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Integration of Geomatics in Research & Development

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Perspective

Integration of Geomatics in Research & Development

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Abstract

The use of Geographical Information Systems (GIS) within the society as well as in academic work has increased rapidly over the last decades. This also means that Geomatics has started to create problems in both academic and non-academic worlds. Firstly because it bridges borders that have been in place for a long time and secondly because Geomatics, or rather the basic concepts of Geomatics, is increasingly used. In the eighties it was natural that departments dealing with Geomatics were located at technical or natural faculties. Today this is not the case anymore. Spatial analysis has proven to be important in all disciplines. We can find examples of strong GIS units in e.g. humanities (archaeology, human ecology, language studies etc.), social science (human and economic geography, economy, economic history etc.) and medicine (social and occupational medicine, epidemiology etc.). This means that Geomatics is part of research in most disciplines and that many users are facing the issues that are related to the integration of Geomatics in their field. Geomatics is also used frequently in interdisciplinary settings and this also generates specific issues. In this paper some of these issues are discussed and suggestions are made how to avoid or reduce problems. The need for human capacity building, regarding the technique (including possibilities and limitations) as well as applications in "non-technical domains", low cost, accessible, data, a defined policy/strategy regarding Geomatics, as well as a well functioning unit (preferably centralized supporting other units) of Geomatics within the organisation are stressed.

Keywords: Geomatic, research, development, Geographical Information Systems, society.

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1. INTRODUCTION

Geomatics is a wide subject, dealing with collection, storage, analysis and visualisation of geographical (spatial as well as non-spatial) data. GIS and Remote Sensing (RS) are normally considered to be parts of Geomatics. This paper is a brief summary of experiences that has been gained over the past decades, concerning implementation of new geo-technology in complex organisations. The ambition is by no means to cover all aspects of these processes. Rather it is an attempt to highlight specific parts and problems. The launching of the first Landsat satellite in 1973 was the starting point of the renewed and rapid development in the field of Geomatics we have seen over the last thirty years, as did the introduction of aerial photographs for civilian application after the Second World War. Possibilities to obtain detailed information about our environment, through the earth observation satellites, yielded increased advanced research and opened new possibilities for e.g. image processing and geodesy (see e.g. Jähne, 2004). Then, as a spin of effect, the enormous increase in the use of GIS and spatial modelling followed. From being mainly linked to remote sensing applications, GIS is today an analysis tool used in almost all disciplines. The integration of Geomatics/GIS and spatial modelling all over the society is steadily increasing, and has probably not reached its peek in a global perspective. This has to be considered as something positive and desirable.

However, rapid development and increased use also causes difficulties. Sometimes an almost blind faith in new technology occurs. People believing in the novelty (in this case GIS) have a tendency to get "too much" specialized, at the expense of well worked in and reliable methodologies. Apart from an obvious narrow mindedness this can also results in tensions. One group defends so called development, while the other one consists of traditionalists.

Another problem is the matter of status. The statement "the more high tech equipment you have the better you are" is widely spread, though not explicitly. People maybe not really believe in the new technology but sees the technology as an excuse to gather equipment for their department or unit, without really having neither knowledge nor willingness to make use of it. How many plotters and digitizing tables world wide have only been used a few times, or never, and how many computers have only been used for Internet surfing and playing games?

These difficulties with the technological development have also yielded a counter-reaction. We have seen many examples of research councils and donors that, in a way that looks deliberate, have made it more or less impossible to integrate e.g. Geomatics in "non-traditional" fields. Hopefully this has been because of calculated risks for less successful projects, and not reactionary thinking. However, sometimes we have reasons to doubt this.

In the text below we briefly discuss the above-mentioned problems as well as trends in the integration of Geomatics, in the developing as well as in the so called developed World.

2. SPATIAL INTEGRATION

Spatial modelling and visualisation are, and have always been, important in most parts of society, outside as well as within the academic disciplines. Maps have been used to analyse spatial and temporal trends and relationships, as well as visualising states and analysis results. The use of the spatial dimensions has of course varied in amount and quality, between as well as within subjects and disciplines.

