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The Use of GIS with property maps

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Summary

This paper focuses on the use of GIS with old property maps in estate atlases. A prototype of such a GIS is made. It contains information of historical property maps. First, the parcels were localised and drawn on a modern, digital, topographical map. Then, the information the maps provide were put into a database and this was added to the GIS. Now there are several analyses possible. An important part of the research project, is the users research. The purpose of this research is to see if the GIS is able to answer the questions that historical researchers have. Besides that, a better understanding of how historical researchers use this technology in their work will be investigated. For this research, the so-called 'think-aloud' method will be used.

Introduction

In 2001, a research project on Dutch estate atlases started at the Utrecht University. These atlases contain handwritten maps, which contain the properties of landowners. Often only one or two parcels of land are drawn on those maps. Some examples of these maps will be shown. The project consisted of two parts: historical research of the maps and research on the possibilities of computerised analyses of the maps, using GIS. This paper will focus on the second part of the project.

The research to computerised analysis of property maps has two goals:

- To develop a system, concerning the expectations and wishes of potential users
- To know more about the cognitive processes of historians, using GIS

Therefore, a users research will be hold on potential users of the developed system.

This paper starts with an explanation of property maps. This section is based on the work of drs. M. Storms, a colleague who does the historical research of this project. Then, a prototype of the GIS will be explained. The next section deals with cartographic users research and their different methodologies. One method, the think aloud method, will be explained further. This paper closes with a concept of the users research for the GIS for property maps.

Property maps

An estate atlas can be defined as a series of manuscript maps, bound as a book, on which an administrative region or the property of an institution or individual landowner is registered. Most estate atlases depict the landed property of religious institutions, such as abbeys, churches, hospitals and orphanages. Other types of estate atlases visualise private property or functioned as a regional cadastre for a manor or polder.

Compared with other European countries, estate mapping in the Netherlands started very early. The oldest known estate map of Dutch territory was made in 1358. From the 1530s, estate mapping became common in the Netherlands, and from the 1550s, maps of estates began to be drawn

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to supplement or to replace written surveys. The oldest estate atlas in the Netherlands was made in the period 1550-1553 by surveyor Coenraet Oelensz and depicts the landed property of the Convent of Saint Barbara in Delft. The second and third oldest survived estate atlases, made in 1554 and 1555 by Pieter Resen, are also made for Delft institutions. Loose map series of the Delft Hoflanden are dating from the 1540's. Outside Delft, the oldest estate atlases are found in The Hague, Amsterdam and Leiden and are dated from 1558 and 1559. The larger majority of 16th century estate maps are made in the provinces of Holland and Utrecht.

These estate atlases are very rich sources for historical geographical research. The maps can be used in various disciplines:

- The reconstruction of property

The most common type of research is the reconstruction and localisation of property. The map elements that are important for this research are names of landowners and tenants, the status of the parcel (tithe, loan etc.) and geographical names. Besides estate maps, other sources are important for this type of research. The most important one is the first Dutch National Cadastre of 1832.

- The reconstruction of the historical landscape

In addition, the reconstruction of the historical landscape is an important research subject. All the topographical elements in the map, like settlements, farms, roads and waterways, are important for this type. In addition, land use types and geographical names are used in this research type. The purpose of this reconstruction is to date old elements in the present landscape and to map lost elements. Figure 1 shows for example different types of land use.

