GEOcybernetics
innovating in geomatics for society

Geocybernetics: A pathway from empiricism to cognitive frameworks

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SUMMARY

Many exciting events have happened from a scientific perspective over the last thirteen years since the foundation of CentroGeo in 1999. The Journal of Geocybernetics is a new venture focused on the publication of the scientific core of this avenue of research, extending an invitation to other networks and communities around the world that are exploring new knowledge in the realms of geomatics, geographic information sciences and the transdisciplinary work that is emerging as a result of worldwide efforts.

The term geocybernetics needs to be introduced and, therefore, some basic concepts are included in this initial paper. To help to convey the main message behind this avenue of research, the ideas are presented in an interactive and novel manner. An overview of the concept is illustrated by presenting the conceptual background, the disciplinary backbone that induced its emergence and its basic theoretical building blocks. The intent is that the concept will define itself through the publication of articles related to geocybernetics in the following issues of the Journal.

The scientific management model and the knowledge-based approach used in the empirical work strengthens a paradigm shift in the niche of "geomatics and society." Nowadays, most of the world's population lives in developing countries where the systematic collection and processing of data is scarce. The skills of local societal actors and geomatics scientists can contribute to develop scientific solutions to urgent problems such as poverty, health, safety and unemployment. The adoption of CentroGeo's methods and/or the publication of similar experiences in other countries, regions and communities could bring about a breakthrough in networking and sharing knowledge within geomatics.

The final section presents an explicit statement about the Journal, describing the main characteristics of this publication to potential authors.

Keywords: cybercartography, geocybernetics, geomatics, transdisciplinary, cybernetics, complexity.

RESUMEN

Desde una perspectiva científica en los últimos trece años, a partir de la fundación del CentroGeo en 1999, han ocurrido muchos eventos interesantes. *Geocibernética: Innovando en Geomática para la Sociedad* tiene como propósito la publicación de los fundamentos y resultados de estas líneas de investigación pero además extiende una invitación a otras redes y comunidades a nivel mundial que aportan nuevos conocimientos e innovaciones en el ámbito de la geomática, las ciencias de la información geográfica y el trabajo transdisciplinario.

En este contexto, el término geocibernética requiere de ser expuesto en este número inicial, y por tanto, en este artículo se presenta una visión general del mismo. Con este fin se ilustra el concepto presentando los principales antecedentes conceptuales desde la geomática, la columna vertebral científica, que indujo su emergencia y proporciona sus bloques básicos de construcción así como nuevos ámbitos de investigación. La intención es que el concepto se defina a sí mismo mediante la publicación de artículos relativos a la geocibernética en los siguientes números de esta publicación.

El modelo de gestión científica adoptado en el CentroGeo y el enfoque “basado en el conocimiento” empleados en el trabajo empírico refuerzan un cambio paradigmático en el nicho "Geomática y Sociedad". En estos tiempos, la mayor parte de la población mundial vive en países en desarrollo dónde la recolección y procesamiento sistemáticos de datos y su procesamiento son limitados. Por esta razón, las habilidades de los actores sociales y científicos geomáticos locales es un elemento clave para hacer posible el desarrollo de soluciones científicas a problemas apremiantes relativos a la pobreza, salud, seguridad y desempleo, entre otros. La adopción de los métodos del CentroGeo y/o la difusión de experiencias similares en otros países, regiones o comunidades en esta publicación pueden acarrear el florecimiento de las redes y el compartir de los conocimientos en la geomática en Latino América y a nivel global.
En la última sección de este artículo se presenta de manera formal los objetivos y alcances de *Geocibernética: Innovando en Geomática para la Sociedad* y se describen las características de la publicación para autores potenciales.

Palabras Clave: Cibercartografía, geocibernética, geomática, transdisciplinario, cibernética, complejidad

1. INTRODUCTION

The main purpose of this paper is to share the experiences over the last thirteen years with an experiment that resulted in the successful implementation of a research management model and a fruitful avenue of research for geomatics, named “**geocybernetics**” (Reyes et al. 2006, 7-20). We hope that the contents of this paper will provide potential authors of the Journal the essence of the efforts undertaken by the scientific mainstream and inspire them to follow similar paths or propose novel ones.

In the tradition of the scientific journals “of the last century,” it was not well-accepted to mention anecdotal stories about how authors use creativity and intuition to obtain their results. On the contrary, the papers had to give the impression of presenting ideas, hypotheses, proofs, etc. with a “formal, deductive structure” (Byers 2007, 10). While this is certainly still a valid manner to report scientific findings, when one is exploring “new” and emerging realms of knowledge – as is the case of **geocybernetics**– some freedom to use storytelling. (e.g. Waldrop) to describe the process of science can be very helpful. Throughout this paper, we will tell the most relevant stories that made CentroGeo's journey a success.

