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VISUALIZATION IN CYBER-GEOGRAPHY:

RECONSIDERING CARTOGRAPHY'S CONCEPT OF VISUALIZATION IN CURRENT USERCENTRIC CYBERGEOGRAHIC COSMOLOGIES

Troels Degn Johansson

Centre for Advanced Spatial Analysis
University College London
1-19 Torrington Place
Gower Street
London WC1E 6BT

Tel: +44 (0) 171 391 1782
Fax: +44 (0) 171 813 2843
Email: casa@ucl.ac.uk
http://www.casa.ucl.ac.uk

http://www.casa.ucl.ac.uk/cyberviz.pdf

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Biographical note:

Troels Degn Johansson was an academic visitor at the Centre for Advanced Spatial Analysis, University College London in the autumn 1999.

He is a Ph.D. Scholar at the Danish Forest and Landscape Research Institute, Department of Urban and Regional Planning, at the Ministry of Environment and Energy, Denmark. He did an MA in Film and Media Studies at the University of Copenhagen. During 1996-99 he was associated the Department of Film & Media Studies as an Assistant Professor. TDJ is currently involved in a research project on web-based 3D-visualization of landscape change with special reference to public planning communication. This project forms part of the Changing Landscapes-programme, Centre for Strategic Studies in Cultural Environment, Nature and Landscape History (1997-2001), the Strategic Enviromental Research Programme of Denmark.

Abstract

This article discusses some epistemological problems of a semiotic and cybernetic character in two current scientific cosmologies in the study of geographic information systems (GIS) with special reference to the concept of visualization in modern cartography.

Setting off from Michael Batty's prolegomena for a virtual geography and Michael Goodchild's "Human-Computer-Reality-Interaction" as the field of a new media convergence and networking of GIS-computation of geo-data, the paper outlines preliminarily a common field of study, namely that of cybernetic geography, or just "cyber-geography) owing to the principal similarities with second order cybernetics. Relating these geographical cosmologies to some of Science's dominant, historical perceptions of the exploring and appropriating of Nature as an "inventory of knowledge", the article seeks to identify some basic ontological and epistemological dimensions of cybernetic geography and visualization in modern cartography.

The points made is that a generalized notion of visualization understood as the use of maps, or more precisely as cybergeographic GIS-thinking seems necessary as an epistemological as well as a methodological prerequisite to scientific knowledge in cybergeography. Moreover do these generalized concept seem to lead to a displacement of the positions traditionally held by the scientist and lay-man citizen, that is not only in respect of the perception of the matter studied, i.e. the field of geography, but also of the manner in which the scientist informs the lay-man citizen in the course of action in the public participation in decision making; a displacement that seems to lead to a more critical, or perhaps even quasi-scientific approach as concerns the lay-man user.

1.0 Introduction: A "Second Age of Geographic Exploration"

Although today our world maps have no more white parts, no more "terra incognito", a new age of geographical exploration seems still to have been initiated. At a conference recently,[1] a leading scholar from the study of Geographic Information Systems (GIS), Michael Goodchild of the now legendary American research network, National Center for Geographic Information Analysis, proposed that the relatively well established field within computer media studies, Human Computer Interaction (HCI) should be broadened and renamed "Human Computer Reality Interaction" ("HCRI"). What Goodchild seemed to suggest was that the increased *dynamization* of the relationship between geographical data and GIS-computation makes necessary such thing as a "user-centric geographic cosmology", that is a notion of the geographical world in which the user plays a decisive part as concerns the nature of the material studied. The so-called "dynamization" of the relationship between geographical data and GIS computation means, 1) that GIS-data are becoming more and more available as on-line data for computation, 2) that GIS-data are more and more applicable to a general convergence of GIS-systems and media in computer networks, that is especially the convergence of GIS and the World Wide Web (WWW) in what is commonly referred to as "cyberspace", and 3) that GIS-computation is used more and more in the organization and monitoring of agents which are themselves to be found in a geographical world, say in logistics and transport (e.g. public transport monitoring for users and administrators). One could add to this that the mobilization of GIS-based work stations makes out an extra dimension to this dynamization of the relationship between computation and the geographical world, since the user in this respect could be said to be a geographical agent rather than a distanced observer when doing field work research. British geographer Michael Batty notes that 'it was not until the convergence of computers with communications over the last decade that the burgeoning use of networks for human interaction and the delivery of services generated new geographical spaces within the either, which are now popularly called cyberspace after [American novelist William] Gibson. The effect of these on the way we organize our infrastructure and our geography of real places has been happening ever since computers were invented but this is gathering pace as cyberspace begins to change the role of real places, as the new material infrastructure of telecommunication and computers itself replaces their non-digital equivalents, thus providing an extended medium for cyberspace; the idea of the information city, smart buildings, and intelligent architecture constitutes much of this geography.' (Batty 1997: 341, my insert). As we shall see below, Batty formulates this observation in terms of a four-level classification of spaces in this complex field of media convergence and the GIS-computation of geo-data; a classification that moves from 1) traditional geographical space, to 2) space as represented in computer media, to 3) the cyberspace of computer

[1] Cf. Michael Goodchild's key note paper for the ESRI conference GIS PlaNET '98, Lisbon 9th - 11th September 1998, 'Rediscovering the World Through GIS. Prospects for a Second Age of Geographical Discovery'.

networks, and finally to 4) traditional geographical space of physical reality as mediated, or organized by cyberspace. Batty (1997: 340ff) designates this fourth level as "cyber-place"; a level then which by the end of the day is to be identified with place on the first level, i.e. a general level of (cyber)place.[2] With Batty, accordingly, we are suggested such thing as an ontological elaboration of this extension of the field of geography.

However, what seems to be important to Goodchild's, and also Batty's notions is not a technological development as such but a particular recognition of the part played by the user, that is in the first instance the "master" of geography, i.e. the scientist who is employing GIS as a tool to achieve new insight of the geographical world, but perhaps also the lay-man user who especially after the convergence between GIS and the world-wide web (WWW) sees GIS as a kind of medium for communication rather than a scientific instrument. This geographical "user-centrism" seems to be based on the recognition that the scientist in the analysis of GIS data sees as his prime matter of investigation not the geographical world "out there" but the *complexity of geo-data that is available to GIS-computation.*[3] This approach might be taken for a user-centric one since the user's treatment of his data material is decisive as concerns the construction of the given geographical reality. The very point of using GIS tools as an instrument for analyzing geo-data is the possibility of handling an exhaustive totality of data resources of an area and of combining data in ways which are not self-evident and which brings about surprising aspects of the world that would otherwise have been neglected. A good example of this is when public sector data, which for administrative reasons have been kept isolated in separate sectors, are brought together in research.[4] The idea of approaching such a complexity of data and to organize and analyze it according to a given hypothesis of how the geographical world is like rather than to traditional perceptions thus leads Goodchild to talk about a "second age of geographical exploration"; a kind of exploration which is obviously different to the classical cartographic unveiling and mapping of "terra incognito". Compared to the art of traditional cartography, Goodchild's notion of the geographical world must be one of multidimensionality and complexity rather than the 2D, or possibly 3D perception of the world that sets off from the surface of the Earth, i.e. from sea level. Whereas it is true that also GIS data are positive, it could in this

[2] I shall come back to this space-place distinction in Batty (and in geography as such) below.

[3] Since we are talking about a recognition of a "new order" of geography, that is of an epistemological issue, one may argue that those "more-and-mores" of the GIS geodata dynamization mentioned above seems more likely to be an observation which is effected by a certain epistemological experience in which the scientist sees his way of treating geo-data. This perception of technological development should then perhaps rather be thought of as a construction that is being effected retrospectively.

[4] This approach plays an important part in a current project under the Danish Environmental Research Program, "Scenarios for Cultural Landscape Development", a so-called sub-project of the "Changing Landscape"-program (1997-2001). Here, land-use and property data of Danish agricultural management data-bases are brought together with ecological, economical, and other kinds of data to obtain a common "total complexity" that may be analyzed in order to achieve an understanding of the structural conditions for possible future land-use. My Ph.D.-project forms part of this project ("Web-based 3D-visualization of landscapes and scenarios for landscape change in the context of public planning").

sense be argued that the computation and presentation of geographical data as seen from this scientific cosmology of geographical user-centrism does not confine itself to the "analogical positivism of cartography" in which data are approached as forming part of a continuous representation of the world, but instead implies a kind of discrete, or punctual positivism that allows a multidimensional construction in the scientific treatment of data. As we shall see below (Part II), this idea of a punctual, or discrete complexity of geo-data that is available to GIS-computation seems to correspond well with the notions of system and complexity in cybernetics. Indeed the very notion of cybernetics, the Greek for steersman, has been picked up by Netscape in their ship steer logo for their Netscape browser application, and along with this steermanship has now become an important metaphor of the user interaction with, or "navigation" on the world wide web. User-centric geographic could in this sense be conceived of in terms of a cybernetic geography, or just simply a cyber-geography. The notion of user in this user-centric geographic cosmology appears to be particularly relevant and interesting to the study of visualization in modern cartography, for visualization is, at least as defined by American cartographer Alan E. MacEachren (1994), about the *use of maps* rather than about mapping as such. When defined as the use of maps, visualization should be conceived of as a cognitive instance that somehow relies partly on the cartographic material studied. Hence the recognized notion of visual thinking (DiBase), or more generally, of "GIS thinking". User-centric geography seems here to imply a possible displacement of the traditional relationship between the expert and lay-man user, between the scientist and the citizen. In the study of visualization in modern cartography, this theme has been particularly emphasized in the recent years as visualizations of complex, online geo-data are becoming available to WWW-distribution, and, perhaps more importantly, as societies are beginning to employ web-media as an important part of their public sphere (that may either be as concerns existing communities or purely web-based ones). The famous motto of the rising cyber-democratic criticism of the last decade, "information must be free", has proved applicable also to geographical media. A good example is the use of web-based visualizations in 3D Multi-User DomainS (MUDS, or their former equivalents: Multi-User Dungeons and DragonS). Here, the giving free of information before an enlightened public may be understood in a three-dimensional sense as the actual choosing of a "camera" point-of-view in a given 3D-communication environment; a point-of-view that one finds most relevant for decision-making. One could add to this that the very dimensioning of a given data-material in for instance 2D or 3D implies an important aspect of choice on the behalf of the user; a choice which has usually been left scientist, or another public authority that could facilitate the public participation in a given agenda, say in planning communication. A good example of this is the traditional practice of visualization in regional planning communication; a practice whose principles were formulated by the English Landscape Research Group back in 1967. Here, the choice of point-of-view is determined by the most dominating, and therefore most relevant points,

or lines in a landscape (say, a vantage-point, or motor-way respectively) from which a given change would be likely to be seen most commonly.[5]

Thus recognizing the rising importance of visualization in the public sphere, or among lay-men users, cartography has been lead to establish a "broader" notion of visualization that applies to a more general sense of "visual thinking" similar to that of scientific visualization but which is still to be separated from a purely scientific context. S*cenarios* seem particularly interesting here since firstly, they are not simply prognoses that are simply taken for granted on the grounds of given laws of causality and a positive data material, and secondly because they are used in the development rather than in the implementation of strategies in for instance planning; in other words, scenarios seem to be used to facilitate "visual thinking" rather than communication. This not only leads to a necessary discussion of what knowledge is, it also calls for a *generalization* of the part traditionally played by the scientist, that is a generalization of scientific visualization. In this paper I will focus primarily on this aspect of the generalization of visualization in the context of the epistemology of cybergeography. However, I will not discuss further the possible applications of visualization in a public context. The aim of this paper is entirely to establish a connection between these two fields.

My work sets off from what seems to be an implicit recognition both modern cartography and Goodchild's and Batty's GIS-cosmologies that visualization and cyber-geography are somehow "corresponding"; a correspondence which implies that they might be taken for epistemologically affiliated. This problem is an epistemological one in as much as it deals particularly with a given scientific experience, or perception of the world and its conceptual implications: How are we to detect this experimental recognition in the application of scientific concepts? Still, on the other hand one might argue that this is also, perhaps secondarily an ontological issue, for what is exactly the nature of a "virtual geography" and what makes it pertinent to the nature of certain kinds of scientific visualizations and scenarios? A secondary ontological inquiry should ask itself what such nature amounts to. I do of course subscribe to the recognition of a certain affiliation between current notions of visualization and cyber-geography, and my task is to confirm this hypothesis by identifying the nature of this epistemological affiliation with reference to Goodchild's geographical "cosmology". The basic assumption is here, that these notions rely on what could be conceived of as a "cybernetic epistemology", namely that the punctual positivism of a complex system of geo-data. Doing so I will however also identify notions that falls out from this common set, that is concepts of visualization that seem not to be corresponding particularly well with Goodchild's idea.