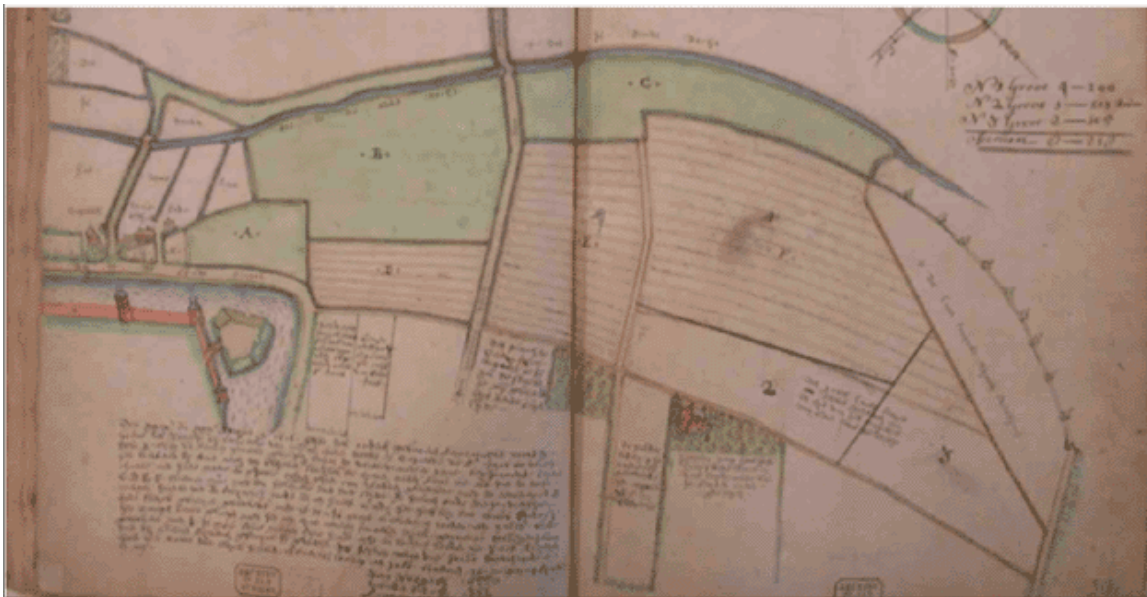


Figure 1. Different types of land use, parcels near the city of Utrecht, The Netherlands.

- Building and architectural history

Estate atlases can be used in architectural history, for example in farmhouse history. Farms are drawn detailed and accurate on most estate maps. For the history of castles and country houses, estate maps can be important sources too. Figure 2 shows a monastery in Belgium.



Figure 2. Architecture in an estate atlas.

- Archaeology

For archaeological research, estate maps are used to locate possible archaeological sites. The most important map elements that are used by archaeologists are buildings and settlements. For example, in a research to the lost castle of Kronenburg, in Castricum, maps of different estate atlases are used.

- Historical cartography

Different researchers are concerned with reproductions of estate atlases. Others are studying the history and work of a single surveyor. These are types of research in the field of historical cartography. In Delfland, the work of surveyor Jan Potter is subject of study. In Overijssel, a single atlas of the Goor municipality is studied.

- Genealogy

Genealogists use estate maps to enrich their family tree research with property information. However, this is not the main purpose in genealogy. The most important information in estate atlases are names of landowners and tenants.

- Toponymy

Toponymy has to do with research on topographical names. After land use, most researchers use this element.

Figure 3 shows an estate map from a estate atlas, which contains several of the elements mentioned above.



Figure 3. An example of an estate map from an estate atlas, parcels around the village Lisse.

The problem with this type of maps is that they are not well known to historical researchers. One reason for this problem is that they are hard to find in the archives. Many of these property maps are part of a book, the so-called estate atlases. In archives, often only the book is described and not the individual maps. To solve this problem, a GIS is developed, which can be used as a database for the maps, but also as a tool for analysis.

Prototype GIS

A prototype of a GIS is made, that contains information of the property maps. Figure 4 shows the opening screen of the GIS. First, the parcels were localised and drawn on a modern, digital, topographical map. Then, the information the maps provide were put into a database and this was added to the GIS. Now there are several analyses possible.

