Impact of Technology on the Evolution of Geomatics Agencies

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Summary

Technology has always played a dominant role in how surveying and mapping activities were performed. Major efforts were made to build accurate geodetic markers and produce hard copy maps of the land using increasingly sophisticated technology. As we enter the new millennium an accurate virtual position framework is available world wide from the GPS satellites augmented by a limited number of ground stations at known coordinates. Maps are rendered in digital form so that they are instantly copied and transmitted over computer networks. Air photo quality images will be available from space but sold through the Internet. Efforts are underway to build infrastructures that make it easy to integrate and analyse disparate, yet interoperable, geographic layers from decentralised databases.

These technology impacts on the traditional survey and mapping organisation are already underway. Geodetic monuments are being abandoned. The sales channels for map products are changing. Copyright is more difficult to monitor. Maps are being updated with satellite images or local municipal plans. The transformation required of mapping agencies is to change from producing hard copy data products to managing and integrating digital information. New relationships with a variety of diverse clients are needed. The role of geomatics agencies in making geospatial information available that is essential for government management and policies affecting land, natural resources, environment, transportation, and disaster response, for example, will be fully recognised.

Introduction

The impact of digital computers and telecommunications is revolutionising the way in which almost all businesses and government operations are performed. At a cost that is plummeting and a performance that is soaring, desktop computers provide a low cost suite of capabilities for managing text, numbers and images that can be accessed from anywhere that has internet connections. These are the software tools that are universally needed to manage any enterprise at the corporate level. In the case of mapping agencies, they also need specialised software tools to produce maps in digital form, and the GIS systems to manipulate the data. Currently, the GIS systems are expensive but dropping rapidly in price. At the same time, GIS architectures have moved from monolithic to a 3-tier architecture and are well underway to becoming truly open systems. It is expected that soon all desktops will be provided with a low cost GIS system as an adjunct to the current suite of capabilities.

On the communications front, there has been rapid expansion of the bandwidth of computers and electronic networks, permitting ever-faster rates of transmission of information. Data compression and decompression algorithms have been developed that allow even more effective transmission of raster and vector information. As a result, it is now worthwhile connecting the GIS databases through the Internet, thus permitting geospatial decision-making for governments and businesses to be done from any connected desktop.

These geospatial networks are being developed in many countries around the world, and already there have been three international meetings to discuss the Global Spatial Data Infrastructure. In Canada, this has only recently been a funded activity, and the whole programme is called the Canadian Geospatial Data Infrastructure (CGDI). The ability to develop these networks is dependent on the necessary IT infrastructure of computers and communication services, but with the advent of satellite communications, this infrastructure can be rapidly installed worldwide.

Technology trends

The driving force for changes in mapping agencies has been caused by new technology. This is not only from a perspective that technology can dramatically improve efficiency of operations but by the fact that demand from clients of geospatial products increases due to the fact that they too can now afford these very powerful analysis and visualisation tools. Therefore, products also have to transform themselves along the way to remain useful. Geomatics Canada produced a Strategic Plan in 1994 that attempted to extrapolate how technology would change for each component of the agency – surveys, mapping, remote sensing, and GIS. This diagram is shown in figure I. Although the change in communication capability was depicted, the rapid growth of the Internet and its impact on operations were not anticipated. Nonetheless, it was a useful blueprint for charting the progress of Geomatics Canada in its adoption of new technology. The ultimate result of these technology changes moves the agency into a role of providing solutions from integrated data sets.

The fundamental positioning role moves along the line of traditional instruments through differential GPS, active control systems, and real-time GPS, eventually available as a reliable service on the wristwatch. GIS systems move from graphic systems to integrated database, decision support, and finally, expert systems. Remote sensing moves from reception and archive of raw data to the use of geometrically corrected mosaics, real-time monitoring with high performance satellites, and high-speed delivery through satellites of high-resolution information with high frequency reputation. Maps were deemed to move from hard copy base maps, through thematic mapping, integrated map monitoring, sustainable development and assessment, to real-time monitoring and modeling.

New technologies[1]

Demand for information in the global economy is satisfied by increasingly cost-efficient and responsive new technologies that allow information to flow freely and quickly across political, economic, and intellectual borders. New technology first offers improved means of doing traditional tasks, but it soon enables people to create products that were never before possible. For example, satellites first helped improve weather forecasts. Today, data transmissions from low earth-orbit satellites and cellular networks enable 'nowcasting' – the immediate communication of events to emergency management agencies, farmers, pilots and the public at large. The Internet, the world wide web (www) and cellular technologies have begun to revolutionise the way that consumers acquire information and the methods by which entrepreneurs disseminate information. Unit costs for both technology and information are decreasing.

Information technology also raises client expectations. In this era of 'plug and play', consumers expect technology to be both fast and cheap, and they expect information to be reliable, interoperable, accessible, and ubiquitous. Furthermore, consumers expect products to include information that is immediately accessible, inexpensive, and easy to use. Providers of information who do not live up to these expectations will find that competitors with better skills and a better customer orientation will fill the gap quickly. The use of scientific data will increase dramatically because real-time, high-capacity data systems are becoming more commonplace. This phenomenon will drive a new generation of scientific applications and methods to integrate and interpret large quantities of data. In the earth sciences, new technologies and real-time information will be used to nowcast earthquakes, volcanic eruptions, and floods, and to mitigate the impact of such natural disasters on society.

