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## **Leadership of Geomatics in Canada: reworking the concept**

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# Leadership of Geomatics in Canada: reworking the concept

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## Abstract

In a previous era when geomatics was the domain of a few specialists and the principal objective was to produce a complete, consistent, coherent and current topographic map of the entire country, the leadership of the entire community was found in the national mapping program. The national mapping program was the largest single geomatics activity in Canada: determining policy and priorities, setting standards, gathering and representing the data of the land surface, developing and consuming the latest technology, and assuming a respected role internationally.

Over the past 25 years, digital geospatial data bases, geographic information systems and geospatial information infrastructures have had a dramatic impact on geomatics. The geomatics community now consists of significant capacities in federal, provincial and local governments; universities, technical colleges and schools; industry and the general public. In addition, influential groupings have emerged: learned societies, professional institutes and industry associations. Each part of the community conducts its business as a supplier or consumer of geospatial information and services leading to a very much heightened awareness of the clients, and the diversity of their requirements.

Leadership in Canadian geomatics community is no longer assumed by virtue of the traditional measures of performance: budget, territory mapped, technical wizardry. Nor is it consecrated, inherited, bestowed or usurped. The introduction of new perspectives and participants as well as the dynamic formation of alliances within the community needed to address complex, multi-scale issues means that leaders are found throughout the community. Leadership is now earned; its reach and duration are limited, not by the person or the institution, but by the nature of the problem being addressed. The leader may be the one who can articulate the vision, provoke the debate, engineer the consensus, or organize the resources.

The Earth Sciences Sector unites the geological and geomatics activities of Natural Resources Canada in order to respond explicitly to the issues identified by the Government of Canada. The Sector, like the community, has been re-cast into very adaptive structure in which capacity is brought from all over the organization to address an issue. The Sector has positioned itself, not solely as a national mapping agency, but as a key institutional contribution to the principles and application of sustainable development in Canada. Most of the current activities are directed at the collection and interpretation of information needed to understand the many fundamental facets of sustainable development and to guide the subsequent decisions.

## Introduction

It is difficult to put a precise date when ideas are first articulated, discussions become proposals, when concepts become plans. It is also difficult for those immersed in the process of change to appreciate fully the impact of the new ways of doing business. The paper at hand is an overview of the dramatic changes that are taking place in the Canadian geomatics community.

Nothing is more symbolic or evocative as the name a profession or a business calls itself. *Geodesy*, *surveying* and *mapping* are ancient and honourable activities. Many of the practitioners were, and still are, craftsmen. In an effort to describe the inclusive but rapidly widening constituency, the name *geomatics* was coined about 20 years ago. This linked the science, the engineering, and the technology to the profession and the products. In particular it responded to the need to acknowledge the growing importance of the new technologies *e.g.* Earth Observation, satellite navigation, and geographic information systems *etc.* In the last few years, an old name is in the ascendant - *geography*. Geography too is an old discipline that emphasizes spatial awareness: in the past 50 years it has evolved from being characterized as descriptive or qualitative to being analytical, constructing quantitative models in support of the decision making process. The added value of geographically sensitive advice and decisions is deemed significant. There is increasing acceptance of the role of geospatial frameworks and methodologies in the collection, integration and analysis of information in complex multi-dimensional, multi-stakeholder issues such as sustainable development. A few national and transnational mapping activities now carry the label (*e.g.* Geography Division of the United States Geological Survey, EuroGeographics) suggesting that they are important suppliers to the business of geography.

All Canadian government agencies are re-thinking their science and science-related activities. Particular emphasis is being placed on the need for information and services to support government policies or initiatives. The Earth Sciences Sector of Natural Resources Canada, the administrative home for the Geological Survey of Canada and Geomatics Canada, is transforming itself from an organization aligned with traditional disciplines to one in which the disciplines of geology and geomatics contribute explicitly and in an integrated fashion to the issues of the government.

