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(Web-cybercartography)

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WEB-CYBERCARTOGRAPHY

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Abstract

CentroGeo (Centro de Investigación en Geografía y Geomática Ing. J.L. Tamayo) is a Mexican public research center supported by the National Council of Science and Technology (CONACYT) and dedicated to research, education and technological innovation in Geomatics and Geography. This center, as result of empirical research, has designed, produced and inserted several cybercartographic atlases in different organizational and community environments.

Cybercartographic atlases were developed at CentroGeo using software, which responds to the requirements and demands of specific societal actors. The development and social insertion of these artifacts gave rise to a theoretical framework which must be revisited as the concept and technology of the web are incorporated as a means of expression of Cybercartography.

Through the atlases, there is an explicit transfer of content within a cybernetic cycle [knowledge-message-information-knowledge] in which the user is an essential actor in the process. In cybercartography, one can foresee the construction, sharing and evolution of collaborative, explicit geospatial knowledge frameworks which are supported by the web. Addressing issues of meaning and knowledge representation may be enriched by current research about semantic webs and ontologies as well as by the knowledge grid approach. Currently, the understanding of the processes involved in the generation and representation of knowledge and its interweaving with information is still incomplete. In this chapter, a Cybercartographic Knowledge Grid is proposed where knowledge is the driving force for the web services and the traditional pyramid of data- information-knowledge is inverted adopting a top-down approach.

The communication process derived from the social insertion of cybercartographic atlases was approached using the metaphor derived from Pask Conversation Theory, where the exchange of messages is a productive activity that leads the participant actors to build agreements and shared knowledge. The communication process between cybercartography and society takes a different form in the context of the web. Conversation theory is a main building block for addressing collective conversations between online cybercartographic artifacts and their users and their impact on knowledge construction.

Technological developments have to support Cybercartographic artifacts in the web so that they may become agents capable of linking information and conceptual frameworks in messages that can present the user with coherent narratives able to evolve towards

increasingly complex knowledge by means of an inbuilt capacity to learn from the collective interactions with their users.

1. Introduction

CentroGeo (Centro de Investigación en Geografía y Geomática Ing. J.L. Tamayo) is a Mexican public research center supported by the National Council of Science and Technology (CONACYT) and dedicated to research, education and technological innovation in Geomatics and Geography. The center is committed to the advancement of science to fulfill society's needs. Since it was launched in 1999, CentroGeo has produced significant scientific work and, as result of empirical research, cybercartographic atlases have been designed, produced and inserted in different organizational and community environments.

Cybercartography is a concept that was first introduced by Taylor in 1997 (Taylor, 2005). Since then Carleton University (Canada) and CentroGeo (Mexico) have had well-established research avenues in this topic (Taylor, 2005) (Reyes et al., 2006).

Cybercartographic atlases were developed at CentroGeo to respond to the requirements of specific societal sectors that needed to address problems present in their territories. Despite the fact that internet technology was available at the time, these atlases were developed using software, as it was considered a more adequate technology for adoption by the social groups towards which the atlases were directed and which still remained marginal to web connectivity. These atlases deal with environmental and territorial planning problems in Lake Chapala, Lake Patzcuaro and the Lacandona Region and with vulnerability analysis in the case of the Fire Risks atlas. At least 500 hundred copies were produced in a CD-ROM format. This turned out to be the ideal medium for the successful social insertion of the atlases in the corresponding territories.

Currently there are some examples of the atlases on the webpage of CentroGeo which are used to illustrate some of the functionalities. However, the limitations posed by commercial and open source geospatial web software clearly show that there is a gap between the theoretical frameworks developed for Cybercartography (Reyes, 2005: 63) and the abovementioned web expression. This fact clearly points to the need of revising the concepts and technology currently available in order to fully take advantage of the resources offered by the web

The first question that comes to mind is whether the initial efforts to establish a theoretical framework for Cybercartography (Reyes, 2005) and (Reyes and Martinez, 2005) stand when the concept and technology of the web are incorporated as a means of expression of Cybercartography. An issue that is explored throughout this chapter is whether there is a natural cognitive common place between the web and Cybercartography from theoretical and methodological perspectives.

