CHAPTER 6

Technology and Culture in Cybercartography

MARÍA DEL CARMEN REYES

Centro de Investigación en Geografía y Geomática
J. L. Tamayo (CentroGeo), México, México

ELVIA MARTÍNEZ

Centro de Investigación en Geografía y Geomática
J. L. Tamayo (CentroGeo), México, México

Abstract

Cybercartography emerges at a time of revolutionary advances in computing sciences and communication technologies. Consideration of the cultural characteristics of a society is essential for developing the content of the geospatial messages embedded in the communication process of cybercartography. The circular relationship between culture and technological development is recognized throughout the process in cybercartography to generate, support, and communicate geospatial information and knowledge. In this chapter, the authors explore the relationship among technology, culture, and cybercartography; share their experiences in the design and production of cybercartographic atlases that were developed within the Latin-American context and present a description of the *Cybercartographic Atlas of Lake Chapala* utilizing the theoretical and methodological frameworks described in Chapters 4 and 5 of this volume. This exercise enables the authors to complete the first stage of the scientific cycle of performing empirical work; making explicit the knowledge acquired in the process; rediscovering the atlases using the proposed theoretical and methodological frameworks; and finally, to propose new avenues of research.

1. Introduction

Technology is a revolutionary force, which continues to change many aspects of life at an increasingly accelerated rate. Bertrand Russell's (1967) reflections about the role of science in society underline the way in which science has been a dominant factor among educated men and women for more than 300 years, while the impact of technology has been significant for less than two centuries.

Russell (1967: 23) comments "science, ever since the time of the Arabs, has had two functions: (1) to enable us to know things, and (2) to enable us to do things." Technology is, therefore, an intrinsic component of science and in the twentieth century, technology had a profound effect on many aspects of society. For example, the atomic bomb in the last century changed geopolitical world scenarios in a similar but more extensive way than the introduction of gunpowder in the middle ages. Throughout history, technology has been both a threat and a source of hope.

Alternatively, Medhurst *et al.* (1990: ix) argue that the technological age commenced not with the atomic bomb or with computers but with the invention of language and points to the strong relationship between symbols and technologies. Medhurst also quotes Galbraith's definition of technology as "the systematic application of scientific or other organized knowledge to practical tasks" (Medhurst *et al.* 1990: x).

The generations, who have lived the contemporary technological age can easily identify a large number of scientific developments that have affected their personal lives. Millions of people are still alive due to the technological benefits, such as penicillin, and people have entered the 21st century in the midst of exponential growth in the number of innovations that impinge upon the way in which people live their daily lives.

The concept of technology has often been misused and misunderstood, especially in how it relates to science. Technology is sometimes viewed as less intellectually important than "pure knowledge," and there can be insufficient awareness of the basic science behind a technological development.

The fascination of society with technology and its unquestionable glamor often lead scientists to concentrate their attention on the artifacts themselves, rather than on other essential elements. These include, the processes involved in the incorporation of technology into societal activities, the intrinsic cultural aspects of technological development and use, and the needs of users.

There has been a trend over the last 50 years, toward increased specialization in either very specific areas of scientific knowledge or in the development of highly specialized technologies. The result has been that public policy actors and scientific communities alike have given insufficient attention and importance to the feedback process between the "knowing" and the "doing," as conceived by Russell. It can be argued that this has been the case in some of the spatial sciences in the field of geomatics.

For example, in the area of Geographic Information Systems (GIS) it is not unusual to find cases where governmental offices have acquired hardware and software with totally inadequate conceptual support for their applications. As a consequence, the technology is often used only for map reproduction and often the projects as a whole do not fulfill the expectations. The lack of appropriate knowledge frameworks to take advantage of available technological resources, and a misconception of the role of technology in cognitive and social processes has limited the potential of this emerging discipline. On the other hand, there is insufficient awareness in the geomatics scientific community about the importance of the interaction with society through geospatial technology to identify interesting avenues of fundamental research.

In cybercartography, as argued in Chapter 4 of this volume, both knowledge and technology play a fundamental role. In the first part of this chapter the role of technology and culture in cybercartography is analyzed. In the final section the results of seven years of empirical work are outlined by describing the cybercartographic atlas of Lake Chapala, both as a technological artifact and as an interactive social artifact. This encompasses the lessons learned from the incorporation of the atlas into the societal processes of this region of Mexico, as well as from the interactions with different groups of users. By describing the *Atlas of Lake Chapala,* we provide an empirical example that illustrates the cybernetic cycle, which we argue is inherent in cybercartography.

2. Technology and Culture

Don Ihde (1990), in his book on the Philosophy of Technology, defines a "notion of technologies as those artifacts of material culture that we use in various ways within our environment." As such, technologies have a core role in our daily lives, in fact, the author claims that "our existence is technologically textured" (Ihde 1990: 1).

Idhe differentiates the human experiences that are technologically mediated from those that are not, such as sensorial experiences or direct bodily contact with an environment. He concludes that "virtually every area of praxis implicates a technology. From burial to birth to eating and working, the use of artifacts embedded in a patterned praxis demarcates the human within his or her world.... the technological form of life is part and parcel of culture, just as culture in the human sense inevitably implies technologies" (Ihde 1990: 20).

By focusing on the phenomenology of the human experience of technology, Ihde proposes a typology that characterizes the relationships between humans and technologies. The types are:

(1) *Embodied relations*: These encompass humans' bodily engagement with a technology, as in the case where eye glasses become part of the way users ordinarily experience their surroundings. In this case, there is a binomial human-technology relationship to the world.

(2) *Hermeneutic relations*: These are an act of interpretation that is both textual and contextual and involve the user's language abilities. The reading of a text is an instance of this relationship in which linguistic transparency presents the world of the text. The world is brought to human perception by the technology.

(3) *Alterity relations:* By these, humans relate to technologies-as-other. Although there may be a relationship between humans and the world, through the technology, they need not be related and the world may remain as context and background. An example of this type is provided by human–computer relationships.

(4) *Background relations:* These are represented by functioning technologies, which ordinarily occupy background or field positions such as lighting or heating systems.

(5) *Horizontal phenomena:* The term is derived from "horizon" and these relations occur in the border area between the humans and the artifact, which itself practically ceases to be technology. One example may be the contraceptive pill that once taken becomes part of the organism's processes.