When the scientific project was first proposed, many actors in institutional settings involved in scientific management in Mexico were skeptical. The idea of establishing a research center dedicated to an emerging science in an adverse social and cultural context was considered almost impossible. A lack of a highly specialized critical mass, a very small budget and lack of knowledge about the scientific basis of geomatics were some of the main characteristics of the context in which the scientific project on **geocybernetics** was developed. Nevertheless, as Byers points out, thinking mathematically, “This human story involves people who find a way to transcend their limitations, about people who dare to do what appears to be impossible…” (Byers 2007, 16). CentroGeo is now a well-established research and education center supported by the Mexican government, with a graduate program and influence in various spheres of academia, government and international organizations.

The people involved in the initial design of the scientific project were either mathematicians or scientists. Our hypothesis is that not only the design of the scientific management model but also the main avenues of research emerged from a mathematical and scientific way of thinking whose main components include intuition and creativity, as explored by Byers.

Rather than conducting a historical review of geomatics, we have observed some analogies with the conviction that this is an emerging science and, as such, characteristics of its development are common to other well-established disciplines. For example, at some point during the period in which it was emerging, mathematics was deeply immersed in societal processes that were explicit and directly impacted the solutions to immediate problems. Such is the case of the contributions of Eratosthenes of Cyrene (276 BC - 194 BC) who, besides his well-known contribution of accurately measuring the circumference of the earth, developed a calendar and made contributions to geography. “He sketched, quite accurately, the route of the Nile to Khartoum, showing the two Ethiopian tributaries,” and he also explained the flooding of the lower Nile downriver resulting from regions near its source that sometimes experienced heavy rains (The MacTutor History of Mathematics archive).

In a similar manner, interaction among interdisciplinary and societal actors in the niche of “geomatics and society” has been a driving force in the development of geocybernetics. In other words, the approach of this avenue of research can only be understood within the societal contexts that have posed specific problems to CentroGeo in terms of public policy, regional planning and non-governmental issues, among others.

“Magically,” in 1999 all the “ingredients” fell into place for CentroGeo, the societal demand and a group of GIS scientists. The societal demand came from a non-governmental organization (NGO) concerned about environmental issues related to the largest lake in Mexico (Lake Chapala). They were asking for digital maps to support political interactions among themselves and with the government.

A possible response could have been to simply give them what “they think they need” and “cash the check”. But no! Intuition pointed to another direction. This is an ideal setting for scientists to explore new ideas.
Fraser Taylor had talked to several of us about this vision of a new paradigm in cartography, “cybercartography”. In 1998, he repeated his idea once and again in the corridors of Latin American cartographic institutes and at lunches and dinners. This was certainly intuitive and visionary at the time.

In 1999, we decided to design and develop a cybercartographic atlas for the NGO. The response from all the societal actors was surprising and very stimulating. The experiment continued for three more years with different actors, topics and regions and, as a result, six cybercartographic atlases were produced (Atlas Cibercartográficos 1999, 2000). This initial effort was undoubtedly the driving force to pursue a more comprehensive avenue of research, which Reyes et al., named **geocybernetics** (Reyes et al. 2006, 7-20).

Some questions arose from the “scientific core” of geomatics: Did these applications fall within the realm of cartography? What new elements had we incorporated, from a modeling perspective, to make them different? What would be our next experiment?

Was our scientific management model working from the perspective of “science and society?” Why? Had we positioned ourselves in the niche of “geomatics and society?”

Since cybercartography involved new ways of conversing with societal actors, new software had to be produced. Was the creativity of the team making a breakthrough in software innovation?

As a result of posing such questions, we had to bridge empiricism and the construction of a new theoretical framework to aid in both providing answers to some of these issues and in establishing a robust scientific platform to allow us to continue exploring and deepening our understanding of this avenue of research.

During that first stage, three chapters (Reyes 2005, 63-97; Martinez and Reyes 2005, 99-121; Reyes and Martinez 2005, 123-148) and a paper were published in collaboration with our Canadian colleagues (Reyes et al. 2006, 7-20). Currently, over sixty cybercartographic "oeuvres" have been designed and developed, papers have been presented in conferences, chapters have been published in books, more than ten master theses (2004-2012) have advanced some of the issues and questions posed during the initial effort, two doctoral theses have been formalized that explored interesting theoretical paths in geocybernetics (Paras 2008 and Lopez 2011) and the research group has received positive feedback from society, enabling CentroGeo to participate in over eighty projects in interaction with societal actors.

The Journal of Geocybernetics, which we are presenting in this initial effort, has been inspired by this emerging and fruitful avenue of research. As mentioned by Taylor in his presentation of this Journal, the publishers are interested in both theoretical and practical issues related to geomatics. The Journal intends to cover aspects that would be included in scientific papers, that can be better identified with the core of geomatics and that involve "storytelling" about scientific exercises in which interactions among scientists and actors in society have advanced the generation of knowledge and innovation in the field.