The cybernetic character of artefacts emerges from their interaction with social actors through a process in which knowledge about the territory is built and internalized in the social actors' worldview and/or in their processes of decision and action. CentroGeo researchers were able to observe such interactions by inserting the CD-ROM formats in social processes of communication. This scenario cannot be replicated in a web environment and new forms to address processes of knowledge construction need to be devised.

As mentioned by Reyes (2005: 81), in cybercartographic atlases knowledge is incorporated through multithematic geo-spatial models and via multiple languages. Through the atlases there is an explicit transfer of content within a cybernetic cycle [message-information-knowledge] where the user is an essential actor of the process. Due to the communication resources inherent in the web and its cybernetic essence one would expect knowledge to have a much more significant role in Web-Cybercartography. In fact, one can foresee the construction, sharing and evolution of collaborative, explicit geospatial knowledge frameworks supported by the web.

In this chapter, the approach taken in chapters IV and V of the book Cybercartography: Theory and Practice (Taylor, 2005) will be analyzed within a web environment from two perspectives: Computational issues and Cybernetics and communication. Some final comments are included.

2. A vision of Web-Cybercartography from a computational perspective

The web has been used for mapping purposes for more than a decade. The literature, such as Web Cartography (Kraak, A. 2001), Mapping Cyberspace (Dodge, 2001), Maps and the Web (Peterson, 2005) and Cybercartography: Theory and Practice (Taylor, 2005), shows examples of the different efforts undertaken by distinct research groups within the Cartography realm. Simultaneously, the computer science and information technology (IT) communities have been advancing in the same direction but with a different perspective (Tang, 2003), (Kim, 2005), (Erle, 2005), (Chung, 2006), (Visser, 2004), (Bry, 2005), (Yang, 2005), (Feng, 2005), (Brown, 2006).

In Web-Cybercartography, advances in both perspectives should be taken into account without losing the essential concepts behind this new paradigm in Cartography. As mentioned by Reyes (2005: 76), the prefix "cyber" in Cybercartography goes beyond the fact that computers and the web are used as an expression of the concept. In this sense, Web-Cybercartography is not a tautology. The cybernetic characteristics that are essential in Cybercartography as described in the theoretical vision of Reyes and Martinez (2005) should also be in the kernel of Web-Cybercartographic solutions.

In the design process of the "cybercartographic prototype" software, several considerations were made in the empirical stage such as the cartographic model to be adopted, the existing technological resources, existing geospatial standards and visualization capabilities and the role interfaces would play within the artefacts, among others. Similarly, when the web concept is introduced there is an additional need to analyze the different components that will play a role in the design of Web-Cybercartographic solutions.

As in the design of cybercartographic atlases, components such as visualization and interfaces have to be incorporated in the design of Web-Cybercartographic atlases; however, other conceptual elements that are currently in development and research in computer science and IT have to be taken into a account such as the concepts of Grid Computing (Cunha, 2006), Semantic Grid (Li, 2006: 127), Web Semantics (Taniar, 2006) and Knowledge Grid (Zhuge, 2004), among others. As is usual with emerging concepts in science, descriptions and or definitions are difficult to handle (Dey, 2006: 192), (Caliusco, 2006: 70). To deal with this difficulty some characterizations and current developments in the discipline are mentioned.

2.1 The realm of Grid Computing

Grid Computing is a term that is already found extensively in the computing science and information technology literature. For our purpose we will adopt the following definitions: "a wide area environment that transparently consists of workstations, personal computers, graphic rendering engines, supercomputers and non-traditional devices e.g., TVs, toasters, etc.," "a single seamless computational environment in which cycles, communication, and data are shared, and in which the workstation across the continent is no less than one down the hall" (Nemeth, 2006) and "Grid Computing allows new ways of collaborative work" (Goodyer, 2006. 285).