[5] The Landscape Research Group's guidelines consist of four "paragraphs", namely that a given object, or chance should be visualized 1) as realistically as possible as such, 2) from a relevant viewpoint in the landscape as concerns 3) those who will most commonly be watching the object, or chance, and 4) during which circumstances those people will approach this object/change.

However, before venturing into a more concrete concept analysis I will at first elaborate a little further on what might be implied by this notion of user-centric cyber-geography. In order to do so I will attempt to establish a broader perspective by drawing on various, seemingly similar traditions in science since the Renaissance; traditions in which Nature is thought of as a kind of body, or "inventory" of knowledge that is to be unveiled and thus appropriated by the scientist for the good of a scientific public sphere. Secondly, although Goodchild's suggestive idea might at first appear peculiar to its context of geographical exploration and GIS technology I will proceed by demonstrating that it shares some conceptual features with some current traditions outside of geography, that is especially with cybernetics and semiotics. These interdisciplinary traditions seems at least helpful to a critical discussion of a Goodchildean cybernetic geography, or a "virtual geography" in Batty's account; that is how we would think of the world from this perspective. Moreover do the system approaches of semiotics and (first order) cybernetics seem helpful as for how to dimension and orientate oneself in complex systems by means of identifying emergent levels of phenomena; levels that may be real or virtual ones which are possible to a phenomenological analysis. This opposition of complex systems and virtual emergent levels seem at least helpful as for how to understand the correlation between Goodchild's and Batty's geographic cosmologies. After having done so, I shall in the third part proceed to analyze the most dominant notions of scientific visualization in modern cartography. I concentrate here on an article by MacEachren (1994) that has proven particularly influential to the study of scientific visualization; influential that is not only in cartography but also in planning and in the study of geographic communication. In this ground I shall finally discuss MacEachren's notion of visualization as generalized "visual thinking" in the context of the particular epistemology, or order of knowledge in Goodchild's Human-Computer-Reality-Interaction and in Batty's virtual geography.

2.0 Cyber-Geography in an Epistemology of Science

> *The experience of the traveller consisting of a series of moves in space produces a phenomenon of a new order, one by which geography overtakes knowledge. "Our geography invades the planet. This is the second voyage, the reappropriation through knowledge. Geography is nothing else, its birth is there, at the moment at which knowledge becomes universal, in spatial terms and not by virtue of any right." Space makes an inventory of the adventures of knowledge, omitting nothing; knowledge traces a cartography of known lands, omitting nothing. The minute filling in of terrestrial reaches and the exhaustive account of cycles of knowledge are one and the same operation and permit The Extraordinary Voyages to establish the difficult relationship between the spatial or geographical model and the model of*

> *knowledge as encyclopaedia. The (re)emergence of this language of paths, routes, movements, planes, and maps, this spatial language of the writing of the world (geo-graphy), marks the moment of passage toward a new epistemology. ... To read and to journey are one and the same act.*
>
> Michel Serres on Jules Verne's "Voyages Extraordinaires" in *Hermes: Literature, Science, Philosophy"* (1982, p. xi)

In this second part I shall elaborate further on what might be implied by this notion of "user-centric cyber-geography". In order to do so I will attempt to establish a broader perspective by drawing on various, to a certain extent similar traditions in science since the Renaissance; traditions in which Nature is thought of as a kind of body, or "inventory" of knowledge that is to be unveiled and thus appropriated by the scientist for the good of a scientific public sphere. Secondly, although Goodchild's suggestive idea might at first appear peculiar to its context of geographical exploration and GIS technology I will proceed by demonstrating that shares some conceptual features with some current traditions outside of geography, that is especially with cybernetics and semiotics. These interdisciplinary traditions seems at least helpful to a critical discussion of a Goodchildean cybernetic epistemology, that is how we would think of the world from this perspective. Moreover do the system approaches of semiotics and (first order) cybernetics seem helpful as for how to dimension and orientate oneself in complex systems by means of identifying emergent levels of phenomena; levels that may be real or virtual ones which are possible to a phenomenological analysis. This opposition of complex systems and virtual emergent levels seem at least helpful as for how to understand the correlation between Goodchild's and Batty's geographic cosmologies.

2.1 "Inventories of Knowledge": Cyber-Geography's "New Order"

In accordance with the beautiful passage by French philosopher Michel Serres above it could be argued that geography as a discipline traditionally has encompassed that peculiar "dynamic" relationship between the world and its scientific treatment that Goodchild is evoking by his notion of a "second age of geographic exploration." "Geo-graphy" as "world-writing" does of course in geography quite literally imply the artistic dimension of cartography, but also the "traveling-drawing" of the field work geographer, whose work could be taken as a twice inscription into Geography's "body of knowledge", namely as (encyclopedic) inscriptions into the library of geography, of course, but also into the world in the shape of scientific land marks. This coalescence of geographical inscription is perhaps most imaginatively evoked in what must be a very popular dream among geographers: To drift ashore on the "A" of the "Atlantic Ocean". Serres' notion of a parallel movement of cartographic mapping and traveling, or field working by which "Space makes

an inventory of the adventures of knowledge" and by which "knowledge traces a cartography of known lands" (Serres, ibid.) seems obviously quite similar to Goodchild's idea. Geography does in this sense not only mean to represent the world as in cartographic mapping or by means of other kinds of descriptions among the discursive genres of geography: It also means to appropriate and thereby in a special sense to construct the world as the world of geography in accordance to the laws of geometry (e.g. the three dimensions of geographical space), of physics (e.g. the laws of erosion and sedimentation in the geography of nature), etc. Although seemingly "natural", or inherent to the world, the world of geography is of course no more than an ideological effect of a particular historical scientific discourse; still this is a discourse that is nonetheless special since it manifests itself in the very material it describes. Just notice what it means when you speak of the "geography" of a particular area. This expression does of course not suggest that the area has given rise to a particular branch of geography as a science but that scientific properties form part of the area as if it had been always already appropriated by science (that may be even if the area actually has not undergone any thorough scientific analysis).

However, even in such critical discourse theory perspective Goodchild's vision does seem distinctly original by what seems to be an absolute inversion of geography's traditional relationship between world and discourse. For a truly user-centric GIS computational approach to positive geo-data implies that the discursive construction of geographical reality in the analysis of a given data complexity makes out an integral part of the geographical reality that is to be analyzed. Indeed, the very point of making available and approaching a geographical multidimensionality must imply a moment of construction, or perhaps rather, of dimensioning, that is of making this complexity simple enough for analysis, interpretation, and presentation. In other words, a user-centric geographical analysis both means to frame the world in perhaps only one or two dimensions, and secondly to study it on the grounds of this framework. Of course, this should not be taken to mean that any GIS-based geographical analysis contains this aspect of self-reflexivity as concerns the dimensioning of geographical reality. In most standard GIS software applications, the moment of dimensioning, or framing is given as part of the user-interface. Here one should talk of user-centrism for reasons that are different to that suggested by Goodchild.

Serres' notion of a "new order" by which the world is "re-appropriated through (geographical) knowledge" could be said to be characteristic also to Goodchild's GIS-cosmology, but however, on yet another level. Also in Goodchild one may say that "geography is overtaking knowledge" by the making out of space as an "inventory of the adventures of knowledge"; still this space of knowledge is primarily a virtual one. It is real in the sense that the fundamental complex of geo-data is positive; still it is virtual since the construction, or dimensioning of this complexity is taking place before the user in a represented, or mediated environment. In this sense, one may designate Goodchild's multi-dimensional explorations as being those of a "virtual geography". Batty (1997) suggest this term to cover the geography of those three level of space that are unfolded by means of computer and

computer network mediation. According to Batty, virtual geography is 'the study of place as ethereal space and its processes inside computers, and the ways in which this space inside computers is changing material place outside computers. Around this Janus-like face of virtual geography lies the study of the geography of computers and networks from a traditional, non-ethereal standpoint.' (Batty 1997: 340). I shall pursue this notion of virtual geography below in a general discussion of the difference between the virtual and the cybernetic dimension of GIS-computation and visualization of geo-data.

2.2. Historical Orders of Knowledge

If one sticks to Serres' notion of a "new order" of geographic phenomena, or knowledge, it seems possible to relate this cosmology to a simple historical development of the orders of geographic knowledge. The establishment of modern geography as the recognition of space as an "inventory of knowledge" coincides with the birth of science in the Renaissance, at least as concerns the perception that Nature is to be recovered absolutely as for its fundamental laws. This is the age of classical cartographic exploration with Columbus' discovery of America, da Gamas's search for a trade route to India via America, and Magellan's journey around the world. In this mechanistic (in Danish "mekanicistiske") cosmology, Man is situated in the middle of a rational world as explorer although the astronomers of the times, i.e. Galileo and Copernicus redefine the Earth's location as part of a solar system; a decentering which of course goes on to the Big Bang theories of today. In French psychoanalyst Jacques Lacan's words one could say that this decentering also applied to Man himself since Man's body, perceptual apparatus, and cognition, now were to be thought of a forming part of that "Umwelt" that Man could understand rationally. Hence Descartes' belief in the rational *cogitans* rather than in the soul (cf. Brier 1999c: 43ff.).[6] For in the cosmology of mechanistic, the world is perceived as being utterly rational in the sense that its laws are to be discovered and constantly tested. This not only supports Man's belief in his own rational competence as being able to understand the world but also his ability to recognize the world empirically. The world could in this sense already be thought of as a "body", or "inventory of knowledge", yet this knowledge were only proper to the extend that it had been "appropriated" by the "adventures" of Man, i.e. that it had been explored and has been made available for other rational beings to re-appropriate. Here, book printing of course plays a significant part as the medium by which the scientist leaves the results of his adventures for other rational beings to appropriate, i.e. to "read for themselves." By the establishment of the University, Man institutionalized this (re-appropriation) of "universal" knowledge, and later on, in the 17th Century

[6] I am referring to Lacan here not only because he, to my knowledge, is the one who introduces the notion of "Cartesian decentering" but also because this aspect plays an important part in Lacan's own idea of the Self (or rather the "I" of the *cogitans*) as being split, or decentered in relation to the language (system) to which it is subjected. Hence Lacan's notion of Man (i.e. the subject) as being subjected to the language of the unconscious (cf. Lacan 1994).

the independent academies of science (e.g. The Royal Society, established in 1622, cf. Brier 1999c: 49) looked after that these universities maintained their independence from the Church and other authorities, that is in accordance with the ideals of the emerging public sphere of enlightened citizens.

Now, in the age of Enlightenment, Nature is thought of as being an "inventory of knowledge" in a new, and perhaps more literal sense, namely as the correspondence between knowledge's manifestation in the Encyclopedia and the Nature, and a little after, in the Natural History museum. This is the age of classification, say in the taxonomy of the "Kingdoms" of Nature, i.e. of plants (Carl von Linne) and animals; a taxonomy that manifests itself in both areas and which lend itself to historization in a new, more radical sense as in Darwin's theory of evolution.

However, by the emergence of positivism and the 19th Century science laboratory, the notion of Nature as being an "inventory of knowledge" finds yet another historical version. The cosmology of mechanistic is still prevailing, and whereas much history of nature of the times is seen as either too speculative, too metaphysical, or too dependent of the dogmatic of Christian, or other authoritarian beliefs, experimental methodology becomes much more important to obtain *positive knowledge* of the world. This is the age of such new disciplines as chemistry and medicine, and later on, of experimental psychology. Here, Nature could be seen as an "inventory of knowledge" to the extend that one could re-appropriate knowledge by "reading nature oneself" as if a book by repeating a given experiment. Technology and Science now become partners in Man's ambition of extending and refining his sensual apparatus (say, by means of telescopes and microscopes, that is in a sense by "remote-sensing"). Technology is employed to make possible an environment for objective research that would otherwise not be available for experimental testing (say, in the chemistry lab or the later (e.g. CERN) cyclotrones of nuclear physics experimentation). Accordingly, technology is used for the scientist to make out of the world a scientific laboratory, an "inventory of knowledge" to be appropriated.