2. BUILDING BLOCKS OF GEOCYBERNETICS

From the scientific core of geomatics
to the application of science in society

How did the concept of geocybernetics emerge? What are the main theoretical building blocks that support this approach? And what has been the role of innovation? Since these are rather complex questions, this section uses a "conceptual framework" to present only an overview of the paths that have been followed (see Fig. 1). The framework is a menu to access "knowledge capsules" used to clarify the essential ideas. The intent is to indicate the main ideas behind how some building blocks– the science of cybernetics, complexity and chaos theories, as well as the Strabo and Reyes methods– have allowed for a breakthrough in the overall concept of geomatics.

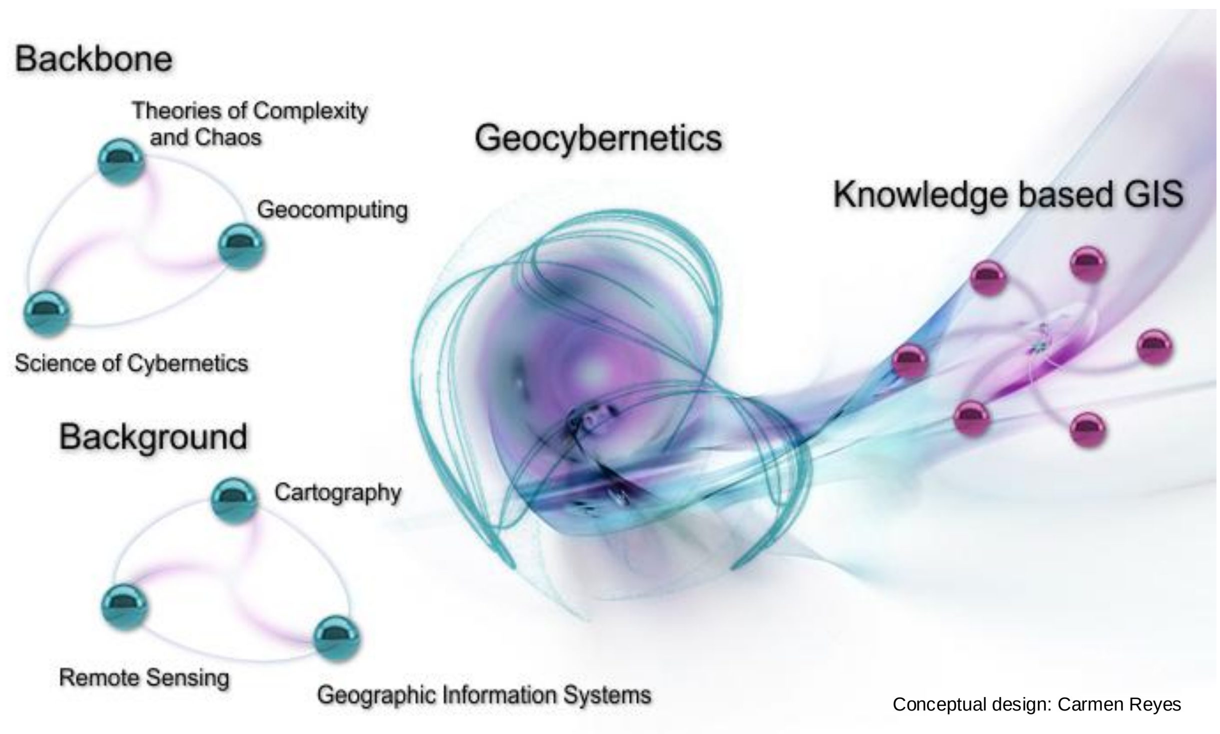

Fig. 1 Conceptual Framework

2.1 Introduction to the Conceptual Framework

We incorporated into each of the "knowledge capsules" presented the issues relevant to geocybernetics in order to clarify the contributions made by the approach and to give some clues to readers and potential authors regarding future contributions.

The first figure identifies three main components: the background, the backbone and geocybernetics. As for background, the disciplines most relevant to our purpose are cartography, geographic information systems and remote sensing, whereas for the backbone, we envision several disciplines developed in the 20th century to be essential to the cognitive framework. Finally, geocybernetics is represented as an "attractor," in which the above-mentioned disciplines interact and are intertwined in a transdisciplinary exercise.

Fig. 2 presents some of the areas of research derived from geocybernetics and the knowledge-based approach to GIScience, and includes a brief description of the main ideas using "knowledge capsules."

2.1.1 Background

Cartography, remote sensing and geographic information systems were identified as the three disciplines within geographic information sciences that have played a key role in the development of CentroGeo's scientific project. The research team involved several experts from each one of these disciplines working in collaboration to respond to societal demands. This teamwork has been a driving force behind the development of empirical methods in geomatics solutions that adequately respond to specific requests. As a result, new areas of knowledge have emerged, such as cybercartography, complex solutions in geomatics and the geomatics prototype, among others.