Moreover, Lopez (2006) mentions that the main purpose of Grid Computing is to give well-defined meaning to information and services, "better enabling computers and people to work in cooperation." This approach originates from the need of organizations to efficiently manage large volumes of information that are expressed through e-mails, presentations, white papers, etc.

Through automation Lopez proposes to "uncover key inter-relationships across multiple data sources across and between enterprises that, in turn, allows us to draw the important correlations that formulate business intelligence." For this purpose he explores strategies that are being put in place by IT practitioners. Such is the case of graph-based representations for managing metadata or the creation of information models (the ontology) based on data schemas from specific organizations. Therefore, the final purpose with Grid Computing is to allow "groups of independent, modular hardware and software components" to "be connected and rejoined on demand to meet the changing needs" of organizations.

Web Semantics and Ontology is an approach where the need to structure the web is assumed. According to Taniar (2006), "Web Semantics is the key of the next generation of web information system, where information is given a well defined meaning, better enabling people and programs to work in cooperation with each other."

An Ontology is defined as a standard that allows for more meaningful and efficient searching "by providing contextual and structural information about the presented contents" (Taniar, 2006). At a conceptual level, Woulters et al. (2006: 25) discusses the differences between databases and ontologies mentioning that the ontology is primarily a metadata structure. Kamthan et al. (2006: 43) adopt a formal definition of ontology as "an explicit formal specification of a conceptualization that consists of a set of concepts in a domain and relations among them." From a different perspective, Caliusco et al. (2006) defines ontology as a set of concepts that imply a set of terms and relations. They also formalize the concept of ontology through an axiomatic system.

The Semantic Grid can be understood "as a service-oriented architecture (SOA) in which *entities* provide *services* to one another under various forms of *contract*. The Semantic Grid can provide not only computational services, but information and knowledge ones as well" (Li, 2006: 127). The Semantic Grid is in itself an extension of the concept of Grid Computing.

According to Bai (2006: 45) two basic types of grids have emerged: service grids and data grids. Data grids "allows a community of users to share content" and a "service grid will support applications such as electronic commerce, sensor monitoring, telemedicine, distance learning and Business-to-Business" or as described by Pankratius (2006: 319) computational grids "mainly focus on a better utilization of the CPU cycles of computers which do not run to capacity or run idle."

Currently a considerable number of efforts to implement some of the abovementioned concepts are found in the literature such as: Semantic Web (Sevilmis et al., 2005), (Serafini, 2005), Semantic Web Services (Alesso, 2005), Grid Services (Li, 2005), Web Services (Ma, 2005) and Data Services (Tang, 2005).

The conceptual trilogy of data, information and knowledge is implicit in the literature concerning Grid Computing where different topics have been explored such as societal needs (Cunha, 2006), Herrero (2004, in First International Workshop, SAG), computer architecture (Serafini, 2005), languages (Alesso, 2005), (Euzenat, 2003), software (Aloisio, 2006: 75), programming (Gorlatch, 2006: 99), (Shu, 2005), algorithms (Giunchiglia, 2004), technologies (Li and Baker, 2005), (Walters, 2005) or theoretical issues (Bassiliades, 2004), (Kalfoglou, 2004), (Roberstson, 2005), (Sanchez, 2006), among others.

2.1.1 The Geospatial Semantic Grid (GSG)

One of the significant research trends in information technology as explained by Lopez (2006), is what he calls the construction of a "Geospatial Semantic Grid (GSG)." Derived from the original concept in IT of Semantic Grid, this author proposes the construction of a GSG supported by similar standards such as the W3C (Alesso, 2005).

For these purposes the author mentions the possibility and intention of creating new knowledge "generated from the aggregation of multiple data sources." In this context he assumes the meaning of "knowledge" as related with metadata about applications or processes, metadata about metadata, data extracted from textual documents with semi-automated tools among others (Lopez, 2006).

2.2 The Knowledge Grid

The Knowledge Grid Center is a project established in the year 2000 that "includes research groups and laboratories co-sponsored by universities and institutions in many parts of China" (Zhuge, 2004). Several objectives of this project came to our attention in the design of Web-Cybercartography.