2.3 Cyber-Geography and the 19th Century Science Lab

It should be obvious by now that Goodchild's "second age of geographical exploration", i.e. the exploration of the virtual geography of a given geo-data complexity, must relate quite differently to, at one hand the *terra incognito*, the "unknown land", and on the other, the scientific public sphere, than what was the case in the age of classical geographical exploration after Columbus, and certainly also after the establishment of the laboratory of the positive sciences. Owing to the rapid growth of web-based conference systems such as Microsoft's "Net-meeting" application, the cyber-geographic lab should in principle be simultaneously accessible for more users. In a research context this means that not only a single scientist but in fact groups of researchers, or entire research

team are able to carry through a common cyber-geographical writing-of-and-traveling-in the world in the sense suggested by Serres above. This means of course already that the *traditional division between field-working, map making, and desk-top working becomes suspended.* However, I have already suggested that a web-based communication environment seems to contain an inherent public sphere dimension to the extend that the Internet is generally accessible before the public. It should at least be obvious that the differences between the *stages of investigation and presentation* in this lab of virtual geography seems more blurred than is the case in the lab of positive sciences, including that of geography. First of all this means that the principle of verification, i.e. that an experiment and its results should be available for testing by given conditions. This seems to imply that the lab is conceived of as being fundamentally separate not only from a given subject matter in order to obtain objectivity but also from the scientific public sphere. In other words one should in principle be able to "go home and do it oneself" to "see that this is really true".

In his work on the establishment of the modern scientific laboratory of the 19th Century, Andrew Barry has described this as follows:

> *How can a report of an observation be relied upon it that observation has been made at another place? One historical solution to this problem was the development of the scientific laboratory. The laboratory was demarcated as a space within which matters of fact could be determined without recourse to public debate and without recourse to traditional authorities. Thus the laboratory was both a physical and a political enclosure. (Barry, p. 46).*

Obviously, the laboratory and the scientist have to be endowed with a particular credibility in order for this system to be maintained; a credibility which clearly manifested itself in those images of authority by which scientists took part in the popular culture of the times. According to one of Barry's starting-points, Bruno Latour's paper 'Visualization and Cognition: Thinking with Hands and eyes' (1986) which forms part of his and Steve Woolgar's legendary ethnographic interventions into science laboratories, the overcoming of distances and the use of so-called inscription devises are of fundamental importance to their epistemology. Latour:

> *If you go out of your way and come back heavily equipped so as to force others to go out of their ways, the main problem is that of mobilization. You have to go out and come back with 'things' [i.e., inscriptions] if your moves are not to be wasted. But the "things" have to be able to withstand the return trip without withering away [and] the "things" you gathered and displaced have to be presentable all at once to those you want to convince and who did not go there. In sum, you have to invent*

> *objects which have the properties of being mobile but also immutable, presentable, readable and combinable with one another (Latour 1986: 7).*

Now, if one compares these apparently essential aspects of the positive science laboratory with those of a user-centric virtual geography, one can identify both differences and similarities. Of course, the *digitalization* of scientific data in GIS-computation of geo-data does fulfill the dream of appropriating (knowledge of) Nature as truly "immutable", or incorruptible "things". In the general convergence and networking of computation, digital data are those "objects" that are invented to obtain ultimate "combinability", "readability", and "presentability". As suggested above, the very point in Goodchild's notion of Human-Computer-Reality Interaction is the exchangeability of geo-data from physical place to computation to cyber-space, and finally to cyber-spatially mediated physical place, i.e. Batty's notion of cyber-place. However, one could claim that the nature of knowledge "objects" in GIS computation and in the positivistic laboratory in Barry and Latour are not exactly of the same kind. For whereas the "things" that the scientist come back with in Latour do not in themselves contain information as for their position in the system of knowledge (that is not before it has become registered, say in terms of the number in a collection), geo-data actually do so, since geo-data, like any other kind of digital data must "contain" a meta-data information that "tells" a computer how to handle this kind of knowledge.

Distance is in sense a key word also in Goodchild and Batty, but distance in Latour's conception plays a distinctively different part compared to the virtual geography of GIS-computation. Whereas it is true that the notion of "remote sensing" is an important aspect in current GIS research, that is as a way to obtain data from otherwise non-accessible geographical fields, this notion does not seem that decisive as for Goodchild's notion of HCRI. In a sense, it does not matter whether the primary complexity of geo-data consists of remote or "close data". Rather, what is important as for the nature of field that is to be explored, is precisely the primacy of the complex system of data. In this sense, one should rather talk about a general, and indeed more absolute remoteness, or much rather, separation, since the data studied, no matter how close its field may be to the observer, are still inaccessible as such without the complex system of which it forms part.

Notions of "outside" and "inside" seem also important to this discussion. Firstly, whereas the scientific laboratory is defined in accordance with its isolation from the outside world and the scientific public sphere (hence the popular expression "inside the lab"), the cyber-geographic laboratory is perhaps rather "outside" of the particular field of study. One could say that by dimensioning and view-pointing a given complexity of geo-data, the cyber-geographic lab must establish itself on another emergent level; a level which is "higher", or more abstract than that of the data of the complexity. In a sense, notions of "outside" and "inside" become irrelevant to a characterization of the cyber-geographic lab, since the principal isolation of the positivistic

laboratory does not apply to that of the former. Moreover could it be argued that the categories of "closed" and "open" do not seem very relevant either, for whereas it is true that a web-based research environment may be "open" to the extend that it is accessible to other users, the nature of the research undertaken is of course non-accessible if those other user do not know of the principles that are being employed in the analysis and interpretation of the given material. Accordingly, one could argue that in as much as dimensioning and view-pointing is about establishing an emergent, higher level for the understanding, or scientific appropriation of this material, categories of higher and lower seems more important, or relevant than those of "open" and "closed", or one could argue that the latter pair of categories are defined by the former.

In this sense, basic spatial categories which characterize more or less explicitly each system of knowledge, proves helpful here for the understanding of how the material of research is constructed. Such cognitive analysis of categories (cf. Lakoff 1987) seem not far fetched in the cosmology of Goodchild's Human-User-Reality-Interaction, for what is important here is precisely the dimensioning and view-pointing of a given material in accordance to principles that are accessible to others; or one could perhaps even say, that is "commonly accessible" as a kind of "common-sense" dimensioning. This aspect has at least been defended by some of Goodchild's colleagues at the NCGIA, and most notably by English philosopher Barry Smith and his current research initiatives on "naive geography" and "geographical ontology" at the philosophy department at SUNY Buffalo. Notions of naive, or common-sense geography are at least important to the discussion of the part played by the user, not least as for whether this instance should be thought of as an expert, or lay-man user. For, whereas it is true also a cognitivistic treatment of a geo-data complexity will maintain this distinction in as much as the agency of dimensioning still differs from that of a simple reading, or orientation (to maintain a geographical vocabulary, the traditional user positions still appear to be *displaced*. First of all, the point of making accessible a complexity of geo-data by means of some kind of naive geography corresponds to that of Lakoff's cognitive analysis, namely to pave the way for a trans-disciplinary approach to systems of logic that one would otherwise have to abandon. As concerns the lay-man user dimension, one should not too hastily assume that the common-sense mediation of a geo-data complexity puts the lay-man in the same position as that of the scientist. It is true that cognitivist research is concerned with how to present geographical issues in a was that corresponds best with our basic (cognitive) ways of understanding and mapping space e.g. the study of cognitive mapping); still this research is primarily concerned with how to present, that is to "dimension" spatial, or geographical issues in a way that is easy to understand for lay-men. However, one can at least in theory identify a new position here which in a sense correspond to that of the trans-disciplinary scholar, namely that of the "critical" lay-man user who not only "reads", or orientates himself in a given communication environment, but indeed takes an active part in its dimensioning and view-pointing in accordance with some common-sense principles, say in two- or three dimensions. I shall return to the

identification of this possible position in chapter 3 below in by discussion of modern cartography's concept of public visualization.

2.4 The Virtuality of Virtual Geography: Place and Ethereal Space

In his prolegomena for a virtual geography, Batty does admit, that 'in the rapidly emerging world of "unthinkable complexity" that the digital and the virtual now imply, classifications are intrinsically limited to provide total comprehension as each change in the perception of this new world generates a different emphasis.' (1997: 342). Accordingly one could say that the "Janus-like face of virtual geography" (cf. Batty's quote above) not only is that of the relationship between real physical place/space and computer (network) places/spaces but also that of the relationship between a complex system of geo-data and a *more general virtuality of emergent phenomena that are "grounded" on this system* and which lend itself to scientific appropriation by geography as scientific objects proper*;* "grounded" that is GIS-mediated, or GIS-organized entities but also ontologically grounded), that may be either in cyberplace, c-space, or cyberspace. To continue my discussion of spatial categories above, we note that also Batty employs basic spatial categories to distinguish between the four level of place/space in his system (cf. Fig. 1 below). As mentioned, Batty talks about a study of what goes on "inside" computers and networks and how these processes may "change material place outside computers". These categories are very easy to understand since they correspond not only to our everyday categories ("inside the computer", the "outside world"), but also to those employed for the establishment of scientific objectivities in geography and the study of computer and Internet media (as concerns computer space, or "C-Space", and cyber-space respectively).

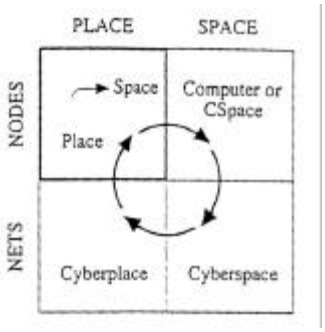


Fig.1. Batty's conception of the four levels of place/space in the common field of virtual geography. Reproduced from Batty (1997).

Still, Batty's point is obviously that these four levels of place/space in a certain sense interact, or influence each other thus making up a common field of virtual geography. As Batty has it,

> *The circularity implied in Figure 1 [Fig.1] is meant to suggest the order in which space and place has been influenced by the gathering momentum of the digital world; with stand alone computing first being the norm in terms of cspace [i.e.*

> *"computerspace"; simply computer mediated, or represented space, say by means of CAD-based systems], then networking applications between computers - cyberspace - becoming significant, and the impact of computers and communications on place itself following in this wake. Of course once set in motion, this process of influence feeds back and forward in every conceivable way... (Batty 1997: 341, my inserts)*

This particular sense of influence from geographic place to cyber-place which we also recognize in Goodchild's account implies that the objectivity of the four separate levels is founded on a common complexity of geo-data computation, and this is of course a central point in Batty. Accordingly, the virtuality of virtual geography should then not too hastily be identified with those (virtual) objectivities of computer (network) mediated space (i.e. "c-space", etc.). Virtuality rather seems to be tied up with Batty's special perception of place and space in this particular context. As mentioned initially, Batty's perception of virtual geography does not only consist of four levels of space but also an *important distinction between space and place*. This space-place dichotomy is actually derived from geography's traditional separation of the abstract space of geography from an original field of concrete places: 'Space is geography's or the geographer's abstraction of place' (1997: 341). Yet in Batty's account, space as an abstraction could be said to differ from this traditional definition by being not "simply" a cognitive but rather an "ethereal space" (hence Batty: 'virtual geography ... is the study of place as ethereal space and its processes inside computers' (1997: 340). This idea of space being a "processual place as ethereal space" is important since it evokes a notion of an "abstract", systemic processuality on four levels that in a sense "functions" irrespective of the geographer. In other words, one should distinguish clearly here between space as a scientific abstraction (hence the traditional place/space-dichotomy in geography) and (ethereal) space as a kind of "technical abstraction of place". Moreover is it necessary to distinguish between scientific abstraction of place and ethereal space, that is abstract not only to place but also critically to the discipline, and a more general, cognitive abstraction. However, I shall come back to this issue later (3.4.). Yet to the "proper" geographer, these distinctions would only mean that both place and ethereal space lend themselves to scientific abstraction. In a sense this idea only supports the idea suggested by Batty that GIS-mediated, or -organized place *qua* "cyberplace" ends up sharing the same ontological status; not only as concerns the point made by Batty that place ends up being GIS-grounded but also as for their making out the field of "virtuality place" for this science termed virtual geography. This problem of abstraction will lead us below to a comparison with similar problems in cybernetics and subsequently to a discussion of to which extend the complexity of geo-data's ethereal space resembles the relationship between on the one hand fundamental complexity of geo-data and on the other, emergent levels of phenomena that are to be appropriated in science. For now, let me sum up by making an overview of the relation between abstraction, place, and space in the following fashion:

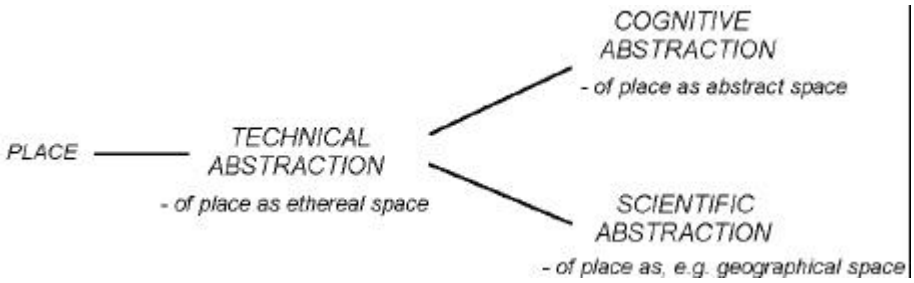


Fig. 2. This figure shows the three possible kinds of abstractions of place in Batty's (1997) account of a virtual geography (i.e. technical, generally cognitive, and scientific abstraction). Technical abstraction here is the abstraction of place as ethereal space characteristic to virtual geography as such. The bifurcation suggests that technical abstraction may either lend itself to cognitive or scientific abstraction, that is to the abstraction of ethereal space as either generally abstract or abstract with reference to a particular science as for instance geography.