2.1.1.1 Cartography

A map can be viewed as an inseparable binomial phenomenon of modeling and communication. For thousands of years, geometry has been used by cartography to model the geographical landscape. The language of maps has been extensively studied by many scholars. For example, Peucker mentions that "geographers use maps for the analysis, communication

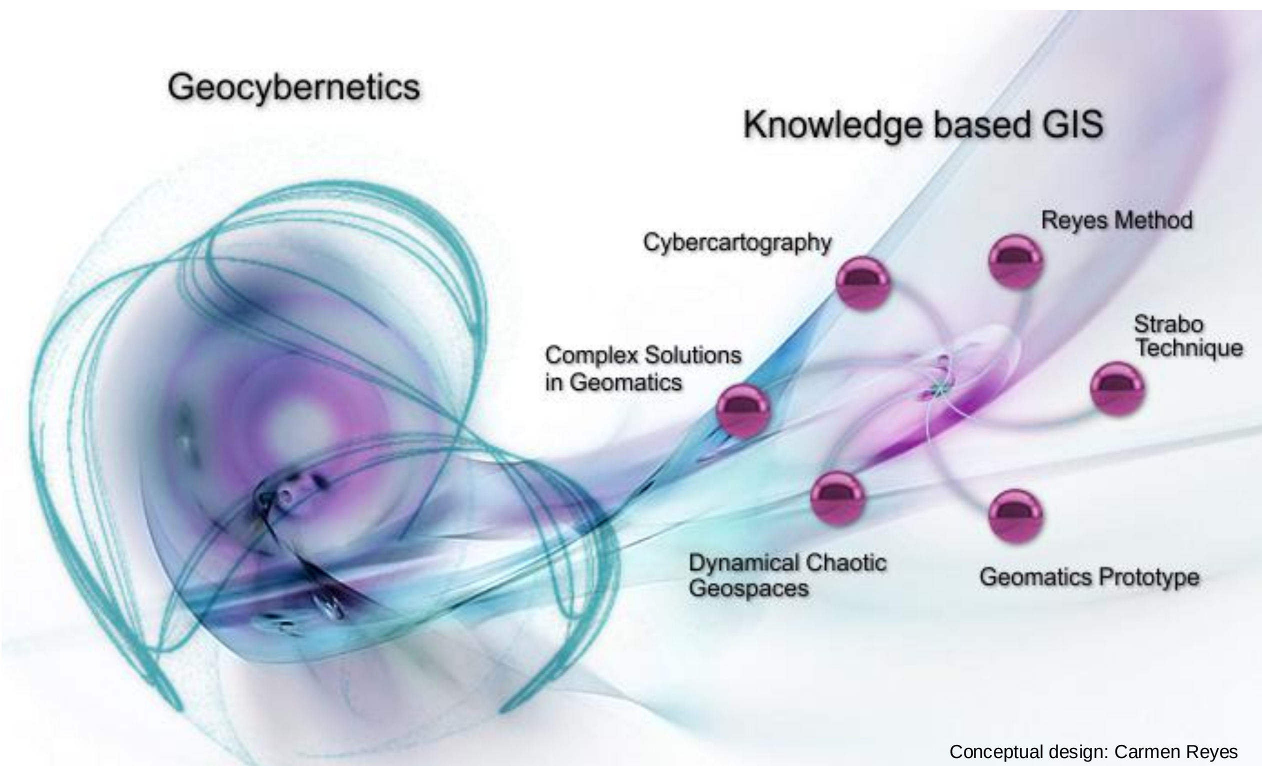

Fig. 2 Knowledge base GIS

and storage of their findings and explores the relationship of the new languages of computers and its impact on the development of cartography" (Peucker 1972, 1).

2.1.1.2 Geographic Information Systems (GIS)

During its initial stage, the discipline of GIS emerged empirically out of the societal need to solve specific problems related to natural resource management and regional planning. In terms of scholarly needs, developments in quantitative geography and spatial analysis required a state-of-the-art resource to effectively apply geospatial models.

Spatial analysis, information theory, general systems theory and computer science are the main theoretical building blocks in GIS; information and communications technology are essential to the implementation of GIS solutions.

2.1.1.3 Remote Sensing

Remote Sensing and Image Processing have been and are essential components of data acquisition in geomatics.

Many geospatial expressions are obtained through remote sensing. There are many variables that can potentially be deducted from remote sensed images, and they all share a common characteristic related to the optical properties of the objects, their distance to the sensor or their position. And although these variables can be obtained both directly and indirectly, the fact is that satellite data is transmitted in such large volumes that they are difficult to grasp simultaneously, therefore automatic tasks are in strong demand. The use of sensing systems requires preparation, tuning and validation of the satellite sensors and data products that constitute informative assets. Hence, mathematical applications drive practical needs to digitally process images, and remote sensing, computer intelligence and all disciplines involved in studying human and machine behaviors, as well as new algorithms and methods to process relevant geographical information need to optimize many applications.

Data processing techniques and geo-spatial modeling approaches used in cartography, geographic information systems and spatial analysis are shared and, in some cases, intertwined with remote sensing and image processing. For example, topics related to regionalization and fuzzy modeling in spatial analysis share modeling and processing approaches with contextual classification and the fuzzy data fusion approach for image processing. Moreover, spatial maps and other geospatial expressions intertwine cartography, remote sensing and GeoWeb products.