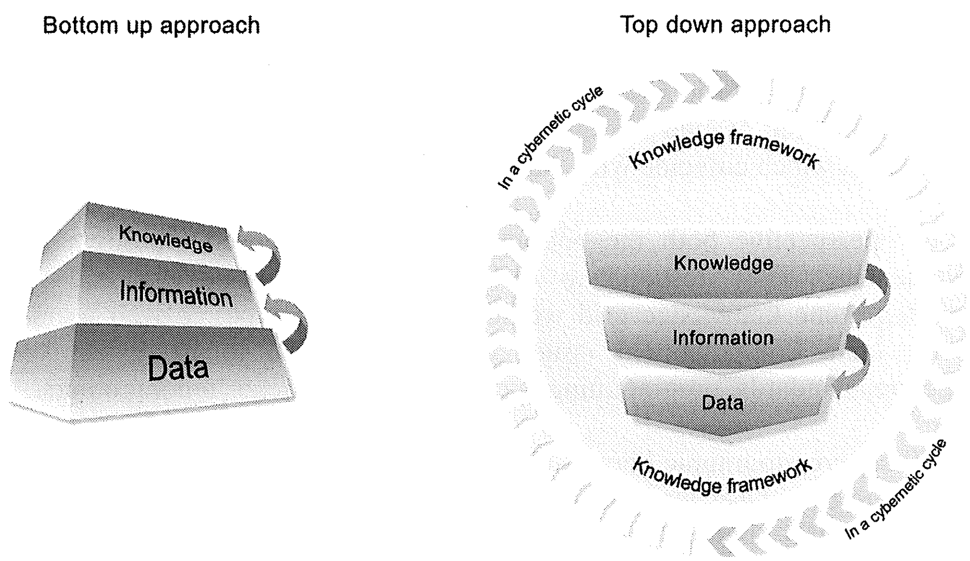
- "The Knowledge Grid (KG) is to be a large-scale human machine environment, where people, machines, society and nature can productively coexist and harmoniously evolve.
- Its ideal is to foster worldwide knowledge creation, evolution, inheritance, and sharing in a world of humans and machines.
- Knowledge is a product of society. It evolves and endures throughout the life of a culture rather than that of an individual.
- The KG methodology is a multidisciplinary system.
- People can communicate and gain knowledge from each other through mutually understandable semantics.
- It is hard to cope with the complexity of human cognitive processes. There is a need for a *semantic computing model.*
- The Grid is not the only platform for realizing the KG and the KG should absorb the ideal and some ideas of the Grid.
- The Semantic Grid is the direct basis of the KG" (Zhuge, 2004).
- KG looks into improved information retrieval, filtering, mining and question answering techniques.

The Knowledge Grid as presented by Zhuge (2004) clearly intends to advance further than Grid Computing. The main principles are clearly exposed and its building blocks are thoroughly described (knowledge, epistemology, systems theory, ontology, etc.). Some other elements such as the KG environment parameters are described (Zhunge, 2004: 27) and some theoretical results are presented across the book. Overall it is clear that this innovative avenue of research is still in a developing stage.

2.3 The Cybercartographic Knowledge Grid

The paradigm of the information driven economies for the 21st century as exposed by Taniar (2006) is a central idea behind the societal need for information management that is expressed in the description of Grid Computing and other concepts that have surged around it such as the Semantic Grid, Semantic Web and Semantic Web Services, among others. On the other hand, the Knowledge Grid approach clearly identifies knowledge as the central component for future services in the web giving a fresh view to the initial vision posed by Grid Computing but still adopting the information paradigm where one of the main concerns is the vast amount of data and information currently available to the user through different media.

In the abovementioned avenues of research one can identify a bottom-up approach where the point of departure is data, information and metadata (Figure 1). In other research areas of computer science, such as knowledge discovery and data mining (KDD) (Fayyad, 1996), (Fayyad, 1996), similar avenues are being explored.



