Geocibernética y Ciencia 2.0

(Geocybernetics and Science 2.0)

Carmen Reyes Guerrero, Ph.D. y Margarita Parás

CentroGeo

Contents

Geocybernetics and Science 2.0

Carmen Reyes Ph.D.
CentroGeo (Geography and Geomatics Research Center)
Mexico City, 14240, Mexico

and

Dr. Margarita Paras
CentroGeo (Geography and Geomatics Research Center)
Mexico City, 14240, Mexico

ABSTRACT

The term Science 2.0 came to our attention almost a decade after the scientific management model of CentroGeo had been in place. The Scientific Management Model (SMM) that supports CentroGeo's Scientific Project places societal context as a starting point as proposed in the trend of Science 2.0. A methodology was designed, based on second order cybernetics to incorporate qualitative methods, empirical work, theoretical frameworks and a feedback processes in a collaborative mode of producing knowledge.

This scientific management approach became a "freeway" for the advancement of an avenue of research that Reyes et al. named "Geocybernetics". The science of cybernetics is a main building block in the theoretical framework for innovative geocybernetic concepts such as Cybercartography, Complex Solutions in Geomatics and Collective Maps.

This essay is part of an effort to confront the "living experience" of an innovative SMM as well as the scientific results of geocybernetics with the different related meanings of Science 2.0 found in the literature, as means to explore new research areas.

Keywords: Geocybernetics, Science 2.0, Mode-2 knowledge production, Geomatics, Geographic Information Sciences, Scientific Management Model.

1. INTRODUCTION

As mentioned in Reyes et al. [1] Geocybernetics is a new avenue of research in Geomatics. The concept of Geomatics has been in the literature for over a decade. As an emerging discipline an overall consensus on its definition has not yet been found. There is however some common ground on its meaning. Knowledge and practices derived from the different geographic information sciences are accepted as part of the body of "Geomatics". Moreover, it was precisely on the area of technological development where the need became clear to conceive a broader discipline to embrace the accelerated advances in the application of artifacts that allowed the acquisition, processing, management, display and dissemination of geographic information.

From our point of view, the domain of knowledge of Geomatics is emerging; founded in an interaction realm of converging disciplines; and as such its borders are "complex and fuzzy". From our perspective, there are three emblematic research instances of this forthcoming process: Cybercartography, Complex Solutions in Geomatics and the latest developments of the Strabo Technique. [1]

The Cybernetic essence in the empirical and theoretical development of Cybercartography as reported in Reyes and Martinez [2] [3] has been one of the key factors in the advancement of this innovative concept. Similarly, the kernel of the empirical work that lead to complex solutions in Geomatics and the new approach to the Strabo Technique is based on the Science of Cybernetics.

Geocybernetics has therefore emerged as the result of a fresh look into the interrelationship between Cybernetics and Geomatics and for the last eleven years has been the main avenue of research of the scientific project at CentroGeo (Mexico).

As in any successful scientific endeavor, either in an implicit or explicit manner, a management model is embedded in the process that leads to knowledge creation and innovation.

CentroGeo is a Mexican public research center supported by the National Council of Science and Technology (CONACYT) and is dedicated to research, education and technological innovation in GIS. Since 1999, CentroGeo has produced relevant scientific work in a short period of time and, as a result of empirical research has designed, produced

and has had impact in multiple public policies, political interaction, strategic and tactical processes, that include geo-technological artifacts in diverse organizational, institutional and community environments nationally and internationally.

This essay is part of an effort to confront the "living experience" of an innovative SMM as well as the scientific results of geocybernetics with the different related meanings of Science 2.0 found in the literature [4], as a means of exploring new areas of research.

2. THE BUILDING BLOCKS OF THE SCIENTIFIC MANAGEMENT MODEL (SMM)

Although the topic of knowledge management has been in place for some time in the literature, within the Mexican scientific community it has not yet become a driving force in institutional development. However, CentroGeo designed and implemented SMM since it was establish in 1999.

One can identify four main building blocks for the SMM: a scientific strategy to compete at the international level, human networking, heterarchical groups and a method to approach knowledge production.

For Mexican researchers to compete at the international level with little resources and adverse environments the identification of appropriate niches is a strategic issue. In this sense three avenues of research were explored: Geomatics and Society, Geospatial Modeling, and GeoWeb 2.0.