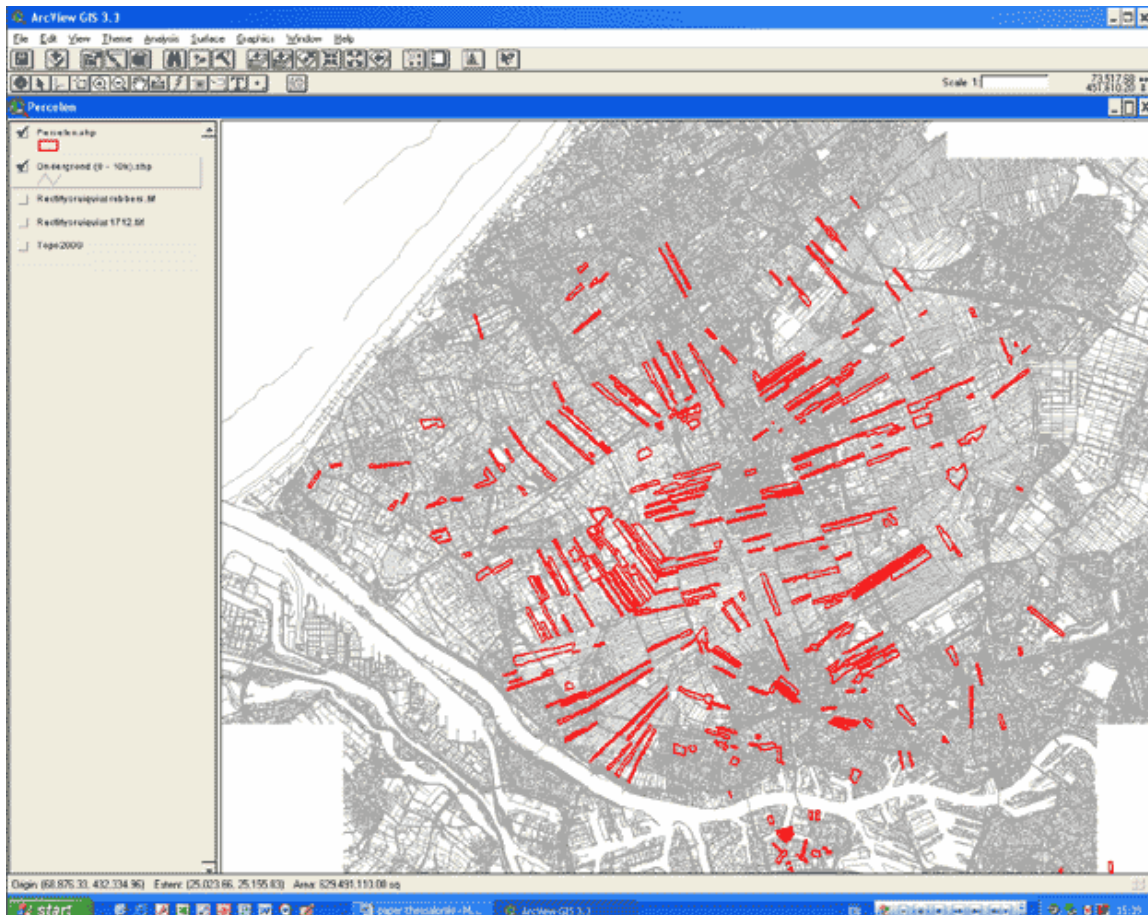


Figure 4. GIS for property maps.

Contents of the prototype

The property maps are described in an MS-Access database. The advantage is that the maps can be described in a uniform way. The tables can also be exported to MS-Excel, when analyses that are more complicated must be made, and to a GIS like ArcView. Data that is stored in the database contains information about the identification of the map, such as title, date, name of surveyor, folio, number of pages and direction of the north arrow. Also, map content is stored, like infrastructure (roads, water), topography (farms, mills, gates) and land use. The database content shall be expanded with more map elements, like topographical names and personal names.

Furthermore, the system contains other kinds of maps. For example, a large-scale map of Delfland (a part in western of The Netherlands) from 1712, some 19th century topographical maps and a time series of 20th century topographical maps. Also planned are additions of different kinds of thematic maps, like quality of ground water or geomorphologic maps. In addition, references to other sources will be added. An example can be books, in which the landowners wrote the names of the tenant farmers, including rents and land use. With these future additions, the usability of the system will improve.

Functionality of the prototype

The prototype knows four kinds of functionalities, see also figures 5a-c:

- Calling up the information from the database, for each parcel.