Although each of these elements in the typology can be observed, with different degrees of emphasis and in variable combinations, across cultures, the cultural diversity of societies introduces another dimension in the analysis of the relationships between man and technologies and in fact, in those between social systems and technologies. According to Ihde, this can be observed in the process of technological transfer from one socio-cultural system to another. The recipient receives not only the artifact per se but also a set of cultural relationships (values and processes). When the new technology relates itself with practices already familiar in the culture, the adoption of the artifact within its immediate use-context will be simpler than in those instances when the recipient culture requires learning and interpretation of the practice itself. However, in both instances the cultural interface involves the complex level of higher level cultural values. Furthermore, as Ihde argues, "technologies may be variantly embedded; the 'same' technology in another cultural context becomes quite a 'different' technology" (Ihde 1990: 144).

Technology has been recognized as a leading force in the development of the new paradigm of cybercartography. As such, it is necessary to explore the cultural dimension of these technologies: How do cultural contexts feed the construction of cybercartographic artifacts and how can these artifacts be introduced successfully in different social contexts?

The experience and knowledge of Dr Taylor provided him with the vision of the concept of cybercartography. The demand of society was the driving force for the development of cybercartographic atlases. The construction of these cybercartographic artifacts was supported as a methodological process as well as by the intuition of the research group at CentroGeo, who built these atlases. The vision and the intuition of the form, color, media, and the general characteristics of the atlases could not have become a reality without technology. Technology was the basic tool by which the researchers from CentroGeo could communicate with society. It should be noted that in the atlas creation experience, differentiation is required between the technologies themselves and the artifact; in a similar manner as the technology used to produce this book differentiates itself from the contents of the book.

In cybercartography, the technologists have to either use existing tools available in the market (such as multimedia, WEB and computer graphics technologies) or develop "tailor made ones." In this sense, the knowledge of the availability of information technology (IT) and communication technology (CT) is essential as well as developing trends in both fields.

As in many other areas of geomatics or geographic information sciences, geo-specialists take advantage of existing developments in IT created for other disciplines or adapt existing technologies (e.g. data base and visualization technologies). The best scenario has been where the geo-specialists have been able to obtain a suitable solution and to create specific geo-technologies, such as the implementation of topological data structures or cartographic generalization algorithms.

The development strategy in geomatics, in the last 20 years has given rise to the growth of software firms, which supports geospatial applications. For the software and hardware developer, the specialist and the user are often seen in separate "silos"; while the consultants in geomatics will bring together and integrate a solution by recommending or developing technology for specific user applications.

It is common in analyzing the "human factors" in the use of geospatial technology to take an approach, which focuses solely on issues, such as the user interface and usability, which are essential characteristics of the technology as such (Frank 1993: 13). Some of these are described in several chapters in this book. It is argued that cybercartography differentiates itself from the one traditionally followed by industry and opts for a systemic and holistic view, where the main issues are aimed in satisfying the wider needs of the users. This view includes an overall modeling process that incorporates various aspects, such as content, the knowledge frameworks of the users; qualitative characteristics of the process by which the artifact is embedded (organizational, community, or research environments among others), adaptability; openness; and of course, usability.

In empirical work in creating cybercartographic atlases it is possible to distinguish the role of technology (as an essential part of the artifact); the content of the artifact, the process of embedding the artifact in the suprasystem and the role played by the cultural context in Mexico and Latin America, where the atlases were designed and produced (Reyes in Chapter 4 of this volume).

The cybercartographic atlases of CentroGeo are not limited to the depiction of the physical, economic, and environmental characteristics of the regions they describe; they also reflect the richness and specificities of the socio-cultural context of these regions.

As will be discussed later in this chapter, the design and production of CentroGeo cybercartographic atlases were supported by a qualitative research methodology. By following this process of inquiry, anthropologists and graphic designers played a significant role, as they were able to capture in the cybercartographic atlases the cultural particularities of the geographical regions and express them artistically. This approach is cumulative. The knowledge gained during the design and production of the *Cybercartographic Atlas of Lake Chapala,* which was the first atlas produced, could be built on during the development of the other cybercartographic atlases (*Lake Pátzcuaro, Lacandona Region, Fire Risks and Lake Chapala: children's vesion*). For example, issues of ethnographic research and their relation to design were tackled in a more explicit way in the *Atlas of Lacandona*, where the role of anthropological research extended to music, design, and images included in the atlas. Besides being aesthetically important these elements allowed local actors to perceive the atlases as referents, which reflect characteristics of the local culture.

It is not yet clear whether the capturing of cultural elements in the cybercartographic atlases helps local users to adopt them more easily. In local processes that include showing the atlases information and processing capacities, using them as instruments to aid decision making and planning processes, or building local capacities for their use. The research group has observed that local users show great interest in the artifacts and relate to them in an easy way. However, these are the only observations, and further research is required in order to understand the way in which the incorporation of cultural elements in the design of the atlases helps the adoption process. In addition, there is also a great need to focus research efforts on more effective ways to capture cultural particularities in atlas design.

The cybercartographic atlases are expressions of "modern" or "sophisticated" technology. However, they address regions, which face complex environmental, economic, social, political, and cultural conditions. In all the regions infrastructure is poorly developed and there is extensive environmental degradation. They all have ethnically diverse populations with large sectors living in extreme poverty. The dynamics of these phenomena vary among the regions according to their particular geopolitical situation and history.

The adoption of cybercartographic atlases in such contexts poses major research questions. The visualization of geographical space and its correlated problems holistically is not a common practice in those contexts; nor is it in governmental institutions that deal with the environmental problems of the regions involved.

Hence, the process of adoption has to be intentionally promoted, by means of building local capabilities to perceive and understand the geographic space and to act upon it in ways that allow its harmonic development. Such endeavor needs to take into account the specificities that arise from the local cultures.

CentroGeo's cybercartographic atlases are technological prototypes developed to integrate and communicate spatial information and knowledge about structures and processes that occur in specific geographical contexts and to be used in local contexts as instruments that support decision making, collective action, and education. Accordingly, it might be concluded that they are technologies useful only in the socio-cultural context they target. However, this is not so; any user in any part of the world can relate to these atlases and learn in a holistic way, issues related to their knowledge model. For example, people from any nation can appreciate the ecological problems related to water resources by using the cybercartographic atlases of Lake Chapala or of Lake Pátzcuaro. Furthermore, the cultural roots of the atlas's designs may promote a global vision of a culturally plural planet.