Recognizing the general perspective of virtuality in virtual geography, one could perhaps conceive of virtual geography's field as a multi-dimensionality of place rather than just as of various levels of representation of place; a multidimensionality which by the end of the day is difficult to distinguish from the complex of geo-data as such as for its ontological status in the general system of virtual geography. This perception seems to correspond with Michael Benedikt's suggestion that space (or, to geographer, perhaps rather place) and information in a sense could be seen as being identical. Benedikt asks: 'is information in space, or is space in information? I submit that this is a pivotal question. In fact, we should get ready to take the next step, which is to explore the more radical idea that space and information are one and the same thing' (Benedikt 1996: 163). Setting off from Leibniz' argument that an entity's, say an atom's identity is given by its realization in time and space (thus ruling out the possibility of not only twins but identical entities as such without a spatial realization),[7] Benedikt defends the necessity of a spatial information theory, and that information this sense becomes inseparable from space and *vice versa*. As noted however, from a geographical viewpoint we are better off identifying this notion of space as place, not as concerns the principle in Leibniz, which indeed is about space as the abstraction of place, but as for information realized in the multi-dimensional virtuality of (cyber)place. Being an architect and thus basically referring to architectural "space", Benedikt's notion of space as unfolded in architecture should perhaps in this sense be identified with a geographical concept of place. Although lending itself to abstraction, place is non-reflective, non-abstract as such. As we shall see in the next part below in our discussion of scientific visualization this idea will prove important to our final distinction between visualization *qua* abstract "visual thinking" and communication which eventually is more about an immediate reading of a "geographical message."

[7] Benedikt is referring here to Leibniz' principle of the Identity of Indiscernables.

2.5 Cyber-geography and Second Order Cybernetics

I think at this stage that it appears quite obvious that Batty's account of a virtual geography and Goodchild's notion of HCRI, or of what I have preliminary designated as user-centric cyber-geography, both implies what in Serres' sense could be taken for a "new order" of scientific knowledge; an order that have similarities but still is different to Serres' notion of Nature as an inventory of geographical knowledge. Most importantly, this "new order" differs from that of the latter by abandoning a notion of scientific objectivity, that is a field of exploration that is "out there" and which behaves in accordance with certain laws. This idea corresponds well with Heinz von Foerster's (1984) observation that leads him to develop further Norbert Wiener's cybernetics: '.. I see the notion of an observer-independent "out There", of "the reality" fading away very much...' (Von Foerster 1984: preface, quoted from Brier 1999a: 39). Although cyber-geography in the sense outlined above does not appear particularly relevant to Von Foerster's, Varela's, and Maturana's, general principles for a second order cybernetics, we recognize, at least ideally, both in Batty and Goodchild the idea of a self-organizing geographical nature in that place mediates and organizes itself as cyber-place by means of ethereal spaces in computer and cyber-space. Hence Batty's notion of a circularity in the systems that allows "feed backs" and "feed forwards" to/from cyber-place in its geo-computational and network mediation. One might say that, when laid out in this perspective, Goodchildean cosmology makes out a particular order of knowledge that resounds earlier mechanistic ones, namely that *living* Nature could be seen as an inventory of knowledge in accordance with basic laws, not of Nature in the traditional physical sense but of the exchange of information; or just simply, as Brier (1999a: 100) puts it: 'To live is to know.' This notion of knowledge and communication corresponds not only with that of second order cybernetics but also the bio-semiotic cosmology of Jesper Hoffmeyer (1997).

I agree with Brier here as concerns the general necessity of discussing the aspect of giving up objectivity in second order cybernetics: 'My [Brier's] concern here has mainly been the function of "outside reality" in the analysis of the behaviors of auto-poietic or "observing systems". My point has been that although one rightly has given up the notion of "objective reality" in second order cybernetics, one should not give up the notion of a partly independent "outside reality".' (Brier 1999a: 42, my insert). This contention seems to align with my own, more concretely motivated interest in identifying part played by the lay-man user in the dimensioning of an auto-poietic complex system of geo-data. Still, one may in fact argue that the problem of externality and observation in second order cybernetics as such points toward the necessity of generalizing knowing, or knowledge acquisition, as in an ontological sense more fundamental cognitive pursuit than purely scientific (viz. mechanistic) knowing, i.e. that scientific knowledge in a sense is only secondary to what might be designated as "general knowing". Brier:

> *Realizing that the ability to obtain knowledge is before science, and that knowing needs an autopoietic and languaging system, and that language needs signs and a*

> *society to convey meaning, allows one to see the limitation of purely scientific explanations of the phenomenon of information. Knowing is the prerequisite for science. How then can knowledge and intelligence ever be though to be fully explained by a science based on a physicalistic or functionalistic world view? (Brier 1999a: 50)*

This argument is pivotal in Brier's general critique of second order cybernetics as science; that is as a mechanistic science of the laws of "communicating information" in "living knowing Nature". Although I admit that this general approach to second order cybernetics touches upon some aspects of the problem that I am dealing with here, I shall however not pursue further Brier's project as such. Still, what I will do next is to try to adopt certain aspects in Brier's attempt to re-found second order cybernetics on the grounds of Charles Sanders Peirce's semiotic philosophy. In a sense, this adoption will apply to what resembles the same problem in cybergeography, namely that although on the one hand cybergeography could be thought of as being particularly "user-centric", my analysis has identified Brier's issue as for how to think of an external knowing, or observing instance in an auto-poietic system. However, I have already introduced the problem of abstraction in Batty's notion of (ethereal) space in cybergeography, and this concept does seem helpful for this discussion since it implies an aspect of "external reflection" to the system, that is in the first instance only a (fundamental) technical abstraction. Still in Batty's cybergeography, it is obviously possible to externalize oneself further, that may be either in terns of general abstraction or of a specific scientific abstraction in respect of the three "new" levels of space that could be studied as separate emergent fields of the common virtuality of virtual geography: c-space, cyberspace, and cyberplace. In the next part below, I will compare this notion of abstraction with Brier's semiotic re-foundations of second order cybernetics.

Admittedly, this aspect of self-organization, or the living knowledge of auto-poiesis, which in this sense could be identified with Batty's notion of circularity in cybergeography, is not a matter that has been introduced as the primary topic of this paper. What I have been stressing rather is how these new GIS-cosmologies seem to imply a new understanding and practice as regards scientific and lay-men users' cognitive interaction in this field, and that this understanding might prove relevant to discuss in terms of visualization. On the other hand, as this epistemological exposition has tried made evident, it is still necessary to realize the ontological grounding of any instance of abstraction on this general, auto-poietic virtuality of cybergeography. In this sense it does seem paradoxically that we were able to set off initially from asserting that the GIS-cosmology of Goodchild could be taken for distinctively "user-centric". For, at the current stage, the "user", or cognitive instance seem profoundly decentered in the self-organizing system of cybergeography. On the other hand, I have now identified some cues that may leads us to an understanding of an

ontologically “GIS”-grounded cognitive instance, and eventually such thing as a “user”. This will be my pursuit below.

3.0 Towards a User Concept in Cybergeography

I have already stressed the paradox that initially we were able to speak of a “user-centric cosmology”, since the cosmos of cybergeography was identified later on with a given complex system of an auto-poietic nature in which any cognitive instance should be thought of a being radically decentered. In this part I will try to develop this paradox a little further by comparing the notion of abstraction in cybergeography with Brier’s attempt to found second order cybernetics on the semiotic philosophy in Peirce. This will eventually lead me to an overview of what turns out to be four separate orders of “knowledge” in cybergeography, ranging from the level of data to that of science. In these, gradually higher orders I identify various cognitive instances that may be identified later on with possible user positions. However, before venturing into this discussion I will at first briefly sum up what a user, or cognitive instance may be conceived of in the cybergeographic cosmologies of GIS.

3.1 Three Basic Aspects of the User Position in Cybergeography

To make an overview of this paradoxical position of the cognitive user instance in cybergeography I will now proceed by identifying three very different yet equally characteristic aspects:

1. *The dimensioning and explorative aspect:* The user that both dimensions, “viewpoints”, and explores the cyberspace of multidimensional geo-data, and thus in a sense situates himself in the center of the scientific “GIS-cosmos”. Still this centrality should not be mistaken for that of the scientist of the laboratory who is exploring the unknowns of a world “out there” from an idealistic view of the primacy of scientific knowledge. The centrality is rather a construction that bases itself on the externalizing abstraction from a given complex system of geo-data that is already a technical, or virtual abstraction. Moreover is the centrality only apparent inasmuch as the exploring body could be seen as forming part of a world that is mediated and organized dynamically by GIS.

2. *The bodily cyber-geographic aspect:* The user as a body that forms part of cyberplace, that is of a geographical reality that is given as being mediated and organized by means of the cyberspace of computer network GIS computation. I was mentioning this aspect initially when introducing the notion of cyberplace in Batty.

3. *The existentialist aspect of GIS-subjectivity* . The user that sees himself as a subject that takes for an existential given his being subjected to the virtuality of cyberspace. This aspect is that of a "GIS-Carthesian" de-centered subject that may reason as follows: "I think by means of a given system that mediates me as a body, therefore I am'. I shall not elaborate further on this existential aspect of realizing oneself as a "GIS-subject" but leave it to a subject theory informed approach to the Human instance in cybergeography.[8]

I shall develop the connections between these aspects below. For now I will try to represent them in a common field, or topology in the following figure:

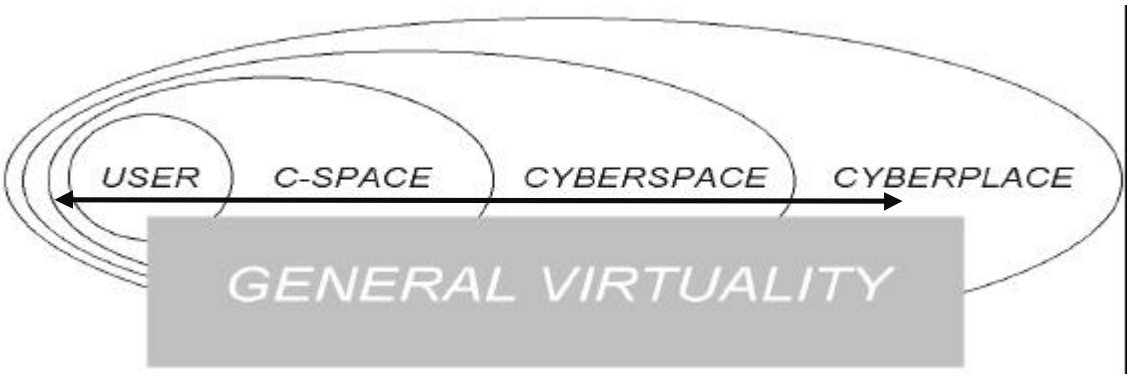


Fig. 3.: User-centrism in cybergeography. This figure represents the user as being central in a four-level cosmology of cybergeography (cf. Batty above). The arrow between the inner, or central part ("User") and the outermost part ("Cyberplace") indicates the "connection" between the user and cyberplace inasmuch as the user as a bodily instance is forming part of the geographical reality that is mediated and organized by the common virtuality of geo-data (viz. the 2nd aspect). The gray box, "general virtuality" suggest that the four fields are grounded ontologically on a common field of general multidimensional virtuality (viz. the 3rd aspect).

