Modeling of communication in WebGIS for dissemination of spatial data and promotion of spatial analysis.

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ABSTRACT

The work aims to support the dissemination of information and spatial analysis within the GIS via the media of the world wide web "- the global network, which provides that documents are linked and executed on the Internet. For this task, it is necessary to understand the relationship of communication promoted by new digital media, particularly with regard to consultation and analysis of data spatially localized, with the aim of building information on the territorial reality. In this sense, our interest is understanding how to make the processes of communication, especially for studying this process in applications of information technology for dissemination and analysis of spatial data. Once studied the phenomenon, is proposed for modeling of a product based on GIS (geographic information system) to support decision making through the media web by implementing the proposal called Webgis in case studies in Brazil and Italy. From the assembly of prototypes, tests are designed for functionality and usability, through access to the network between countries, multi-access.

1. Contextualization

With the exponential growth of people who are connected to the worldwide network of computers, the World Wide Web has become a very important vehicle for dissemination of information for everyone. Their activities began with the dissipation of documents containing text and some images of low quality, such as GIF and JPEG. The protocol HyperText Transfer Protocol (HTTP) and HyperText Markup Language (HTML) on the operation and were allowed, and transmit content online, increasing interactivity, and although limited to the current standards of conventional graphics applications. The most basic form of dissemination in the context of geospatial data, are WebMaps. According to Ramos (2005), from the concept of hypertext, the hipermagas emerged, defined as interactive digital maps, which allow the user to access a series of georeferenced information through links. It is an index map, which allows queries to different scales and different sets of information. The constant evolution of technology has enabled the creation of digital libraries for publishing data. The digital libraries of geographic information are centers that provide spatial data infrastructure for the creation, structuring, storage, processing, retrieval and distribution of spatial data (Chambers et al., 1996). You could say that Webgis and the portals are part of such service. Technological advances resulted in a new map in which the products are organized more quickly and interaction is almost in real time. Starts up the period of multimedia cartography. The design of interactive multimedia and hypermedia was introduced to refer to the media combined with the structure of interactive links. The emphasis changes from "static" to "dynamic". With this, the media has become the interface of
communication between sender and recipient of information, interaction and the key to the formation of knowledge. "Systems are becoming interactive ways to communicate the endless spatial information" (Rijken, 1996, p.37).

The Webgis then can be understood as a system for providing construction and mapping using the interface of the Internet. It seeks to solve the difficulty of taking the information from point to point, or decode the information specialist for the end user. Currently, the construction of the thought of Geoinformation is centered at the stage of concern about communication between the specialist producer of information and the end user may often not know much about the concept mapping. This is because of the perception that the production of information does not necessarily mean the transmission of knowledge, since the data only becomes a loss of knowledge if you bring a new perspective and a new look. Consequently grow the studies on ways of viewing and communication patterns toward the correct dialogue between the two points of knowledge. With this, enter the modeling of communication as an important tool to study and understand how the different types of users use Web browsers and how they decode the information generated within the GIS. With this, you can create geographic information systems with interfaces to high level of communication and usability and ready to be published on the internet.

2. COMMUNICATIONS MODEL

Within the context of mapping and communication models, the maps arise as important means of communication to provide the user information about spatial phenomena duties of support for decision making and spatial analysis. The role of communication beyond the maps are used as tools for visual analysis, the process called cartographic visualization (International Cartographic Association, 2001). From simplified, means use of visualization methods for graphical analysis and presentation of data (DiBiasi et al, 1992).

The use of maps as a means of communication, there are three elements involved: the cartographer as the transmitter, the map as a channel of transmission, the end user as a receiver. There is always the risk of noise in the communication if the sender did not USA and the code if the code is not shared by sender and receiver, and if the channel does not contain the code properly. The interest on the production of maps is not new. One of the most important studies was Kolacny (1977) which proposes a model of cartographic communication shown in Figure 1.