Societal changes

In the last few years, there have been major changes in the way the general public have access to entertainment, portable communications, and electronic gadgets of all descriptions. Probably the most dominant changes have been in the use of cell phones for instant communication and the rapidly growing use of the Internet for access to information. Surprisingly, video games and the home movie delivery have driven the performance of computers and communication infrastructures. The other change that is emerging and exciting to the stock market is the introduction of electronic commerce. In Canada, the government is embarked on a major programme to deliver internet service to all regions in a programme called Connecting Canadians. As well as providing the network infrastructure, new laws are under development to make electronic commerce established within legal commercial practices. For instance, the law is being changed to recognise electronic signatures and providing standards for encryption software. The CGDI programme mentioned earlier is related in that it will bring access to geographic content to all parts of Canada.

Another aspect has been the increasing demand of society for improvements and lower cost delivery for government services. This has lead many mapping agencies into more business like operations with dependence on sales of products and services to fund much of their operations, and, at the same time, to look at geospatial networks as a new economic way of delivering their programmes.

[1]Plagiarised from USGS Strategic Plan, http://www.usgs.gov/strategic/index.html

Geospatial networks

As a consequence of the technology and societal changes, geospatial networks will have a major impact on mapping agencies. They demand a fresh look at many of the operations that have been standardised when traditional hard copy products were produced. Already, most mapping agencies have moved to producing digital replications of their maps, and so they have become engrossed in pricing policies and the licensing of intellectual property and distribution formats. Geospatial networks make further demands to consider standards for network distribution of geographic data, consistent description of datasets (metadata), how to integrate legacy digital databases, and a strong move towards a universal GIS standard for warehousing, manipulating and analysing geospatial information.

The Canadian Geospatial Data Infrastructure[2] will make geographic information available through the Internet as a national resource for policy, decision making and economic development. CGDI proposes to develop seven new programmes to build a national geo-information infrastructure, as follows:

- GeoExpress (access to government geo-information);
- National Framework (base platform for data integration);
- GeoPartners (federal-provincial data partnerships);
- GeoInnovations (private sector technology partnerships);
- National Atlas (aggregated national perspectives);
- Sustainable Communities (geo-info demonstration pilot projects);
- Geomatics Skills Network (geo-info skills development).

These programmes will support a number of important Canadian Government priorities:

Jobs and economic growth – geomatics is a high-growth area of the knowledge-based economy. Industry has stated that CGDI is the most important thing government can do to support this continued growth.

Public and private-sector partnerships – CGDI will be developed through strategic matching investments with the private sector and other levels of government. CGDI focuses on leveraging the resources of the private sector to accelerate access and technology development. Further leveraging with the provinces and territories will ensure cross-government harmonisation of activities.

International competitiveness –Development of innovative technologies and services required for CGDI will be contracted to the private sector. This will enable Canadian companies to develop experience and expertise.

Rural and remote community access – CGDI will deliver geospatial products and services to rural and remote communities. Development of CGDI will 'level the playing field' providing equality of access to government geospatial data, by both urban and rural communities. Access to geospatial data and tools via the Information Highway will support local decision-making, capacity development, and new economic activity and investment in these communities.

[2] Evangelatos, T. and Labonte, J. (1998). “Canadian Geospatial Data Infrastructure Activities in the Federal Government”. *Geomatica*, Vol 52, No. 2, pp214-222.

New model of governance – CGDI has been coordinated horizontally across federal agencies. With the participation of all provinces and territories, CGDI has a common national vision of shared responsibility and partnerships. An inter-governmental management board, will guide programme development, administer funding and oversee communications.

Change management

The requirement for data sharing with various partners requires a deeper understanding of their needs and stronger relationships and agreements on revenue sharing and harmonised licensing policies. The concept of moving geospatial information through various levels of government is appealing but requires efficient generalisation and data modeling software to extract the required information according to predefined or custom product specifications and scales. A competing alternative is to use the future high-resolution satellite images or to use mobile GPS data gathering techniques.

Changes are also required in how distribution is performed. The new E-Commerce Internet channels can be extremely efficient and are likely to replace the traditional wholesale retail chain. New ways of marketing on the Internet and processes to ensure that licensing agreements are viable will have to be developed.

The most important change is the integrating role that a mapping (geomatics) agency can play in linking with other government agencies at all levels, to establish geospatial networks and their use. The role of the Geomatics agencies will become one of geographic information manager and integrator, assisting policy development within governments, and as a stimulus to the private sector to provide services to businesses. There will be pressure to lower costs of geographic information, particularly as the cost of reproduction and distribution will be greatly decreased. Since much of the effort and associated costs go to supporting clients once they have acquired the data, innovative means will have to be developed to make those clients self-sufficient in the effective use of the data. If not, this will dramatically limit the growth in geospatial data use. With wide exposure to geographic databases, there will be a greater emphasis on up-to-date information and older information will lose its value. There will be increased pressure to eliminate limitations in use and redistribution of data or to reduce the period of applicability of the copyright.