In Fig. 3 above I have tried to represent the paradoxical topology of the three basic aspects of the cognitive instance in the GIS-cosmos. Suggesting the peculiar connecting between the "user" and cyberplace, this figure implies a moment of "turning itself inside out". If one adopts the idea of circulation in Batty's account of virtual geography (cf. Fig. 1 above), this "turning inside out" might perhaps be envisioned spatially in terms of the theoretical figure of the Moebius Strip, i.e. a circular strip, or tape that turns itself inside out by a half twist in the course of the loop. This moment is particularly relevant for the second aspect above, namely that the user may form part of cyberplace *qua* its bodily existence. I find it difficult to represent in a satisfactorily manner the third, existentialist aspect, yet the grounding, general and multidimensional virtuality of the system is shown with a gray box.

[8] Such approach should take as its starting-point Jacques Lacan's notion of the decentered Carthesian subjectivity and compare it with the cosmology of cybergeography.

3.2 Mediating Triads: Beyond Ontology and Epistemology

Now, I have already outlined the problem of what virtuality might be conceived of in Batty's notion of virtual geography. First of all should virtuality not as such be identified with the common objectivities of computer (network) mediated space. Still, virtuality is about establishing virtual dimensions in a self-organizing system of geo-computational and network mediated place, that is, to be precise, dimensions of ethereal space, or place that may lend itself to the geographer's cognitive abstraction. In this sense, one could perhaps say that virtuality is that material of multi-dimensional place that lends itself to a scientific objectivity of geography.

Brier's approach of grounding second order cybernetics on Peirce's Kant-inspired logical and realistic order of knowledge (i.e. of Firstness, Secondness, and Thirdness) seems helpful here since it is possible in this manner to identify a position of observation, or at least of a cognitive instance "outside", or beyond the system of cybernetics. I allow myself here not to go into details as for a general definition of basic Peircean terminology. Instead I shall stick to those terms applied in my argumentation. In Brier's interpretation,

> *Secondness is the first distinction of an observer (cognition) marked by a primary sign, the Representamen. The observer is Peirce's Interpretant that belongs to his Thirdness. Only through this triadic semiosis can cognition be created. To become information differences has [sic!] to be seen as signs for the observer. This happens when they become internally developed Interpretants. (Brier 1999a: 46, my insert)*

I shall not venture into a discussion of which interpretation of Peirce's is the right one, and which one that isn't. Still I will argue that to identify the "observer" with Peirce's concept of interpretant as such restricts the notion of observer significantly, and I will not myself admit that the concept of Interpretant in Peirce should be seen as a reflective, cognitive instance (i.e. general or scientific abstraction). On the other hand, I agree with Brier that the order of the Interpretant may share some properties with various observing instances not least as concerns Brier's definition of information, namely that "to become information differences have to be seen as signs for an observer." In the following paragraphs I will try to elaborate a bit further on this point.

Peirce defines his concept of sign, or sign relation, in various fashions, yet one of the most recognized, or referred to is the one that follows:

> *A sign, or Representamen, is a First which stands in a genuine triadic relation to a Second, its Object, as to be capable of determining a Third, called its Interpretant, to assume the same triadic relation to its Object in which it stands itself to the same*

> *Object. (...) A Sign is a Representamen with a mental Interpretant. (Peirce 1955, quoted from Brier 199a: 46)*

Maintaining this definition, the concept of interpretant should rightly be understood as the mediating principle that realizes the representamen-object relation as a sign in its thirdness, i.e. as habit as Peirce also has it. I distinguish here of course between sign as representamen and sign in its interpretant mediation as thirdness, i.e. the sign as sign relation. This definition is often represented as follows:

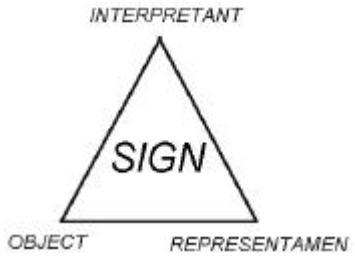


Fig. 4. The sign, or sign relation in Peirce as the interpretant mediation between object and representation, that is between an object in the world and something that stands for it as a sign.

In this perception, the interpretant should only be thought of as a mediating instance as such. In other words, it does not reflect anything but the sign-object relation that it mediates. This does not mean however that the interpretant, or to be precise, its "substituting" instance on a higher level, that is when further mediated, should not be associated with some kind of reflective, or even cognitive characteristic.

However, if we maintain Briers's notion of information and observation we recognize that the principle of mediation is also to be found on other levels in the system of cybergeography. First of all, *geo-data* could be seen as "ordered" in a similar fashion in as much as geo-data are possible as representations of geographical objects only with reference to a particular set of meta-data, that tells the system of (network) GIS-computation how these particular data are to be "understood". In other words, meta-data seem here to play the same mediating function as the interpretant in the basic sign relation.

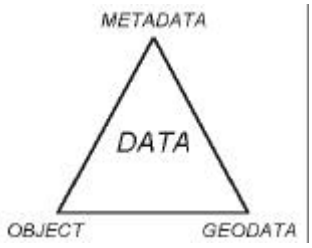


Fig. 5. Geo-data thought of as a sign relation of object and geodata representation, that is being mediated by metadata.

This triadic understanding of metadata is in a sense provocative inasmuch as it annuls the "meta-level" of metadata. Metadata in a Peircean apprehension should then rather be seen as a mediating principle that fundamentally forms part of a triadic order.

In a similar manner one might lay out what we have identified as the general virtuality of cybergeography as a mediated triad of data, data representation, and virtual data models. The relationship between data and data representation should here be understood in precisely the same fashion as that of the object and the representamen respectively. Virtual models in "c-space" and cyberspace could here be taken for a relevant mediating instance inasmuch as it designates the relationship between data and virtual data representations in their given spatial relativity. Yet models here should not be understood neither as the two-dimensional representations of spatially relative instances nor the three dimensional image that one may be able to perceive as a perceptive illusion from such two-dimensional representation. Virtual models in this sense are rather the "vertical" relationship that exists between data and their representation in the horizontal dimension of the latter. The notion of a general virtuality in cybergeography designates precisely this realm of possible models before any virtual representation in either cspace or cyberspace.

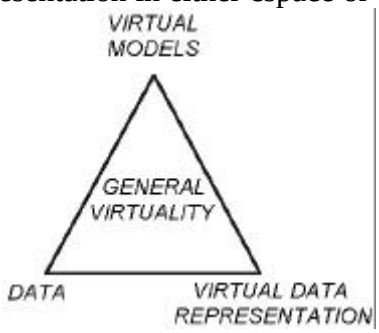


Fig. 6. General virtuality thought of in terms of a sign relation between data and data representation when mediated by virtual models. We recognize here that data take the position as object in the basic sign relation.

The diagram, or perhaps rather the representative aspect of diagrams, is a particularly good example of a virtual model which in this sense stands for a mediating instance in respect of between data and data representation in the representation of a geometrical space. The concept of diagram in Peirce

designates precisely the iconic sign relationship in which iconicity is given by a relation.[9] The representation of theoretical models like the Peircean triad is another, very obvious example in this context! However, theoretical models seem peculiar in respect of the status of their two-dimensional representation. Here the virtual model and the cognitive model of the reading of the representation should at least in principle be seen as symmetrical.

We recognize that when laid out in terms of the basic sign relation (cf. Fig. 6), the instance of data here takes on the position of object. Data should not be seen here as geodata as such but geodata in its relation to objects and in its interpretant mediation of metadata. In other words, data here should be identified with the entire sign relation of the geodata. This idea stresses the point that as concerns the founding technical abstraction of general virtuality in cybergeography, *there is no fundamental object outside of the system but data.*

Finally, Brier's "mediative" apprehension of information should also lead us to identify a similar order on a higher, epistemological level, namely as concerns science as a mediation of objectivity and scientific knowledge. This idea may be represented in the following manner:

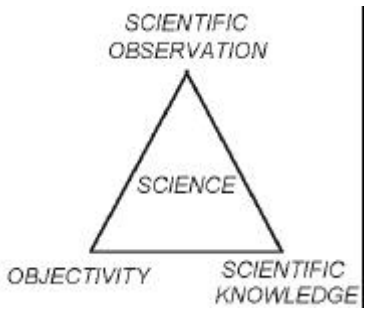


Fig. 7. Science understood as a triadic, epistemological order similar to the basic sign relation. Here, scientific observation is seen as an "interpretant" mediating principle that maintains the relation between objectivity and scientific knowledge.

This model (Fig. 7) suggests that objectivity is incomprehensible without scientific knowledge and vice versa, i.e. that these three instances in a sense construct each other in a triadic order. So, following a certain principle in Peirce's triadic system, one can identify a reflective, or cognitive observer instance on a level in which it would play the part of a mediating, or to use the terminology above, appropriating function that establishes objects as objectivity in relation to a body of knowledge. Moreover do we recognize that general virtuality when perceived as a sign relation in a sense might make up the position of objectivity in this, highest order in the system, that is in the very same manner that data made up the position as object in virtuality. Objectivity is in

[9] The diagram can thus be seen as a second order (relational indexicality) of firstness (iconicity), that is compared to the first order of firstness (i.e. the "icon", or the ordinary image), and the third order of firstness (i.e. the metaphor).

this particular sense not that of a fundamental, external world as in the mechanistic, or proper sciences. *It is precisely this peculiar condition that characterizes cybergeography.*

We recognize in the elaboration above two very different understandings of the concept of the interpretant, namely on the one hand the perception of a genealogically fundamental entity (i.e. the primary, or first thirdness of an original firstness that founds genealogically higher levels of knowledge and existence), and on the other hand, the general principle of mediation that may be found on lower levels of data as well as higher levels of knowledge. My first objection to Brier's suggestion rely entirely on the fact that I generally identify the concept of the interpretant in Peirce with a (or rather "THE") genealogical instance. However, I recognize the point made by Brier when he suggests that the interprentant could be seen as a general mediating principle. Still why not simply identify such "meta-interpretant" as mediating thirdness on various levels of knowledge?

Moreover do we recognize in this elaboration that in a sense it does not matter at this stage whether we speak of the ordering of existence or of knowledge. In other words, the ontological issue seems grounded on a notion of the order of knowledge, that is of epistemology; yet this order of knowledge is thought of as being so "primitive" that it should not be taken for an epistemological account in the proper sense. Similarly, although Hoffmeyer in his bio-semiotic account does speak of "communication" and knowledge" in complex, auto-poietic biological systems, he would probably not allow us to establish a "bio-semiotic epistemology of life" (at least I would not). I think that we should identify this chiasmic relationship between ontology and epistemology rather as a problem of information, or simply of semiotics. In other words I suggest that Peirce's semiotics should not be reduced to neither an entirely ontological nor epistemological account. Still I admit that the disagreements as concerns the "true" laying out of Peirce often have recourse to precisely this problem.

3.3 Abstraction and Observation in Cybergeography

Now, maintaining that there are at least two levels of "ordered knowledge", namely that of science and geodata respectively, one should fundamentally distinguish between a reflective and a non-reflective mediating, or observing principle. Although geodata may be mediated as for their very being as information by means of metadata, they are not reflective instances in a cognitive sense. Moreover is scientific knowledge given by its reflective "externalization" of geodata. This idea seems to correspond with our analysis of the concept of abstraction above where virtuality in Batty's notion of virtual geography was defined ultimately as a multi-dimensional place that lent itself both to a generally cognitive abstraction of space and a specific scientific abstraction, say in geography. However, as I also demonstrated it should of course also be possible to speak of another kind of reflective abstraction, that is an externalizing reflective instance that stands for the generally

cognitive abstraction of virtuality. This instance was distinguished from the scientific one by not making abstractions critically, that is in respect of a given scientific discipline and its body of knowledge. Accordingly, one might be able to coordinate in a common figure the genres of abstraction with the mediating triads of knowledge that we have been identifying above:

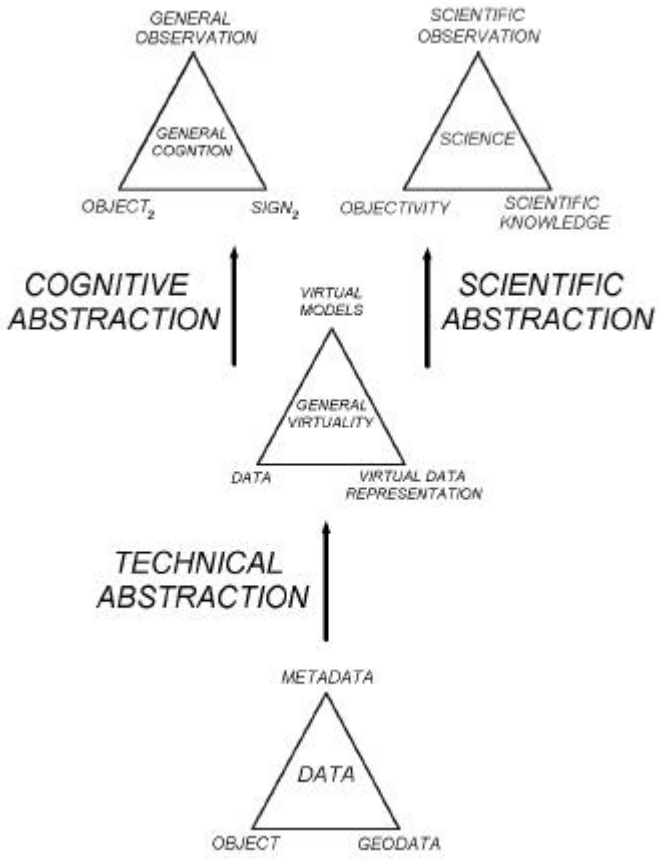


Fig. 8. This figure represents the relationship between technical, scientific, and generally cognitive abstraction of the general data virtuality in cybergeography (cf. Fig. 2 above) with reference to the mediating triads of data, virtuality, and general/scientific observation (cf. Fig. 4-7).