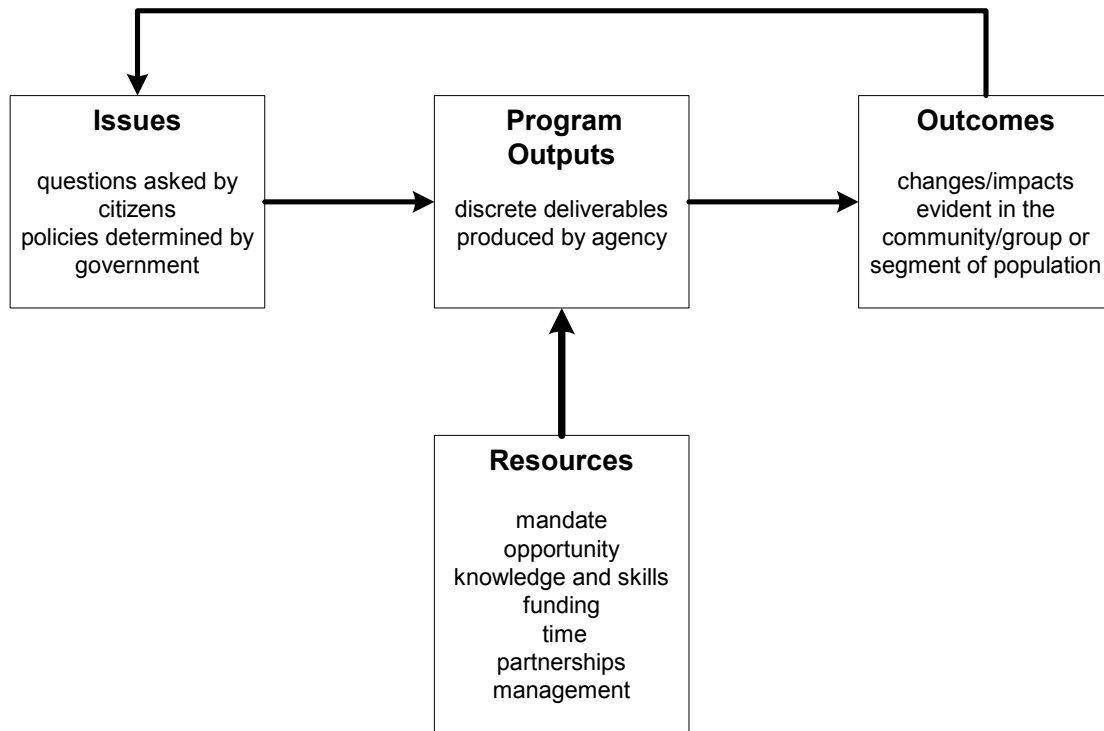


Figure 1. A schematic linking the key considerations in the design of programs in the Earth Sciences Sector.

It is reassuring to point out that a study of important government policy documents of the past 10 years shows that the issues of the day show a remarkable durability. The key words change, as does the emphasis and the relative priority, but the basic issues, and the contributions that can be made by the Earth Sciences Sector, change very little.

The Earth Sciences Sector is now described through its contributions to sustainable development of Canada's natural resources, a clean environment, aboriginal peoples, development of the North, strong safe communities, connecting Canadians, groundwater, climate change impacts. In addition, it has been accepted that Geomatics Canada makes an important contribution through the provision of certain infrastructure components for Canada: the Canadian Spatial Reference System, Satellite Data Reception Operations. Each program in the portfolio is designed to deliver outputs that will contribute to a larger outcome that has been identified as a priority of government. (Figure 1).

The strategy for constructing programs is based on five precepts:

- Maintaining highly motivated, innovative and focused staff.
- Building a balanced science and technology portfolio (balanced in terms of activities, risks, partners *etc.*
- Doing the appropriate science and technology at the appropriate time.
- Owning only what the Sector must, and influencing all the Sector can.
- Using the best resources where ever they exist through the use of internal and external networks, partnerships and alliances.