This model assumes that there must be an overlap of the realities of cartographers and users so that they understand the significance of representations of information. For the preparation of a map, the cartographer says the world about their perspective and represents the map. The user draws a map of this message. What the map can communicate efficiently, we must evaluate all the conditions of influence in this process, ie the needs of the user, means of presentation, the level of understanding of users, the fact of use, the perception of the user, possibility of techniques and their costs than the complexity of information. Added to these concerns, the process involves two stages: the appearance and form and content in the second stage the details, such as the symbology used.
As the map on paper could not meet all users due to different levels of knowledge and perceptions, will begin a new stage in the process of cartographic communication:

"The computer, which until recently was used to automate the production of maps on paper, begins to incorporate a form of interactive mapping and becomes, in this case, not only a means of producing maps, but a means of communication. (Peterson, 1995, p. 147)

The interactive maps, or using any media, were seen as a new way to manipulate the information so that the characteristics and phenomena of the real world would be better perceived:

"Maps on paper can only represent a world in a static and immutable, the mental representations that are derived from it define the user’s interaction with reality." (Peterson, op.cit., P.20)

As the user can change the map to bring it to their perception of the world, the map is no longer a static and becomes an Open Work, turning into an interactive presentation and controlled by the user. The concept of Open Work by Umberto Eco is proposed (1962), great Italian linguist and author of important studies of semiotics, which has been professor at the University of Bologna. The author argues the importance of participation by the interpretative readers (in our case user mapping), the completion of meaning that readers do the work in the context in which they operate.

Peterson presented the proposal for a new model of cartographic communication which the control of the communication process is the participation of the user and is no longer only in the hands of the cartographer. In this model there is an environment for the use of the map prepared by the cartographer and the foundations and layers of view, but the user who decides how and what information will be provided.

(Figure 2).
A great effort has been done for the development of applications for interactive mapping. These surveys began in 1979 as the system DIDS (Domestic Informations Display System) and see increasing until today with the creation of systems such as i3geo that can be incorporated into the class of open systems by having the source code available to developers for initiating the process of customization of data. This is a system open to both the cartographer as to the user:

"Perhaps the most important change in the practice of interactive mapping over the last ten years is the emergence of" user-producer "of maps." (Fairbain, 1994, p 11).

Based on this view and dynamic user interaction and cartographer, according Cowen (1990), there are four stages in the construction of the highlights of Geoinformation thought: the modeling of processes, the development of applications, the emphasis on tools and interest in database. Adds to these four stages a farm, raised the concern with the dialogue between the products generated by GIS and its users. This justifies the modeling data to objectivity of the information.

In this, the new mapping is in communication with the concepts of the Open Work, as can be seen as a model of communication possibilities that never runs out completely. For Erwin Panofsky (1955, p.29) the information provided in a communication are not as a fixed and settled, but as a proposal of meaning that the interpretation will be given by each in different ways. To summarize, the originator of the information produces a communication in itself and just want it to be enjoyed and understood the way produced. But the reaction to stimuli and understanding of relationships, behind a concrete existential situation, a conditional sensitivity to certain tastes, experiences, experiences that allow the understanding of the information is verified according to a particular individual perspective. In theory, the final form of communication can be understood the second multiple perspectives while being herself.

Within the Open Work, the code is not hidden, or allows the continued construction by others who want to incorporate the project. Good examples are the free software available on the Internet to create Webgis, as is the case of i3geo said. This software provides the codes to open a user uses the data generated to date and continue the work from a certain point can create a new standard of communication and availability of data.

3. INTERFACE AND INTERACTION

According to Freitas (2005), the concept of interface is expressed by the presence of one or more tools for use and handling of any information system, be it material, whether it is virtual.

According to Leite (2000) believes that a man-machine interface is part of an artifact that allows a user to monitor and evaluate the operation of sensitive devices through their actions and able to stimulate their perception. In the process of interaction the user-interface system is the combination of software and hardware needed to enable and facilitate the processes of communication between the user and application. The
An interface designer should know the functioning of cognitive activity of the user interfaces to design effective and easy to use (Eberts, 1994 apud Lucena, 1998).

"The user interface must be understood as part of a computer system with which a person comes into contact - physical, perceptual or conceptual." (Moran, 1981, p.7).

The Common Front Group (1995), an interface design is a combination of art and science. Moreover, it needs to rely on aspects of cognition to your efficiency is full. Another important factor in the design of interfaces is to ensure consistency of application with the use of icons, the name of the functions, location of buttons in different windows always the same, etc.. Some of the important elements in the composition of an interface are: communication and interactivity, navigability and usability, accessibility and applicability.

