Titre : Lessons learned from 14 years of the GEOIDE Network

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RESUME

Le long de 14 ans de sa vie, le réseau GEOIDE s'établi comme repère d'excellence dans sa poursuite de liens entre les chercheurs de toute discipline et la communauté d'utilisation.

ABSTRACT

Over fourteen years, the GEOIDE Network has set a standard for excellence in delivering results of research to user communities across disciplinary boundaries.

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MOTS CLES

Sciences du territoire, réseaux, innovation, géomatique, Canada

INTRODUCTION

There are many factors in developing a knowledge management infrastructure, but perhaps the most fragile involves mobilizing people from diverse backgrounds to work together. This chapter will consider the challenge of mobilizing interdisciplinary collaboration from the perspective of a particular research network in Canada, the GEOIDE Network.

Canada has a long record of innovation in science management, in part due to its multiple heritage (France, England) and proximity to USA. Canada went through periods of centralized science typical of the early twentieth century with the National Research Council[1], actually more of a insitution of government-funded researchers similar in concept to CNRS in France. Canada

[1] M. THISTLE *The Inner Ring. The Early History of the National Research Council of Canada*, Ottawa, NRC, 1966.

also established science funding councils in the 1978[2] that took precedence for university-based research, along the lines adopted in the United States in the post-war expansion of research funding [3] and more recently instituted in France as ANR. By 1989, various tendencies led to the creation of an institution to engage researchers more closely with "recipient communities" (such as industry and government). This entity was called the Networks of Centres of Excellence (NCE)[4]. The NCE built new kinds of institutions, "networks" in place of "centres". Much of this could seem like bureaucratic smokescreens for the same old arrangements, but these networks do operate differently. The practices of NCE can provide some lessons for the interdisciplinary effort of 'sciences du territoire'.

This paper will derive much of its empirical component from one network: GEOIDE, founded in 1998 under the full title "Geomatics for Informed Decisions; géomatique pour les interventions et décisions éclairées". GEOIDE provides an example of a fourteen year experiment in conducting research linking various sectors, and eventually how this became a model for other similar entites around the world. GEOIDE is interdisciplinary, international and designed around delivery to user communities (industry, government, and non-profits generally). Since this is also the design of the GIS CIST, it is pertinent to consider the history of the Canadian experiment.

1. GEOIDE NETWORK: COLLABORATION DESIGNED FOR PUBLIC BENEFIT

Fourteen years ago, a team of geomatics researchers, at Université Laval, University of Calgary and the University of New Brunswick, built a national collaboration of government, industry and the research sector to win a highly competitive competition[5]. The result was the GEOIDE Network (GEOmatics for Informed DEcisions), funded by the Networks of Centres of Excellence (a permanent programme of the Government of Canada) for these past fourteen years. It has

[2] http://www.nserc-crsng.gc.ca/NSERC-CRSNG/History-Historique/chronicle-chronique_eng.asp

[3] Milton LOMASK, *A Minor Miracle. An Informal History of the National Science Foundation*, Washington DC, US Government Printing Office, 1976.

[4] Jean ATKINSON-GROSJEAN, *Public Science, Private Interests: Culture and Commerce at Canada's Networks of Centres of Excellence*, Toronto, University of Toronto Press, 2006.

[5] Nicholas CHRISMAN et THOMSON Keith, "A short history of GEOIDE" in Nicholas CHRISMAN et Monica Wachowicz, *The Added Value of Scientific Networking*, Québec, GEOIDE, 2012, p. 1-27.

engaged teams of researchers from 34 institutions across Canada with over 500 partners in every sector. The inputs and outputs are easy to catalogue, but it is the benefits for society that matter.

GEOIDE assembles researchers across Canada, in a range of fields including termed "geomatics" in Canada (including surveying, geodesy, photogrammetry, remote sensing, image processing, geography, planning, and geographic information science). It also mobilizes domain specialists from various environmental sciences, engineering, and the social sciences. Over a fourteen year period, GEOIDE has funded a total of 121 projects, with a total investment of 79.3million$CAD (at current exchange rate 61million euros)[6]. Over this period, 395 research scholars from Canada have participated in the projects, and a total of 1437 students. In addition, 174 industrial affiliates have been engaged, alongside 95 governmental entities at all levels. Researchers from around the world have been linked formally and informally from 146 institutions (research laboratories, universities and the like). In terms of traditional output measures, GEOIDE projects report 2675 peer reviewed papers and another 2070 in non-peer reviewed outlets. So, in the traditional measures, GEOIDE has been a big research enterprise, but it must show results beyond this.

Interdisciplinary mix- What is in a name?