In this model (Fig. 8.), following our analysis in Part II above, abstraction is seen either as a technical instance that makes possible the given virtuality of the system or as generally cognitive or specific scientific abstraction that causes a reflective externalization of the system by means of some kind of cognitive reflection. Following the identification of the triadic data sign relation with the data object in that of general virtuality, the notion of an "outside" objectivity is only possible as a result of such externalization, that is as a cognitive construction.

It should be noted that Peirce – by following Kant -- does appear to recognize the impossibility of the object, since any actual object might always take on the position as a representation in another sign relation. This leads Peirce to speak of an endless semiosis and a fundamental distinction between a real and a mental object. The real object here is thought of as Kant's "Das Ding an Sich",

the object in itself beyond any actualization in a sign relation. However, I refuse to identify the Kantian problem of the object with that of cybernetics, or at least that of cybergeography. For whereas it is true that in cybergeography's system of virtuality, the relation to the "real object" in a sense is suspended, this is not due to the sign relation and its possible play of substitutions but the system in its ontological primacy. The status of the single object as a positive instance is of course evident qua the geo-data, but due to the technical abstraction of general virtuality, these outside objects lose their ontological primacy to the system. This is not a Kantian problem of the object in itself, I suppose, -- that is not even in the Peircean sense -- since here, the very problem of singularity of the object is suspended. When referring to the system of cybergeography, it makes little sense of speaking of a singular object and its most profound existence since any single object in the system is only secondary to the system; secondary that is in an ontological sense as concerns the systemic grounding of any positive object-data relation.

The Kantian problem of the object seems indeed to vanish in Peirce if one accept that the semiotic system proceeds both ontological and epistemological accounts (or reductions) proper, that is in the sense suggested in section 3.2. above. In this perspective, profound ontological issues are instead reduced to a discussion on the chiasmic relationship between system and actualization. In my view, the Kantian problem of the object only exists in these very terms, namely to the extend that an object in an actual sign relation vanishes in the system when being identified as a representamen and thus being subjected to endless semiosis. I shall not pursue this problem further here but admit that is discussion is also pivotal when it comes to the arguments on who is the "true" Peircean.

3.4 General and Scientific Observation

I mentioned earlier (3.3.), that general virtuality *might* make out the objectivity of science (cf. Fig. 8), but I have also stressed (2.4.) that virtuality and scientific objectivity should be seen as distinctively different instances. So, what is it then that makes out virtuality as a possible objectivity in science, that is in the triadic mediation of scientific knowledge?

When analyzing Batty's concept of abstraction I found that general virtuality should be seen as not only lending itself to scientific but inevitably also to a generally cognitive abstraction. At the time I made a distinction between general cognition's abstraction of place/ethereal space as space and a scientific cognition that is abstract not only to place but also critically to the discipline. I would like at this point to take up this idea of critical abstraction as a characteristic of scientific appropriation of objectivity. What I mean by critical abstraction of space is that the virtual space that is being abstracted in a given science (critically) reflects the discipline's body of knowledge (critically), that is in terms of making systematic and explicit points of references to a body of knowledge, say in terms of literary references. So-called recognized references are those which are referred to

systematically by a discipline, and a discipline again is a interpretative community that refers systematically to given points of references from different angles without having radical disagreements as for how to understand, that is systematize this given reference. Another notion of system seems to be in play here, namely the system of knowledge that is being actualized and perhaps developed by the so-called systematically critical work of science. I shall not venture further into this problem, since although this notion of the system of a body of knowledge seem in some respect to correspond with that of cybergeography's system of virtuality. What I would like to ask though is whether scientific abstraction of virtuality is possible without a preceding general abstraction? The question touches upon the previous one, that is in which respect virtuality could be seen as making out the objectivity of a science, and in this case the science of cybergeography. Of course, for any scientific treatment of a material it should be accessible to a common-sense when presented before scientific public. This point sees itself to demonstrate, that scientific abstraction should be conceived of as making out a double abstraction, namely a generally cognitive, and a specific scientific one. According to this argument, me must perhaps reconsider our bifurcation model above that served as a virtual model for our understanding of abstraction in Batty. What seems now more likely is that general cognitive abstraction should rather be seen as an intermediary level that lends itself to further abstraction, that is when reflected systematically to a scientific body of knowledge. General observation (as opposed to scientific observation) should perhaps then be seen as that instance that could be identified with objectivity in the mediating triad in science. This does at least make sense inasmuch as objectivity has already been defined with an instance that relies for its very existence to the mediating triad of science that is in relation to a scientific observer and a body of knowledge. The scientific observer is here incomprehensible without a notion on the one hand of systematic knowledge and on the other, of common reasoning. This should perhaps lead us to identify rather general cognition as a triadic order with scientific observation as such. Still I think that this question is of less importance (indeed a "hen-and-the-egg" question). What is important is for now to recognize the importance played by general cognition for cybergeography as a science to be able to externalize itself from the system that in a genealogical sense constitutes the knowledge and existence of the material studied. I have tried to represent this idea in the figure below:

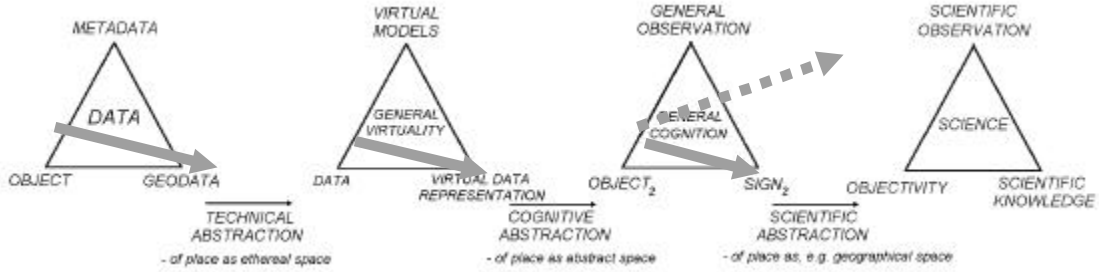


Fig. 9. This figure suggests the existence of a four-level order of mediating triads in the context of cybergeography's three types of abstractrion. The model follows the recognition that scientific observation and objectivity relies on a mediating triad on a lower level, namely that of general cognition. The gray arrows indicate the connection between the four levels of order. We see that the two left triads belongs to the realm of place (i.e. place/ethereal space) in geography, and that the to right ones belong to that of space. The broken arrow indicates the uncertainty as for which position general cognition might take in the order of science (that is whether objectivity or observation).

Let this be my final step towards developing in the realm of cybergeography Brier's question to second order cybernetics, namely "how knowledge and intelligence can be though to be fully explained by a science based on a physicalistic or functionalistic world view when knowing is a prerequisite for science, and when knowing needs, or is taken to be grounded on an auto-poietic system that must itself based on signs to convey meaning?"[10] What I have done not is of course not to have outlined a notion of "user" in cybergeography. Still, one might say that I have moved "towards" a user concept inasmuch as I have identified the basic virtual and cognitive orders of information and knowledge in cybergeography, In the final chapter below I will try as a perspective to, or "grounding" of this work to compare these orders with the concept of visualization in modern cartography; a concept that seems to bridge theoretically various cognitive instances with the use of geographic presentations, e.g. maps in a scientific and a general context.

4.0 Visualization and cybergeography: - The Use of Maps

In order to establish a perhaps more coherent and current perspective to my elaboration on the epistemology of cybergeography and its possible, externalized cognitive positions, I shall now in this final section perform an analysis of current concepts of visualization with special reference to my (preliminary) notion of a user-centric cyber-geography. Being defined as the *use of maps,* (or of other forms of cartographic presentations) (MacEachren 1994), the concept of visualization should lead more directly to a notion of user as concerns navigating and exploring cyber-geography. Moreover, as mentioned in the introduction, visualization as defined in modern cartography seem to

[10] Cf. Brier 1999a quoted above pp. 16.

touch upon the very question of various kinds of knowing, or observing a given system in its complexity, that may be as regards to scientific appropriation of (proper) knowledge on the one hand, and a more intuitive observation of the non-reflective, multi-dimensional virtuality.

4.1 Visualization: From Mapping to the Use of Maps

As mentioned above, modern cartography has during the last decade begun to recognize the rising importance of some new context for maps and other kinds of geographic presentations. On the one hand, the context of information technology as opened up for new approaches to the treatment and presentation of geographical data. In this paper I have so far been dealing especially with the profound epistemological consequences of geographical information systems, or just simply GIS. However, this new context is not only about another perspective as for how to perceive the geographical world as such, it is also about how to apply new methods for its exploration and analysis. It goes without saying that human-computer interaction, more than anything else, has been the exiting news for cartographers in this respect. This context of the use of cartographic presentations on the grounds of GIS has led to a new discipline in cartography, namely that of visualization; a discipline that additionally implies a third context, namely as for how GIS-based presentations interact cognitively not only with the mind of a scientist but also with that of the lay-man user. Following the wake of the widespread distribution of the Internet, this context has become just as urgent as the two former and has made the study of GIS an even more interdisciplinary challenge. Accordingly, leading scholars in this field have recently proposed an (at least potentially) new field of study, namely that of “public visualization” which is to be separated from that of traditional “scientific visualization”. In the following paragraphs I shall attempt to lay out what is meant by visualization in modern cartography and how this notion possibly corresponds to cybergeography and Goodchild’s more immediate but indeed suggestive vision of “Human-Computer-Reality-Interaction."

In an often quoted article, Alan MacEachren (1994) sets off from the observation that the new interest in making scientific presentations available before the public by means of new digital media seem to coincide with a general adoption of the concept of visualization as a heading for a new discipline of cartography. Here, MacEachren provides us not only with a good presentation of the main contributors to this new field, he also advances what is now commonly accepted as the basic dimensions in scientific and public visualization. Still, even in MacEachren I think we are short of a systematic definition of what visualization is, that is not least when compared to cartography and the practice of mapping in general. However, what seems distinctively characteristic of visualization is not only the purely technical dimension of scientist now being available to present the results of their work in a graphically suggestive manner before a large audience, say on the WWW (hence perhaps the popularuse of the notion, “to visualize” something). Fraser Taylor (1993)

notes that although in cartography visualization was originally about the new possibilities of computer graphics, visualization soon moved beyond this characterization and became instead a discipline about "visual thinking" thus emphasizing strongly the cognitive aspects of both the analytical and the communicative dimension in visualization. This perception seems to correspond with a traditional, yet less dominant the notion of visualization such as Philbrick's (1953: 11): 'not only is a picture with a thousand words but the interpretation of phenomena geographically depends upon visualization by means of maps.' Thus seemingly suggesting that maps, or cartography is about making possible visualization qua "interpretation of geographical phenomena", visualization could be understood as the use, or application of cartography in research and communication. MacEachren: 'the approach presented here, *defines visualization in terms of map use* (rather than in terms of map-making or research approaches to cartography). (1994: 6). This idea aligns well with Fraser Taylor's (1991) conception which is illustrated in Fig. 3 below:

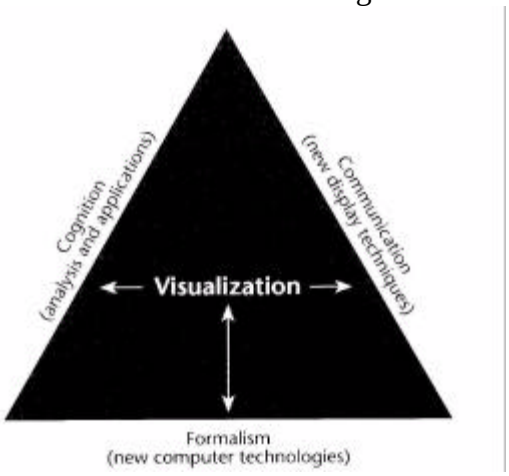


Fig. 10. D.R. Fraser Taylor's representation of visualization in the context of GIS-computation ("Formalism"), graphic interface ("Communication"), and cognition. Reproduced from MacEachren (1994).