2.1.2 Backbone

Scientific efforts such as information theory and general systems theory have been at the core of the development of cartography, GIS and remote sensing since the 20th century. In geocybernetics, the sciences of cybernetics, complexity and chaos are key components of its theoretical building blocks.

2.1.2.1 The Science of Cybernetics

The mathematician Norbert Wiener (1894-1964) founded the discipline of cybernetics. In 1950, he wrote the book *The Human Use of Human Beings, Cybernetics and Society*, in which he mentions that the word "cybernetics" is derived from the Greek *kybernets* (which means steersman) and shares its etymological root with the word "governing," to which Plato gave the meaning of "the art of science." Wiener introduced the word "cybernetics" in scientific language to describe the science of communications and control within an organism, a machine, humans and society (Wiener 1967, 23).

The science of cybernetics provides the theoretical pillar for cybercartography. The results of the empirical work in this avenue of research speak for themselves, with more than 90 projects developed through close interaction with society.

2.1.2.2 Complexity and Chaos Theories

The research group at CentroGeo has explored avenues related to "complex solutions in geomatics" (Reyes et al. 2006, 7-20) and, more recently, "complex geomatics" (Lopez 2011, 10), considering the initial view by Waldrop on the science of complexity– that it is "still so new and so wide-ranging that nobody knows quite how to define it" (Waldrop 1992, 9)– as well as more recent developments in many areas of knowledge, such as those presented by Mainzer and Mitchell.

Chaos theory, as presented by Kellert, Mainzer and Mitchell, points to some concepts that could help to establish knowledge frameworks for the geocybernetic processes that we have observed over the last thirteen years. In this regard, Lopez explores the essence of ideas about self-organization and attractors within the "geomatics prototype" (Lopez 2011, 5).

2.1.2.3 Geocomputing

Geocomputing is a transdisciplinary realm of knowledge where both geomatics and computer science play a key role. The main mathematical concepts encompass geometry, graph theory and topology.

The paper written by Tom Peucker and Nicholas Chrisman on "Topological Data Structures" has been a cornerstone of the efforts over the decades that followed (Peucker and Chrisman 1975, 55-69).

The initial intertwine between computing science and geomatics emerged through data structures (lists, trees, queues) and geometric features (lines, areas, surfaces). These representations were the basis for constructing more complex entities such as Thiessen polygons (Voronoi diagrams) in computational geometry.

Object-oriented programming and conceptual advances in data bases (classes and metaclasses) have led to a new way to model lines, areas and surfaces using a more intuitive correspondence with thematic applications.

Other areas of computing science, such as artificial intelligence, have explored spatial analysis modeling, including cellular automata, multiagent systems, semantic networks and ontologies, among others.

2.1.3 Geocybernetics

This term "geocybernetics" was proposed by Reyes et al. to encompass several avenues of research that explicitly incorporate the science of cybernetics, general systems theory, modeling and complexity theory as theoretical building blocks.

Currently, the research group at CentroGeo is conducting empirical and theoretical work in several of these areas: (1) cybercartography, (2) complex solutions in geomatics, (3) collective mental maps, (4) the geomatics prototype, (5) the Strabo technique and (6) the Reyes method.

2.1.3.1 Cybercartography

Cybercartography was the initial area of research at CentroGeo when it was founded in 1999, and was based on the original vision by Fraser Taylor (Taylor 2005, 3). From a theoretical point of view, the building blocks of cybercartography are the science of cybernetics, general systems theory and modeling.

From an empirical perspective, the cybercartographic approach has turned out to be very successful in supporting societal processes such as political interaction, regional planning and public policy, among others. The demand, acceptance and adoption by different sectors of society clearly suggested the adequacy of the geomatics solutions proposed, encouraging the CentroGeo team to pursue this area of research.

As argued by Reyes, Taylor, Martinez and Lopez, theoretically, cybercartography poses a paradigm shift for cartography by the explicit incorporation of cybernetic concepts according to three main axes: modeling, communications and knowledge-based processes (Reyes et al. 2006, 7-20).

2.1.3.2 Complex Solutions in Geomatics

Though multiple cybercartographic exercises took place within CentroGeo from 1999 and 2001, as argued by Reyes et al. (Reyes et al. 2006, 16), they responded to societal demands essentially within the cartographic knowledge domain. The need to explicitly incorporate geospatial models arose during a project undertaken to support land use planning in the municipality of Tizapan el Alto, in the state of Jalisco. "Complex solutions in geomatics" is a cybernetic approach that explicitly incorporates cybercartography and geospatial modeling and adopts the notion of complex systems to respond to societal demands.