Throughout the re-focusing of the Earth Sciences Sector, there was concern that the resulting program portfolio would reveal a capacity-driven organization: it has emerged that the organization is, in fact, capacity limited. Initially there appeared to be more opportunities than resources; as the understanding of the issues deepened, projects developed and commitments made, it became clear that the programs would have to be selected and designed carefully so that significant, predictable outputs were delivered on-time and on-budget. Partners and clients had to be more sharply defined and their commitment to the outputs secured. Every new step was a challenge to the cadre of newly minted program managers working with those who used to be colleagues and peers.

The Sector believes it now has a fair understanding of what it is able to do as an organization focuses on particular high level government issues. It also knows that it has to provide services internally (e.g. computer services, administration, finance, human resources) so that the organization functions. It was realized that the Sector also delivered products and services that were of direct importance to geomatics professionals and the public. What many people would regard as a national geospatial infrastructure (regional scale topographic mapping, Earth Observation data reception, the Canadian Spatial Reference System, and the Canada Land Survey System) could only be found beneath the political horizon. While these provide an essential resource to the issues-driven programs, they also provide services that the government is to ensure are available to the nation, and are thus relevant beyond the traditional confines of the geomatics community.

Although there has yet to be a formal re-organization of the Sector, a matrix management structure has been introduced with the associated re-assignment of responsibilities and clarification of accountabilities. Matrix management appears costly, particularly when viewed at the outset when it is not possible to detect an improvement in overall organizational performance. Staff have found it hard to accept that the organization is no longer defined by its traditional professional and technical skills, activities and products. Surprising to some was that knowledge and skills developed in the former context were no longer valued to the same degree; whereas other skills, particularly in leading edge research areas, were in very short supply (in Canada).

At present, the Sector is dealing with some of the more pedestrian tasks of adapting budgeting procedures, project information systems, administrative, human resources and financial services to the new structure.

## **Roles for other geomatics organizations:**

The re-focusing of the Earth Sciences Sector has been driven mainly by an understanding of the requirements of the Government of Canada and a few specific partners, principally other federal government agencies and the provincial mapping agencies. As the process reached the end of the definition stage, it became clear that there were important questions and client groups that had not been addressed as methodically from a federal level as they had been in the past. The most obvious to the external stakeholders in Canada's geomatics community are: engagement of the private sector as a supplier of added-value data sets and a provider of services, benefiting from the research and high quality personnel cultivated in an academic environment, and Canadian participation in international initiatives. These can be expressed equally well in politically resonant terms: jobs and economic growth, innovation and the "Canadian way", respectively. The requirements of each are linked through the applications (and supporting methodologies) of the geospatial information. The strengths and capacities that can be brought to the issue define the roles each player can assume. This partition emphasizes the departure of the current thinking from the evolutionary path of geomatics in Canada over the past 3 decades.

As a fundamental tenet of its operating philosophy, the Earth Sciences Sector *owns only what it must and influences all it can*. This presages a division of labour between various participants and organizations in the geomatics community. Government programs exhibited significant, and lasting, overlaps and holidays which compromised the coherence and effectiveness of the community. That the Sector neither performed, nor owned, everything in its mandate was a serious challenge to the old way of going about its business and pointed to the need to engage partners fully.

Again within the Earth Sciences Sector, the connotations of partnership are being sharpened with the mantra: *shared vision, shared risk, shared benefits*. This is exceedingly demanding: it is easy to find a partner who will subscribe to the last criteria, it is more difficult to share the risk, and a shared vision erodes differentiations that have defined many organizations in the past. The cynic would observe that partnerships can be cemented through the topical application of money; and indeed, this has been the role federal government agencies in many partnerships. The Sector's expectations of partnerships are much more demanding: a partnership takes longer to cultivate but the result is more sustainable and productive as it is founded on common interests.