As MacEachren notes, Taylor's notion of visualization seems to imply an 'amalgamation of approaches to cartography associated with cognition, communication, and the formalism of computer technologies' (1994: 4). What appears to be emphasized by Taylor is the general immediacy in visualization between the graphic interface ("communication"), cognition, and GIS-computation as, perhaps, a complex system of geo-data in an environment of computation. One must stress that Taylor's notion of communication here is slightly misleading inasmuch as he is referring to the graphic user interface, or "display techniques" only. The aspect of communication, that is the sharing of information might be included in this notion but only in the context of visualization in its entirety. One could also argue that the difference between display techniques and computation perhaps not is that clear-cut in GIS as Taylor seems to suggest, that is at least to the extend that display techniques are easily modifiable in GIS-research. This is however not the case in most GIS-applications designed for professional, or non-professional lay-man users. Still, to understand what is meant by visualization in Taylor, it might perhaps be instructive to generalize

his model slightly in the following fashion thus emphasizing the concept of visualization as a "common set" of cognition and GIS. Or, in a sense, as "GIS-cognition", i.e. "thinking by means of GIS" as a complex system of geo-data as presented by a given display, or interface technique.

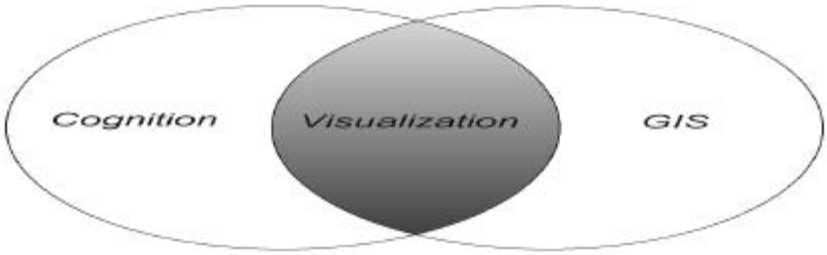


Fig. 11. This generalization of Taylor's model (Fig. 3) outlines visualization as a common set of cognition and GIS, that is in a sense as "GIS-thinking", or thinking by means of GIS.

This model (Fig. 10) corresponds more immediately to my elaboration in the last chapter above which was dealing especially with the intermediary levels of knowing, or knowledge between non-reflective GIS-virtuality and cognitive instances. This model gives rise to a definition of visualization as "GIS-thinking", that is thinking by means of GIS virtuality.

Whereas Taylor in a sense could be criticized for not distinguishing more clearly between communication and explorative GIS research (as well, perhaps, as between "communication" and "display techniques"), David DiBase (1990), emphasizes this aspect by depicting visualization in the course of a common research project. In this context, he distinguishes especially between "visual thinking", which is visualization used in the analysis of scientific data, and "visual communication"' which is about the presentation of the findings made in research, i.e. by visual thinking. Hence the now fairly well established conceptual opposition in cartography between scientific and public visualization (cf. Fig. 4 below):

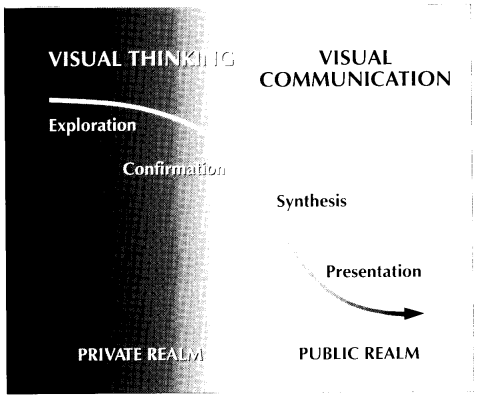


Fig. 12. DiBase's (1990) illustration of how visualization qua the use of cartographic representation alters depending of the stages of a common research sequence, i.e. from visual thinking to visual presentation before the public. Reproduced from MacEachren (1994).

DiBase's account seems to correspond well to our traditional way of separating visual presentations from scientific analysis, or "visual thinking". Moreover do we recognize our generalized notion of visualization, or "GIS-cognition", in Taylor in DiBase's concept of "visual thinking". Regrettably, DiBase does not go into details as for the nature of visual thinking. His main aim is obviously to distinguish between various genres of visualization in accordance to our traditional way of organizing the course of a research project. And seemingly, one is able to identify more genres in this course of research as regards DiBase's notion of the affirmative and synthesizing treatment of the findings. However, this distinction also means that DiBase subscribes to the idea of maintaining the science lab as an isolated space, i.e. as a "private realm" compared to the "public realm" where one does one's presentations. However, this also means that visualization *qua* visual thinking is still a matter here for the scientist, or at least for the "private realm". Moreover does DiBase stick to a sharp-edged division between "visual thinking" and communication, thus implying that communication is not about either visual thinking as an analytical, or intuitive response to a material, or to what I call the dimensioning and view-pointing of a communication environment.

Finally, MacEachren sums up from this conceptual development by advancing a three-dimensional model that seems to encompass the main dimensions of visualization as suggested by Taylor, DiBase, and MacEachren himself.

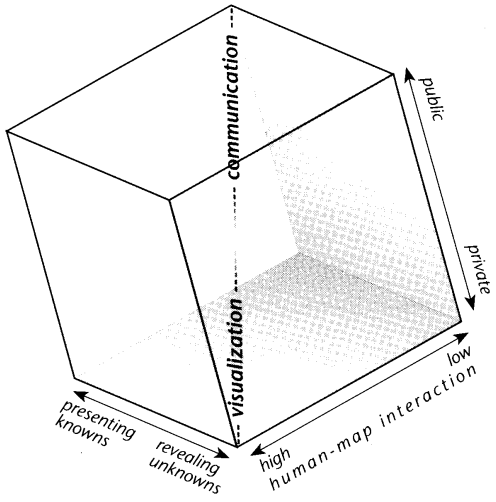


Fig. 13. MacEachren's (1994) synthetic, and perhaps "explorative" representation of the basic dimensions of visualization. One recognizes here DiBase's distinction between public (communication) and private visualization, and moreover that of presentation and exploration ("revealing unknowns"). Reproduced from MacEachren (1994).

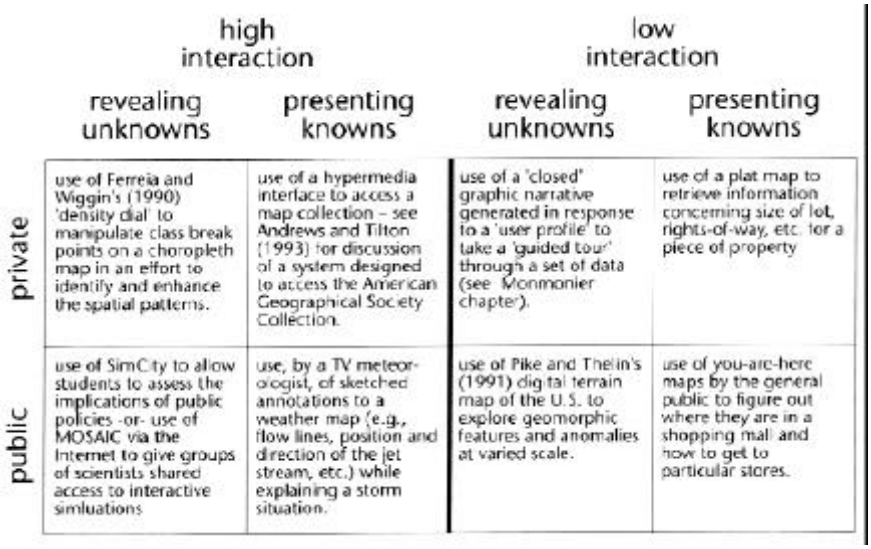
MacEachren lays out the model (Fig. 5) as follows:

> *The fundamental idea is that map use can be conceptualized as a three-dimensional space. This space is defined by three continua: (1) from map use that is private (where an individual generates a map for his or her own needs) to public (where previously prepared maps are made available to a wider audience); (2) map use that is directed toward revealing unknowns (where the user may begin with only the general goal of looking for something "interesting") versus presenting knowns (where the user is attempting to access particular spatial information); and (3) map use that has high human-map interaction (where the user can manipulate the map(s) in substantive ways - such as effecting a change in a particular map being viewed, quickly switching among many available maps, superimposing maps, merging maps) versus low interaction (where the user has limited ability to change the presentation). (ibid, p. 6-7).*

Although thus adding an extra dimension, namely that of "interaction" (and perhaps also that of revealing unknowns/presenting knowns), MacEachren seems at first to affirm the division made in DiBase between "visual thinking" and visual communication", and probably so for good reasons. Still, the idea of (scientific) visualization as being more interactive than that of communication confirms at first that the concept of public visualization in modern cartography is primarily a matter of presenting a material that has already been dimensioned and "view-pointed", and which in this sense is not available to "visual thinking" in a way that is suggested in Taylor, i.e. that visualization is about the amalgamation of the cognitive and the technical/graphical potentials in GIS and other

kinds of cartographic geo-data presentations. Consequently, when it comes to the combination of "presenting knowns" in a "low-interaction" fashion, and in a "public" realm, MacEachren seems to refuse to talk about visualization altogether. This is entirely a matter a "communication".

Still, if one sees MacEachren's figure as an invitation to "think visually" in the sense suggested by DiBase and also by the notion of cognitive modeling just above, one might take the former to suggest that visualization in his own terms is not just a purely scientific, but perhaps a more general matter. For, by comparing the three dimensions of revealing, interaction and public/private with each other he does of course outline six positions, i.e. corners, that are not immediately to be identified with the visualization-communication dichotomy. Some of them are of course trivial (say, presenting knowns/revealing unknowns in a private realm with low or high interaction) whereas especially the combination of "revealing unknowns" with "high interaction" in a "public realm" is interesting for us since this is the position of the lay-man, or public "visualization" user position that we have suggested earlier. Actually, MacEachren provides us with an example of what this position, or particular combination may be like, namely the 'use of SimCity to allow students to access the implications of public policies - or - use of MOSAIC via the Internet to give groups of scientists shared access to interactive simulations' (MacEachren 1994: 7, Fig. 1.4. NB: MOSAIC is a predecessor of WWW), cf. Fig. 6 below.



	high interaction		low interaction	
	revealing unknowns	presenting knowns	revealing unknowns	presenting knowns
private	use of Ferreia and Wiggin's (1990) 'density dial' to manipulate class break points on a choropleth map in an effort to identify and enhance the spatial patterns.	use of a hypermedia interface to access a map collection – see Andrews and Tilton (1993) for discussion of a system designed to access the American Geographical Society Collection.	use of a 'closed' graphic narrative generated in response to a 'user profile' to take a 'guided tour' through a set of data (see Monmonier chapter).	use of a plat map to retrieve information concerning size of lot, rights-of-way, etc. for a piece of property
public	use of SimCity to allow students to assess the implications of public policies -or- use of MOSAIC via the Internet to give groups of scientists shared access to interactive simluations	use, by a TV meteorologist, of sketched annotations to a weather map (e.g., flow lines, position and direction of the jet stream, etc.) while explaining a storm situation.	use of Pike and Thelin's (1991) digital terrain map of the U.S. to explore geomorphic features and anomalies at varied scale.	use of you-are-here maps by the general public to figure out where they are in a shopping mall and how to get to particular stores.

Fig. 14. MacEachren's table of possible examples of the various combinations of the three dimensions in map use: High/low interaction, public/private realm, and revealing of unknowns/presenting knowns. Reproduced from MacEachren (1994).

So, although maintaining that scientific visualization in modern cartography is primarily about "visual thinking" and the "revealing of unknowns", and that public visualization is about communication, that is of presenting knowns, MacEachren also shows that other positions are

possible, and indeed relevant. MacEachren notes that 'I [MacEachren] do *not* suggest that the dividing line between visualization and communication is sharp (in fact, I think it is becoming fuzzier all the time). Communication is a component of all map use, even when visualization is the main object. Correspondingly, even the most mundane communication-oriented map can serve as prompt to mental visualization.' (1994: 7). In this sense, actually, MacEachren seems to abandon altogether a rigid division between scientist and lay-man. By the end of the day, MacEachren "only" talks about people, that is of individuals, or groups.