As has already been mentioned, theoretical, and methodological advances are found in the literature. However the main challenge is the lack of a full understanding of the processes involved in the generation and representation of knowledge and its interweaving with information. As Bai (2006: 55) mentions, "Transferring data between two computers on the grid is a well understood problem. The transfer of information is much more difficult, while the transfer of knowledge is almost impossible without some form of explicit human intervention."

2.3.1 Cybercartography and knowledge frameworks

In this sense the methodological framework of Cybercartography as presented by Reyes (2005) could be better characterized as a "top-down approach" (Figure 1). The so called "Content Framework" is an explicit body of knowledge derived from scientific disciplines that respond to the need for explanation, prediction, public policy design and implementation or simply the dissemination of solutions to situations posed by society. In Cybercartography the knowledge framework adopted becomes the central element for the modeling and communication in the design of each solution. For example, in the Lake Chapala atlas the knowledge framework was supported on a territorial planning perspective, landscape ecology guided the framework of the Lacandona Region atlas while, for the atlas of competitive territories, the framework was built using a complex systems approach. The solutions are well-structured and an essential resource for the message transmission resides in the knowledge body embedded in the artifacts. Moreover, this knowledge framework is the main guidance for the management of information, metadata and data within the artifacts.

2.3.2 A vision of a Cybercartographic Knowledge Grid

The knowledge framework that is expressed through different languages in cybercartography is the point of departure to build a Cybercartographic Knowledge Grid. The main purpose of Grid Computing suits the initial demand-driven approach and the main ideas centered around the meaning of knowledge as identified in the Knowledge Grid approach which coincide with the point of departure in Cybercartography.

From our perspective both the bottom-up and the proposed top-down approach are complementary. They respond to different needs from society and as such the cybercartographic knowledge grid would offer new resources to web users. There are, however, main computational issues that would have to be undertaken such as architecture, standards, programming and theoretical elements, among others.

How will cybercartographic knowledge grids operate? How can the graphs that represent knowledge in the atlases facilitate the construction of collaborative geospatial knowledge frameworks? Will the basic building blocks for the semantic engine be "geospatial concepts" rather than data, information or metadata? How can we take advantage of the communication strengths of the web to extract the potential of the explicit knowledge inherent in the cybercartographic atlases in the process of the construction of collaborative knowledge?

3. Web-Cybercartography and communication

The CD-ROM proved to be the adequate technological medium both for the transference and effective adoption by the local social actors of cybercartographic atlases, and for the opening of the possibility of establishing a social laboratory where the communication process derived from the social insertion of these artifacts could be researched. Feedback loops emerged in the communication process giving rise to representations of the geographic space in the atlases resulting from the participation of different stakeholders. Such representations impacted the vision and the decision making processes of local social actors. These researches lead to the development by Reyes (2005) of a theoretic Cybercartography framework that heightens as its backbone, Cybernetics, or the science of control through communication. Also, second-order cybernetics was proposed as the framework for the analysis of the communication processes that emerge from the social insertion of the atlases. (Martínez and Reyes, 2005). The feedback relationship, which is a key concept in cybernetics, is applied in second order cybernetics to a meta-system integrated by an observer interacting with the system which in this case is the cybercartographic atlas. This conceptualization allows focusing on the communication loops between the observer and a cybercartographic atlas in order to inquire about processes that emerge from communication, such as meaning or knowledge construction. (Figure 2.)

One could approach Pask's Conversation Theory from a second-order cybernetics perspective. Pask used the term "conversation" to denote that, not only do the participants of the communication process exchange messages, but also that this exchange corresponds to a productive activity that leads the participants actors to construct meaning and to discover new things. In a conversation these participants are at the same time receivers and emitters, they observe each other and interact by integrating a cybernetic system that feeds interpretations and meanings back with a common purpose: to build agreements and shared knowledge in the shape of new concepts (Glanville, 1993), (Boyd, 2001), (Scott, 2001). The conversation describes a process of "cognitive interaction, in which concepts are exchanged, combined and recombined (the construction phase), with the aim of achieving agreement about shared meanings (the coherence phase)" (Heylighen, 2001: 693). Reyes and Martinez (2006) have proposed Conversation Theory "as a powerful theoretical guide for addressing the communication processes which emerge by the insertion of cybercartographic atlases in social contexts."

