INTEGRATING GIS WITH A LAND VALUATION INFORMATION SYSTEM: SOME NON-TECHNICAL CONSIDERATIONS FOR THE ESTONIAN CASE

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ABSTRACT

For many organisations all over the world, which produce and/or process geo-spatial data, the choice of an appropriate GIS system that fits the needs of all departments within the organisation is an enforcing task. This article addresses non-technical issues for integrating GIS technology within a complex geo-spatial organisation. In particular, we consider the factors that may be of importance when selecting a GIS within a multitasking governmental environment. We illustrate our considerations by taking the Real Estate Valuation Department of the Estonian National Land Board as a case.

1. INTRODUCTION

GIS technology, being already over three decades in operation, has found commodious use in many organisations all over the world. GIS systems are satisfactorily applied for multiple geo-spatial data and information processing purposes. Nevertheless, many (governmental) organisations in particular in Central and Eastern European countries are still struggling with the question how to integrate GIS technology in the everyday workflows of their organisation.

It is often attractive to look at the problem of integrating a GIS system in the organisation just from the technological point of view. In this restricted approach insight in the appropriateness and functionality of a GIS can be obtained by carrying out benchmarks. A solution, which may be appropriate at the technological level, may however be improper when considering the organisation as a whole. This problem may become even more striking since there is an obvious development going on that organisations, also those involved in the production, processing and distribution of geo-spatial data and information, are becoming increasingly responsible for a growing pallet of activities. This does not necessarily mean that their size is expanding. No, at the contrary, often the increase of tasks is accompanied by a reduction of the number of employees.

This change is enabled by rapid advances in technology. Also the tendency that the actual production part of the tasks is increasingly carried out by third parties, contributes to this development. Indeed, a bent is going on that governmental organisations are restricting themselves more and more to product specification and product check, i.e. the front-end and the tail-end parts of the production cycle, whilst the actual production is performed by private firms. Because the technological and organisational requirements may be conflicting, whilst

the goals of organisations are growing towards multitasking, the integration of GIS technology in a complex organisation should be done from multiple perspectives. Based on our Central European experiences we provide in this article a number of considerations involving these multiple perspectives.

2. MULTITASKING ORGANISATIONS

Stating that society is becoming increasingly complex is no more than an understatement. The causes of complexity originate roughly in two sources: (1) rapid developments in information and communication technology (ICT), and (2) increasing interaction among people and among organisations. Of course, the one is strongly correlated with the other. Almost every day we got confronted with the rapid developments in the field of technology. The transport of data along wires and increasingly along wireless media is exploding. Power and storage capacities of computers are still rapidly growing, it seems a never ending story.

These developments cause that the traditional tasks of governmental agencies are eroding and consequently their operational and physical walls are becoming increasingly artificial. This evolution in combination with the need to improve services while reducing costs, results in mergers between agencies, which have in the past been considered to be separate organisations. For example, the merging of a National Cadastre with a National Mapping Agency may be beneficial for both, in particular because both are involved in the same type of tasks: the collection and registration of geo-spatial information. Since a complex organisation has to carry out many different tasks, integrating GIS technology in a complex organisation is a challenging endeavour.

So, one of the key problems one faces when integrating GIS technology within a complex organisation, is that increasingly this organisation has to carry out a multitude of tasks. In order to carry out these tasks in a manageable manner, organisations split up themselves into smaller units. These units maintain not only information streams with each other but also with work places outside the organisation, the Outer World (OW). For example, in a Cadastral environment, the measurement of property boundaries may be put out to contract to private surveying firms. The medium, along which the information streams are messaged, is increasingly becoming Internet. So, we have a complex network of people, data, tools and facilities, all of which may be shared by the units of the organisation making up the network (Figure 1).

We restrict ourselves now to the tool part of the picture, and even more specific GIS systems. The different units within a multitasking organisation may have different requirements on the functionality of a GIS. For example, one of the departments may like to purchase a certain GIS, just on the basis of the fact that the Outer World organisation with which one shares information streams on a regular base, uses this system.