By the increasing development of Geomatics, offering user-friendly tools to document, analyse and visualise data and processes, possibilities to widen as well as deepen the spatial integration in less technical disciplines have evolved. We have seen both good and bad examples of this integration and often a wish for rapid technological development has jeopardized the scientific/practical aim of the implementation in different projects that the authors have had contact with in Africa and Asia, particularly during the beginning of GIS implementation, from 1985 and up to around 2000 (e.g. EIS Africa, 2001 and IJGIS, 1991).

3. QUANTITATIVE AND QUALITATIVE INTEGRATION

In most general textbooks GIS is claimed to be an integrative tool between quantitative and qualitative research methods (Eklundh & Harrie, 2008). Qualitative data like text documents, audio and video is said to be easily integrated in a GIS that is quantitative in its nature (Chrisman, 1996). All users, independently of background, should be able to use user-friendly GIS software as a general tool for data storage, analysis and visualisation.

The above-mentioned statement has showed to be at least partly wrong, because of technological reasons as well as methodological ones (Parks, 1993). The software is still far to complex and complicated for people not used to work with digital data. The struggle to make it user-friendly counteracts the wish to make GIS more comprehensive, including more and more functionalities and data types. One example of a very user friendly and widely used application is the GOOGLE Earth and Map family software that is available to everybody and very easy to use. However, the functionality is limited and the main purpose is to visualise data in different formats.

The methodological difficulties are maybe even more problematic. Today computer software cannot easily offer the same possibilities as non-digital analogue qualitative analysis. Examples are analysis of interview material, where parts of/statements in interviews are grouped, and detailed analysis of in-depth interviews, where a better overview (e.g. by using paper slips on a table) than a standard GIS program offers is needed. A classical example of this is the cadastre and land titling systems, where despite the fact that very modern technology is used and high quality maps produced, integration of e.g. legal and economic aspects permitting the authorities to solve the land titling problems is difficult (de Soto, 2000).

In the foreseeable future GIS will be mainly used as a quantitative analysis tool, but also for storage of qualitative data. The added value of geo-coded data is as important for qualitative as quantitative research and applications. Well organised databases where many types of data can be imported, organised, edited, retrieved and visualised will maybe constitute the most important integrative achievement within the field of Geomatics the next decades.

4. CAPACITY BUILDING FOR INTEGRATION

Probably the main problem hindering a sound integration of Geomatics is the lack of human capacity and knowledge about Geomatics. Capacity building has been driven with the technology in focus, e.g. on hardware and software, but often neglecting basic principles of Geomatics, Geography and spatial data concepts. In many countries there is also a cadre of self-taught "geomaticians" that know how to solve a specific problem but has no overall vision or understanding of the larger context (one example is France, Gadal, 2007). Even if software packages get more and more user-friendly, a deeper understanding of space and time is needed for a successful integration. If accepting this, then we can ask ourselves the question: *Is it more appropriate to train a spatial modeller in the relevant, traditionally non-technological, subject (e.g. economy or archaeology), or should we train a person familiar with the subject in spatial thinking and modelling?* Of course the answer is related to the extension of the use of the new technology. Limited use/integration implies training of old staff, while extensive use/integration implies employment of new staff.

5. LICENSE COSTS OF INTEGRATION

Licence costs are severe obstacles to integration of new techniques and software in all disciplines when it comes to advanced use and users, e.g. a full license for ESRI GIS products costs more than 30000 USD. Neither private, governmental and non-governmental organisations, nor universities, normally can afford huge extra expenditures due to purchase of software if they are not very specialised in the use of Geomatics, and this is a threat for implementation and spreading. Often new users face only two alternatives: To not implement the new technology or use illegal copies of needed software. Even if it is not official, we know that many users in the world are running on illegal copies of e.g. ArcGIS. It is a well known fact that software piracy is widespread in large portions in the world, and few measures to stop it have proven to be efficient. Rather, the more protected a software is, the more glorious is it to crack it.