2.1. The User

As mentioned by Taylor (2003a), the importance of focusing on a user-centered approach to the development of technology is essential for the success of cybercartography. Authors, such as Johnson (1998), have stressed the importance of focusing on users in the analysis of the role and trends of technology. Johnson is particularly interested in technical documentation centered on the user rather than on the designer or developer of the technology. Several authors in this volume consider this topic.

Johnson (1998: 13) argues that the Greeks treated technology from the point of view of the "use of the product, not in the design or making of the product itself." He introduces the concept of the "knowledge of use" indicating that, particularly, in the case of computers, there is a tendency to think that the computer specialists are the knowledgeable actors and that the users who do not understand the artifacts are some kind of "dummy" (Johnson 1998: 13). In more recent developments this view is changing, for example, computer scientists, such as Draper and Norman, have focused more on people rather than on the artifacts themselves expressing that their "book is about the design of computers, but from a user's point of view" (Johnson 1998: 12).

Johnson (1998: 12) also explicitly acknowledges the importance of culture in the development of technology and quotes the historian John Staudenmaier who argued that "all artifacts are affected by the social sphere, the cultural ambiance, thus making technological artifacts and systems dependent upon, instead of autonomous of, human intervention."

As Medhurst *et al.* (1990: x) mention, besides the "purist" definition of technology, it is essential to focus on the culture of technology. The political motives to develop technology, its psychological impact and its relations with the "economy, ideology and power" and the manner in which it affects the communication process are also issues of prime interest.

Wood (2003: 113–114), in reviewing the relationship between the instinctive nature of mapping and the evolution of cartography over the last decade, argues that technological developments provide new "interactive exploratory facilities" that allow their use in a more holistic sense. This represents a shift from previous trends that reproduced the dichotomy between professional mapmaking and map-use: "the mapper as percipient merely studied the map with a view to expanding her/his knowledge. Now she/he can truly interact with the map (and with its data sources) and become, in the process, also a mapmaker."

2.2. Communication as Technology

There is a vast literature that considers the topic of the role of technology in communication including all forms of media from paper to telegraph, telephone, voice and e-mail. Some aspects of the literature considered relevant to the communication process in cybercartography will be explored briefly in this section.

Medhurst *et al.* (1990: xiv) in their book on Communication and the Culture of Technology consider both language and logic as technologies in spite of the fact that they are not physical artifacts, such as telephones, televisions, or computers. Similarly, Beach while studying processes of group communication stresses "how language is used as a technology for accomplishing a task" and conceives a conversation as a "technological resource, the organization of which is ultimately rooted in practical circumstances of everyday choice and action" (Medhurst *et al.* 1990: xiv). These concepts point to relevant issues regarding the role of cybercartography in social processes. As will be presented in Section 4, there is an empirical evidence that shows the power of cybercartographic atlases as discussion tools in community groups that have quickly resulted in public policy action.

Penland (1974) in Communication, Science, and Technology, explores important issues, on communication services, especially those related with information, library, and media specialists. More than 30 years later, many of the technological limitations of that time, have been overcome. However, the main cognitive guide includes some of the basic concepts adopted for the theoretical framework presented for Cybercartography in Chapter 4 of this volume. In this regard, Penland takes a social-science research approach and a behavioral psychology perspective focusing on human communication and assumes that human behavior is the product of "a cybernetic system composed of a perception-concept subsystem, a motive-selector subsystem and an effector-feedback subsystem" (Penland 1974: vii).

2.3. The Spatial Dimension in Organizational Communication Processes

There is a voluminous literature regarding the use and/or impact of communication technology on organizations. For example, Büchel (2001: 18) reports rankings of the use of communication media in organizations, where face-to-face meetings have the highest score and faxes the lowest. Similarly, in terms of feedback the face-to face communication process is immediate while electronic mail is moderate and formal letters are slow. Büchel outlines the manner in which workers in an organization adopt different media to take into consideration a variety of factors, such as urgency, ability to convey personal feelings or communicate multiple cues, and the speed of feedback, among others. Visual communication is, however, not considered, and the role of cybercartography in knowledge organizations would be an interesting line of research.

Minoli (1994), in reviewing current and future electronic imaging systems, identifies the main users as bankers, medical, publishing, and scientific communities. The major benefits in using this technology include reduced storage costs and reduced chance of document loss among others. He only tangentially, mentions engineering and geographic applications. Cartographic applications have many of the same characteristics, such as scan, store, display, print, and transmit. Minoli wrote a decade ago, and technology has developed rapidly since. The importance of geospatial technology has been increasingly recognized, together with nanotechnology and biotechnology, as one of the leading technologies of the information era (Gewin 2004).

In more recent developments, Vriens (2004) analyzed, from different perspectives, the role of information and communication technology for competitive intelligence. In an organizational context, competitive intelligence is described as "producing and processing information about the environment of an organization for strategic purposes" (Vriens 2004: vi). The main argument rests on the fact that the business have always acquired and analyzed information regarding their competitors, suppliers, and consumers. A number of factors have emerged requiring a more detailed consideration of the resources to support organizational tasks and strategic decision making. These include the rapid change in the availability of information technology, the globalization of the markets, and a general increase in the complexity of the business environment. Vriens reviews basic concepts (data, information, knowledge, and intelligence), looks at competitive intelligence, both as a product and as a process, and gives guidelines for the acquisition and use of available software products. The author outlines the different models used by Dutch organizations, including simulation, scenario analysis, and competitor profiling to support competitive intelligence activities and points to the Internet as the best resource for information collection (Vriens 2004: 17).

On the topic of competitive intelligence, Hendriks (2004) looks at Geographical Information Systems (GIS) as a resource to incorporate the spatial dimension into the process. The author argues that this resource has been underused and presents the key elements for linking GIS and competitive intelligence. He recognizes that in order to take advantage of GIS it should be coupled with competitive intelligence at a conceptual level, and analyzes "the spatial perspective" in business. By presenting different lines of thought in spatial analysis and connecting them with specific interests in business, such as territorial market definition, routing, and geodemography, Hendriks illustrates the importance of a geographical approach in competitive intelligence. A detailed linkage with several of the competitive intelligence processes and spatial analysis potentialities are presented, though the limitations of the current GIS commercial software are being recognized. Although many of the topics considered by

Hendriks have been explored in other publications, such as the journal of "Business Geographics," the value of Hendrik's argument is in the effort to make the important conceptual link between competitive intelligence and the spatial perspective.