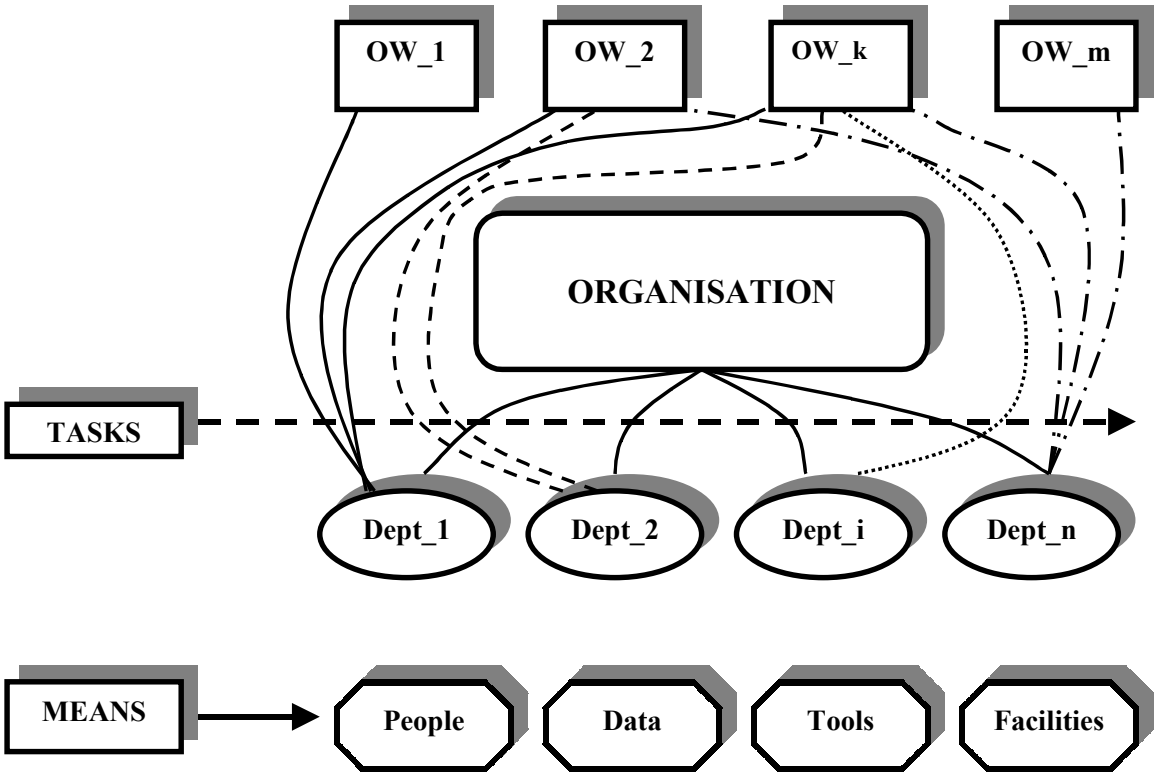

Figure 1: Performing multiple tasks in a manageable manner, requires that organisations split up in smaller units (Dept), and maintain multiple contacts with organisations in the Outer World (OW). The means to carry out the tasks are people, data, tools and facilities.

3. GIS DESIGN BACKGROUNDS

3.1 User's View Point

From a user's point of view, one may look at GIS technology in many different ways. For example, a retailer may consider a GIS to be a tool to find the optimum route between delivery addresses in the support area of a distribution centre. The main facility of the GIS has to be in this case a fast routine to calculate the optimal routes, to incorporate rapidly traffic information from remote sources and to present the routes in an easily understandable format. A land surveyor may consider a GIS to be an excellent tool to create parcel based data bases. The main functionality of the GIS should than be the capability to easily input and edit graphical and administrative data and to retrieve selected data and data that obeys certain characteristics from the data base. In addition, an appropriate mapping function, including editing facilities, is required. A hydrologist uses a GIS as a tool to determine, for example, flood risk of a lowland region, covered with a complex system of rivers and streams. The requirements he will put on the system are easy incorporation and processing of many types of data and the availability of advanced analysis tools. So, a retailer may put much emphasise on the visualisation functionality of a GIS, while a land surveyor may emphasise the easy registration and data retrieval dimension of a GIS. At the other hand, the environmental expert, may look at a GIS as an analysis tool which enables him to see relationships among the data and to process the data in such a way that he arrives at useful information. The many

GIS systems, which are presently on the market, reflect in their design philosophy, the many ways one may use a GIS.