Organizational Issues

A very adverse context in terms of financial support, lack of human capital and a weak scientific culture at the institutional and social level within the Country pointed to the convenience of adopting a networking approach. In contrast with other similar institutions in Mexico, CentroGeo has a small number of permanent researchers. RedGeo is a network of researchers and experts from different organizations both local and international that support its main tasks.

For research and educational purposes CentroGeo has adopted a horizontal and dynamic model of organization. Chaos (understood in a scientific manner) is the model of interaction within the organization. Work is organized around projects that are supported by heterarchical groups constituting a geo-spatial knowledge network.

Accordingly to the topics and purpose of the project a coordinator is designated, as well as academic and technological directors. The groups are multidisciplinary and are composed by researchers from both CentroGeo and RedGeo.

Team work is the essence of the group and the interaction among all members is encouraged. The coordinator is responsible of complying with all the established goals.

Methodological Aspects

For our purposes, the most important building block of the SMM is the method, which at initial stages, was intuitively designed. In the following paragraphs the general method is described.

For the advancement of Geomatics, as an emerging science, it became evident that the interaction with society would be strategic as it had been for Mathematics or Physics around two thousand years ago. Therefore, the starting point of the scientific project was set off from a direct demand from society. In this case it was a need for an innovative approach of analyzing environmental and risk management for the most important lake in Mexico.

Our response involved the design of processes supported by a Cybercartographic Atlas [5] which was appropriated by all stake holders and became a thriving instrument of negotiation among all parties. From a societal perspective, the success was such that for the consecutive years some realms of the Mexican society, the federal and state governments as well as international organizations became a "live laboratory" for the researchers.

Several relevant issues of the science of cybernetics as understood by Wiener [6] can be identified as strongly related with the modeling of the processes and the artifacts.

- The role played by messages and information in the communication process.
- The awareness of the relevance of communication in the control of society.
- Through the concept of feedback, the implication of the explicit involvement of the "user" of the system within the system itself.
- The fact that all "sense organs" are involved in the communication process.
- The recognition of the importance of the communication of visual images.
- The role played by information in measuring the relevance of content of a set of messages in a communication process.

Societal Processes

The interaction with society is based on the network of networks of the researchers and the trust derived from long term relationships. An additional actor was explicitly identified and was named as "knowledge manager". In some cases they are researchers and in others well qualified professionals with an understanding of the impact of geo-spatial knowledge on specific and societal problems.

The conversations between the actors of society and CentroGeo take place through the heterarquical group. Certainly some individuals play a key role in the different stages of the interaction process that can include aspects of marketing, the modeling of a Geomatics solution and the intertwined knowledge framework between Geomatics and Society among others.

Usually CentroGeo produces an initial interaction process and technological artifacts that turn out to be actors in themselves in the joint conversations with society. The feedback from society is expressed and incorporated in the technological artifacts through workshops and collaborative processes offered by CentroGeo supported by the heterarchical group.

Societal processes have been a key issue in the advancement of research at CentroGeo. The "hard core" scientific issues derived from this interaction have opened new avenues of research in Geomatics. But most importantly the "impact" of the geocybernetic processes inserted in communities, organizations and institutions certified by involved societal actors is overwhelming evidence of the pertinence and relevance of the contributions.

As mentioned before, during the initial stage of CentroGeo the emphasis was on advancing with an empirical approach (with a group of robust scientists). In 2002, two groups were working on the concept of Cybercartography; the Geomatics Unit of the University of Carlton, Canada and CentroGeo, Mexico. In a joint effort, researchers from both groups advanced in establishing theoretical frameworks for this innovative concept. As a result in 2005 a book that incorporated the most relevant results at that time was published [7]. Throughout the years researchers from both groups have been advancing in the cybercartography avenue of research from different but complementary perspectives.

3. THE CYBERNETIC CHARACTER OF THE SCIENTIFIC MANAGEMENT MODEL

In our manner of conducting research and our approach to scientific knowledge two issues are singled out:

a) The emphasis on processes of self- organization, cognition, communication and the way we -as observers- interact within the systems subject of study in accordance with *second order cybernetics.*

b) The transdisciplinary character of research, which calls for the recognition of the complex nature (matter-energy) of the universe and the need to integrate our fragmented and disciplinary knowledge with that universe.

The implication of a second order cybernetics approach to our scientific management has enabled us to address Geomatics as a science that emerges in close interaction with society's knowledge in deliberation and collaborative spaces that ultimately enhances the scientific body of knowledge.