Cybercartography has the potential to be embedded in an organizational context and can open up the areas of empirical and theoretical work in organizational communication and competitive intelligence. Organizations need to learn how to use geographical space in strategy building and decision making processes and how to derive a competitive advantage from it. As cybercartography uses a spatial language, transmits holistic messages, and utilizes interactive tools, it can help its interacting social actors in perceiving geographical space through a systemic view. This will allow them to gain knowledge about the complex dynamic processes that occur in such space and enter in processes of communication and conversation that support consensus building and collective action toward shared purposes.

2.4. Society and Communication Technology

There are critical and thoughtful voices in this era of high-speed communication. Authors, like Inayatullah and Leggett (2002), question the role of communication in societal development. They refer to the fact that not only the message, information, and communication are involved, but also the "social, gender and civilisational context embedded in the process." In their edited volume several scholars analyze the costs and benefits of the communication era and its new technologies. Cyberspace can contribute to the creation of a more egalitarian world and support collaborative efforts among groups. For example, from a gender perspective, women can appropriate communication technologies to strengthen their networks. Other authors explore possible scenarios that could lead either to human well-being or to an overload of cybermarket and cyberfantasy via video games. The need to analyze the role of technology from a societal perspective is clearly highlighted. This includes issues, such as the need to select the technology appropriate to different cultural environments, methods of "culturally appropriate communication", and the politics of empowerment.

In synthesis, as mentioned in the statement by Inayatullah and Leggett (2002: 7) "technologies are part of culture not outside it." The design and development of technology cannot be disconnected from the cultural context, where it takes place. As cybercartography is, undoubtedly, based on information and communication technology, issues regarding its role in social processes and the identification of cultural elements that have an influence in the development of the concept itself are of considerable importance.

In the literature on Geographic Information Systems (GIS) some authors from a critical perspective, have expressed their concerns on the possible dual role of GIS as the empowerment vis-a-vis the marginalization of societal groups (see Harris and Wiener 1998). Some of the issues discussed include the social and ethical implications of the use of GIS and public access to geospatial information. With the exponential growth in the development and use of geotechnologies, in the near future avenues of research that focus on geomatics, culture and society, and human factors will certainly multiply.

At a national scale, Gupta (1999) analyzes the role and impact of media communication on Indian society. He recognizes electronic and satellite communication as the driving forces in the growth of the media industry and tackles their impact on "human activity-life styles, entertainment, work culture, modes of communication and... social and cultural values in society" (Gupta 1999: 1). The information revolution in India he describes includes issues, such as the convergence of computing, telecommunication and broadcasting technologies, and the actions taken to establish policies for developing education, the empowerment of women, and sustainable development.

Gupta (1999: 92) presents in a very inspiring manner, the concept of communication: the word communication is derived from the Latin word "Communis," which means:

> To make common, to share, to impart, to transmit. Communication is the basic instinct of man and a social, economic, political and cultural need. Without communication no society can exist, much less develop and survive. For the existence as well as the organization of every society, communication is a fundamental and vital process. The word communication means not only transmission but also community participation. Communication integrates knowledge, organization and power, and runs as a thread linking the earliest memory of man to his noblest aspirations through constant striving for a better life.

Information technologies, such as multimedia and the WEB, can be resources for economic development besides being "information carriers." The Cybercartography and the New Economy Project views cybercartographic atlases as powerful tools for communication, with a clear vision of the potential role of this new concept in economic development (Taylor 2003b).

Ramussen (2000) draws our attention to the fact that until recently, in the era of mass communication, the focus was mainly on technical, economic and policy issues. The cultural and social impact of artifacts, like the telephone were probably ignored due to its "domestic" character. With the rapid advance of the societal adoption of new technologies, such as the Internet, cellular phones, and video games the impact of these new technologies on "human action in an everyday world" and on human behavior and culture, is a cause of increasing concern. There is a need to incorporate more sociology and social theory in the study of communication technologies (Ramussen 2000: 1). Ramussen (2000: 6) presents a theoretical framework to advance the social understanding of what he calls the "new media" and "communication technologies" that include multimedia, hypermedia, and interactive media (Ramussen 2000: 1).

Two issues related to cybercartography are of special interest: the role of the user-technological artifact relations including the communication feedback process; and the role of geospatial information in broadcasting media.

The new paradigm of cybercartography needs to respond to these challenges by developing knowledge and technology to improve the performance of human-artifact interaction and by developing prototypes for the broadcasting industry.

2.5. *Technology and Geo-communication*

Traditional geo-communication technology is the "hard-map." For centuries it has served as a valuable resource in the most relevant societal activities and in almost every culture around the world as Monmonier argues in this volume. Throughout this book, the importance of information and communications technologies for the development of cybercartography has been emphasized. In the following review of some of the main technological resources there is a special reference made to existing shortfalls and possible new areas of technological development that could be explored within cybercartography.

2.5.1. *Multimedia, the WEB and Computer Graphics*

There is a voluminous literature on multimedia, the WEB, and computer graphics. A number of these studies are of particular interest for the production of cybercartographic atlases. Mahbubur (2001) explores some key issues including: the standardization of terminology, its study from a semiotic perspective, the use of fuzzy query languages, spatiotemporal data modeling, and educational applications.

Ditsa (2003: Preface) analyses the development of multimedia to support systems for information management. He argues that multimedia has transformed the interaction between individuals and computers, since it has "made it possible for us to see, hear, read, feel and talk."

In the realm of the World Wide Web, in addition to more technical research, efforts are being made to understand the relationship between technology, identity, and culture (Wood and Smith 2001). Several topics are of special interest for further research in cybercartography including: the analysis of the WEB as a cybernetic organism; the construction of online identities; interpersonal communication; and conversation processes including virtual support systems and legal issues.

Computer graphics is an area of computer sciences, which has rapidly advanced in the last decades (Newman and Sproull 1981). The development and application of technology in the entertainment industry, medicine, and education, is amply demonstrated in the annual conferences of SIGGRAPH. Although some of these resources have been used for communication in cartography, such as the developments in visualization, there are many others that remain unexplored, such as interactive music, animation, human–computer interfaces, and mixed reality technology among others.