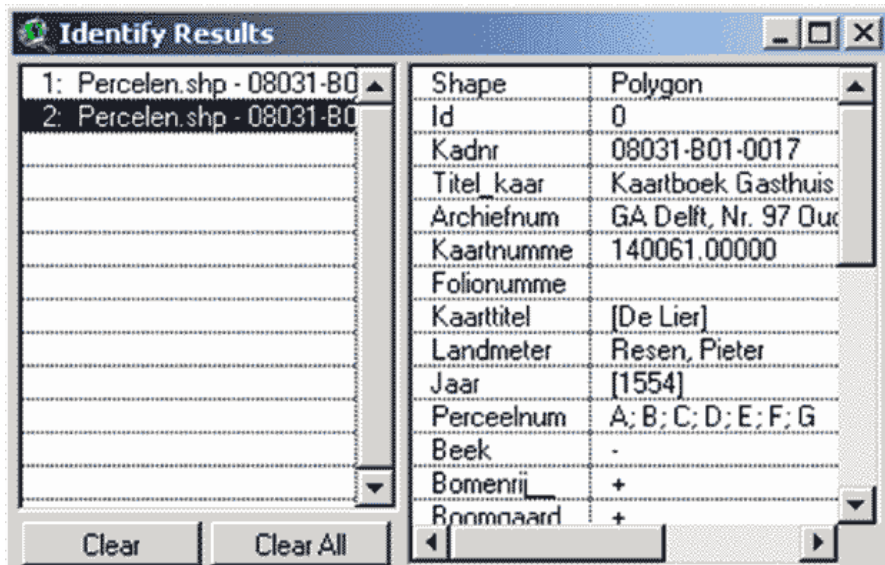


Figure 5a. Showing information of one parcel.

- Making selections of every database object.

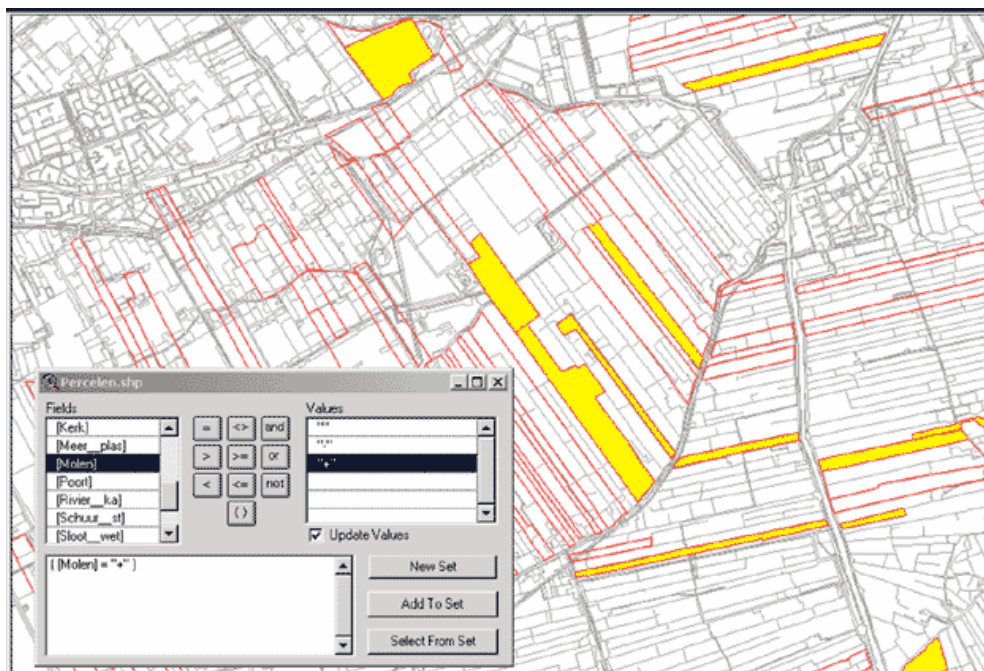


Figure 5b Selections on the element 'mill'.