The mix of disciplines involved in GIScience or geomatics has fallen out differently from place to place, country to country. The role of institutions has varied, with strong state support in some places, and more industry role in others. Overall, this multi-disciplinary convergence presents an interesting case study in the history and sociology of science and technology. The naming of the field itself demonstrates this diversity of approaches, as well as signaling the complexity in building true international coherence. The long-established disciplines of cartography, surveying, geography, and geodesy have merged in various ways in different countries. For example, cartography as an academic subject is mostly practiced inside geography departments in North America, but this is not the case in most of Europe. Surveying as an academic subject has declined in North America despite the dramatic technological advances in the field. Michel Paradis saw this coming in 1981 and used his opportunity as keynote speaker to develop the new term "geomatics"[7] for the Canadian professional milieu.

[6] http://www.geoide.ulaval.ca/geoide-mission.aspx

[7] Michel PARADIS, « De l'arpentage à la géomatique». *The Canadian Surveyor*, Ottawa, Canada, 35 (3), 1981, pp. 262-268.

In most countries there have been mergers, but which disciplines have merged with others is not guaranteed. The more recent fields of photogrammetry, remote sensing, geographic information systems have been merged in some places with some of the older disciplines under the title of geocomputation or geographic information science[8]. In Canada, the term "geomatics" *(géomatique en français)* took root twenty-five years ago as a covering term for the whole collection of undertakings to collect, analyze and distribute geographic information[9]. In Australia, the term 'spatial sciences'[10] has become the rallying term for the same coalition. The term "sciences du territoire" promoted by this volume (and the organization behind it) is hard to translate into English with the same degree of clarity as it holds in French. For the purposes of this chapter, I will retain the Canadian term "géomatique", with a willingness to understand how this term separates us from some groups as much as it aligns us.

Whatever the name, the interdisciplinary nature of GEOIDE is crucial to its results. GEOIDE covers many disciplines, from mathematics, engineering, natural sciences to social sciences and health. Table 1 shows a snapshot from one point at the end of Phase III (2009).

Table 1:

Departmental affiliation of Network Investigators (Phase III, 2009)	**Number of researchers**	**% of total**
Geomatics	23	17.3
Geography	19	14.3
Earth Science (Geology, Geophysics, Atmospheric Sciences)	19	14.3
Civil and other Engineering	18	12.8
Computer Science	12	9.0
Statistics (Mathematics)	9	6.8
Environmental Studies (Biology, Landscape Ecology, Ocean)	8	6.0
Forestry	6	4.5
Medicine (with Public Health, Kinesiology)	6	4.5
Physics	5	3.8
Planning (with Landscape Architecture)	4	3.0
Archaeology	3	2.3
Business	2	1.5

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[8] GOODCHILD Michael. "Geographical information science", *International Journal of Geographic Information Science* 6 (1), 1992, pp. 31-45.

[9] Paul GAGNON et David COLEMAN, "Geomatics, an Integrated, Systemic Approach to Meet the Needs for Spatial Information" *CISM Journal ACSGC*, 44 (4), 1990, pp. 377-382

[10] http://www.sssi.org.au/

This particular mix reflects the disciplines involved at that time to solve one set of challenges. Each new project would bring a new collection of disciplines; there is never a fixed list.

A single example of a GEOIDE project offers a glimpse into its scientific process and results. Atlantic salmon hold great value to ecosystems and to humans. The economic value of wild atlantic salmon stems largely from the sport fishery, worth tens of millions of dollars annually. The species is, however, in decline across its natural range, prompting a call to action for resource managers and the science community. A GEOIDE team adopted an integrated approach to salmon habitat from headwaters to estuaries; mobilizing fluvial geomorphology, biology, and geomatics technology. One key element investigates mortality of salmon smolt in their perilous journey from fresh water to the ocean. By using various geomatics techniques, including the innovative use of passive sensor tags inside the float sac of the smolt, they have been able to resolve open scientific questions about a smolt's navigation capacity and its ability to sense salinity and the location of the ocean. Arrays of antennae in the stream bed have enhanced spatial and temporal resolution by orders of magnitude[11]. A previously unknown “commuter” behavior of salmonid juveniles has been observed and validated by subsequent research. The researchers contend that they would not have detected this behavior without the interdisciplinary breadth of their network project[12]. The project’s affiliates (government resource managers, sport fishermen, first nations and the hydro-electric utility) are directly interested in the scientific results since new knowledge of how salmon interact with their environment will influence land management decisions and public policy on rivers and estuaries.