Cartography, geography, and GIS have responded to the rapid development of computer science and telecommunication technologies. As examples one can mention the efforts of Cartwright *et al.* (1999) in *Multimedia Cartography*, Dodge and Kitchin (2001) in *Mapping Cyberspace*, Kraak and Brown (2001) and Camara and Raper (1999) in *Spatial Multimedia and Virtual Reality,* and Peterson (2003) in *Maps and the Internet.*

Taylor's (1999: 315–321) chapter on *Future Directions for Multimedia Cartography* outlines the origins of major ideas behind the concept of cybercartography. Since multimedia cartography is one of the main resources for cybercartographic atlases, the topics discussed in the Cartwright and Peterson (1999) book are a point of departure for the exploration of new avenues for research and development in cybercartography, as are those in Gartner's (2001).

Kraak and Brown (2001: 1) argue for the need to examine the "new opportunities and challenges offered by the WWW" and the incorporation of multimedia cartography. In their book, the perspective of the cartographer is emphasized by various authors, who present new visualization processes, ideas on semiology, applications, and forms of cartographic publishing. Dodge and Kitchin (2000) pose questions on the meaning of space and time in an era of Information and Communication Technology (ICT) and cyberspace. Geographical ideas such as distance and friction of distance are re-evaluated, and concepts such as "spaceless" and "placeless" within globalization are discussed. Overall, the focus is on the interest of geographers in the social, cultural, and political implications of ITC and cyberspace. The concept of "cybergeography" is introduced as the geography of cyberspace and the definition of cyberspace as a "navigable, digital space of networked computers" (Dodge and Kitchin 2000: 1). This contrasts with the approach adopted in Cybercartography as presented by Reyes in Chapter 4 of this volume, where the initial building blocks for a theoretical framework are three areas of knowledge: cybernetics, modeling, and general systems theory. The "common place" of cyberspace as described by Dodge and Kitchin could however be considered as part of applied cybernetics.

2.6. Technological Trends for Cybercartographic Modeling

Two different levels of modeling can be identified in cybercartographic atlases. The first is a metamodel that comprises the main characteristics of a cybernetic artifact as was discussed in Chapter 4 of this volume. The second level finds more specific modeling efforts that cover a wide range of purposes. Some trends in computing science and representations of the geographical landscape that might be relevant for the modeling process in the atlases are considered here.

Since the developments in computer science have been a driving force in cartography for several decades, these are worthy of further examination. Wegner and Doyle (1996) outline several avenues of research in computing that are of interest for the development of cybercartography. These ideas originated in the MIT Laboratory for Computing Research and three main trends are identified: foundations, systems applications and infrastructure. In each trend there are topics of special interest to cybercartography. These include computational geometry, artificial intelligence, networks and telecommunications, object-oriented programming, and Human Computer Interaction (HCI). The HCI has been extensively studied and is of special interest for cybercartography, since a user-centered approach is one of its main characteristics (Myers *et al.* 1996). Several chapters of this volume explore this topic.

Developments in object-oriented modeling are found in Gartner *et al.* (2001). Major studies of visualization include the work of Dykes (1997), Evans (1997), Breuning (1999), Uhlenkuken *et al.* (2000), Dransch (2000), Brainerd and Pang (2001), Megrey *et al.* (2002), Ogao and Kraak (2002) and Takatsuka and Gahegan (2002), among others. From a more technical perspective, there are developments toward a more effective use of artifacts such as video devices (Peker and Divakaran 2003).

Also of special interest for cybercartography is the work of Harding *et al.* (2002: 260), where a multi-sensory system was developed for the investigation of scientific data. In the prototype, stereo vision, touch and sound are used simultaneously to explore "overlapping surface properties."

In terms of the specific topic of the content of a cybercartographic atlas, a wide variety of spatial modeling approaches can be incorporated. In the case of the atlases produced by CentroGeo, the main modeling approaches used were based on landscape ecology, territorial planning, and environmental science. The atlases do not incorporate the spatial analytical tools themselves, but rather conceptual representations or interpretations of results that are expressed through a variety of geospatial messages, such as geotext, virtual maps, and diagrams.

3. The Cybercartographic Atlas of Lake Chapala: An Empirical Case

In order to describe the empirical experience from which the *Cybercartographic Atlas of Lake Chapala* emerged, the first part of this section describes how the atlas was conceived by utilizing an intensive interaction process with Mexican society. The second part describes the artifact and the processes involved, adopting the theoretical and methodological frameworks presented in Chapter 4 and 5 of this volume. The authors are an active part of the cybercartographic process and the conceptualization of cybercartography has evolved through a cycle of scientific research that involves empirical work, creation of knowledge, and feedback between users and developers of atlas prototypes.

3.1. The Network of Actors

The main social actor involved in developing an instrument to help understand the interlinked problems of *Lake Chapala* was the *Comisión de la Cuenca Directa del Lago de Chapala*, a Non-Governmental Organization (NGO), with representatives from the main sectors interested in environmental problems of the largest lake in Mexico. Actors in the Commission include fisherman, businessman, peasants, local, state and federal government officials, and a large retirement community of Canadians and Americans. In 1999, there was a complete lack of agreement over the actions required to deal with the environmental problems facing the lake among different groups represented in the NGO.

The Mexican Ministry of the Environment (SEMARNAT) identified the Lake basin as one of its priority regions for environmental restoration. Inside the Ministry there was an informal network of public servants with a special interest in the region's ecology who supported the NGO's efforts. There were two core members of this network. One was in charge of the international agenda of the Ministry. He had a background in regional planning and suggested to NGO membership that they should utilize geographical information to support planning and decision making processes. The second individual was from the statistical and environmental information services division, who had a good sense of the information needs of the NGO.

The lead author of this chapter, as an external consultant, had participated in this informal network, since 1998, in the design of a National Environmental Geospatial System (SNIARN). Also, in the same year, she started working with Dr Fraser Taylor and highly specialized groups from Canada and Latin America on a project supported by the Inter-American Development Bank (IADB) and executed by the Pan American Institute of History and Geography (PAIGH). One of the main purposes of the project was capacity building in Latin America on topics such as the construction and use of electronic atlases. In the course of the project, the vision of Dr Taylor on cybercartography had a strong influence and the final results of the project, an electronic *Atlas of Latin America,* was a prototype of things to come (www.centrogeo.org.mx/atlaslatinoamerica).

CentroGeo was established in March 1999 as a public research center in geography and geomatics supported by the Mexican Council for Science and Technology (CONACYT). The lead author was designated as the Director of CentroGeo and the Ministry of the Environment, formally requested support for the Lake Chapala NGO in developing digital mapping.