The Earth Sciences Sector is forcing a deeper understanding of the nature of partnerships in the belief that it is the only way that the geomatics community will be able to contribute to the outcomes sought by the government and citizens. The resources are not available for each organization to do a little of everything, or have unique access to particular clients, even if today's client is well served. The most successful approach is likely to be based on collaborations with a division of responsibility (a division of labour rather than everyone working more or less on the same tasks) but with very clear interfaces and protocols as tasks and products move between the partners. An important result of this approach is that Canadian geomatics organizations will be interdependent but with each focusing on the development, promotion and exploitation of their core competencies. The centres of expertise will be identifiable within the community and sought for their talents wherever and whenever applicable.

### **Public sector agencies:**

The predecessors of the Earth Sciences Sector mostly completed the primary data collection of the regional scale (1:50k) topographic information more than two decades ago. These data are now being refined through the incorporation of provincial data and Earth Observation data sets. The delivery of standard map/data base products have replaced the fundamental tasks of mapping.

Generally the Sector deals with the provincial and territorial mapping agencies which tend to be focussed on maintaining information about the provincial land resources; hence, there is usually a strong link to the land tenure base. Provincial data bases are usually higher spatial resolution than what has been collected by federal agencies. While the Earth Sciences Sector enters into agreements with the provincial mapping agencies to acquire or share base mapping data, different provincial agencies will need to be engaged in many of the programs in the new portfolio of the Sector. It is extremely difficult to engage 10 provinces and 3 territories simultaneously to work on a program that has a national vision and scope.

The GeoConnections Program ([www.geoconnections.org](http://www.geoconnections.org)) is a national partnership to build the Canadian Geospatial Data Infrastructure. The partnership embraces federal, provincial and territorial agencies, the academic and private sectors and non-governmental organizations. The activities under the partnership are proposed, approved and executed through a hierarchical series of committees working individually and collectively through the concept of "shared leadership". A secretariat coordinates, rather than directs the process, although each of the committees is assigned specific responsibilities. These range from the determination of the requirements of communities of practice, to data acquisition partnerships, to distribution policy, to standards, from the technical architecture through to the development and operations of infrastructure services. The committees are interdependent: tasks performed by one are crucial to the success of several others. The interfaces between the various committees are uncomplicated, and each committee seeks to present its outputs in a form that is complete and re-usable elsewhere in the GeoConnections Program.

A specific example of this has been the proposal to develop GeoBase, a consistent base data set covering all of Canada (equivalent to a topographic base map). A committee structure was formed using the concept of shared leadership. The Earth Sciences Sector, which chairs the project's steering committee, gathered the participants (federal and provincial agencies), and fostered the collaboration. It did so by leading the discussion towards the development of a common vision, conceptual models for the cooperative development and maintenance of the data base, assessment of risk and the sharing of benefits and visibility. As a result, the principal federal and provincial suppliers of geospatial data have recently defined a set of framework themes that will be developed jointly for the entire country. The layers are: international and provincial boundaries, topography (digital elevation model), roads, inhabited places and names, and Landsat-7 ortho images. Interestingly, hydrology/drainage is not deemed to be robust enough to be aggregated from multiple sources. The accuracy and density of this new data base will be variable but be suitable for representation at a scale of greater than 1:50k. The road network in particular will be "GPS compliant" *i.e.* the location of the road features stored in the data base will have been determined using the Global Positioning System (GPS). The resulting data base, unlike earlier Canadian geospatial data bases, will be accessible at no cost to all users.

It is often easier for federal agencies to cooperate among themselves, largely because it is possible to build partnerships that are closer to the model sought by the Earth Sciences Sector. At smaller mapping scales in particular, the convergence of federal interests and requirements are more common, and in many ways easier to cement. One of the principal attractions of working with other federal agencies is that they have already in place agreements with provincial agencies to collaborate on specific tasks within the discipline. Most federal programs obtain data through specific agreements with the provinces and territories. These data agreements are managed by the federal agency with the mandate for the topic. Thus the natural agreements for the Earth Sciences Sector to manage are those related to the acquisition, production and dissemination of topographic and geological base data. As an example, the national scale (1:1M) thematic framework data sets recently published were assembled through a collaboration of the Earth Sciences Sector, Environment Canada, Agriculture Canada, and Statistics Canada, each bringing data sets that they had assembled from data provided by the provinces. These very important data sets are accessible through GeoGratis (<http://www.geogratias.nrcan.gc.ca>) and a version is being contributed to the Global Map.