This change process is shown in figure 2. It illustrates how an organisation goes from its typical major role in data capture to activities in extraction and synthesis of information and brings it closer to government policy decision-making. In order to carry out these changes, close attention must be given to the mix of human resource skills. The traditional concentration on cartographic technicians will evolve to employees with system engineering, data modeling and integration, and computer skills to manipulate information and understand wider policy issues. A strong science base will also be necessary to ensure the development of acquisition, management and dissemination tools the Geomatics community requires. The marketing and distribution functions will be expanded to include all the implications of E-Commerce. New personnel with the outgoing personalities necessary to develop new relations with other agencies with geographic information, and to cement partnerships are required. With the pace of technological change, it is sometimes difficult to adapt the workforce in tune with these changing requirements. Careful consideration for recruitment, retention and rejuvenation of the work force will be essential and will need to be acted upon in tandem with the development and introduction of new technologies.

Conclusions

Mapping agencies will be driven by new technology and the need to improve services to change the way they operate. It is a challenge and an opportunity as the introduction of geospatial networks puts these agencies at the forefront of management and synthesis of geographic information from diverse geographic databases. It will have a significant impact on the human resources and skills needed for its implementation. There is a need to develop beneficial relationships with a wider range of stakeholders and partners. The management structure should be rebuilt to include real influence by the partners on the way the entire geospatial network is operated.

This new way to operate with networked geospatial information can be grasped or left to others to fill the void. Mapping agencies are the logical choice for this role because of their understanding of the foundation data layers that are the backbone of the entire geospatial data infrastructure.

FIG 1 EXPLORING A STRATEGIC ARCHITECTURE FOR GEOMATICS CANADA

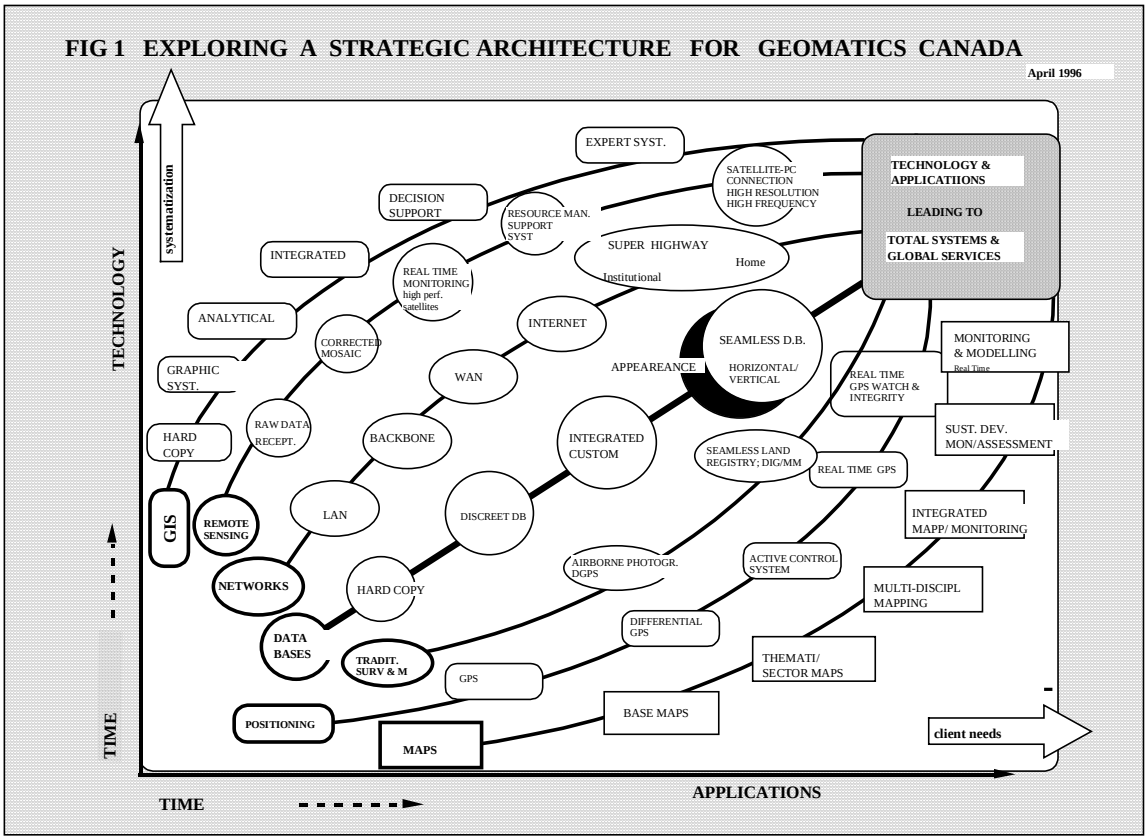

FIG 2 MOVING FROM DATA TO KNOWLEDGE