Although the network and collaborative process was implicit, it was not formal. This process helped to create favorable conditions for the development of a cybercartographic proposal to satisfy the needs of the Commission. Moreover, the trust among the different members of the network that came from interpersonal relationships over many years was a key factor in the success of the project.

Between April and September 1999, a small group of researchers and specialists in theoretical and applied GIS and cartography, landscape ecology and territorial planning, computing science, graphic design, anthropology, and communication science of CentroGeo, designed and produced the *Cybercartographic Atlas of Lake Chapala.* Important actors from the community and government were involved in the production process of the atlas. In many cases the information and knowledge incorporated was provided by a number of people including graduate students, fieldworkers, and governmental officials.

In late 1999, CentroGeo presented the *Cybercartographic Atlas of Lake Chapala* at a formal meeting of the Commission that took place at the Lake. The unanimous applause after the presentation and the positive reaction of the audience indicated that, for the first time, the members of the NGO agreed on the main environmental problems. Each of the constituent groups recognized that they were both part of the problem and part of the solution. Until that time, action by the federal government had been perceived as the only answer. After the presentation groups realized that by working together meaningful action could be taken at the local level. From then on, the atlas was used as a point of departure in local and state meetings and was widely used by local media in articles and commentary on the environmental problems of the Lerma-Chapala basin of which Lake Chapala is a key part.

In January 2000, at a meeting at the Lake, with the participation of members of the NGO, the Ministry of the Environment and the Governor of the State of Jalisco and approximately five hundred interested people from public and private sectors, the *Cybercartographic Atlas of Lake Chapala* was presented. At that meeting all groups signed an agreement to provide resources for the first stage of restoration of the Lake.

The *Cybercartographic Atlas of Lake Chapala* by conveying the right messages to the relevant stakeholders, had accomplished one of its main purposes: being used as a political interaction and a discussion tool among the different actors. It should be noted that the members of the NGO had never agreed earlier on any issue due to their evident conflicts of interests.

The atlas was also presented to a gathering of several hundred retired Canadians by the lead author and Dr Taylor to garner their support for the endeavor.

3.2. Communication, Modeling and Knowledge in the Cybercartographic Atlas of Lake Chapala

As mentioned in Chapter 4 of this volume, the *Cybercartographic Atlas of Lake Chapala* can be modeled as a multi-dimensional system composed of three axes: communication, models, and knowledge. The methodology presented in Chapter 4 of this volume was used for the overall conceptual design of the atlas. The utilization of these three axes to create the atlas as an artifact is described below.

3.2.1. The Communication Axis

The potentiality of the atlas to communicate geospatial messages was focused on two main issues: the holistic character of environmental problems in the Lake Chapala Basin and the need to strengthen the awareness of the community of the nature and causes of the environmental problems of the Lake. To accomplish this, multimedia (maps, remote sensed imagery, videos, photographs, texts, diagrams, and three-dimensional "flights"), interactive mapping (zooms, overlays, queries to attributes, distances, drafting of new geometrical elements, and metadata among others), "user-friendly interfaces" (user-oriented language and menus), and explicit knowledge representation (via the structure of "navigation" features and information recovery) were used.

3.2.2. The Modeling Axis

As discussed in Chapter 4 of this volume, modeling is an essential element of the design process of a cybercartographic atlas. The structural methodology and the content framework as described in Chapter 4 of this volume, were applied and as a result territorial planning and landscape ecology approaches were adopted. Both were selected as a result of the User Needs Analysis (UNA) and qualitative research analysis. As a result, the six subsystems of the atlas respond to a planning framework (characterization, diagnostic, scenarios, and management). In both communication and knowledge axes the models play different roles. In some cases the models are used to communicate geospatial messages and in others they are the backbone for visualization processes. Some of the resources used include: virtual and digital maps of the region, data structures with the relevant environmental information, digital terrain models of the Lake Chapala Basin, dynamic three-dimensional satellite images showing the Lake and its surroundings, geo-texts, diagrams, videos, and photographs.

3.2.3. The Knowledge Axis

As discussed in Chapter 5 of this volume, the main content framework for the atlas is based on landscape ecology theory and territorial planning. This decision responds to the results of the qualitative research exercise undertaken as part of the structural methodological process and to the UNA. To have such a well-defined structure for the development of the atlas has certain advantages. The guidance provided by the conceptual framework adopted is of great help in the definition of the geospatial messages to be included and as a result the communication process is improved.

3.2.4. The Resulting Cartographic Artifact

In the design and development of the atlas, several elements have to converge in an "interaction space" as outlined in Chapter 4 of this volume. These include: the complementarities of the different components; the synergetic effect that has to be present; the appropriate integration of the different models and languages; the aesthetic component; and the critical cultural and societal factors.

The purpose was to create a cybernetic artifact with all of the characteristics required including openness, interactivity, and adaptability. It was also important to ensure that the geospatial messages were able to communicate the desired information. Both hearing and seeing are involved in the process of communication, but this involvement goes beyond the linguistic interpretation of messages by the receiver. In the interaction between the users and the atlases, the visualization of images plays a major role in the meaning derived from the complex messages involved.

3.2.5. Technology Used in Building the Atlas

As part of the overall scientific strategy of CentroGeo, technological development is conceived as essential to advance basic research in cybercartography. For that reason, a small group of technologists (one at the beginning) was involved in the design and production of the atlas. The experience has been highly enriching and has given strength to the institution and the possibility to satisfy users without having to rely always on expensive (for Mexican standards) commercial software. The main technologies used include: Map Objects (ESRI); visual basic programming language; and HTML schemas.

The technological functionality of the atlas is innovative in several respects, for example, the users are able to draft and save new geometrical figures to represent specific areas of study together with new photographs, videos, or text that are incorporated into the atlas.

CentroGeo approaches technological development as an opportunity for a number of reasons. There is a gap between the theoretical developments in spatial analysis and geography in general and the commercial software available. In Mexico and Latin America educated human resources need to be enhanced to adopt and create new geo-technology; the competitiveness of the geomatics industry must be increased by developing in-house software; and tailor-made technological solutions for cybercartography are required to allow further research.