- Showing a picture of the old property map

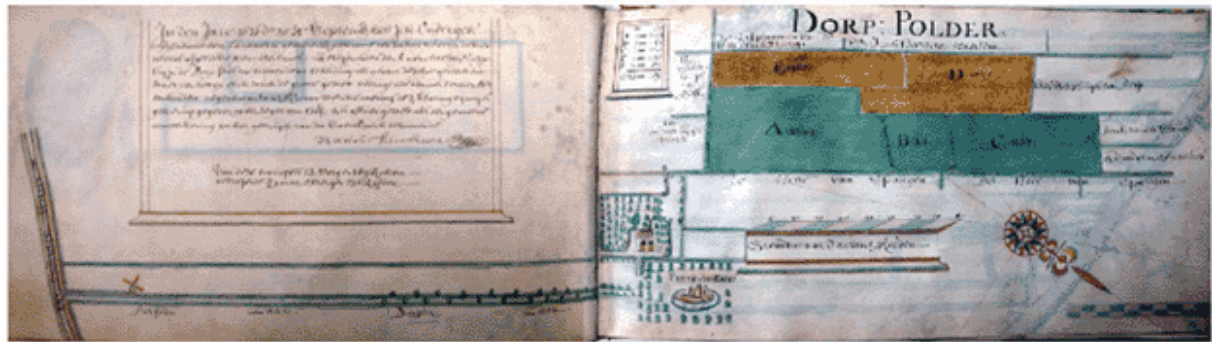


Figure 5c. A picture of the old map, as it is shown in GIS.

- Zooming, as well on the digital modern map, as on the picture of the old map.
- In the future different additions will be made to the GIS, such that more functions are possible, like:
- Tool for localisation for parcels
 - Accuracy analyses
 - Landscape reconstructions
 - 3D reconstructions
 - Animations

Users research

An important part of the research on GIS for historical property maps is the users research. The purpose of this research is to see if the GIS is able to answer the questions the historical researchers have. Besides that, a better understanding of how historical researchers use this technology in their work will be investigated. Three kinds of map users research can be distinguished (Elzakker, 2004, pp. 23-28): perceptual, cognitive and functional map use research and. These three types of research are complementary to each other. Both perceptual and cognitive research try to give answers on questions how maps work, by individual users. Perception is about people's reaction on map symbols, cognition is about the whole process of perception, thoughts, early experiences and memory.

Besides cognitive research, one can distinguish functional research. With this kind of users research one supposes that a map has a certain purpose. In the research, the map is tested if this purpose aims its goals. An example can be the research to route planners. Also, research to the needs and characteristics of the users are of this type. The results will lead to an improvement of effects of the maps. Much attention is paid to the design of the users interface. A good design of the interface will lead to an improved usability of a system and better use of the system functions. Of course, functional research is not only for maps alone. Also the use of visualization tools or GIS can be investigated this way. Research projects can be purely cognitive, purely functional or a combination of both.

Some examples of methodologies

In this section will point out some examples of users research. Each of them has their own methodology. To get a better understanding of the users of the American Hydrological Atlas Series Dyman (1989) held a written inquiry. The subject of the atlas is ground water conditions. The advantage of written inquiries is that it is a relatively quick method and the analysis is quite easy. It is a good way to do a research with a large amount of subjects. The disadvantage is that you can't

be sure about the response and that there is no interaction between researcher and subject. Because of these disadvantages, written inquiries are not suitable for cognitive research. In 2001 a research was published to route planners. The purpose was to let users evaluate the quality of the, on that time, most recent route planners on CD-ROMs and Internet. Besides that, Poppe (2001) made an inventory of the users' expectations and wishes of route planners. Poppe held a survey on Internet. Potential users of route planners were lead to his research website and were asked to fill in a questionnaire. Internet inquiries have some advantages. They are relatively easy accessible, it takes less time and less money to execute the survey. Neither the subject nor the researcher has to travel. The subject can choose for himself when he's willing to fill in the survey. Otherwise, there are some serious disadvantages. You can only test Internet users, so the groups who have an easy Internet access are over represented. Those users are male, students, financial rich, American, West-European or Australian. Besides that, the disadvantages are similar to those of written inquiries.

Davies and Medyckyj-Scott (1994 & 1996) investigated the use and satisfaction of GIS users with their own GIS software. The purpose was just to know more about GIS users. The results were meant to understand more about and improve the interaction between users and system. Davies and Medyckyj-Scott made a workplace-research. They visited the subjects in their own labour environment. The subjects were given a task that they had to fulfill. The performance of this task and a part of the subject's normal work was taped on video. This video was analyzed together with the subjects. Workplace studies have some disadvantages: the researcher can't have complete control over the test environment, subjects takes less time for the tasks and portable equipment is of less quality then laboratory equipment. Workplace studies are a good alternative when there is no laboratory, you do not want subjects to travel much and when you want to visit subjects in their own environment. Van Elzakker (2004) used a laboratory for his research. His purpose was to investigate the role maps are playing in exploratory research. A number of 10 subjects came to the laboratory and were asked to explore a large dataset, concerning the province of Overijssel (The Netherlands). After this exploration they had to draw a spatial model of this province with the, in their opinion, most important regional structures. Van Elzakker used the so-called think aloud method for his research. This method will be explained in the next section of this paper.

Think aloud method

For the research to GIS for property maps, the think-aloud method will be used. This method has a long history in social sciences, but it was only recently used in cartographical research. The research takes place in a research laboratory. Test persons are asked to say what they think, during the performance of a given task. The performance will be taped on video and on audio tape. These tapes will lead to a Verbal Protocol. The think aloud method arose from introspective methods of psychological research. The psychologist Wilhelm Wundt (1832-1920) was one of the first who used this method. He let an event happen, observed the reactions and draw conclusions about mental processes. In 1875 Wundt got his own laboratory for his experiments. For the first time one could speak of experimental psychology (Boerree, 2000). The introspective methods were insufficient to know more about internal, mental processes. To solve this problem verbalization was used. Subjects had to explain their thoughts after the tests, so in retrospect. Later, at the end of the 1940's, verbal protocols were made during the tests. Subjects had to speak out loud during the tests what they thought. This was the starting point of the think aloud method. The think aloud method was first used in psychology, later followed by educational research (for example research

to reading skills), linguistics (for example how to learn a new language) and ergonomics (for example user interfaces for computersystems). In cartographic research, the method is hardly used. One of the first who used the think aloud method in cartographic research was the psychologist Thorndyke. He used verbal protocols in research to individual differences in knowledge acquisition by maps (Thorndyke & Stasz, 1980).

It takes a while before cartographic researchers discover the advantages of the think aloud method. At the end of the 1980's and the 1990's some cartographers used the method in research projects to contours on maps, tactile maps, recognition of regions, navigation, maps on screens and thematic mapping. More recently, Van Elzakker en Blok used the think aloud method in their projects. The subjects in these researches were asked to speak aloud during the performance of the task. The talk was taped on video and audiotape. These tapes were combined with tapes of recorded screen changes. This combined data was written out in so-called think-aloud protocols. The think aloud method was also used by Blok (2005). She investigated the variables in cartographic animations. First, she asked cartographic experts to look at animation software she used for this research. With their comments, she improved the software package. A group of potential users tested these results. In this stage, the think aloud method was used. Both examples of use of the think aloud method shows that the method can be used by both cognitive research (Van Elzakker) and functional research (Blok).

Principles of the think aloud method

With the think aloud method the researcher collects real-time comments from subjects, performing a task. Subjects are asked to talk out loud what they are thinking, during their task. No interruption takes places during the task, other than remembering the subject to talk loud. The spoken words are taped on video and audiotape. In the research of Van Elzakker, also computer screen changes are taped. The combined tapes form the data for the verbal protocols.

Advantages and disadvantages of the think aloud method

The use of the think aloud method, and laboratory research in common, fits especially when the researcher wants complete control over his research. Other advantages are that qualitative data about cognitive processes is directly available, subjects do not have to remember the thoughts they had and subjects don't have to give interpretations of their thoughts. Otherwise, this method is very time consuming. Especially the analyses of the protocols take much time. Another problem is that the protocols can be incomplete. You can't control if a subject really tells everything he thinks. Not everyone has the skills to tell their thoughts and perform a test at the same time. Most people think quicker than they can talk. Therefore, thoughts can be missed and protocols become incomplete. Incomplete protocols can also be a result of reactivity. Reactivity is influences on a subject. The presence of the researcher, as well verbal as non-verbal, can cause reactivity. Also the hearing of one's own voice can cause reactivity. Another example that can cause reactivity is, when a subject is very busy with his task performance, so his verbalisation skills decrease. The think aloud method is also labour intensive and expensive. Nevertheless, in the study of cognitive processes, there seems not to be an alternative yet. In table 1 gives a summary of the different methods, with their advantages and disadvantages.

