Neo-cartographic influence on map communication in LBS

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Abstract: Neo-cartography spans ubiquitous cartography, user participation and considerations for geo-media techniques. This new expansion of multimedia and internet cartography combines the latest Web developments with traditional cartography and imagery research. Therefore the focus within the conceptual communication model shifts and leads to a separate investigation of information-carrier and information-content. At least this separation helps to efficiently prepare geospatial data, especially within virtual 3D presentation methods. But it is also a crucial aspect of geo-media techniques whenever detailed information is put on lower resolution interfaces. This contribution introduces the notion neo-cartography, discusses the mutation of importance within the conceptual communication model and explains its consequences for geo-media techniques in LBS.

1.Introduction

The handling of geospatial information reaches new perspectives with ubiquitous cartography, Location Based Services (LBS) and webmapping technologies. Whereas geospatial information was accessible only to restricted user groups in former days, this kind of information becomes openly distributed with evolving WWW and LBS technologies. This intensification of map distribution shows some impact on mass-communication, where everyone, who is influenced by the media, becomes distorted in the mental map and the individual picture of space [Bülthoff et al 2001]. This effect of mass-communication influences individual decisions, movement in space and knowledge acquisition. Therefore these effects breed urgent questions for possible metamorphosis of existing conceptual communication models, a relocation of communication base items and thus deliver arguments for future directions in cartosemiotic theories, especially for small displays and adopted Service-oriented engineering [Hagedorn et al 2007].

This contribution introduces the notion neo-cartography as well as possible changes of the conceptual communication model, uses these notions to highlight main principles of geo-media techniques for restricted graphical devices (small size), demonstrates the impact on 3D geo-visualization and shows directions of Cartographic Visualization Services for some future work.

2.Neo-cartography

The recording, documentation and analysis of geospatial data were developed throughout centuries within the domain of cartography. On one hand processes of recording, projection schemata and precision formed main elements of cartographic work, on the other hand modifications of these data and partial deformations according to a beautiful artistic visualizations mainly shape the “old” use of landscape documentations. Further developments of traditional cartography lead to precise coding mechanisms of recorded data and mostly to its military use. Maps at those times mainly dealt as non-public planning tool for geospatial activities. This exclusive situation of map access changed to a large extent with developing communication technologies and their public accessibility. Main examples are Nasa´s World Wind, Google´s Earth or Microsoft´s Virtual Earth. Basically these applications make use of Web Services, which access geospatial repositories for their rendering of pictures.

Neo-geography is a notion for “new geography”, which bases on a public access to geospatial data and participation in geographic applications [Turner 2006]. The access to geospatial data is executed via the Internet and various Web Services. One does not have to load complete datasets to the client computer, but receives simple pictures according to the requests of Web Services that may be used by specific applications (like Google Earth). The participation in geographic applications describes the user's possibility of recording and sharing geospatial data, which have special importance for him/her. One prominent example is openstreetmap, an worldwide initiative for the public recording of street data [www.openstreetmap.org].

In addition to the public recording and exchanging of geospatial data, the notion neo-cartography combines neo-geographic characteristics with ubiquitous cartography and geo-media techniques. Beside a time- and space-independent access to maps and modification of geospatial data, neo-cartography takes the characteristics of transmitting media, the impact of information-content and user needs for the presentation of geospatial information into account. The new aspects of neo-cartography indicate the possibility to directly access mental imagery by using user inputs. The ubiquitous existence of maps and a public participation develop a social imagery of space that should be used for the abstracted and simplified presentation of space.

3.Communication model´s metamorphosis

The increasing importance of neo-cartography, mass-media influence and public participation in map creation leads to a sneaky metamorphosis of conceptual communication models. Although the very simple model with stimulus-object-response (S-O-R) [Kobzina 2006] is needed, it is not well suited for the new situation in neo-cartography anymore. It was neither when mass-communication became efficient with its intense dissemination. By identifying the main components and relations of a general communication process, a process of relocation can be observed. This process then points out some influence of the neo-cartographic framework on the communication model. The metamorphosis of the conceptual communication model can be illustrated by S-O-R, Shannon and Weaver and Westley/Maclean [Jobst 2008].

The S-O-R model focuses on the inter-human communication, whereas individual preferences and settings are considered as central variable within the overall influence process. The general theory of mass-society becomes substituted by concepts of small groups. The individual is neither isolated from society nor an upright part of society, but belongs to groups with specific characteristics (family, friend, work, ...). These groups serve as orientation for individual behaviours [Horsky et al 1983]. The individual behaviour, which underlies an overall influence process (impact of mass-media), can be split in three main components: a cognitive, affective and conative ones. The cognitive component concerns perception and imagination, which then builds up new knowledge. The affective component relates to collateral emotions when cognitive tasks are processed. The conative component describes tendencies of behaviour that are activated by perception and imagination of an object. Thus S-O-R models base on a stepwise communication.