3.3. The Sociocybernetic Character of the Atlas

In the unfolding virtual helix presented in Chapter 4 of this volume, the requirements of both the Commission and the Ministry of the Environment (SEMARNAT) were taken as the point of departure to describe the development cycle. According to the methodological framework proposed, a qualitative research approach was used in the design of the atlas. The design and production of the prototype took approximately six months (April–September, 1999). During the final stages, the atlas was presented to some of the main government stakeholders, to researchers knowledgeable about the environmental situation of the basin, to the regional community, and to other members of society. This was to ensure that their views were incorporated and to increase the acceptability of the atlas in political and social terms. This experience turned out to be very successful for the embedding of the atlas into environmental public policy processes. In other words, the selection of the geospatial messages and the manner in which they were incorporated into the atlas, the functionality of the prototype and the graphic design, among others, was conducted by interaction processes that included designers, producers, and users in what can be called a "qualitative dynamic modelling" cycle (See Chapter 4, Fig. 4.10).

Sociocybernetics as presented in Chapter 5 of this volume, provide a theoretical framework to explain some of the social phenomena that were observed during the development of the atlases, which marked the first stage in the development of cybercartography. As a result of research in the creation of theoretical and methodological frameworks for cybercartography that has taken place during June 2003–June 2004 the second order cycles and their role in the construction of a spatial language, as outlined in Chapter 5 of this volume have become more evident. For example, the perception and understanding of the designers and producers of the atlas has evolved and the feedback of more "mature" users reflects its impact on both their spatial understanding and their ability to plan and manage the environmental challenges of the Chapala region.

The *Cybercartographic Atlas of Lake Chapala*, as a social product in its initial stage, had a substantial impact on the interaction among the different actors and was a driving force in building environmental public policy. The community recognized the importance of the Atlas as a means for teaching children to take a holistic view of the region where they live and the importance of "taking care" of the Lake. In fact, CentroGeo produced an educational version of this atlas. Each of the actors in the region became aware of their responsibility regarding the environmental problems of the Lake and members and working groups of local, state, and federal governmental institutions have used the atlas in diagnostic and planning activities. CentroGeo has organized workshops in order to familiarize different groups of stakeholders in the use of the atlas. In such workshops, the facilitator is part of the cybercartographic process and communicates the conceptual basis of cybercartography.

Although the efforts to embed the, *Cybercartographic Atlas of Lake Chapala* into different societal processes (organizational, educational, community, or governmental) is far from complete, the initial results clearly point to the fact that the methodological and the theoretical approaches adopted are taking the overall research in the right direction.

In the use of the *Cybercartographic Atlas of Lake Chapala* by the "mundane," as described by Johnson (1998) several lessons were learned. These include the establishment, at the early stages of design and throughout the production process, of an adequate environment that promotes cordial personal relationships, effective conversations, trust, and collaboration. This required an explicit strategy of relationships and processes aimed at building a common language among stakeholders. It also involves the adoption of an adequate methodological and technological framework to allow the research group to focus on the appropriate ways to embed the artifacts in organizational and community processes. In the interaction with society the use of geospatial information and knowledge was a key factor to obtain consensus on environmental issues and other topics of public policy. In addition, the importance of the continuous feedback with society in building the atlas became evident as did the need to follow up the insertion of the atlas in the communities and/or organizations in order to complete the cybernetic cycle. The atlases were presented in different social contexts, involving academics, public servants, politicians, and community groups, and it is worth noting that community groups accepted these artifacts much more readily than some highly specialized traditional cartographers.

4. Conclusions

This chapter discussed the relevance of technology and culture for cybercartography. In describing the cybercartographic atlases produced by CentroGeo two main recurrent themes emerged: the influence of the social and cultural contexts in the construction of these technological artifacts and the feedback cycles created by their insertion in diverse organizational and community processes. However, much research needs to be done in order to learn about the different social, cultural, political, and technical factors that influence the development of cybercartographic technological artifacts that effectively respond to the social needs in different cultural contexts, and at the same time, that allow theoretical and methodological advancements in this discipline. Several key research questions remain:

- Does the incorporation of cultural elements in the design and construction of cybercartographic artifacts help the transfer and adoption of these technologies? And if that is so, which are the best ways to identify and incorporate such elements?

- How can the role of cybercartographic artifacts in the course of different social processes, such as decision making, awareness generation, consensus building, planning, public policy construction, or education be identified, and how relevant is this role in the steering of such processes?
- What is the role of cybercartographic artifacts in knowledge organizations and what is cybercartography's contribution in competitive intelligence?

Additional theoretical and methodological questions for cybercartography include:

- The possible role of cybercartography in the broadcasting media and in the communication-feedback processes
- The impact of multimedia advances on cybercartography
- The influence of the WEB on future trends in cybercartography

The development of geo-technology, may benefit from common areas of research with computing science, geospatial modeling, and computer graphics.

The development of new technological frameworks and artifacts will contribute to providing answers to these questions and will support theoretical advances in cybercartography. Similarly, as in the advancements on the construction of theoretical and methodological frameworks, these first efforts to explore the new concept of cybercartography, from a technological and cultural perspective, point to a wide range of possible avenues. Both, empirical and theoretical work is needed, and as mentioned in Chapters 4 and 5 of this volume, a multidisciplinary and collaborative approach should be strengthened and the interaction and feedback with society should remain as the driving force of research in cybercartography. The various chapters in this book make a major contribution to advance this research.

Acknowledgments

CentroGeo is a public research center supported by the Mexican Science and Technology Commission (CONACYT) MSC. Fernando López was the main programmer and designer of the technological solutions for the cybercartographic atlases. A team of researchers, programmers, and graphic designers from CentroGeo as well as members of the Ministry of the Environment (SEMARNAT) and of the Commission of the Direct Basin of Lake of Chapala among others were involved in the design, testing, and development of the *Cybercartographic Atlas of Lake Chapala*.

Jack Dangermond (president of ESRI) supported the project by providing Map Objects software. Fraser Taylor's advice was invaluable in the overall process.

References

Brainerd, J. and A. Pang (2001) "Interactive map projections and distortion", *Computers and Geosciences*, Vol. 27, No. 3, pp. 299–314.

Breunig, M. (1999) "An approach to the integration of spatial data and systems for a 3d geo-information system", *Computers and Geosciences,* Vol. 25, pp. 39–48.

Büchel, B. S. T. (2001) "Using communication technology", *Creating Knowledge Organizations*, Palgrave Publishers Ltd., Great Britain, pp. 18.

Camara, A. S. and J. Raper (eds.) (1999) *Spatial Multimedia and Virtual Reality,* Taylor and Francis, London.