3.1. Report / Interactive

The concept of objectivity (Souza, 2005) refers to the correct dialogue, through the interfaces, the message from the designer about what the system (which may be a website, a computer program, a video game or interface of the mobile phone), and make clear that this system serves, for whom it is intended, how it works, etc.. The assumption underlying the concept of objectivity is that if a user understands the decisions that the designer has to build the interface, increasing your chances to make good use of that system.

The interaction then becomes an essential factor for which there is a proper dialogue with the user's system. According Makedon (1994, p. 41) is the interactivity that "puts you in control of the system, manipulating the media in several different modes of interaction." And that will allow the cooperative multiple authors.

3.2. Airworthiness and Usability

It is common, it is the concept of usability, the use of the term "easy to use." It is common understanding that "easy to use" readily be confused with "less clicks to get to an expected response." In short, people confuse architecture with usability of information.

Usability is the technical term used to describe the quality of use of an interface (Bevan, 1995). This is an important quality because it interfaces with usability of users increase productivity, reduce errors and the occurrence (or its severity) and, not least, contribute to the satisfaction of users. Satisfaction is an important criterion, but not the only, to determine the overall quality of application. In general, this is a criterion for the end user purchases a software or regularly visit a site.

Navigability and usability are the same concept, that is: the degree of ease that you may have in contact, maintain interest, navigation and use of hypermedia, ranging from the use of icons, and menus to search by keyword key.

3.3. Accessibility

Accessibility is the term used to describe the usability problems encountered by users with special needs, such as users that have some type of visual or hearing difficulty. Accessibility involves making an interface usable by anyone, regardless of any physical, sensory, cognitive, condition of employment or technological barriers.
Accessibility and usability are closely related concepts, as both seek to improve satisfaction and efficiency of use of the interface. However, accessibility refers to a population far broader and more generic.

3.4. Applicability

The applicability of a system also determines the quality of use. This concept is related to the usefulness of this system in a variety of situations and problems (Fischer, 1998). This concept determines how the system is useful for the context in which it was designed and in other contexts that the system can be useful.

3.5 Usability tests

The test is performed in laboratory usability and aims to allow it to assess the factors that affect the usability of software, or ease of learning, ease of use, efficiency of use and productivity, user satisfaction, flexibility, utility and safety in use (Preece et al., 2002). Through the test seeks to quantify the performance of the user. In this measurement, attempts to quantify the measurement of time and user actions, such as time spent to perform a task, number of errors performed, the percentage of users able to recover from an error, or percentage of users to they are satisfied with the application, or to choose the application to other system being used. The results collected identifies problems according to their severity. The result of the analysis finds the weaknesses in relation to the application interface and use the same and it is important to repair serious defects of the application. The tests are:
- Problems catastrophic: it prevents the end user to perform the task.
- Serious problems: atrapalha the task.
- Cosmetic issues: the implementation delays or annoys the user.

3.6. Communicability test

Just like the usability tests, the communication test is also make in a controlled place. However, its objective is to evaluate the quality of communication between the designer and the user: "The test of objectivity is examined through a small set of expressions that the user can potentially use to express in a situation where a break occurs in the communication with the system. " (Prates et al., 2000, p. 34).

In the case of tests reported, the recording of user interaction with the system during the test should be made, because the analysis will be mainly from the registry. In addition to the notes of the observer during the test, the recordings on video can also be made to enrich the data, and allow verification of the reaction of the user on any part of the interaction observed. The analysis is divided into three stages, according Prates et al., 2003: Labeling, Interpretation and Semiotic Profile, those described below.

3.6.1. Labeling: It consists of recordings to watch the interaction and give appropriate expression in times of disruption of the interaction. In labeling, the evaluator assists the recordings made of the user interaction with the application. To see a breakdown of the evaluator interaction sequence of actions associated with a problem of words to communicate. Describe some set of expressions, their meanings and actions of some interface that characterized each of them.
To be able to determine all the expressions and actions, it is important to observe the user and make notes or record the features of the user through a webcam or a camera. It is essential to make annotations on their actions in the application to determine the problem in communication and to adjust the noise.

3.6.2. Interpretation: It consists of tabular and consolidate the information obtained, ie, the expressions obtained by linking them to problems of classification and guidelines for interaction design. The generic classification defines the problems of interaction as the navigation, attribution of meaning, perception, failure to run the task, and lack or refusal of affordance.