3.2 Geo-spatial Information Cycle

Design and functionality of a GIS are often strongly related to the type of activity one had in mind during the pioneering stage of development. The geo-spatial activities can be roughly categorised into four groups (Figure 2):

- Planning of changes in environment
- Making decisions about aspects involving the environment
- Maintaining constructions and situations in environment
- Carrying out actions to change (improve) environment

In order to be able to perform the above four categories of activities there is a need to collect data. Often the data requires a preprocessing stage before being suited for entering the next stage. The preprocessing may for example concern a standard transformation to another geodetic reference system, or a much more complex generalisation step. The next stage is the derivation of information from the data by using models of the world. The application of these models is done by computational processes by means of appropriate analysis tools. In order to communicate the information and to improve the data and information a visualisation, editing and presentation stage is necessary. The entire cycle can accordingly be subdivided in four stages:

1. Geo-spatial data acquisition
2. Preprocessing in order to transfer the collected data to a format that is appropriate for further processing
3. Analysis, where the data is transformed to information which is suited for the application domain at hand
4. Visualisation, Editing and Presentation

Initially, GIS designers and constructors have emphasised the visualisation, editing and presentation stage. Presently, all GIS systems are good in that. In the pioneering stage GIS technology has been considered by many as a handy tool to support mapping. About a quarter of a century ago one started to become aware of the fact that a map in digital form is more than just a data source which facilitates the “automatic” production of traditional printed maps. Those organisations involved in the collection and registration of geo-spatial data, started to use GIS technology as a storage and retrieval tool. This awareness resulted in the development of GIS systems that supported the data collection part of the data flow. At the other hand environmental scientists recognised that GIS technology creates the possibility to do things in alternative ways. By analysing the digital geo-spatial stemming from many different sources with software tools, a thorough understanding of social as well as physical processes, such as erosion, may be gained.

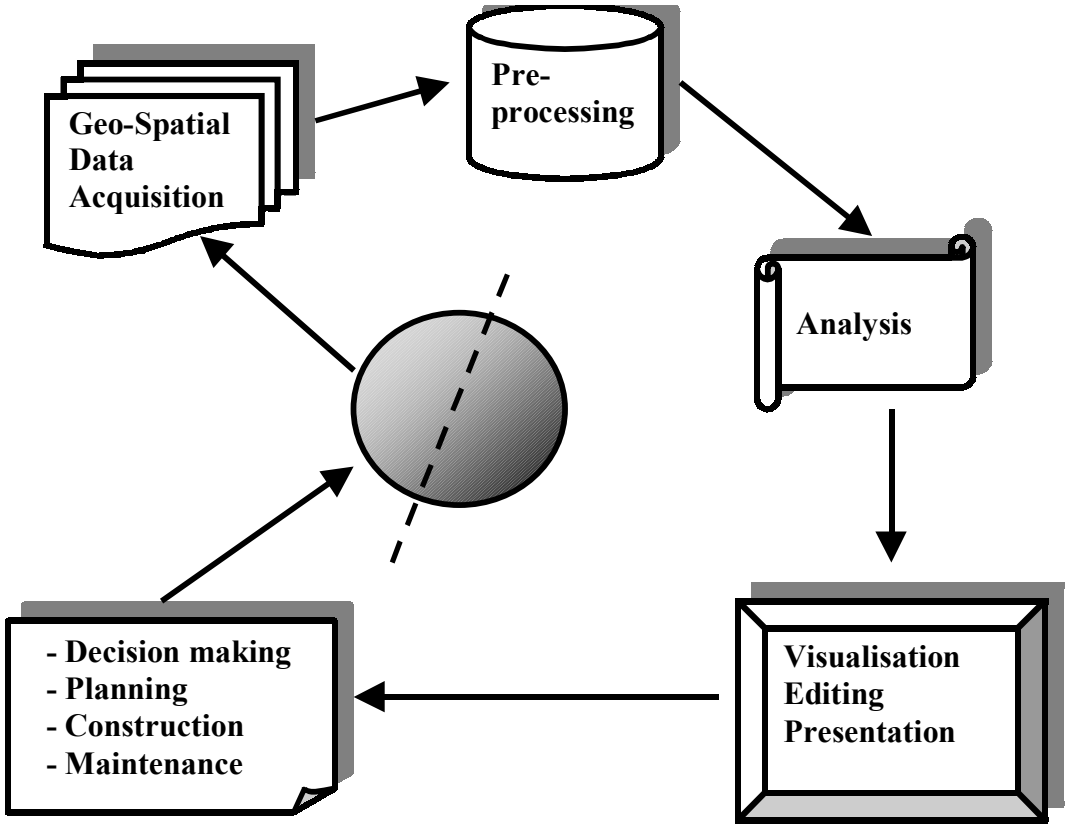

Figure 2: Geo-spatial Information Cycle.