Is the solution to lower the prizes of software? This is probably impossible, at least if we mean general reductions and not "once in a while bargains". More promising is the increased development and use of open source software and free ware. Not least at the universities we have seen an increased demand of GIS/Geomatics courses focusing on free software. Most probably this demand reflects the market, indicating that governmental as well as private organisations now judge non-commercial software to be good and user-friendly enough to be used professionally. This is very promising, and yields faster software development and is probably a reason behind lower prices of commercial software (see e.g. Gadish, 2004). The development of available freeware, not only in the Geomatics sector, is mainly done by the user community. When the phenomena of user developed software first occurred, many people were thinking that this was only for a very small and restricted community of computer specialists, but development has proven that this was wrong. Today e.g. Microsoft is facing competition regarding both their Operation System (where LINUX has evolved to be an OS used even in big organisations) and for their office package where free versions of text handling, spreadsheet, presentation tools, etc are available as freeware.

6. THE DATA ISSUE OF INTEGRATION

Everybody involved in implementation of Geomatics projects also agree that the success is depending very heavily on the availability of data for a certain application. It is a well known fact that data availability is good in some parts of the world, at a price or not, and not so good in other parts. Generally the data that is needed to drive applications within the field of Geomatics is expensive and hard to get. Looking on the world market, it is obvious that data availability and prices for data are inversely related, that is, when availability increase, prices decrease. A particular problem with data in developing countries is that data collection historically (during the last 40-50 years—normally since "independence day") to a large extent has been more or less driven by donor organisations from the former colonial powers, each using their own national consultants and companies, creating confusion concerning classifications systems, data standards, etc.

As well as the other factors mentioned above, availability and pricing of data have a strong influence on importance of Geomatics in the development and research activities and on the integration of Geomatics in society. Difficulties in accessing data at reasonable prices definitely hampers the development of systems that are efficient for maintaining the long term development goals set up by governments and organisations all over the world (Cho, 2005). When authorities have collected and maintained data, which is normally expensive, and their information is to be used for development and research, it is in many cases impossible to ask for full cost recovery prices that cover the full production costs. Data MUST be made available to the users at a cost that is reasonable, and it MUST be possible also for economically weak users to access data if the integration of Geomatics in society should be successful.

7. GEOMATICS EVOLUTION AND PARALLELS WITH SIMILAR SYSTEMS

The last decade's evolution of Geomatics is not the first example in history of how new spatial technology and its applications attract very strong interest. Within the field of environmental management there has been at least two precedents—the Remote Sensing (RS, implying satellite sensor based remote sensing) and the Geographical Information System (GIS) boomed some thirty five and twenty years ago respectively—like the boom of the "modern" Geomatics we have seen in the 2000's.

As mentioned above the RS started out as a "fantastic" tool that was though to be the solution to virtually any type of problem, and research grants and project funding were more or less guaranteed if the applicants included remote sensing, particularly computerised image classification, in the application. The general belief that all types of features, objects and even processes, could be mapped by applying RS-technique was very strong and resulted in many misunderstandings. Over time (and by the process of immense failure due to over-estimation of the capabilities) remote sensing was "scaled down" to realistic dimensions and is at present a commonly deployed tool in many different disciplines. The technique has evolved from being the latest "talk of the town" concept advocated by scientists, developers, planners and international donor organisations to an ordinary and normal tool that is adopted with precaution and prudence whenever judged useful.