Method	Advantage	Disadvantage
Written inquiries	<ul style="list-style-type: none"> - Quick method - Easy to analyse results - Suitable for large number of subjects 	<ul style="list-style-type: none"> - Not sure about the response - No interaction between researcher and subject
Internet inquiries	<ul style="list-style-type: none"> - Easy accessible - Quick method - Cheap Method - Subject can do the test in his own time 	<ul style="list-style-type: none"> - One can only reach the Internet population
Workplace studies	<ul style="list-style-type: none"> - Visit subjects in their own environment - No travelling for subjects - No need for a laboratory 	<ul style="list-style-type: none"> - No complete control of circumstances - Portable equipment is of less quality then laboratory equipment - Subjects seems to be in more hurry to fulfil the tasks
Think aloud method	<ul style="list-style-type: none"> - Complete control on circumstances - Direct available qualitative data - Not retrospective 	<ul style="list-style-type: none"> - Reactivity - Time consuming - Expensive - Labour intensive

Table 1: Some users research methods.

Users research to GIS for property maps

When the functions of the GIS only had to be tested by subjects, one should maybe choose for another method than the think aloud method. However, because one of the goals of this research is to get to know more about cognitive processes of the users, the only usable method is the think aloud method. Who are those users? In the first place, the system is meant for historical geographical research. Therefore, the first group of potential users are historical geographers.

In the section of this paper about property maps, several disciplines were mentioned where property maps can play a role in research projects. Taking these disciplines in mind, also archaeologists, historical cartographers, genealogists, and other historians could be possible users. In this research project, (eight to) ten of them will be asked to join the think aloud sessions in a laboratory. Nielsen (1994) shows that about eight subjects are the optimum amount of subjects. More subjects will not lead to better results in the research. Probably most of them will not have good experiences with GIS use. Therefore, the first stage is to let the subjects make feel comfortable with GIS. After that, the subjects will be asked to explore the dataset. At the stage of writing this paper, the concrete tasks have still to be developed. After the tasks, the subject will evaluate the protocols together with the researcher. If things are still unclear, this will clear them up.

Conclusion

Property maps are a rich source for different kinds of historical research. Unfortunately, they are hidden in archives. A GIS can function as a database for these maps and in combination with other sources also as a tool for analyses.

To get to know more about the use of the GIS a users research will be held. There are different kinds of methods for this research. Table 1 shows some of them, with their advantages and disadvantages. In the research to users of the GIS for property maps, the think aloud method is chosen, because this method provides the most information about the cognitive processes of the users.

References

- Blok, C.A. (2005). *Dynamic Visualization Variables in Animation to Support Monitoring Of Spatial Phenomena*. KNAG / Faculteit Geowetenschappen / ITC: Utrecht / Enschede.
- Boeree, C.G. (2000), Wilhelm Wundt and William James.
<http://www.ship.edu/%7Ecgboree/wundtjames.html> [gezien 20-03-2006].
- Davies, C. & D. Medyckyj-Scott (1994). *GIS Usability: Recommendations Based on the User's View*. In: International Journal of Information Systems, vol. 8 nr 2. pp 175-189.
- Davies, C. & D. Medyckyj-Scott (1996). *GIS Users Observed*. In: International Journal of Geographical Information Systems, vol. 10, nr 4. pp 363-384.
- Dymon, U.J. (1989). *Do We Really Know Our Map Users?* In: Cartographica, vol. 26, nrs 3 & 4, pp. 49-58.
- Elzakker, C.P.J.M. van (2004), *The Use of Maps in the Exploration of Geographic Data*. KNAG / Faculteit Geowetenschappen / ITC: Utrecht / Enschede.
- Nielsen, J. (1994). *Estimating The Number Of Subjects Needed For A Thinking Aloud Test*. In: International Journal of Human-Computer Studies, 41 nr. 3. pp. 385-397.
- Poppe, E. (2001). *De Weg Naar De Ideale Routeplanner Op CD-ROM En Internet*. Thesis Utrecht University: Utrecht <http://cartography.geog.uu.nl/routeplanner> [seen: 31-12-2005].
- Thorndyke, P.W. & C. Stasz (1980). *Individual Differences in Procedures For Knowledge Acquisitions For Maps*. In: Cognitive Psychology 12, 137-175.