**Academic sector:**

The academic sector has always been valued for its role in the innovation process: for the basic research and for the creation of high quality personnel. Until about 10 years ago, the situation was muddled. University research was underfunded and in one business model attempted to offset this through the encouragement of the entrepreneurial spirit of the academic staff. The latter continues to be encouraged. At the time, however, it was recognized that there were many classes of projects that universities were ill-equipped to handle e.g. production, long term monitoring. Project management and intellectual property questions and difficulties in maintaining project continuity offset the apparent efficiency of using university staff and students. There were always concerns that the universities themselves would not be able to make the necessary investments to move a concept through product development, marketing and routine delivery.

New funding from the federal government research councils has helped to clarify the role of university. Very substantial grants are now available for staff undertaking fundamental research. These are complemented by several mechanisms that provide the associated facilities and specialized equipment. Graduate scholarships remain an important part of the system. A new layer has been inserted in the system – the network centres of excellence. These support research in the universities that is somewhat more applied. The research is, in principle, guided by the requirements of an identifiable, and consulted, private sector or a government client who is able to make the subsequent investment towards routine delivery of a product or service. The centres of excellence are associated with the universities, and the projects undertaken are often extensions of more fundamental research programs. The Earth Sciences Sector supports a number of centres of excellence focused on sustainable development, water resources, geomatics for informed decision making, space and environmental science.

The organization of the academic research community and the tangible outputs of their activities should not eclipse the unassailable mandate of the universities to produce well trained staff that can support Canada in all aspects of geomatics. For the past 30 years, there has been a belief that business and government benefited explicitly from cross-disciplinary expertise. The academic community has done a remarkable job of bridging numerous academic and business disciplines by instilling an appreciation of geography and geographical analysis in the students. Most new employees arrive with good basic skills in a geographic information system environment. This is particularly apparent in the environmental and social sciences. As well today, large companies cannot survive without skills in business geographics and the geomatics community anticipates the explosion of location based services. One might wonder if, in the rush to create a marketable high quality person, the emphasis has been on skills rather than understanding. More than packaged skills are essential to most organizations if the complexity of the data sets are not going to be a barrier to their successful analysis and interpretation. In the midst of a growing need for apprentices, journeymen, craftsmen of all sorts, Canada needs a few masters of the science of geomatics, the art of geography. Masters are in shorter supply and are difficult to retain once they are truly able to contribute to the issues at hand.

**Private sector:**

The strengths of the private sector are in the management and execution of projects that have well defined objectives, processes, a beginning and an end. The role that industry can play is determined very much by the environment in which it is able to generate business: the capacity of industry evolves with the market. The private sector in Canada currently plays an essential role in the production and dissemination of geospatial data. There are numerous companies that providing specialized technologies for geomatics: instrumentation, processing software, as well as a wide variety of services. The clients are all levels of governments (and their consultants), businesses in economic sectors and occasionally non-governmental organizations.

Several models exist for the interaction of the Canadian government with the private sector varying from the private sector being a strict client or service provider to one of a partner in the development of a technology, methodology or capacity that is of benefit to both government and the private sector in its dealings with other clients. The latter is favoured in research related projects. The opportunity exists to use industry to perform autonomously higher level tasks in the development and production of standard products. As with the engagement of the private sector in research activities, their engagement at the higher-skill end of production and dissemination develops a re-usable, marketable capacity.