Exactly the same development can be seen with the arrival of the GIS (that actually is older than digital RS—as a concept it was used in Canada already in 1960's (Goodchild, 1993), and even before that, in the 1950s', Swedish meteorologists produced weather maps using computers (Geographical Information Systems, 1999). In the beginning many researchers were using GIS in their project plans, more or less being guaranteed funding while doing so. Very soon GIS implementation projects, GIS agencies, GIS units, etc, popped up in every street corner of the virtual highways beginning to take over more and more of the inter-human communication. Within the GIS concept, new ones where invented, e.g. Geographical Information Technology (GIT), Geographical Information Tools (also GIT!), Geographical Information Assessment (GIA), Environmental Information System (EIS), Planning information Systems (PIS), and so on ad nauseam. Similar to the RS development, the usefulness of the tool was overestimated and particularly the effort needed to construct databases to run the GIS was heavily underestimated. But, since many people involved in the promotion and development of RS also were involved in GIS implementation, a certain level of precaution and realism was present from the very beginning. Today, the use of GIS has become an inevitable component in many types of planning, assessment and management operations.

8. EXPERIENCES FROM THE IMPLEMENTATION PROCESS

Several studies of implementation of new geo-technology have been conducted over the past years, particularly during the period 1990-2000 (see e.g. Singh, 2005; Birks *et al.*, 2003; EIS Africa 2001; Campbell, 1992, IJGIS, 1991; Croswell, 1989). One of the more interesting is a World Bank evaluation of the implementation of Environmental Information Systems (EIS) in Sub Saharan Africa 2001, since it compares the processes in five different countries (Environmental Information Systems Development in Sub-Saharan Africa, 2001). The project pointed to several key factors of success for the implementation, and several possible manors to achieve a successful implementation process. Of major importance is the framework in which the system operates. The main issues pointed out by the final report from the project are:

- Systems do not work (operationally) if they are not part of a policy that is truly implemented and used in active operations
- Data holdings, data producers and other stakeholders must be involved in the implementation process and the communication, data standardisation and data harmonisation processes co-ordinated among them. Mandates of different stakeholders are also important
- Indicators, measurements, threshold values, etc. must be defined and commonly agreed upon if the system shall become operational
- It is more important to think wide and include as many stakeholders as possible than to advance quickly in the design and implementation of systems to assure maximum flexibility and multiple uses
- Educated staff is a very important resource and special attention must be paid to keep trained staff in the organisation
- Timing of different steps in the implementation process is very important

The project also considered that a major reason to failure before about 1995 is the fact that these projects to a very large extent where donor driven, with little or no influence and control exerted by national governments and professionals. After 1995, national influence and the consciousness of national professionals increased and projects started to become more driven by the needs of local authorities. This has meant that the ownership and operation of the databases become logically parts of the local organisations. Failure may still occur due to lack of built-in sustainability in the implementation projects and processes. Awareness of this phenomenon is important when attempting to build new structures and systems, since there are many similarities between the efforts in the past and the efforts to come in the future.

Our experiences gained over the last decades show that many implementation efforts have had less than expected success and some even complete failures. Examples from Universities (Makerere, Uganda and Kalanyia, Sri Lanka) governmental organisations (General Organisation of Physical Planning, Egypt, Ministry of Environment, Thailand, National Agriculture and Forestry Institute in Lao PDR, Eslövs kommun and Höganäs kommun in Sweden) where the authors have been active demonstrate this (see also Birks *et al.*, 2003, EIS Africa 2001; IJGIS, 1991). RS centres and GIS facilities have been built around application projects, huge databases have been assembled and naturally large amount of time and money has been invested in these projects. Such projects generally worked very well initially. Often focus was on data collection activities, database construction, etc. to build knowledge about an area or region. But when the initial phase was completed, many databases have not been used as intended and eventually many of them slowly become out-dated and useless, as was the case in the examples cited above. However, in most cases the situation today is significantly improved due to a second or third "wave" of implementation efforts (something that is visible when comparing EIS Africa, 2001 and IJGIS, 1991).