Shannon and Weaver formalized communication and built up the mathematical theory of communication [Weaver 1972]. The main work lies in the examination of the decoding problem within information theory. For the understanding of Weaver, communication is any kind of contact in a very broad sense [Weaver 1972, S. 3 f]. The principle model of Shannon and Weaver can be exemplified by modalities of telecommunication: a sender uses a transmission line to send information to a recipient. This information needs to be coded in a way that it can be put on the transmission line, e.g. electrical pulses. Consequently this signal has to be decoded again in order to make information accessible. Thus an understandable code at the sender and recipient side is needed to achieve a successful communication. In terms of cartography this simple process has to be expanded to semiotic dimensions, which are formed by syntactic, semantic and pragmatic aspects. For instance the coding of the meaning of an object lies within the semantic dimension, which calls for nearly the same understanding on the sender as well as the recipient side in order to communicate successfully [Petersen 2002, S. 17].

Fig.1: conceptual model of Westley/Maclean, Lacy 1989, p. 5.

By reason of mass-communication´s complexity, information transmission is not as easy as it is explained by S-O-R or Shannon and Weaver, especially when semiotic dimensions have to be considered within the coding/decoding process. The model of Westley/Maclean [Lacy 1989] tries to consider mass-communication, which means that the information reception at the recipient side is divided to a direct, media-based information reception and an environment-based reception. Westley/Maclean assume a ration of 1:4, which means that 20% of the reception are environmental-based and 80% are media-based. Thus this model defines three steps within a mass-communication system that combines actors by feedback processes. The model can be applied to mass-media processes with the overall aim to describe reality on the highest level of objectivity. Then an actor A, who may be a cartographer, describes and prepares reality for specific media C. These processes of preparation underlie various influences X, which disturb an objective description. For example an apparent pollution of water that is obviously disseminated in the news may lead to an extraordinary coding of that affected region in the map (this procedure should only be true for time critical map productions; normally the coding process within a map requires more reliability).

In respect of cartography with a narrow focus on geovisualization and individual visual processing of information, DiBiase stated that "*..visual methods are common and perform a range of functions in scientific research..*" [DiBiase 1990, p. 3]. In an idealized visual research sequence the processes span from visual thinking to visual communication and cover four stages. These stages are the exploration of data, confirmation of apparent relationships, generalization of findings and presentation of research results. Based on the bias that an abstraction of structural features is the basis of perception, which leads to the beginning of cognition, the main potential of computer-based visualization lies in generating mental images and using these images for new ideas. Therefore visual methods form an important part for cartographic mass-communication and play their central role in neo-cartography.

These given examples for conceptual communication models show that for cartographic mass-communication, even the model of Westley/Maclean, are not appropriate because their description is too simple (comparing with communication processes in reality). Due to the metamorphosis of communication complexity and structure, these models do not fit the processes best. This situation becomes more complicated with an exchanging role of sender and recipient as it occurs nowadays in neo-cartography. Nevertheless as result of a broad comparison of conceptual communication models, core elements and their relations can be identified.

4.Relations and main factors in a conceptual mass-communication

A description of mass-communication (and conceptual communication at all) makes use of four core elements, which are heavily related to each other. These elements are the sender, recipient, media and information. Thus six relations can be defined, which are used for expressing importance of the relations.

Fig.2: Relations of the main factors in conceptual mass-communication.

- Sender and Recipient: The main characteristic of mass-communication is the indirect and unidirectional processing of communication. This means that the success of communication generally cannot be directly observed and recipients cannot use the same instruments for a response. This technical-based direction does not exclude an alternating relation, especially when appropriate technologies allow for spontaneous feedback as it is done in Web 2.0.

- Sender and media: The specific characteristics of media offer concrete possibilities for the design of the interface and selection of content. Following the main aim of a successful communication leads to the significance of media regarding a clear understandable coding and decoding.
- Sender and information: In general the sender packs the message/information according to his/her individual criteria of selection. Thus the sender repairs to a situation of necessity in terms of understanding at the recipients side: the information forms some kind of "truth" for the recipient. For a graphical design in maps the sender follows the guidelines of an aimed expression or map usage.
- Recipient and media: The importance of the relation of recipient and media lies in diverse characteristics of media and their consequences for information selection, experience and impact. A high support of the human sensual system results in a high value of immersion and thus a "realistic" experience of the presentation. Virtual environments call for a high grade of media immersion and therefore deliver intuitive and direct interactivity for exploring the synthetic world.
- Recipient and information: The relation of recipient and information mainly concerns processes of perception and cognition. The perceptive correct assimilation of information can be understood as selective, projective, signifying and shaping activities. Most of these activities are affected by previous knowledge of the recipient, which leads to an individual interpretation and according to its importance to a first mental storage.
- Media and information: The relation of media and information bases on the two-way dependency of media characteristics and aim of expression. The information has to be adapted to the transmission performance of a selected media. In terms of cartography this adaptation is called cartographic modelling, which includes generalization, interactivity- and content design.