Problems of failure in the execution of the task are most serious, since the user can not achieve the goal that led him to use the application. The navigation of concern to those in which users are "lost" during the interaction with the system. The allocation of meaning, as the name says, happens when the user is unable to assign a meaning relevant to the signs found in the interface. The perception is when users can not see any response from the system or its current status. For the problem of lack of affordance, the user can not understand a solution offered by the designer, and ultimately perform the desired task in a more complicated, that does not characterize the solution of the main designer. Finally, in case of refusal of affordance, the user believes the main solution offered, but chooses not use it in its place and use another form of interaction that judges be better.

3.6.3. Semiotic Profile: It consists in interpreting the results of the previous step, within the theoretical framework of semiotics in an attempt to reconstruct the meta-message being sent by the designer through the user interface. Through the tabulation of results, this last step adds to the assessment of language problems identified in the application interface, and can make comments on possible assumptions of design knowledge and tactical use.

3.7. Usability Test X Communication Test

The difference of the two tests is of use as they wish to provide for the interface. The tests aim to assess usability of the solution to the designer of ease of handling the application, while the test evaluates the objectivity of reporting done on this solution. For this, the usability tests typically collect quantitative data and information designers seek during the development cycle which does not correspond to objective criteria for the desired software. Testing of objectivity, in turn, collect qualitative data and are intended to inform designers about their points of application that are not being successfully transmitted to users. It is important to make two tests fail to achieve the application performance to ease of use and understanding of communication.

4. ROADMAP FOR THE METHODOLOGICAL MODELING A WebGIS

This work was based on principles of communication for the composition of application of Webgis. Thus, following the methodological steps of organization and operational deployment of the system itself.

4.1. Operational Level: Development of application:
At the operational level objectives are met in the level of conceptual and operational techniques. In this stage define what users would like in an application of GIS on the Internet, which the visual characteristics of these elements so that they are communicative, what are the advantages and difficulties to tinker with software already on the market, etc. The procedure is divided into three steps: definition of tools, building the interface and an indication of the analysis of interest to be covered by the system.

4.1.1. Tools: To determine which tools would be needed within the application, we selected twenty-seven people with different abilities in using the computer and the Internet to answer a questionnaire and do some practical tests to assess where the difficulty of handling. In this context, after studying with this group, set up what would be the use of basic tools, which would be the use of custom and what the best graphic icon to represent the tools. For basic use of tools, the buttons were set to zoom, pan, refresh, fit view, information. For interactive tools, were defined: measure words, measure area, consult the database, insert xy, insert graphics, insert text, lens, interface with Scielo (Scientific Electronic Library Online), interfacing with Google Earth, 3d models, interface with servers and printing photos of thematic maps.

4.1.2. Interface: To be defined as the interface was also selected a group of thirty people with different knowledge about the use of computers and the Internet. They discuss everything related to layout, for example, where the tools should be located where the menus should be located, what the characteristics of the caption should be open, or which of these features the user can customize according to their interests.

4.1.3. Analysis: In this step a group of four experts answered a questionnaire saying what would be the minimum territorial analysis. Were cited the analysis of territorial area of influence such as centroid, buffer, groups, dissolves, and distance between points and query by attribute space.

4.2. Level of Implementation

Initially it is necessary to examine the conditions of hardware and software available for deployment. The objectives outlined in the conceptual stage and define the operational environment of application.

so defined of interaction. In to use the i3geo, Apache software the GIS Grass. was a Shapefile geometry and feature space. WGS84 geographic coordinate system. As the interface was chosen from the test of objectivity, that it is a clean interface in which a large part of the screen was available for viewing the map (Figure 3).
In this custom interface, the toolbar is basic positioned in the left corner of the screen, the interactive tools on the top bar and area for handling of layers on the right side of the screen. There are three tabs available from the control layer. The tab “add” is responsible for download and upload files tab and “legend” for the display of the components of the themes of legend visible.