Cartwright, W. and M. P. Peterson (1999) *Multimedia Cartography*, Springer, Germany.

Ditsa, G. (ed.) (2003) "Information management", *Support Systems and Multimedia Technology,* Idea Group Inc.

Dodge, M. and R. Kitchin (2001) *Mapping Cyberspace*, Routledge, Taylor and Francis Group, London.

Dransch, D. (2000) "The use of different media in visualizing data", *Computers and Geosciences,* Vol. 26, pp. 5–9.

Dykes, J. A. (1997) "Exploring spatial data representation with dynamic graphics", *Computers and Geosciences*, Vol. 23, No. 4, pp. 345–370.

Evans, B. J. (1997) "Dynamic display of spatial data- reliability: Does it benefit the map user", *Computers and Geosciences*, Vol. 23, No. 4, pp. 409–422.

Frank, A. U. (1993) "The use of geographical information system: The user interface is the system", in Scott and H. M. Hearshaw (eds.) (2003), *Human Factors in Geographical Information Systems*, Belhaven Press, London, pp. 3–14.

Gartner, H., A. Bergmann and J. Schmidt (2001) "Object-oriented modelling of data sources as a tool for the integration of heterogeneous geoscientific information", *Computers and Geosciences*, Vol. 27, pp. 975–985.

Gewin, V. (2004) "Mapping opportunities", *Nature*, Vol. 427, pp. 376–377, 22 January.

Gupta, V. S. (1999) *Communication Technology, Media Policy and National Development*, Concept Publishing Company, New Delhi.

Harding, C., I. A. Kakadiaris, J. F. Casey and R. B. Loftin (2002) "A multisensory system for the investigation of geoscientific data", *Computers and Graphics,* Vol. 26, pp. 259–269.

Hendriks, P. (2004) "Intelligence from space: Using geographical information systems for competitive intelligence", Chapter IX, in Vriens, D. (ed.), *Information and Communication Technology for Competitive Intelligence*, Idea Group Publishing, pp. 194–226.

Harris, T. and D. Weiner (1998) "Empowerment, marginalization and community -integrated GIS", *Cartography and Geographic Information Systems*, April 1998, Vol. 25 i2 67(1).

Ihde, Don (1990) *Technology and the Lifeworld. From Garden to Earth*, Indiana University Press, Bloomington and Indianapolis.

Inayatullah, S. and S. Leggett (2002) "Transforming communication; technology, sustainability and future generations", *Praeger Studies on the 21st Century*, Praeger, Connecticut, USA.

Johnson, R. R. (1998) *User-Centred Technology; A Rhetorical Theory for Computers and Other Mundane Artifacts*, State University of New York Press.

Kraak, M. and A. Brown (eds.) (2001) *Web Cartography*, Taylor and Francis, London.

Mahbubur-Rahman, S. (ed.) (2001) *Design and Management of Multimedia Information Systems: Opportunities and Challenges*, Idea Group Publishing.

Medhurst, M. J., A. Gonzalez and T. R. Peterson (1990) *Communication and the Culture of Technology*, Washington State University Press, Pullman, Washington.

Megrey, B. A., S. Hinckley and E. L. Dobbins (2002) "Using scientific visualization tools to facilitate analysis of multi-dimensional data from a spatially explicit, biophysical, individual-based model of marine fish early life history", *ICES Journal of Marine Science*, Vol. 59, pp. 203–215.

Minoli, D. (1994) *Imaging in Corporate Environments; Technology and Communication*, Bell Communications Research Inc. and New York University, McGraw-Hill, Inc.

Myers, B., J. Hollan and I. Cruz *et al.* (1996) "Strategic directions in human-computer interaction", *ACM Computing Surveys*, Vol. 28, No. 4, December.

Newman, W. M. and R. F. Sproull (1981) *Principles of on Interactive Computer Graphics*, McGraw-Hill, Inc., Japan Ltd.

Ogao, P. J. and M. J. Kraak (2002) "Defining visualization operations for temporal cartographic animation design", *International Journal of Applied Earth Observation and Geoinformation* Vol. 4, pp. 23–31.

Peker, K. A. and A. Divakaran (2003) "An extended framework for adaptive playback-based video", *Proceedings of SPIE Vol. 5242 Internet Multimedia Management Systems IV*.

Peterson, M. P. (ed.) (2003) *Maps and the Internet*, Elsevier, Amsterdam, pp. 405–420.

Penland, P. R. (1974) *Communication, Science and Technology*, University of Pittsburgh, Marcel Dekker, Inc., New York.

Rasmussen, T. (2000) *Social Theory and Communication Technology*, Ashgate Publishing Limited, England, Hampshire.

Russell, B. (1967) *The Impact of Science on Society*, George Allen and Unwin Ltd.

SIGGRAPH, www.siggraph.org

Takatsuka, M. and M. Gahegan (2002) "GeoVISTA studio: A codeless visual programming environment for geoscientific data analysis and visualization", *Computers and Geosciences*, Vol. 28, pp. 1131–1144.

Taylor, D. R. F. (1999) "Future directions for multimedia cartography", in Cartwright, W., M. P. Peterson and G. Gartner (eds.), *Multimedia Cartography*, pp. 315–321.

Taylor, D. R. F. (2003a) "The concept of cybercartography", Chapter 26, in Peterson, M. P. (ed.), *Maps and the Internet*, Elsevier, Amsterdam.

Taylor, D. R. F. (2003b) *Cybercartography and the New Economy, Project Proposal*, Carleton University, Ottawa, Canada (www.gcrc.carleton.ca).

Uhlenkuken, C., B. Schmidt and U. Streit (2000) "Visual exploration of high-dimensional spatial data: Requirements and deficits", *Computer and Geosciences,* Vol. 26, pp. 77–85.

Vriens, D. (2004) *Information and Communication Technology for Competitive Intelligence*, Idea Group Inc.

Wegner, P. and J. Doyle (1996) "Editorial: Strategic directions in computing research", *ACM Computing Surveys*, Vol.28, No. 4, December.

Wood, M. (2003) "Some personal reflections on change... the past and future of cartography", *The Cartographic Journal*, Vol. 40, No.2, pp. 112–115.

Wood, A. F. and M. Smith (2001), *Online Communication; Linking Technology, Identity and Culture*, Lawrence Erlbaum Associates, Publishers, London.