Mission

The core of the GEOIDE’s mission is to promote the development of geomatics research in a way that delivers benefits to Canadians. Unlike "curiosity-driven" research councils, NCE favors an interaction between "receptors" and the research community. Through this two-way flow, the traditional linear model of a linear pipeline of "technology transfer" is abandoned. Projects have

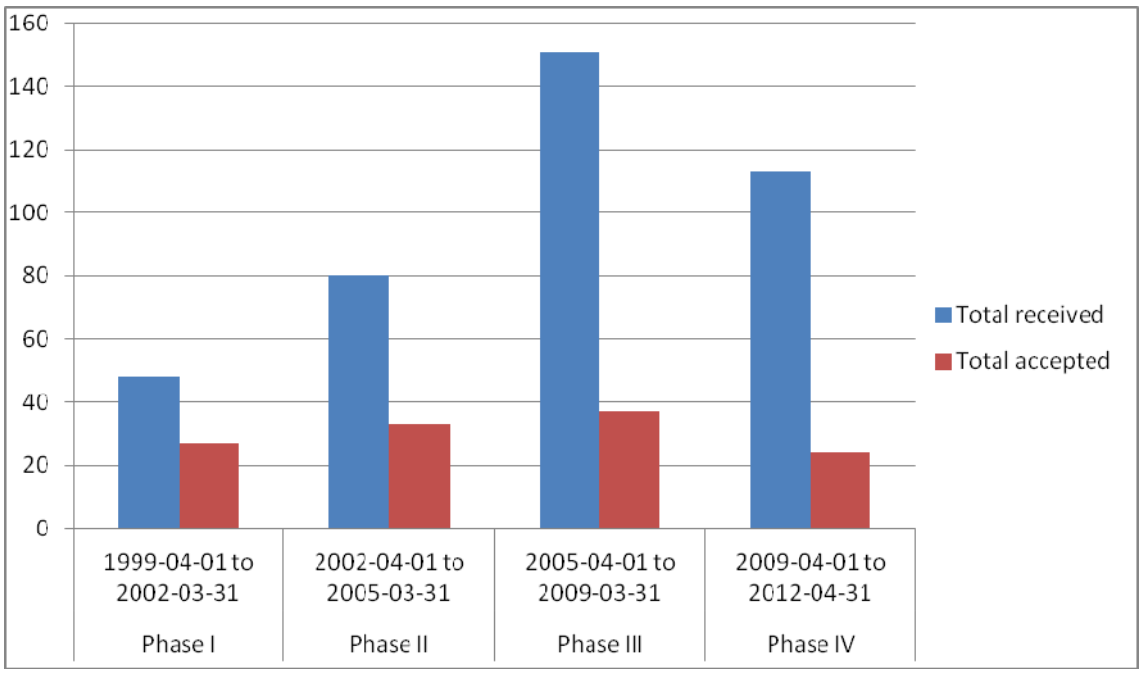
[11] Patricia JOHNSTON, F BÉRUBÉ et Norman BERGERON, "Use of a flat-bed antenna grid for continuous monitoring of wild juvenile salmonids movements in a natural stream" Proceedings of the 7th international symposium of Ecohydraulics, Concepcion, Chile. January 12-16 2009.

[12] Julian DODSON, Normand BERGERON, Patricia JOHNSTON, Richard HEDGER, Patrice CARBONNEAU et Michel LAPOINTE, “GEOSALAR. The Atlantic Salmon (Salmo Salar) and its Riverscape” in Nicholas CHRISMAN et Monica Wachowicz, *The Added Value of Scientific Networking*, Québec, GEOIDE, 2012, p. 189-211.

been selected for their robust interdisciplinary communication and for their collaborations with a user sector in industry, government, or the non-profit sector. Substantial additional funding is expected from these user sectors, and GEOIDE has been more and more successful in obtaining cash contributions, in some cases matching the research council funding 1:1. Overall, the recent average is closer to 1(from users) : 2(from the councils).

GEOIDE has operated on the basis of open calls for proposals, followed by peer-review. As Figure 1 demonstrates, over the history of GEOIDE, the rate of selection has become more and more rigourous. The acceptance rate started at 56%, and fell to 21% in Phase IV. Phase III saw more proposals, but for somewhat smaller projects with an acceptance rate of 25%. (Each Phase had approximately the same funding per year, but Phase IV accepted some larger projects.) The network did not turn into a clique of insiders who divided up the spoils; there was substantial turnover, along with certain teams that were able to continue funding in a more and more selective peer-review process. This practice may be hard to implement in other countries, since the research authorities are unlikely to devolve authority to an entity such as GEOIDE.

Figure 1: Proposals submitted and funded by Phase, 1998-2011



In preparation for Phase IV (2009-2012), specific themes emerged through a process of strategic planning for the last NCE-funded round of proposals. The three themes were purposely broad but also designed to avoid too much duplication.

Mobility: centers on tracking and predicting the motion of people and objects. User representatives include transportation sector, logistics enterprises, and security services. Researchers working on tracking technology, space-time models and simulations, and dispatching analysis at various scales form the teams working on this theme.