One conclusion referring to the discussion above is that it is very important to revise experiences gained in different parts of the world when designing and integrating Geomatics in an organisation. An obvious question to ask here is if there are any differences in the fundamental concepts of Geomatics between continents, between rich and poor, between different language and culture groups (see as an example UNHABITAT, 2005). The answer is basically no – there are not any differences between different parts of the world and the problems are very much the same, weather you are trying to implement a strategy in an OECD country municipality or in a municipality outside these countries, and the reason for this is that most people recognise that the main issues when introducing new technology are related to the institutional and organisational aspects (see Singh, 2005; Campbell, 1992), that are likely to be of similar character independently of country and also development level.

9. WHERE DO GIS AND GEOMATICS BELONG?

As mentioned above the use of Geomatics within the society as well as in academic work has increased rapidly over the last decades. This also means that Geomatics has started to create problems in both academic and non-academic worlds. Firstly because it bridges borders that have been in place for a long time and secondly because Geomatics, or rather the basic concepts of Geomatics, is increasingly used. In the eighties it was natural that departments dealing with Geomatics were located at technical or natural faculties. Today it is not at all evident that it is only technical departments that should be dealing with Geomatics. It is found in most departments, since spatial analysis has proven to be important in all disciplines. At the authors' home university, Lund University in Sweden, we can find examples of strong GIS units in e.g. humanities (archaeology), social science (human and economic geography and economic history) and medicine (social and occupational medicine).

Even if the need of GIS in different disciplines is obvious, the diversity can sometimes cause difficulties. One thing is that small units have less strength, e.g. few staff members make the unit vulnerable if someone changes position, less capacity to develop projects and applications, etc. If we consider GIS and Geomatics as a discipline or subject it is questionable to "spread it out" over the university. A discipline should normally be linked to a department or part of department and it is not advisable to have two or more units at a university (or in any organisation) working with the same subject. This will create confusion and internal competition, most probably resulting in a strengthened unit at one position (or faculty) in the organisation and weakened units at other. This in turn can lead to diminution or possibly removal of spatial modelling competence at the parts hosting the weakened units. We have seen examples of the latter, where faculties active in Geomatics totally have changed their methodological direction due to internal competition. This definitely obstructs innovative research and development. On the other hand, if spatial analysis/GIS and Geomatics are strongly linked to only one faculty it is difficult to spread the use of the techniques to other departments within the university or organisation.

The solution can be to consider GIS and Geomatics as techniques/tools for documentation and modelling in space and time. However this definition is heavily opposed by geographers, surveyors and other specialists involved in development of the tools. A technical tool or method does not belong to a certain faculty or subject, but can be used by all disciplines if needed. Initially in this paper we are talking about the interdisciplinarity of Geomatics and how it can be used by people from different faculties. This is a very important issue and we are strongly in favour of using Geomatics as a tool that is not directly linked to a certain department or unit. It should be regarded as an interdisciplinary tool that could be used by all disciplines. We recommend a "centralized" unit serving the rest of the organisation. The use should be free and no costs involved. There should be no competition and nobody should be feeling inconvenient by the use. But is this possible? Well, at least it is not easy. There is still a lot of competition in WHO is going to be the host or seat of the Geomatics centre, GIS centre, etc, since the development of a centre will generate more jobs at that department, investments in hardware and maybe better salary and status for the staff.

Guidance is needed to facilitate the use of the tool. One of the main tasks of the central unit of GIS/Geomatics is to support the whole university (organisation) in the same sense as most organisations has an IT support unit. Then there could be a Geomatics support unit operating in the same manner. To avoid competition and increase accessibility the Geomatics unit could be affiliated to a faculty, but it must then be very clearly stated that a main mission for the unit should be to encourage and guide other units in the use of the techniques. Another possibility is to create a central unit, not directly connected to any particular faculty, responsible for the implementation of GIS and Geomatics in non-traditional subjects. The latter alternative should not prevent other faculties and departments to develop teaching and research in the field of Geomatics, and is thus to be preferred for universities and research organisations. A similar construction will probably be the most efficient for any other type of organisation as well, such as ministries, municipalities and larger private companies having applications that use GIS and Geomatics.

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