### 4.2.1. Tools:

For the tools and basic zoom and pan, were tested some existing applications to determine which design best graphic representation of the tool. Some software were the Singer, i3geo, Geomedia and other software that does not relate to GIS, such as the Photoshop and Corel Draw. For determination of the best icon and more communicative element, was made a test with 27 people divided in different groups: people who use the computer occasionally - once a month, people who use the computer randomly - once every week and people using the computer daily. The icons more understood by the vast majority of users were in Figure 4:

![Figure 4 - Basic Tools](image)

For the toolbar with elements defined as the most interactive and different from usual in many applications, the tests were done to assess which of these were interesting to keep in prototype. Among the tools tested, the choices were: measure words, measure area, consult the database (selection), Enters Chart, Insert Text, Lens, Scielo, Connecting to Google, 3D, upload photos printing of thematic maps. Therefore, the testing of graphical representation, most accepted were those of Figure 5:

![Figure 5 - Interactive Tools](image)

As we are dealing with the tools that are actually evaluated for their ability interactive, each tool has some way to attract the user and at the same time facilitate the usability of this, even for users who have the habit of using applications of GIS. All the tools to be inserted in the prototype went through a test with the twenty-seven users to see not only the best graphics use, but what is the best way to make the tool available for it to be used without major difficulties. All the tools described were planned to take the suggestions of users and adjusted from our observation of errors in
communication usability in some software that provide the same tools. For all, it was clear that the best way to release it by opening a dialog box explaining and showing the steps to be followed by the user for the correct use of it.

4.2.3. The interface:

The properties of the map and answer the most important elements of setting if the application is easy to handle and is communicative, ie the interface of the prototype. To get the interface to determine which elements are important for better visualization mapping, a search was conducted with thirty people in three different digital levels of knowledge (people who use Internet every day, people who use Internet casually, people who never use the Internet). A questionnaire was used to determine what users would be able to customize according to their interest to create their thematic maps. As the system brings the idea of open work to be as communicative and accessible as possible, this is a very important step in defining the prototype. The changes required by most users in the questionnaires on the interface were: background color, color selection, size, scale, legend.

Another question was much quoted on the legend of the layers visible in the system. She was a very item observed by all types of users, regardless of the degree of intimacy with computer / internet. All showed the desire for customization according to their individual interests in view. The elements of a larger request for customization are: name of the layer, look (look for some information in the table of data), or text label (stamp on the map the existing data in a column of the table) and edit the graphical representation of the layer. Beyond these possibilities, other customizations are present, such as: table - Tool that works with alphanumeric data. Here, if there is a column with numeric data, you can work with a number of statistical operations.

5. TESTS AND FINAL CONSIDERATIONS

Very little has been studied and developed to date on the communication patterns associated with the mapping. With the significant spread of information, especially those linked to the web, it is evident the importance to create interactive interfaces to decode the language that will bridge between expert and user. This project has the innovative feature of a model interface tested and approved by different types of users. The proposed communication model will be of great interest to the progress of the study of cartographic visualization and visual communication, since it creates a system fully evaluated and tested by more than fifty users of different levels of knowledge. Some results have been achieved, especially concerning the theoretical conceptualizations and operational definitions.

The three prototypes deployed to the testing tools and the properties of interface, usability, communication and multiaccess managed to answer some questions for the improvement of the model.

It was noticed that there is some difficulty with the group of people who are not accustomed to the use of computer / internet. People who have no knowledge of cartographic concepts also had a response below the expectations of the time required to perform the pre-set tasks. The tests showed that although this group of people achieve the goals, it sometimes takes too tired to the point of using the system. Many of them were satisfied with the issue of a work system be open and allow the customization of virtually all elements of the interface.
The greatest gain in knowledge was for the group of those who already use the computer with some frequency, but not daily, and especially for people who have basic knowledge about cartography and also have the habit of moving into other systems on the web daily. This finding confirmed the idea that the intermediate group would be aware of the group would have more gains in learning. The group that was more calm in handling the software, as I expected, was the addition of users who have thorough knowledge of computer know some concepts mapping, i.e., the experts. The results achieved with the system deployed were satisfactory and met the task of detecting the positive and negative points of the model. The result of the system as an Open Work has been received by all types of users. Participation in the ALFA-FARO agreement was of great importance to the two universities involved, as has the dissemination of data through the ornamental rock geoprocessing tools, delivering a system with the final results of the agreement. For the Federal University of Minas Gerais, the benefits are related to the completion of tests of usability and communicability for completing the final step of our Dissertação de Mestrado (Sheyla Aguilar de Santana) during the Analysis and Modeling of Environmental Systems. One result of this development work was the possibility of inter and multidisciplinary coordination between the Federal University of Minas Gerais and the University of Bologna, through exchange of knowledge, providing a product and providing results to the community of users of georesources.

6. References:


