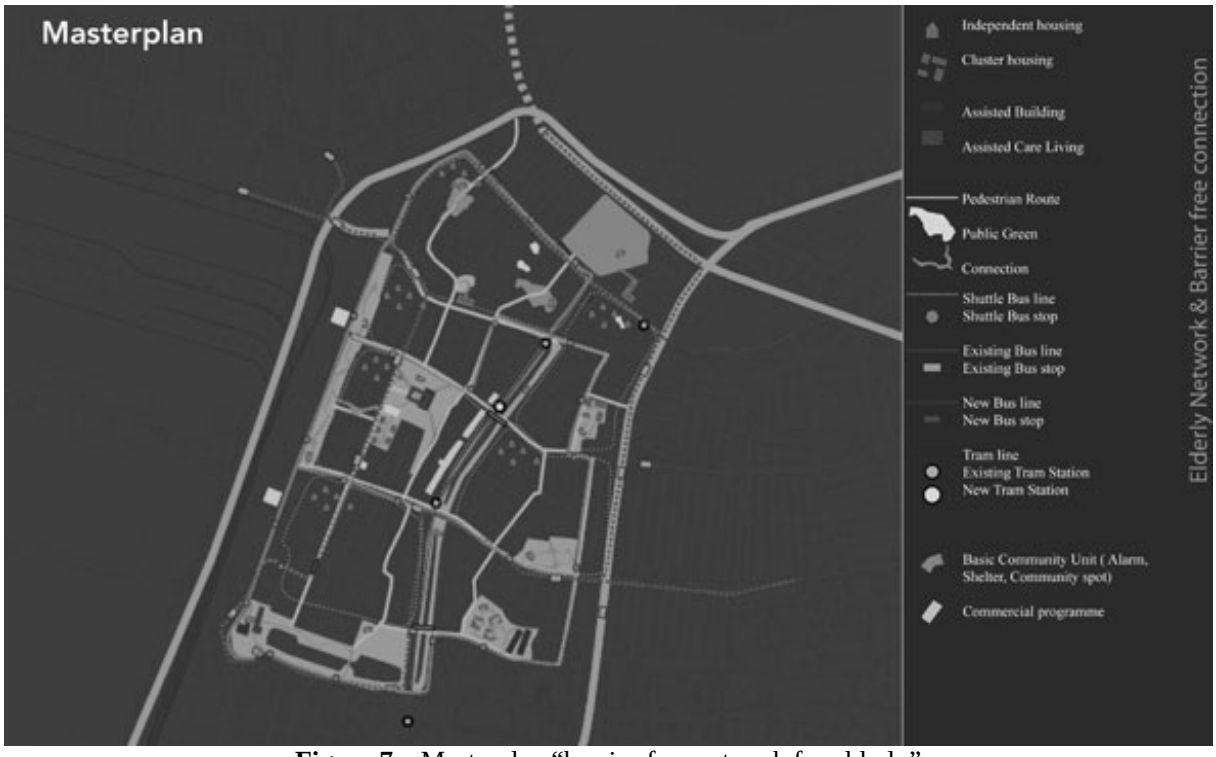


**Figure 7** Masterplan "barrier-free network for elderly"

## 4 CONCLUSIONS

The tracking experiment contributes to the 'Assisted Living' theme in a number of aspects. Firstly, the collection of spatial-temporal data *adds a new layer of information* to existing data layers and statistical information. For example, the type and length of trips is statistical data (see Table 1).

Secondly, using GPS and GIS we can simply project this information on a map, making the *information visual* and *easier to understand* (see Figure 2) and *communicate*. An extra dimension is added as the real locations were people moved and stayed become visual.

Thirdly, the spatial-temporal data provides *insight in processes*. Before, this type of information was very limited: GPS tracking is *more accurate*, offers *new details* and is *more reliable* then methods using activity diaries [2][4]. This insight is a useful instrument to develop proposals, which reflect on actual activity patterns and thus on real use of public space and amenities.

Fourthly, an important aspect of this experiment was the integration with GISweb. This web-based GIS offered *direct access to geo referenced statistical databases*, enabling layering of information. The comparison of the outcomes with several layers of data provided some essential clues.

Finally, the exploration based on the experiment offered a foundation for addressing urban design issues as well as architectural design issues: new proposals were made for the public domain within the district, transportation systems, building blocks, buildings and housing typologies. The method can easily be expanded for a larger sample. And more important, the method can be applied to other subjects, research questions and other specific user groups.


## ACKNOWLEDGEMENT

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