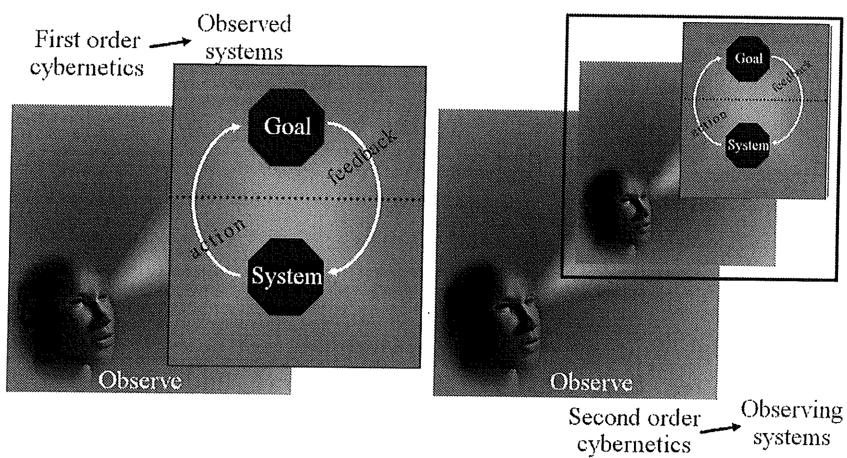


Figure 2. Cybernetics and Second Order Cybernetics

"Conversation theory illuminates the nature of interactions and sequences of interactions entailed in a learning process. It describes the types of questions individuals need to (and, based on empirical studies of learning – do) pose to an information source in order to achieve understanding. Such interactions between new information and the learner's existing conceptual structure may result in confirmation, extension, challenge or contradiction-even plain failure to comprehend or accept" (Ford, 2005: 370).

The social actors involved enter the conversation process with their own vision of the world, derived from their experience, their education, their culture. The cybercartographic atlas enters the process with a knowledge model that plays the part of the *paskian* entailment mesh in which topics are linked by coherences and held apart by distinctions. This mesh is a knowledge representation model that "supports the interactions between learners and information sources as they seek to achieve understanding" (Ford, 2005: 371-372).

Each cybercartographic atlas is focused on a specific subject or topic, the study of which is framed by the knowledge domain incorporated in its geographic models and in its messages. As a cybernetic system, its specific purpose is to communicate messages carrying spatial information and knowledge on a given topic to its audience. The knowledge model provides the structure that supports the messages emitted by the artifact in the conversation processes they have been inserted in. This model was designed originally by the interdisciplinary group that designs and produces the artifacts in interaction with society. But since the model is not static, it may evolve after the artifact's insertion in social conversations. Its purpose is to structure messages in such a way that the audience can draw a relevant meaning for their own learning and action processes.

The knowledge model structure, as well as the structure of the entailment mesh, can be unfolded to allow the entrance to the structure from different starting points. This quality permits the conceptual assembly and organization of information, while bringing to the users the opportunity to access paths of information through the geospatial knowledge structure. Such paths are knitted as richly connected contents expressed in different media that allow the interacting actors to uncover a storytelling process that helps them give meaning to the messages they receive from the cybercartographic artifact. Different messages emerge from the navigation routes, thus permitting the construction of readings that, from various perspectives and territorial scales, let the user approach the environmental factors, the strengths and weaknesses of the territory, in relation to the given subject and, in general, the concepts that could lead to the construction of geospatial knowledge. From the recursive message exchange between agents taking part in the conversation a special complexity emerges. This complexity manifests in the form of new concepts that represent the process of building understanding and knowledge.