4. KEY ISSUES IN THE SCIENCE 2.0 APPROACH OF CENTROGEO

The term Science 2.0 came to our attention almost a decade after the SMM of CentroGeo had been designed. In her doctoral thesis Paras [8] [9] acknowledged the work of Nowtony, Scott and Gibbons [10] [11] recognizing the transdisciplinary character of Geomatics and the parallelism between CentroGeo's SMM and some of the thesis proposed by the abovementioned authors, such as:

- A key issue for the success of CentroGeo in approaching societal actors resides on the assumption that each one of them has either an explicit or tacit form a 'knowledge framework'. The argument of Nowtony et al. around "close encounters with other 'knowledge' organizations" is certainly synchronically with the change of paradigm of how scientists at CentroGeo assume society.

- Being Geomatics emerging and transdisciplinary; the nature of its 'research' needs a widening definition of research which is comprehensive of the environment in which the solutions are designed and ought to be implemented. Similar arguments are given by Nowtony et al.

- Mode-2 knowledge production transcends disciplinary boundaries. It reaches beyond interdisciplinarity to transdisciplinarity implying novel ways for knowledge integration and innovation management.

- Nowtony et al. argue that "Mode-2 society generates the conditions in which society is able to

'speak back' to science; and that this reverse communication is transforming science". The explicit "evolutionary feedback" process of the method adopted by CentroGeo is certainly an example of this statement.

- The driving force behind CentroGeo's research agenda, as mentioned above, has been its interaction with society.

- Innovation has played a central role in the SMM of CentroGeo since the technological artifacts are essential for the conversations with societal actors. Nowotny et al. also identify "innovation as the centerpiece of a new contract between science and society".

- At CentroGeo, the role of "knowledge managers" within its "agora" is explicitly recognized by all its members including academic committees and the so called "users" as part of the SMM. In parallel, Nowotny et al. acknowledged that "Other actors once dismissed as mere disseminators", "brokers" or "users" of research results, are now more actively involved in their "production".

These key issues can be viewed as the pieces of a multidimensional "jigsaw puzzle" that include some of the thesis proposed in Nowotny et al. and the components of the SMM of CentroGeo.

5. HARD CORE GIScience AND THE MODE-2 PRODUCTION OF KNOWLEDGE: GEOCYBERNETICS AND SCIENCE 2.0

As mentioned in the proposal for the International Symposium on Science 2.0 (2010), the term Science 2.0 "has been used with different but related meanings" [4]. Looking at geocybernetics as a scientific project together with the scientific management model that has accompanied its development at CentroGeo, one recognizes that the three identified perspectives convey and are strongly intertwined: Second order cybernetics, new mode of producing knowledge and Web 2.0.

Knowledge integration through a geospatial-cybernetic framework: Geocybernetics

Despite of the fact of the rapid and complex spatial modeling of geographical systems capabilities enhanced by developments in geo-computation, visualization tools and the internet, there is a growing gap between analytical tools and the communication and social insertion of suitable solutions that demand the involvement of social groups, institutions and individuals to address current societal-environmental problems at the global, regional and local levels.

To address these challenges we need to situate ourselves in a different paradigm of geospatial knowledge integration - Geocybernetics- reinforcing the knowledge framework more than focusing on information and data management issues. It's not only a matter of spatial analytical capabilities developed in GISystems that require a new SMM. As described above what it's needed is a cybernetic and transdisciplinary approach designed to cope with the nature of the problems and solutions that contemporary society demand. That is, to provide the methodologies, analytical, communication, and visualization tools, and integration of knowledge and management solutions for ever increasing complex systems.

As explained in Reyes [5] the first cybercartographic atlases were developed as standalone products due to the fact that Mexican society had limited access to the Internet. Nowadays things have changed; GeoWeb 2.0 is one of the main avenues of research at CentroGeo. The "cybernetic" character of the Web 2.0 would allow the development of artifacts or applications that would improve the collective construction of knowledge and the social phenomenon produced in geocybercartographic processes could be shared globally.

Also, in this context the Geomatics solutions address the complexity of the context of social problems and incorporate conceptual and technological resources, generally dynamic mathematical models that advance those proposed by Cybercartography, as a new emerging level that Reyes called "complex solutions in Geomatics". [1]

In the case of Strabo, information and knowledge are expressed and represented spatially. The methodology is designed to address the construction of a collective cognitive map making explicit consensus on the spatial view or tacit knowledge of the participants, through the use of interactive resources for map creation on computers. The knowledge generated by this interactive process is described as a collective mind map based on the knowledge of the experts of the group. [1]

"The Common Places"

In section 4 it was already argued that the SMM of CentroGeo is live evidence of many of the thesis of the so called "new mode of producing knowledge". The perception is that without such an innovative model that supported the scientific project, the avenue of research of geocybernetics could not have advanced so rapidly and successfully at the empirical level.