2.1.3.3 Chaotic Dynamic Geospaces

A "chaotic dynamic geospace" can be described as a set of social and cognitive processes present in interactions involving transdisciplinary empirical knowledge. Different actors have participated in the geocybernetic experiments, including the scientists (ourselves) and a group of people interested in solving problems related to regional or urban land planning, public policy and environmental management, among others. Lopez has characterized and built an initial knowledge framework for the "interactions" and "conversations" that arose from these processes, shedding some light on how "an intelligent consensus" was obtained and helped to advance solving problems related to societal concerns (Lopez 2011, 149-174).

The word "space" has distinct meanings in different knowledge domains, and the prefix "geo" refers to spatial analysis in geography. As Mitchell mentions, "the word dynamic means changing, and dynamic systems are systems that change over time in some way". (Mitchell 2009, 16). Our account of the empirical results points intuitively to the term "chaotic" as an analogy for two characteristics that can be formally explained by "looks very random" (Mitchell 2009, 33) and "chaotic attractors". (Mitchell 2009, 32).

The usual setting can be "a meeting room" with a group of persons from different academic and professional backgrounds and even with different objectives. The conversations take place either in a networking fashion using technological devices or "face-to-face."

The knowledge frameworks of the actors (both scientists and societal) used to address a problem are key to the outcome of the exercises. In our case, this could be considered the "initial conditions" for the experiment. The team that participated in dozens of these exercises agrees that, at the beginning, it seemed as though the "conversations" and "interactions" in the workshops and meetings were "going nowhere." As the processes advanced, "attractors" appeared and an apparently "very simple" and effective solution with a "degree of consensus" emerged, although the question remains as to whether one can predict the outcome of the process and how the incorporation of other actors in the meetings will affect the final results.

Nonetheless, there is a clear view that the outcome of the empirical exercises results in a qualitative account of how order arises (Lopez 2011, 127). As a simple analogy, geocybernetics can be viewed as a social microscope that is significant not only in scientific terms but also in terms of its impact on societal processes; very much similar to Kellert, regarding the role of digital computers and the advent of chaos theory (Kellert 1993, 129).

A group of researchers at CentroGeo has undertaken a thorough study of chaos and complexity beginning with its origins in mathematics and physics. For the purpose of this paper, we do not intend to use the present mathematical formalization of these topics to advance building knowledge frameworks in geocybernetics, but rather, we are interested in exploring the scientific issues that are intuitively involved in the geocybernetic processes identified over the last thirteen years.

Analogies have helped to advance knowledge in several areas of research, such as the evolution of mind and brain, of computability, economies, human culture and society, among others (as reported by Mainzer, Mitchell and others). Whether using analogies in geocybernetics helps us to advance both empirically and theoretically is a continued challenge for the research group. Can we formalize this new knowledge? Is there enough mathematics that has not been applied to help us formalize this knowledge? Does its advancement require a paradigm shift in modeling? Do we need to expand the language of science?

The adopted research management model allowed geocybernetics to emerge from an empiricist approach, assuming that interaction with societal actors in "chaotic dynamic geospaces" is the most fruitful way to identify and advance new avenues of research in geomatics.

Whenever a group of researchers embarks on a topic of interest, theoretical and philosophical issues arise as part of the process to generate knowledge. From our perspective, geomatics is an emerging and transdisciplinary science (Paras 2008).

2.1.3.4 The Geomatics Prototype

In his doctoral thesis, Lopez proposes the concept of the "geomatics prototype." He uses this novel idea as a "conceptual agent" to explore different avenues to model and establish formal frameworks derived from some of the empirical work of the research team at CentroGeo. Based on complexity and chaos theories and employing analogies, he is able to explain some of the geocybernetic processes that have taken place during the empirical stage. Moreover, he establishes the foundations to formalize methodologies such as the Strabo technique and the Reyes method (Lopez 2011, 117).

2.1.3.5 The Strabo Technique

One of the characteristics of many developing countries is the lack of systematic data acquisition for use in mathematical modeling. Mexico is no exception. In the mid 1970s Tom Poiker visited Mexico City, aware of these limitations. He had the vision of a methodology similar to the Delphi technique, with the innovation of incorporating the spatial dimension, which he named the “Strabo technique.” Wayne Luscombe took this initial vision and developed the Strabo technique in his PhD. dissertation (Luscombe 1986).

As mentioned in a private talk I had with Nicholas Chrisman, this was a pioneering idea and very early to that currently developed through participative cartography.

Wayne Luscombe, together with the innovation team at CentroGeo, developed a stand-alone solution for the Strabo technique and, in the last year, the CentroGeo team also developed a web-based technological application. Lopez advanced the theoretical foundations of this methodology based on some of the principles found in complexity and chaos theories (Lopez 2011, 112-124).