The conceptual and theoretical descriptions of cybercartographic artifacts knowledge model incorporate semiotic features that enhance its expressivity and support the reasoning process of the involved social actors. The use of different visual and aural languages for information display gives room to take advantage of human perceptual abilities, henceforth enhancing the possibility to learn.

The CD-ROM opened the possibility for first hand observation of the conversations between the machine and a group of individuals. The feedback loops of the process permitted the inquiry, from a second-order cybernetics perspective, of the agreements between the participants, the search for consensus and the generation of spatial knowledge. In group conversation processes, these artifacts have played a relevant role in the construction of a spatial language, and have functioned as triggers of decision making processes—and of those of planning joint actions—that allow for improvement of the geographic space (Martinez and Reyes, 2005). Nowadays we need to adopt or develop the pertinent tools to further study these communication processes in the web.

The experience of the cybercartographic atlases in CD-ROM and DVD, as the adequate medium for some social contexts such as those of Lake Chapala, Lake Patzcuaro or the Lacandona Region, cannot be extrapolated to every case. In 2005, CentroGeo developed an atlas about Mexican competitive territories that benefited from the empirical experience accumulated through six years of work and mainly from the possibility of counting with an explicit theoretic and conceptual approach. The socialization of this atlas lead the research group to some conclusions on the impending need for its online distribution given that the relevant social actors of this atlas are business executives, entrepreneurial associations and public decision makers that move in the circuits of web connectivity.

3.3 Cybercartography, communication and the web

We believe that the direction in which the research on the new paradigm of cartography should be developed lies in the communication process itself. On one hand, web technology – and in general computer mediated communication technology—as has been argued before, has a profound impact on the communication process and is undoubtedly impacting the social and cultural fiber; and on the other hand, through the process of communication social actors can build geospatial knowledge that may help them relate to that space in an harmonious way. The incorporation of web connectivity in Mexican communities which have remained marginal to this process is imperative for their development and steps have to be taken in this direction.

Internet connectivity opens new possibilities for the acquisition and building of knowledge derived from a communication process that could be qualified as a conversation in which ideas are hosted in people and in the machines needed to take part in the conversation; a process that takes place in the space of relationships between concepts and ideas of both the common man and the great scientists and thinkers.

The communication process between cybercartography and society takes a different form in the context of the web. The researcher can no longer be just an observer, but must participate in a process in which actors converge in time and space to converse about a given topic of interest and, in the process, build understanding, new concepts and shared agreements. Online conversations can be, as pointed out by December (1994) asynchronic. This complicates the tracing and follow up of the feedback processes that occur in the conversation. The challenge then lies in finding research designs that allow for digging up the forms in which Internet users, and in our case, map users or more specifically cybercartographic users, create geospatial knowledge.

The issue of the message meaning has not been successfully tackled in communication theories (Poore and Chrisman, 2006). Also, the communication models adopted in cartography, as described by Peterson (2003) are linear and fail to go deeper into more complex forms of the process because they do not take into account the feedback loops that occur between the involved actors.

What does the receptor understand from the emitter's message? Meaning and feedback are core issues both in learning contexts and in knowledge construction. In conversations mediated by humans, the emerging feedback loops allow for debate, clarification and contextualization of the message meaning. This does not happen in the human-computer interaction or in that between computer programs. Research on semantic webs, such as graphs of concepts linked by relationships, has attempted to tackle the issue of meaning and understanding; however, a main obstacle of the effort has been the adoption of a reductionist approach oriented toward the formal and detailed description of learning objects in a fragmented manner so that users can precisely locate the information they desire. But as Andrew puts it, "its structure and attributed significance are due to the natural intelligence and insight of the programmer" (Andrew, 2000: 638).

In an attempt to overcome the shortcomings of such an approach, some authors have proposed visions in which the knowledge construction process could be effectively achieved at both ends of the human-computer interaction. In their vision, the computer ceases to be a repository of messages that have to be retrieved based on fragmented and static taxonomic structures and becomes an agent capable of linking information and conceptual frameworks in messages that can present the user with coherent narratives able to evolve towards increasingly complex knowledge.