"In synthesis, geocybernetics is based on the science of cybernetics and has advanced supported by a new mode of knowledge production (SMM), at the same time, the SMM has a cybernetic character.

One can identify "common places" through which Geocybernetics and the SMM are intertwined. The most evident is the encounter between the processes in the contextualization of Geomatics and the processes that take place with the insertion of the geocybernetic artifacts. One responds to the adoption of mode-2 production of knowledge and the second one to the methodology adopted in geocybernetics [2].

Other common places are derived from the synchrony among the communication and feedback processes that take place in the interaction with societal actors as part of a project. Usually the point of departure of a project is a contextualization processes followed by an initial proposal from CentroGeo's researchers in terms of a geocybernetic solution. In the following stages of the projects, the SMM and scientific procedures often take place with the same actors and are synchronized.

6. CONCLUSIONS

Throughout the performance of CentroGeo during the past eleven years, the overwhelming empirical results and their relevance in both knowledge production in Geomatics and societal impact, is "living evidence" and demonstration of the effectiveness and adequacy of the designed and implemented management model adopted at CentroGeo and is emblematic of a "new mode of producing knowledge".

By adopting an "experimental" science approach as argued by Asimov, [12] CentroGeo contributes to the corroboration of the broad thesis of the new mode of production of knowledge.

Geocybernetics as the main scientific project of CentroGeo and the SMM are strongly intertwined and have common places. This statement suggests that in order to advance in Geomatics new modes of knowledge production incorporating cybernetic processes should be further explored.

There is empirical evidence that the three perspectives of Science 2.0 are not only related in their meanings but also strongly intertwined in a scientific endeavor such as the one undertaken at CentroGeo.

7. REFERENCES

1. Reyes M. C., Taylor D.R.F., Martinez E., Lopez Caloca F. "Geo-Cybernetics: A New Avenue of Research in Geomatics?", *Special Issue of Cartographica on Cybercartography*, Vol. 41, No. 1, March 2006, pp. 7-20.

2. Reyes M.C. "Chapter 4 - Cybercartography from a Modelling Perspective", Taylor D. R. F. (Ed.) *Cybercartography: Theory and Practice*, Vol. 4 in Modern Cartography Series. Amsterdam, Elsevier, pp. 63-97, 2005.

3. Martinez E., Reyes M.C. "Chapter 5 - Cybercartography and Society". Taylor D. R. F. (Ed.) *Cybercartography: Theory and Practice*, Vol. 4 in Modern Cartography Series. Amsterdam, Elsevier, pp. 99-121, 2005.

4. Shneiderman B., "*Science* 2.0", *Science*, Vol. 319. No. 5868, pp. 1349 – 1350, March 2008.

5. Reyes M.C., Martinez E., "Chapter 6 - Technology and Culture in Cybercartography". Taylor D. R. F. (Ed.) *Cybercartography: Theory and Practice*, Vol. 4 in Modern Cartography Series. Amsterdam, Elsevier, pp. 123-148, 2005.

6. Wiener N, *The Human use of Human Beings: Cybernetics and Society*, Houghton Mifflin, Boston, 1950.

7. Taylor D. R. F. (Ed.) *Cybercartography: Theory and Practice. Cybercartography: Theory and Practice*, Vol. 4 in Modern Cartography Series. Amsterdam, Elsevier, pp. 574, 2005.

8. Paras M, *Aportes al desarrollo científico en Geomatica: Un enfoque de conocimiento transdisciplinario*, Tesis Doctoral, Mexico, 2008.

9. Paras M., "Geocibernetica e inteligencia estrategica para la politica publica", Ensayo, Unpublished, 2007.

10. Nowotny H., Scott P., Gibbons M., *Re-Thinking Science. Knowledge and the Public in an Age of Uncertainty*, Cambridge: Polity Press, 2001.

11. Nowotny H., Gibbons M., Scott P., "Introduction: Mode 2 Revisited: The New Production of Knowledge", *Special Issue Minerva*, R. MacLeod (Ed.), No 41, 2003 pp. 179-194.

12. Asimov I., *The Roving Mind*, Amherst, NY, Prometheus Books, 1997.