4. SELECTION CRITERIA

After the above discussion, we are ready now to make a list of the criteria, which one should keep in mind when selecting a particular GIS system. These criteria can be subdivided into two groups. The first group is related to requirements inside the organisation, while the second group concerns external aspects.

4.1 Internal Selection Criteria

The selection of a GIS at the internal level may depend on a multitude of factors, including:
- Whether the types of tasks within the organisation concern data acquisition, analysis or visualisation, editing and presentation, or a mixture of them
- Preferences of the employees working at the different departments
- Level of skills of the employees
- Required level of standardisation combined with the question whether having more than one GIS system in the organisation is feasible from a management point of view
- Ability of the systems to reduce cost and improve efficiency
- Types of data (raster, vector, surveying) that have to be processed

4.2 External Selection Criteria

External criteria include:
- The way one communicates with the Outer World parties, for example for a certain department it would be very appropriate to use for checking and editing purposes the same GIS package as the private firm that delivers the geo-spatial data product.
- The external workflows and GIS systems used in Outer World organisations
- The strategy and vision of the developer of the GIS system; does the GIS vendor still exist within five years, what is the level of future support, which products are under developments and so on…
- How the system may improve client services
- The need to adapt to OpenGIS standards

4.3 Standardisation

We address now more closely the important question: is it feasible to have more than one system in an organisation or is it necessary that all workers in the organisation make use of the same system? The decision about this important issue may depend on several factors. Standardisation has many advantages, including:
- One is not depend on a small group of experts, who may create an artificial wall around their department. When people leave the organisation, which is –given today's economy- not imaginary, people from other departments can do the job
- Employees of different departments, using the same system, may communicate in a better way
- Ease of exchange of people among departments to cover peaks in work loads
- Establishment of an organisation wide user group which discusses problems and provides solutions
- Maintenance of one system is easier than of many
- Cost effectiveness in the long run.

The price one has to pay for choosing one standard is:
- During the initiation stage, much discussion about the choice of a particular GIS system will occur. Each department will have its preference and during the selection and decision making stage one will put much effort on convincing the management that the "own" system is the one and only that should be selected.
- It is likely that the chosen standard is better suited to operate at the one department compared to other. Consequently, some departments need to put more effort to complete a certain work flow, than when another system would have been chosen. It is important that this drawback is identified and that the department, which is confronted with it, is compensated for this deficiency, for example in the form of extension of man power.
- One will have winners and losers. The departments of which "their" system has not been chosen as standard, may become frustrated and may therefore cause commotion in the organisation
- Employees may leave the organisation because they are unsatisfied with the selected system
- When selecting a GIS system, one of the major pitfalls one may be confronted with, is that GIS technology is for many senior managers a new phenomenon. Consequently, the individuals who cover the floors of the different departments may easily become GIS experts. The one who will have seemingly the best arguments –with an emphasis on seemingly- will win the battle.

5. CASE: ESTONIAN NATIONAL LAND BOARD

The Estonian National Land Board (ENLB) is a government agency subordinated to the Ministry of Environment. Its tasks comprise:
- Co-ordination of land management in urban and rural areas at national level
- Keeping of the Land Cadastre
- Organisation and supervising Land Valuation
- Organisation and supervising Geodetic and Cartographic Works

The variety of ENLB products is used for purposes like land reform, land valuation, land taxation, environmental protection, land use determination and planning. Besides governmental agencies and municipalities, public utility and transport companies and military forces are ENLB clients. Private firms using services of the NLB, include: surveying firms, banks, construction enterprises, real estate agencies and IT companies. Many tasks of the ENLB are carried out at the County Cadastral Offices, 15 in total. Much work is put out to contract to private firms, including surveying, mapping and software development.

5.1 Tasks of the Different Units

The multiple ENLB tasks comprise four main types:
- The Cadastral department processes, stores, retrieves and up-dates vector data, and is consequently located at the data acquisition and registration stage
- The Real Estate Valuation Department has to carry out analysis, not only with respect to data, which one has collected one-selves but also data collected by third parties.
- Topographic base mapping projects
- Soil mapping projects

The units carrying out the topographic and soil mapping tasks need to visualise and edit the data, collected by private firms for checking and improvement purposes. For these units it is important that the works are done in close operation with the concerning firms.