Environmental change: centers on modeling changes in the earth system, fast or slow. User representatives include natural hazard response agencies, geomatics industry representatives, and environmental policy makers. Researchers working on instruments, remote sensing applications, and sustainability policy dimensions join this grouping.

Distributed sensors: centers on advanced technology to measure the environment and delivery innovative information products to users. User representatives include instrument manufacturers, geomatics service providers, and infrastructure managers from government and private sector. Researchers working on sensors, distributed network interactions, and integrative software form teams on this theme.

Innovation

One of the central goals of the NCE programme and the Canadian government is to create new enterprises, or to spur innovation in existing companies. GEOIDE projects have led to at least 20 patents, and many more licensed technologies. A few spin-off companies have resulted, most of them still in business. For example, SimActive, Miovision and Intelli[3] were created by GEOIDE-trained students, with support from GEOIDE Market Development Funds and from other partners[13]. Perhaps the most successful spin-off had the shortest existence, as GeoTango was acquired by Microsoft within weeks of its creation[14]. The technical directions of GEOIDE research point the way for Canadian contributions to web mapping, positioning technologies, image processing algorithms, business intelligence and many more. The current projects continue with augmented reality, volunteered platforms, and distributed sensors – the areas of strong

[13] http://www.simactive.com/ ; http://www.miovision.com/ ; http://www.intelli3.com/

[14] http://www.directionsmag.com/articles/microsoft-and-geotango/123232

growth potential.

Training of Highly Qualified Personnel

Over many years, the Network has funded over two hundred students each year. Over the life of the Network, over 600 students have completed graduate degrees (Masters and PhD). Results of the cumulative investment have been particularly clear as a generation of graduates from the network have taken up positions across the geomatics community. These students were trained in a different manner, placing greater emphasis on interdisciplinary teamwork.

Perhaps a third of the students moved directly into industry jobs, but the new generation is most visible in the academic sector. Over the past four years, 18 former GEOIDE trainees have taken tenure-track positions in academic departments across Canada. In some geomatics departments, half of the new junior hires have been GEOIDE students from earlier Phases. Twelve of the 95 researchers in the Pilot projects for Phase IV are former GEOIDE trainees, including two project leaders and three deputy leaders. As a result, research leadership in the Network is turning to new faces with real experience in networking.

No single student should be considered as a "product". Taken as a group, however, this new generation of geomatics professionals working in all sectors of the geomatics community is already making an impact on the economy, in the form of new businesses and innovation within existing companies. On the academic side, the research community is being renewed and the spirit of networking firmly established. These students are an enduring legacy of GEOIDE and an indicator of future accomplishments[15].

International connections

Over the years, GEOIDE developed stronger relationships with an increasing number of international partners. In 2006, GEOIDE hosted a workshop that assembled the scientific directors (or equivalent) from organizations representing France, Ireland, Australia, Netherlands, USA, European Union, and Latin America. Subsequently, connections have been made to Mexico and South Korea. Each organization has its own origins and distinct objectives. Some are

[15] Rodolphe DEVILLERS, Trisalyn NELSON et Steve LIANG, "The GEOIDE Students' Network and the GEOIDE Summer School. History and Lessons Learned for Thirteen Years of Student' Networking in Canada" in Nicholas CHRISMAN et Monica Wachowicz, *The Added Value of Scientific Networking*, Québec, GEOIDE, 2012, p. 31-46.

research networks much like GEOIDE, with funding for research initiatives. GEOIDE has actively engaged with these groups, sending representatives to their national meetings, attending their workshops, and bringing their teams to GEOIDE events. These efforts have led to enlarged teams (affiliated foreign researchers increased from 17 to 39 in Phase III), bringing Canadian expertise to a new worldwide leadership position. GEOIDE has joined with Australia, Mexico, Sweden, and South Korea to create an organization termed the Global Network for Networks[16]. This unincorporated entity seeks to promote common operations and enhanced exchange.

Conclusion

GEOIDE, founded in 1998 under the full title "Geomatics for Informed Decisions; géomatique pour les interventions et décisions éclairées" provides an example of a fourteen year experiment in conducting research linking various sectors, and eventually how this became a model for other similar entities around the world. GEOIDE has been interdisciplinary, international and designed around delivery to user communities (industry, government, and non-profits generally).

It will take a more detailed review of GEOIDE to extract all of the lessons learned by all the parties. Perhaps the most apparent lesson is how long it takes to see results. One does not change culture and expectations immediately, no matter how much money and other resources are mobilized. The GEOIDE Network adjusted to the circumstances, and adjusted those circumstances as well. The main result of 14 years of funding may reside in the students of the network. A whole generation has been trained in collaborative interdisciplinary projects. Some moved from students to project leaders, launching careers much faster and maintaining their network connections across long distances.

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[16] http://globalspatial.org/

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