There are a number of interesting initiatives by the private sector which may point to new ways of doing business. The first is RADARSAT International (RSI), the global distributor of RADARSAT data as well as other satellite data in Canada. The Canada Centre for Remote Sensing proposed an "Industrial Involvement Contractor" that would take over the money-making part of the Earth Observation data reception, processing and distribution activities. From this concept and with the subsequent support of the Canadian Space Agency, RSI has grown into a successful business. A second example is found the three principal companies in Canada that provide heavily attributed road network data bases. These companies have assembled road networks from federal, provincial and municipal data bases through various partnerships and data purchases. To these have been added numerous other spatially referenced features. Clients either buy access to the attributed road network files or services based on these files. The third example is Telus Geomatics which has assembled approximately 600 layers of geospatial information of all forms building from their base in the province of Alberta. Telus sells access to their servers so that other agencies can visualize parts of the data base and superpose their own data. Some primary data suppliers add and revise the content of their layers in the Telus warehouse. (This model has been adopted within at least one provincial government as well.) Telus also provides turnkey real-time, on-line services based on these data. Each of these companies are adding value by integrating government products with other data and making it accessible, often as a sophisticated information service. Government agencies that are consumers of geospatial data are starting to exploit these turnkey services rather than accessing the source data files from their sister agencies.

**International activities:**

The question is: how does Canada participate in and benefit from international activities? At one level, the answer is simple: those that see the benefits and have the resources, build the alliances that are appropriate. Realizing the benefits as a nation from multilateral, international organizations was the business of government. Earth Sciences Sector, and other government agencies, continue to participate in projects sponsored by international agencies or foreign governments. The benefits to Canada are diverse: from the acquisition of new knowledge, to building supportive networks, to ensuring that the Canadian position on a topic is known and considered. Thus federal government agencies have been very willing to participate whenever the initiative aligned with the agency's mandate. The participation of

provincial governments, industry and the universities occurred, but was frequently limited by their organization mandates.

The Canadian government played once a much larger and more visible role in international scientific and professional organizations than it has for the past decade. Many reasons contributed to a smaller profile: available human and financial resources undoubtedly played a role. An attempt was made to counter the trend by assigning responsibility for the national representation on international professional and scientific committees to the Canadian Institute of Geomatics (CIG), a professional association. Earth Sciences made an umbrella financial contribution and left it up to the CIG to determine which of their members should participate in which organizations. In principle this worked well except that the interests of CIG members, did not necessarily match the financial resources available to the CIG or the individuals. Another observation is that the engagement of the Canadian geomatics community decreased generally and it was usually federal government staff (and to a lesser degree university professors) who had the latitude in their programs to participate in activities of the international organizations.

The Earth Sciences Sector expects the Canadian private sector to pursue opportunities for contracts abroad. The federal and provincial governments are very active in promoting Canadian exports of goods and services. Because of the anticipated growth in geomatics services, the Canadian geomatics industry is frequently an active participant in trade missions. The Sector's supports such early business development such initiatives by offering expert advice to the Canadian companies and their potential clients, frequently by means of seminars on how the proposed product or service is being used in Canada and might be applied elsewhere. The Earth Sciences Sector, and the Canadian geomatics industry also participate in the delivery of Canada's foreign aid budget which is targeted to specific issues in identified countries.

## **Conclusion:**

Canada has made a few bold strokes on a canvas containing only a few soft edged forms. There is little doubt that the Earth Sciences Sector is painting outside the lines which have defined it as a national mapping agency. There are numerous contributors to the emerging picture of mapping in Canada. The challenge now is to maintain the coherence in the program outputs and to sustaining the longer term collaborations and partnerships. This will be done by defining the handoffs and interfaces between contributors, each offering talent and resources towards the realization of the common vision for geomatics in Canada, and each drawing benefits from the collective outcome.

The first steps in the transformation of the Earth Sciences Sector may lead to profound changes in the way the Canadian geomatics community carries out its business. There is a growing distinction between scientific activities (e.g. curiosity driven research, early developmental steps) and science related activities (e.g. those things which support scientific activities and extending beyond to training, commercialization, data gathering, dissemination, value-added services). If government agencies are to focus on policy making, regulation and the delivery of programs, some traditional functions of a national mapping program may be placed in different organizational structures such that the Canadian geomatics community better meets the divers requirements of Canadians. The exploration of the possibilities is only beginning.

Is there a leader of geomatics in Canada? There will be many.

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