What is important to MacEachren is first of all that we should distinguish between various kinds of use of maps, and, indeed, that even "communication" may lend itself to visualization (and vice versa). 'I view my definitions, then, as a convenience that allows us emphasize the difference in goals (and design principles) for maps whose *primary* function is to facilitate transfer of knowledge from a few people to many people; versus maps whose primary use is to help individuals (or small groups of individuals) to think spatially.' (1994: 7-8). How one should identify the difference between a visualization, or communication use of a given map is not clear in MacEacren but this may not be very important either. However, one should at least distinguish between *intended* and *actual* use (that may be visualization-wise or communication-wise). And this may in fact be a very helpful dichotomy as it comes to the evaluation of maps used to either visualize or communicate a given problem before a small "visual thinking" user group, or a big "communication" user audience. The "heavy" notion of target grouping from commercial communication and market research could then perhaps be formulated in these terms.

4.2 Visualization of (Cyber)Scenarios

The visualization of *scenarios* seem particularly interesting here. Supposedly, scenarios are distinguished from prognoses by not simply being a forecast of existing circumstances on the grounds of a given positive data material and certain laws of causality, say laws of Nature, which are taken for granted. In other words, scenarios seem not immediately exhaustive to a mechanicistic cosmology. Whereas it is true that scenarios may be produced on the grounds on positive data and a recognized law of causality, it is still as if the aspect of evidentiality so important to prognoses is suspended as concerns the nature of scenarios. In practice, this may be done by exaggerating, or simplifying noticeably those courses of development in focus. Hence such notions as scenarios of fear and of success. To demonstrate this idea, just think of the fact that whereas the point of scenarios is to have different scenarios to compare, we only need one prognosis, namely a good, viz. evident one. Whereas scenarios are plural, prognoses are only one. The plurality of scenarios may at least be given by a scenario of change's being different from that of a *status quo*.

Thus, in this common-sensical definition, rather than being employed directly for the communication of a given (geographical) message, scenarios are usually developed particularly with the aim of inducing, or facilitating visual thinking. Accordingly, scenarios seem interesting to us here in as much as they are used in the development rather than in the implementation of strategies, say for instance in planning. Certain methods in planning communication such as "future work-shops"[11] makes less relevant the uncritical giving of dimensions and view-points, and much more so the inherent critical perspective which scenarios, at least in this hypothetical conception invites the user to respond to. One could argue, paradoxically, that the visualization of scenarios, when applied in decision making on the highest strategic level (i.e. the level of strategy development), calls for the most intuitive approach and the cognitive register in its entirety, whereas the giving of so-called "relevant information" to the "enlightened" citizen in public visualization narrows the agenda significantly to the logic of space that is represented in a visualization with given view-points an dimensions, say in three-dimensional models.[12] The total register of human competence is necessary not only for the development of future strategies but also for the simultaneous dimensioning, or interpretive construction of the world as it is laid out and explored in this second age of geographic exploration.

We recognize here that one should distinguish between scenarios that has been produced entirely to illustrate, or analyze imaginatively the more or less extreme result of a given course of development and those that have been produced on a positive data material and in accordance with recognized laws of causality. Whereas the former is of interest to us an example of "visual thinking" only, the latter is of course particularly relevant here since it may imply the dimension of a fundamental data complexity which as for computer network mediated geo-data makes out the field of a cyber-geography. This particular genre of scenario which could aptly be coined *cyber-scenarios* must imply what could be seen as an inherent critical, or self-reflective aspect. Contrary to prognoses, scenarios must be characteristic of their explication of the particular givens, or conditions on which they are formulated. A good example of what this might be, is the simulation of an event, or development on the grounds of positive, and perhaps also on-line data. The playing of a game of SimCity, i.e. the popular game that simulates urban development, but now with positive data, would then make out such example. On-line data driven scenarios make out a sub-genre of cyber-scenarios. When it comes to urban planning, this perspective is of course not very relevant since the

[11] In Danish "Fremtidsværksteder". The method of arranging 'future work-shops' for local citizens and interest groups in regional planning communication has for instance been used successfully recently by the Swiss Federal Institute of Forest, Snow and Landscape Research by F. Kienast, M. Hunziker, and M. Buchecker Kienast (cf. F., Hunziker, M & Buchecker, M. 'Landscape Scenario Evaluation - an Important Tool for Modern Top-Down and Bottom-Up Approaches in Landscape Planning', paper for the conference *Our Visual Landscape*, Institute of National, Regional and Local Planning, Swiss Federal Institute of Technology, Monte Verita, August 1999. To be published by E. Lange as a special edition of Urban and Landscape Planning.

[12] To me, this seems like a fruitful starting-point for a critique of Habermas' notion of the enlightened dialogue; a critique that must be applicable to other fields than geographical communication in the sense outlined above.

real-time processes of urban development generally will take more time than a game of SimCity. However, if one deals particularly with the planning of urban traffic, one has perhaps a better case; that is at least if one considers that a game of SimCity may take just as long as the typical peak (morning and afternoon) stages of urban traffic.

4.3 Visualization, Communication, and Science

When summing up from this elaboration, one is inclined here to object especially to DiBase's and MacEachren's notion(s) of communication inasmuch as this concept seems to be defined only negatively, that is as what should not be seen as visualization. The point is in MacEachren that communication should be opposed to visualization to the extend that it does not imply an aspect of "visual", or perhaps rather GIS thinking. This distinction seems far too rigid -- taking into consideration that communication in this sense would *not* be about "thinking along" with the "visual explorers" despite the fact that these explorers do present the material they think with before a public realm (i.e. according to the very definition of this dichotomy). This problem seems to touch upon the problem analyzed above, namely whether a common reasoning of virtuality were necessary for scientific observation and knowledge. Communication in the sense suggested by DiBase and MacEachren seems hardly possible! A perhaps more precise definition would characterize communication here as visual thinking, *not by means of the virtual models of GIS but the cognitive models that may be identified more or less explicitly in the presentation.* Communication is in this respect about cognitive modeling as a special genre of visual thinking.

However, if we accept this notion of communication, we have, on the other hand, to object to the concept of interaction used in MacEachren. This notion seems far too narrow in its scope as being seemingly employed to cover user-interface interaction only. When distinguishing between virtual and models as a characteristic of the visualization-communication dichotomy, there should in principle be no difference in terms of interaction as such. However, when defined entirely in terms of "technical" interface interaction, there is of course a difference, but this latter, narrow understanding of the concept seem almost too specific, and therefore irrelevant to the distinction between visualization and communication. On the other hand, on a technical level, user-interface interaction is of course an important aspect since visualization as the "thinking by means of GIS" implies an important aspect of user -interface interaction. This aspect touches immediately upon the category, or order of knowing suggested above, namely of general cognition as the primary externalization of the system of cybergeography. General cognition of virtuality which was taken for a prerequisite for a science of cybergeography, could in this sense be identified with MacEachren's concept of visualization. If this holds good, it should add further to an understanding of the epistemological character of visualization, that is as regards the relationship between visualization and science. Visualization then should also be seen as a (methodological) prerequisite

for scientific knowledge. However, this problem is not emphasized particularly by modern cartography for whom epistemological inquiries are rare. In a sense it is striking too, that MacEachren pays so little attention to the relationship between visualization and scientific methodology. Visualization as the use of maps seems tied up the interdisciplinary tradition of cartography in which cartography as art, field work, traveling, and lab work merges together. As mentioned initially, visualization in cybergeography fulfills in a sense the dream of any cartographer of doing all this in the same "place", or environment, that is in the virtual environment of cybergeography.

4.4 Reconsidering "HCRI" in the Context of General Visualization

Eventually, it becomes more obvious – but still also paradoxical --- that Goodchild maintains the importance of the Human instance in his notion of Human-Computer-Reality-Interaction. For where it is true that his "second age of geographic exploration" implies a dynamic relationship not only between computation and reality, but also between the Human and the computer, and between the Human and Reality, the Human or at least cognitive instance is radically decentered and founded on the system that it sets off to explore. By the end of the day, although in a sense idealizing the part played by the cognitive instance, Goodchild seems to subscribe to Brier's recognition of the necessity of considering a Human, or at least observing instance as part of a cybernetic geographic cosmology. This Human instance has now been identified further in respect of 1) as the general necessity of a principle of observation, or general knowing prerequisite for science (cf. Brier 1999a), 2) as the *user* of maps, or "GIS-thinker" qua visualization, i.e. the cognitive instance in "visual thinking" when facilitated by the virtuality of cyber-geography, and more concretely 3) as the user-centrism in cybernetic geography's dimensioning and view-pointing of a given data-material. It goes for all of these aspects that they should be thought of as a prerequisite to the appropriation of a scientific objectivity, and all of them leads therefore to what I in part II ended up designating as *general cogntion, or knowing.* This term in turn corresponds to our *generalization of MacEachren's concept of visualization*, i.e. visual thinking as the revealing of knowns in a private realm but not necessarily in the scientific laboratory. To sum up, then, I have identified an at least possible position of visual thinking peculiar to the field of cyber-geography; a position that should not simply be thought of as a purely scientific approach, and a position that seem particularly relevant for the discussion of the status of visualization in the context of using cyber-scenarios in public participation and decision making on a strategic level.

5.0 Conclusion

In this paper, I have been pursuing two current scientific cosmologies of networked GIS computation of geo-data in a general perspective of scientific epistemology and with special reference to modern cartography's concept of visualization.

Having compared the two cosmologies in question, namely Michael Goodchild's notions of "Human-Computer-Reality-Interaction" and a "second age of geographic exploration, and Michael Batty´s concept of virtual geography, I initially identified their fundamental similarities and, eventually, found that both could be taken for notions of cybernetic geography, or just cyber-geography. When comparing these cosmologies in a simple historization with major earlier orders of scientific knowledge, that is various ways of conceiving of Nature as an "inventory of knowledge, I could assert that cyber-geography in Godchild's and Batty's perceptions could be said to make out a distinctly new order of scientific knowledge whose primary characteristics were identified with von Foerster´s notion of second order cybernetics. Especially when compared with the 19th Century scientific laboratory as it has been laid out in Latour and later in Barry, Batty's and Goodchild´s scientific cosmologies appear to abandon altogether an idea of the scientific field being "out there" as a given objectivity. Rather, as in second order cybernetics, Goodchild and Batty - although maintaining and realizing ultimately the scientific laboratory´s positive, immutable, and convertible data - seem to set out from a basic assumption that the field of virtual, or cybernetic geography should rather be thought of as a given, fundamental complexity. Recognizing in these terms Brier's claim that second order cybernetics is still short of a notion of an observing, or knowing instance I finally ventured into a discussion with the latter's attempt to ground second order cybernetics in Peirce´s logical semiotics. Here, by setting off with Brier from Peirce´s basic sign relation I distinguished four different kind of observing instances in what in Peirce could be taken for seperate and still higher orders of knowledge. In this analysis I identified three intermediary orders of knowledge and observation, coined "data", "general virtuality", and "general knowing" which contrary to the interpretant in the basic sign relation is reflective but which still is not is to be identified with common scientific observation.

On this ground I went on in the last part to compare and analyze current concept of visualization in modern cartography's new dealing with "visual thinking" and visual communication in both a scientific and a public context. Defining visualization precisely as the "use of maps", cartography's interest in the analysis and presentation of a geographical data material seemed particularly relevant to this discussion. Although at first these concepts appeared to maintain a rigid, and perhaps not quite evident separation of the part played by the scientist (in visual thinking) and the lay-man (in visual communication), I eventually found in MacEachren the possibility of deriving a more general notion of visualization, that is a general kind of map use, or "GIS-thinking" that should not be taken

for entirely scientific but rather as a methodological prerequisite to scientific knowledge in cyber-geography. To provide a concretization of this, I then tried to argue that scenarios, when defined common-sensically in a comparison with prognoses and when produced in a cyber-geographic field, i.e. on the grounds of a complex system of geo-data as “cyber-scenarios”, seemed particularly interesting for us as a good example of general GIS-thinking in a cyber-geographic virtuality. This idea lead me finally to a final comparison between my notions of general knowing, general visualization, and the field of cyber-geography. Here I tried to argue why Goodchild maintains the importance of a general Human cognitive instance in his notion of Human-Computer-Reality-Interaction. The point was here that his “second age of geographic exploration” implies a dynamic relationship between not only computation and reality but also the human being. Convergence and dynamization should be thought of then in terms of the interaction between three equal parties, yet the system of general virtuality should still be taken for the grounding instance for them all and their possible interactions. This is finally a basic characteristic of visualization in cyber-geography.

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