Actual conceptual models of communication predominantly focus on the relations of sender and recipient [Kolacny 1969, Peterson 1995, Brodersen 2001], which is important for the understanding of semantic and pragmatic dimensions. Within the field of neo-cartography, where the role of sender and recipient change, these models may be restrictedly used. For an increasing amount of examples the role of sender and recipient, the cartographer and map-user, cannot be clearly defined any more [e.g. Openstreetmap Initiative, www.openstreetmap.org]. Map-users take their chance and generate maps by defining their areas and content of importance. Thus the relation of media and information gains importance, although its main focus lies on the syntactic dimension. Supplementary the pragmatic dimension can be more and more incorporated within the relation of media and information due to increasing issues of usability. So, the relation of media and information leads to a crucial differentiation in the understanding of "media".

5.The differentiation of media in neo-cartography

The notion *media* is widely used for any kind of transmission. The notion per se does neither restrict the transport from sender to recipient nor the usage of deployed resources. It follows classifications from an organisational-sociological point of view by differing transmission sign-systems according to sensual modalities (auditive, visual, ...) [Burkart 2002] or communication-technical aspects by differentiating between physical, communicative, technical and institutional media [Bentele et al 1994]. According to an increasing importance of the media-information relation within the conceptual communication model, a communicational-technical classification should be preferred. This technical orientation then leads to the specific distinction between information-carrier and information-content, which leans on the relation media-information and helps in many aspects of geo-media techniques.

The *information-carrier* contains all technical and physical media that are used for an actual transport of information. In exchange all kind of sensual modes, -transmissions and -techniques are used. At least the user independently chooses an appropriate information-carrier that satisfies information needs as expected.

The *information-content* incorporates perceptive manifestations of information. In terms of cartography information-content follows the paradigm of expressive and efficient transmission of geospatial information [Mackinlay 1986]. Concerning this matter the perceptive barrier, which is built up by human physiology and characteristics of information-carrier, has to be considered in information-content design. All instruments that are used to understand and successfully transmit information can be subsumed as information-content. By a classical understanding information-content names text, pictures, videos, animations, 3D elements, ... [Schweiger et al 2001].

The distinction of information-carrier and information-content allows for an expressive quality description of the presentation on a specific transmitting interface. This quality description bases on the relation of information-carrier and information-content, a crucial aspect of geo-media techniques in neo-cartography.

6.One crucial aspect of visual geo-media techniques in neo-cartography

The user interface variety in neo-cartography complicates a precise information-content preparation for cartographic purposes and possible declarations for its quality. In fact any mobile and fixed device can be used as interface for ubiquitous maps. In many cases these interfaces consist of displays with varying techniques (CRT, LCD, OLED, ...) and resolutions (mobile phones, PDA, MID, ...). Thus the resolution is a key factor in order to either manually or automatically prepare expressive visualizations. By reason that the resolution of the information-content does not necessarily match with the resolution of information-carrier, a relation between these two has to be defined. Furthermore an expansion with the resolution of the eye, which is depending on the viewing distance, provides a value to express semiotic quality. This value can then be used for algorithmic embedding e.g. in case of resolution dependent information-content variation [Jobst 2008].

The main part of this semiotic quality bases on a uniqueness relation, which says that the resolution of information-carrier (the transmitting interface) AÜM equals a multiple of the resolution of information-content AIM.

$$AÜM = Kim * AIM$$

Fig.3: Semiotic quality as relation of the eye´s-, interface´s- and information-content´s resolution.

- Kim = 1 (case 1)...describes that the resolution of AÜM equals AIM. In this ideal case one information pixel of the information-content will be represented by one information pixel of the information-carrier. No interferences of the two raster resolutions occur.
- 0 < Kim < 1 (case 2)...in this case one picture element of the information-content will be represented by several pixels of the information-carrier. The more Kim moves to Zero, the more picture elements of the information-carrier will represent one single information-content. As result a rasterization of information-content will be observable.

Picture elements of the information-carrier are not efficiently used.

- Kim > 1 (case 3)...in the case that the uniqueness factor is greater than one, several picture elements of the information-content are represented by one single pixel of the information-carrier. This uncontrolled clustering of information generally leads to information loss and often a loosening of semantically connected information.

Fig.4: A map on a mobile information-carrier depicting (case 2), (case 1) and (case 3).