For example, Stutt and Motta foresee the evolution of the web towards learning contexts based on knowledge representation structures or "knowledge charts" that are built from a group's ontological perspective. The members of such groups would gather in a location in cyberspace to learn about some topic, thus forming "knowledge neighbourhoods." The groups would be equipped with semantic browsers that allow for a "knowledge navigation" process via the entailment among knowledge charts or its components. Such an evolution would articulate scientific narratives and argumentations; the relatedness of the pieces of information involved would allow a user to comprehend concepts, theories or messages in a holistic way while placing them in the socio-economic, political, cultural or historic contexts and in the meta-narrative of some discipline's state of the art or the current debate between its academic stakeholders. From this standpoint, the user-web conversation would evolve towards "a flexible multilayered, multiple-viewpoint, reasoning-oriented approach" instead of jumping from one learning object to another (Sutt and Motta, 2004: 136).

Pask's conversation theory can shape a model of the social construction of knowledge; it also applies to the interactions between roles or perspectives that occur in one person's internal dialogue or may occur between computer programs. This theory leads us to Wiener's original interest in the exploration of communication not only between humans but also between humans and machines and between machines (Wiener, 1956). In fact, Pask developed a program "thoughtsticker" (Pangaro, 2001) which transforms the computer into a conversational partner that helps its counterpart externalize his thoughts in the form of a stable representation of knowledge or entailment mesh. Heylighen (2001) proposed yet another computer program, the "concept organizer," which overcomes some of the entailment mesh limitations and gives rise to knowledge representation structures or "entailment nets," the practical value of which lies on the dynamic construction of new concepts and inferences. Bollen and Heylighen (1996) in their conclusion consider that "the dependence on human network design is a serious limitation to the further development of this medium" and they propose to design algorithms for transforming the web "into an adaptive an active associative network…able to absorb the implicit knowledge of its users and discover new relations between pieces of information." Hence they propose a method that allows for the self-organization of associative networks of hypertexts in which the links between their nodes emerge from the collective user actions as meaningful and useful knowledge representations. The authors regard a world-wide associative network which could be seen as a first step towards a "global brain" (Russell, 1983) in which, the intelligence of relatively isolated individual minds is forecasted to evolve towards highly connected structural entities through an evolution process that evades human control, as it is also mentioned in Chislenko's view in his "new ecology of intelligence" (Chislenko, 1996).

The insertion of cybercartographic artifacts in the web poses a challenge for this evolution process: improvements have to be detected and incorporated within the knowledge model structure, as well as major changes or new perspectives that may even imply the adoption of a new structure for the knowledge representation. The exploration of this issue will be a driving force in the future development at CentroGeo of cybercartographic artefacts that respond to the needs of Mexican organizations and social groups.

There are authors who envision computers that can build meaning by imitating the human process of navigating the web through links that connect random pieces of information, and while this is, by all means, a possibility, we consider that in the actual state of the art, the drawing of meaning and the building of knowledge still require human participation in the conversation. As attractive as those ideas may be, humans are still in control and research about issues related to knowledge construction, still requires the human observer's participation in the cybernetic cycle of communication. We consider that in the short term, models such as Stutt and Motta's knowledge communities offer a possible route for inquiring about the process of knowledge construction that may emerge from the online conversations in the cybercartography domain. Conversational programs, such as those proposed by Bollen and Heylighen (1996), should also guide research on the possible self-evolution of the knowledge model of cybercartographic artifacts.

4. Final comments

CentroGeo has established a working group to explore different angles involved in this new area of research. In this chapter a Cybercartographic Knowledge Grid is proposed where knowledge is the driving force for web services and where the traditional pyramid of data- information-knowledge is inverted adopting a top-down approach. Moreover, conversation theory as presented in this chapter is a main building block from a theoretical perspective. We foresee the need to support research oriented toward discovering the impact of the collective conversations between online cybercartographic artifacts and their users regarding knowledge construction. However, as has been pointed out, there are many other theoretical, methodological, technological and technical issues that still have to be undertaken in the future.

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