5.2 Needs of the Real Estate Valuation Department

We select from the above four larger projects of the ENLB, the task concerning organising and supervising land valuation task. This task is carried out by the Real Estate Valuation Department. The goal of this department is twofold:
1. Collection and analysis of a variety of real estate data for land valuation purposes
2. Distribution of information about Estonian land value and land use in order to enforce the real estate market.

In order to facilitate the tasks of this Department we developed in the period September 1997-February 1999 an information system, called VTIS. In an earlier paper, published at the UDMS 1999 symposium (Lemmens, 1999), we considered the design of the system and evaluated the results of piloting the system. The system, now being in operation over one year, has been utilised for producing bi-annual extensive reviews of the Estonian real estate market. Public organisations, valuators, real estate agents and the general public (by the mouth of the media) expressed their confidence in the system. The VTIS users are the Real Estate Valuation Department at the central ENLB office in Tallinn and the valuators at the 15 county offices. The system should become a part of the National Land Register, that at the time we started the project was not yet fully operational.

Clients include the government and real estate agencies, which need specific statistical information about transactions, market prices and so on. Real estate agencies, for example, are

particularly interested in information concerning prices per area unit used for commercial activities in the counties where they operate over a certain period of time. The information provision is charged at a modest level. One has to pay a fixed amount and on top of that an amount per each delivered transaction information unit. The information usually contains:

- Transaction date
- Price
- Area
- Land use type
- Build-up or bare
- Type of buyer and seller
- Mortage data

Statistics about the real estate market are a new product for the Estonian society. Good presentation tools and well-designed maps will enable that the general public will obtain a quick understanding of the provided statistics and to get faith into the information. With respect to the other aim -collection and analysis of a variety of real estate data for land valuation purposes- the third mass valuation has been scheduled to be taking place in 2001. One of the mean products that should be derived from the data are value zones based on market prices. Value zones form the basis for the determination of the taxable land value. Issues that need to be considered, include:

- Determination of land value in areas where none or only few transactions have been performed, based on transaction prices of areas with the same characteristic parameters, such as land use.
- What is the relationship between the land value and its land use and the land use in the (broad) vicinity?

The answering of such questions requires powerful GIS analysis tools. At the moment ENLB's Real Estate Valuation Department has stepped into a learning curve both with respect to discovering trends in land value and in investigating the proper GIS tools to extract information from the data. There is not yet a clear picture on the patterns, trends and relationships present in the data. Therefore, the spatial analysis tools should be flexible and powerful in order to be able to check quickly relationships that one suspects. This should not only be done at different levels of administration (national, county, municipality), but also for different and distributed spatial units, such as land use types. At present, the emphasis is on producing (thematic) map products with GIS tools. These products enable spatial analysis by visual inspection. In this way, the valuators can obtain an understanding of the hidden relationships present in the data. Furthermore, map products are extremely important for presentation purposes.

6. SUMMARY AND CONCLUSIONS

In summary, a GIS that is appropriate to support the tasks of Real Estate Valuation Department has to fulfil the following requirements:

- Powerful and flexible analysis tools should be available
- Supporting the production of easy understandable thematic maps

Similar analysis can be carried out for the cadastral mapping task, and the topographic and soil mapping tasks. It is obvious that these departments put other requirements on GIS technology. Whether a standard GIS has to be chosen among the departments or whether they benefits the most from selecting different systems, is a matter of thorough consideration, taking the notions presented in this paper into account.

In the present article we addressed non-technical selection issues a GIS system. Our main aim has been to demonstrate that the integration of a GIS within a multi-tasking governmental

organisation, goes far beyond benchmarking of individual packages. Although standardisation is an important requirement from a management point of view, realisation will not always be feasible because of the diversity of tasks the different units within the organisation have to perform. In addition, GIS packages are still rapidly evolving. The choice should therefore not only depend on the status at a certain moment. Equally important or even more important is to obtain insight in the strategic choices of the GIS software manufacturers, because that will determine much of the success for the midterm and long term future. Given the notions presented above, a proper choice for the ENLB would probably be to select one GIS software system that is principally designed for analysis of vector data. In addition, the package should be able to access distributed data according to the OpenGIS standards, while it has or will in the near future have a strong surveying data acquisition component.

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