2.1.3.6 The Reyes Method

The Reyes Method is based on a methodology developed by Reyes, first for the conceptual design of geographic information systems and later for cybercartographic atlases (Reyes 2006, 87). Lopez named the method and proposed a framework for thorough formalization (Lopez 2011, 117). The main idea underlying the original methodology and the general approach can be synthesized as follows:

In the design and implementation of information systems a user´s requirement analysis is usually on the table. Commonly, in the interaction between scientists or experts in the field of geomatics and societal actors, the former consider themselves as the “knowledgeable” ones, whereas the so-called “users” are simply viewed as professionals who require products and services. In this era when society (organizations, businesses, governments and individuals) is recognized as more competitive depending on its “knowledge capital,” the manner in which societal actors are approached and the way the geomatics community responds becomes a key issue. That fact was intuitively identified by Reyes in the early 1990s. The Reyes methodology offers conceptual guidance to establish an interaction framework in which the core of the design and implementation of geomatics solutions is the knowledge of both experts and societal actors working in a close, collaborative manner. This approach has been successfully implemented for more than twenty years in the conceptual design of over eighty applied projects in academic, governmental and international contexts.

2.1.4 Knowledge-Based Geographic Information Science

In the tradition of science, experimentation is a key and invaluable resource, for which data collection and the processing and application of information to sustain or reject hypotheses is a common approach. What makes this approach different is its main thesis– the assumption that “conversations” between scientific and societal actors should be based on cognitive knowledge frameworks. Through the process, a new knowledge framework emerges out of the “fusion” of one or more knowledge domains; i.e. a transdisciplinary process is involved through which cognitive bridges are built not only within geomatics but also with other knowledge domains, such as public policy, landscape ecology and criminology.

In summary, this “knowledge-based approach to geographic information sciences and geomatics” has been very effective for the interaction between science and society and has resulted in novel scientific findings and outcomes. It can be stated that the main driving force in the processes to design and implement solutions from a geomatics perspective is the “K” in knowledge rather than the “I” in information or the "D" in data.

2.2 The Role of Innovation in Geocybernetics

Innovation has played a central role in the development of geocybernetics, which bases knowledge generation on a research management model. It has also been a key factor in the success of CentroGeo as a whole, with the creation of what has been named “geocybernetic artifacts.”

2.2.1 The Research Management Model

In a very broad sense, we understand a management model to be a set of best practices that assures the success of a scientific project. Some of the components of the model include aspects related to human capital, strategic alliances, strategic planning and an innovative organizational framework, among others. The approach adopted by CentroGeo is holistic, collaborative and transdisciplinary.

CentroGeo can be described as a GIS agora– including its facilities as well as its network of networks– where people interact and engage in conversations to gain their own clarity and knowledge, advance and compare ideas, establish benchmarking, discuss the design of technological artifacts or simply explore technical issues. This "chaotic" organizational framework (understanding chaos from a scientific perspective) has been a key condition for innovation and the emergence of new ideas (Reyes and Paras 2009; Lopez 2011, 69).

A central characteristic of the adopted approach is the implicit method with which the team of researchers and knowledge managers intertwine core scientific processes, including the design and implementation of innovative image processing algorithms, geocybernetic artifacts, the application of qualitative methods to interact with societal actors, geospatial modeling and specific public policy recommendations, among others. An example of one of the empirical exercises in geocybernetics can be found in the paper by Lopez and Muñoz, published in this first issue of the Journal.

2.2.2 Geocybernetic Artifacts

Technological innovation in GIS software has played a key role both in responding to societal demands as well as supporting research. The geocybernetic "oeuvres" (technological artifacts + geo-spatial knowledge models and information) have been successfully embedded into a large variety of social environments. We find societal demand, the impact of the geocybernetic solutions and feedback through new demands at the beginning and end of the process. A more comprehensive description of this aspect can be found in a paper by Trujillo and Porras, also published in this first issue of the Journal.

3. GEOCYBERNETICS WITHIN THE SCIENTIFIC REALM

From a scientific perspective, experimentation has been an essential reference for knowledge generation for many centuries. Although there are certainly differences between experimentation in physics or chemistry and experimentation in the avenue of research of "geomatics and society," the scientific essence is the same. Overall, science makes sense only if it is relevant to our everyday lives- albeit today, tomorrow or in the distant future.

As Kim mentions (Russell 2004, vii), "Empiricism in general is the view that our knowledge of what exists and what properties those things have is based upon sense experience." Empiricism was implicit in the initial stages of CentroGeo, during which the processes of "interacting with society" became one of the pillars of its scientific management model.

Throughout the years, there has been consensus among CentroGeo's research team and network, as well as among societal actors, about the adequacy of applying the overall approach adopted in geomatics solutions, which were designed and implemented as described by Lopez (Lopez 2011, 149-174). The success of these experiments in societal contexts addressing different topics (e.g. public policy, planning, decision making, environmental and health issues, public safety and disability, among others) can be measured by the growing demand from society.

In a reference to empirical philosophers, Russell said "experience was as much the source of knowledge of arithmetic as of our knowledge of geography." (Rusell 2004, 56). Similarly, after the first three years of empirical exercises at CentroGeo, knowledge started to emerge and the team began its journey towards publishing theoretical results.