One would argue that this uniqueness relation is only valid for raster to raster projections, when rasterized information-content is used on a rasterized information-carrier (display). In fact this relation is also valid when vector data are rendered on a display. Then (case 2) would show no raster artefacts, but in fact it will use much more picture elements of the information-carrier to visualize one information element of the content. Thus the amount of picture elements of the transmitting interface will not be efficiently used. The main principle that each information pixel should have its role for information transmission will not be fulfilled in that case. Beside an enlarging or downscaling of the picture nothing else happened in (case 2) and (case 3). The information content became not adapted to the resolution of the information-carrier.

7.A common relevance for geospatial communication in neo-cartography?

The mentioned crucial aspect of visual geo-media technique is a well known problem in digital cartography, especially when the clear depiction of signs has to be done with digital interfaces [Malic 1998, Neudeck 2001, Brunner 2001]. The main problem of resolution remains: in comparison to printed information carrier (paper), digital cartography has to deal with much lower resolution, which means that symbols on standard displays (72 – 96 dpi) request about three times more space [Lechthaler et al 2006] in order to be unmistakable understood.

For a general view in neo-cartography this situation becomes even worse: a huge variety of display techniques come along with various resolutions. Whereas the resolution of LCD and LED correspond to standard displays, high resolution OLED´s can technically provide nearly printing resolution (300 dpi). Additionally the display extension varies enormously, from 1” to 5” diagonal and more. Thus a useful geospatial content will vary with the resolution and display extension. This aspect is even relevant for syntactical considerations, without thinking of usability or context situation at this stage.

Moreover the graphical and processing performance of mobile devices increases rapidly. This fact and evolving Web Services in geovisualization [Hagedorn et al 2007] offer new possibilities to incorporate complex computer-graphics on mobile devices. For instance virtual 3D environments can easily be established on PDA or Mobile Internet Devices (MID) with Web Perspective View Services (WPVS). From a communication point of view, virtual 3D environments may enhance geospatial transmission. At least 3D presentation supports the creation of a mental model and knowledge acquisition [Bülthoff et al 2001, Kirschenbauer 2004]. If we want to be sure about the impact of virtual 3D environments on mobile devices, appropriate tests should be done. These tests will only deliver useful results for the semantic and pragmatic dimension, if all discrepancies from the syntactical point of view were removed, e.g. the uniqueness relation should be expanded and verified for virtual 3D environments on mobile devices. At least the graphical presentation needs to follow the main premise to efficiently use all information pixels, thus to avoid “dead pixel values”. In order to do so, variations reach from deforming projections (progressive and degressive projections) to design-mechanism modifications and appropriate use of graphical variables [Jobst 2008].

Fig.5: In order to avoid “dead pixel values” and use the transmission plane more efficiently, a degressive central projection may deliver better results than the traditional central perspective.

A respective example for deforming projections can be given by the degressive central perspective: at the very first glance this example (Fig. 5 left) will make no sense due to the distortion of the ground plate. In fact this distortion helps for an efficient use of the complete presentation plane by syntactical aspects. All information pixels contain relevant information. There are no areas concerned with sky. Although its pragmatic use may be queried, even a possible solution in terms of usability can be given: the “ego-shooter” view in the front allows for a high grade of identification within the surrounding, whereas the ground-view in the back allows for an overview and short-term planning in movement direction. This situation may be helpful in navigation systems, when maps are the indented information-content.

The variety of user interfaces, their resolutions and future Services show the relevance of splitting information-carrier and information-content for neo-cartography. This allows for a precise modelling of the syntactic, semantic and pragmatic dimensions of geospatial communication. Furthermore the possibility for modelling the access to various user interfaces becomes more clear from a cartographic point of view. The characteristics of the user interfaces can be considered independent from any information content. This open approach offers a variety of potentialities to overcome the massive UI restrictions in terms of overview, resolution or information depth.

8.Conclusion

This contribution focused on the new terms neo-geography and neo-cartography, which evolve due to user-participation and opening of “stimulus-object-response” structures. It could be shown that from a conceptual communication point of view, the importance of media and information content grows. This invariably leads to a splitting of information-carrier and information-content, which consequently allows for a definition of uniqueness relation between both. This relation then enables a more precise description of the transmitting interface and the preparation of information content.

Future developments for virtual 3D environments on mobile devices will rely on the relation of information-carrier and information-content if it comes to semiotic correct visualizations, as these are requested in cartography. This crucial aspect of visual geo-media techniques defines considerable steps for the 3D rendering process. The development of rendering techniques results in new ways for information enhancing variations of cartographic semiology.

With the conditions of neo-cartography, one direction to go are Cartographic Visualization Services. Beside an ubiquitous access to geospatial applications and data, the information-content has to be adapted to the information-carrier and specific needs of the user. The splitting of carrier and content (media and information) now allows for Service development. Specific user needs with their situational and cultural based characteristics call for intense investigations in future.

9.References

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