In describing mathematics, Byers mentions, "More than anything else, mathematics is a way of approaching the world that is absolutely unique." (Byers 2007, 14). The decision to design and implement a scientific management model (SMM) as well as CentroGeo's scientific project was strongly influenced by a mathematical way of thinking. Although the basic components of the SMM are familiar to the "scientific management" knowledge domain, they are adapted and interpreted based on mathematical "intuition and creativity."

Similarly, as in other sciences, experimentation has been a driving force in the development of cognitive frameworks in geocybernetics. These frameworks have required the design of new experiments that need to be formalized. The scientific process is evolving and, as a consequence, researchers are innovating and creating new concepts, approaches, and solutions. Such is the case for both the practical and theoretical contributions of cybercartography, complex solutions in geomatics and the geomatics prototype, among others, or overall what we are calling geocybernetics.

Following this trend, and as part of the scientific project, the initiative to publish the Journal of Geocybernetics is the result of an identified need to share and discover similar interests and experiences with other scientific communities.

4. THE JOURNAL OF GEOCYBERNETICS

As part of the design process for the Journal of Geocybernetics, several considerations were taken into account and thoroughly discussed by the working team. The most relevant issues are:

- *The Journal should encourage transdisciplinary work. New bridges between and among disciplines should emerge from this effort.* According to an analysis by Kellert regarding an explanation of why and when chaos theory became relevant to the scientific community: "Ideology affects science by influencing the choice of phenomena to be considered important, the preference for certain kind of methods to study them, and the judgment of which results are successful". (Kellert 1993, 149). Along these same lines, Reyes and Martinez published an essay exploring the impact of culture on cybercartography (Reyes and Martinez 2005, 123-148).

- *The Journal should become a means to encourage communications from scientists from at least all of the Americas*. In the case of geocybernetics, we can identify at least two factors that made it very relevant within the Mexican context. First, as mentioned before, Mexican scientist Rosenblueth played a central role in the development of the science of cybernetics and, second, there was an urgent need to establish a liaison between science and societal actors given the crisis in which the country has been immersed in recent decades. "Know-how" and knowledge transfer can be key factors to the advancement of science (Quintanilla 2002, 303-329).

- *The Journal should offer a fresh space to researchers from other regions who are exploring different (and complementary) avenues that have emerged from their own working contexts.* Chatting in the corridors of Harvard University with Dr. Mauricio Santillana Guzman, a Mexican who has worked within the American scientific community for several years and with a good knowledge of CentroGeo's research, it became clear to both of us that the capacity of some developed countries to generate an exorbitant volume of data and information has biased their research in geomatics towards other aspects of geocomputing, such as data mining, ontologies and global databases. Moreover, the more traditional approach of first establishing a hypothesis, then gathering data to obtain information and finally generating knowledge has prevailed in many of the papers published in the Anglo-Saxon journals in geomatics and GIS.

- *One of the main purposes of the Journal is to become a network to bridge scientific communities throughout the world, each one with its own ideologies, cultures and institutions.* Considering that most of the world's population is immersed in a context similar to Mexico and Latin America, it is extremely important to publish our findings in a scientific journal that accepts at least two languages (English and Spanish). As has been acknowledged, skills and certainly scientific knowledge has been, can be and should be shared, taking advantage of all the available information technology.

4.1 Statement of the Journal on Geocybernetics: Innovating in Geomatics for Society

The purpose of the Journal is to report the results of empirical work being performed in interaction with society and the outcomes that have an impact on the scientific core of geomatics, as well as theoretical, methodological and innovative advances in the field.

This Journal is designed for scientists and professionals in the field of geomatics and its applications. As such it adopts a comprehensive approach, including:

- Peer-reviewed "hard core" scientific articles;
- Peer-reviewed papers in the realm of "geomatics and society";
- Peer-reviewed articles on innovation in geomatics and related fields, including technology and business models, among others;
- A site for conversations among interested parties about specific issues in the field and;
- Reviews of the state-of-the-art in geomatics and related fields.

Articles and social interactions will be published in English and Spanish in order to strengthen the bridges between the scientific and professional communities of Latin America and the rest of the world.

The Journal will be published on the internet and have free access. The geocybernetic approach will allow the construction of knowledge networks on a wide range of topics that are of interest to both scientists in geomatics and society as a whole.

The scope of the Journal will encompass the emergence of new realms of knowledge in geomatics as well as research in geographic information sciences. The decision to incorporate innovation in a manner that is intertwined with theoretical and practical results responds to the view that accelerated advances in technology and novel research management models are key driving forces for scientific advancement in the field as well as for having an impact on society.

By naming the journal *Geocybernetics*, the publishers are sending a dual message. First, the science of cybernetics as initiated by Norbert Wiener and Arturo Rosenblueth is important to current research in geomatics. And second, the intention of the Journal is to embrace a new paradigm in electronic journals, in which messages, communication and feedback are the main building blocks for interactions among the authors, readers, editors and possibly a much broader group of societal actors interested in the application of geomatics to their own fields.

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