INTERNATIONAL SYMPOSIUM
"MODERN TECHNOLOGIES, EDUCATION AND PROFESSIONAL PRACTICE IN GEODESY AND RELATED FIELDS"
04 – 05 November 2004, Sofia

CONSIDERATIONS OF MAP DESIGN FOR HAND HELD DEVICES

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ABSTRACT

In this paper, map design requirements and its constraints are explained in terms of small display cartography. Cartographic visualization and map design fundamentals are examined moreover their requirements caused by new technologies, just as hand held devices, are mentioned. These new requirements are examined comparatively with conventional methods and finally future trends on this subject are briefly emphasized.

1. GENERAL

Cartography is the science, art and technology of making, using, and studying maps. As a result of the technological developments, significant changes on cartographic process occurred in time. Digital map production became as important as classical methods by the help of computer technologies. Moreover Internet brought a new perspective to the cartography so Web cartography became an important and discussing subject for cartographers [Kraak 2002a, 2002b, 2002c]. Nowadays, mobile mapping technologies and methods, which aim to design maps for mobile devices such as mobile phones or Personal Distiller Assistants (PDA), introduced mobile cartography or small display cartography. As a result, all developments on map design and presentation technologies have added new vision to cartography. However it has made new discussion points in cartography.

Map design for hand held devices (Pocket PC, mobile phones, in-vehicle computers, and etc.), which are used for different applications just as navigation, vehicle tracking, data acquisition, and etc., is one of the most important and current discussion point of cartography. It needs different and special design considerations in addition to conventional cartographic methods [Dogru 2004]. Symbol selection, feature sizes, map scale choice, memory limits can be considered as only some of these important subjects. In this study some information about use of the hand held devices are given in the second part than cartographic visualization and its basic problems are examined in the third part. Besides all of the components of map design (symbolization, color, text and etc.) are handled in the fourth part by comparing classical and new techniques and technologies used for small display cartography and screen map design. Finally the last part of the paper includes conclusion and author's recommendations.

2. USE OF HAND HELD DEVICES

Continued technological developments affect cartography and its studying area just as the other disciplines. Cartographers produce maps for the users and users benefit from the maps to obtain the required information. Nowadays, this relationship became more important. Because new technologies have made the maps an important part of everyday life through screen maps published on the internet and navigation systems that use maps as basic component. On the other hand, technologies on electronic have introduced high quality hand held devices to the market. However these devices have a wide spectrum from mobile phones, PDAs, hand held GPS to in vehicle computers. All of these devices have different user types and they are used for various purposes. For example, while some hand held devices (mobile phones or PDAs) are used for personal or car navigation, others are preferred for data acquisition or games just like orienteering (Pocket PC or hand held GPS). The base detail of this technology is that maps are the vital component of them and these maps should be designed by using different visualization and design techniques from the classical maps.

3. CARTOGRAPHIC VISUALIZATION

Cartographic visualization depends on the aim and display media of map. Various maps, just like topographic maps, screen maps, electronic atlases, 3D animations and etc., are presented on paper or screen as online or offline. Moreover, today it is possible to publish them online through intranet or internet. Although visualization can be done by anybody nowadays, the question "How do I present what to whom, and is it effective?" should be answered. Here the word "presentation" includes both graphic and semantic information presentation. "what" includes qualitative and quantitative characteristics of spatial data which will be presented. "to whom" includes map user and his age, characteristics and education and finally the word "how" includes the facilities of the cartographic methods and techniques in different media [Kraak 2002b].

Cartographers use various tools just as functions, rules and conventions for visualization. Simplification algorithms used for generalization of the coastline are the example of the functions. Use of the graduated symbols for representing quantity of attribute data or illuminating from northwest while using shading method for the representation of the elevations can be considered as the example of rules. On the other hand, representing the object with their natural colors (water with blue, mountains with brown and etc.) is only one of the conventions applied by most of the cartographers. However using all of these known things can not be sufficient to obtain the desired result [Hardy et all. 2004, Kraak 2002a, Kraak & Ormeling 1996].

"Generalization" will appear as a problem in visualization because of working with different scales as a result of spatial data base content and aim of the map. For example if data is generalized too much, features can appear angular at large scales. On the other hand, thematic or topographic use of the spatial data effects and changes design. Nowadays, these kinds of design problems are solved with the systems which include the layers with their automated filters according to scale of screen. Representation of the qualitative and quantitative characteristics of the data is another important design problem. Moreover, quality and consistency of the data obtained from different sources appear as an important problem while compiling maps and data acquisition.

Although new technological developments submit useful facilities just like www or multimedia for cartography, they cause the production of low quality maps. It shows that the development of the technology and cartographic design do not proceed simultaneously. However, developments on the Geographic Information System software have caused both new map makers and devices for

producing and presenting maps. This situation has not only increased the map production and developed its production techniques but also resulted with new design problems.

Presentation of the information is an important and classical subject of the cartography. Cartographer works on an unknown spatial data produce multi purpose maps for communication of this data. However exploration of the information needs the specialist of the subject if it is an unknown issue. Maps produced in this process are generally single purpose maps and their compatibility are completely depends on problem solving method of the specialist. Maps are the most available tools for exploration of information in a simultaneous, interactive and dynamic media, when their connection with database is set up. Therefore today most of the companies or organizations use maps as a communication tool. However specialists who interested in these kinds of data to produce maps to present information should be experienced on cartography. Although there are similarities between presentation and exploration data, there are significant differences between these processes. Exploration of the spatial data is the acquisition of the different kinds of data from different sources. There is a tendency to an approach which presents demand-driven data from cartography which presents supply-driven data. Moreover, nowadays cartographers major on developing new tools, spatial data access (generalization, Multiple Representational Data Bases-MRDB, and etc.), and effective communication because, they should design or develop new technologies for presenting the data, which are in different aims, scale or combinations, to the users [Kraak 2002b].

4. MAP DESIGN

Map design includes various factors just as; cognition level, map content, symbols, standards, scale and accuracy, depends on characteristics of the analyses in the scope of the aim of the map. Most of these factors are related to each other and they effects themselves. Production cost, time and aesthetic play a determinative role in all map production processes. Presenting information on screen is much more limited than on paper. However, presenting numerous comparative data along with each other becomes easier by using a well designed database. As a result, although screen map design is more complicated and limited, it has various special facilities just like interaction, animation, multimedia (audio, video and text). Besides, graphical design and symbols that can not be produced on paper can be formed on screen by the help of the technology. On the other hand, some restrictions appear when maps wanted to be presented on internet or hand held devices. The file size of the map or its download performance is limited with the memory of the devices or the speed of the internet access. Therefore more generalization is needed for screen map design according to the aim. Use of vector format can be another solution these kinds of problems. Pull down menus, scroll bars, activated area, voice or image connections are used to reduce the content of the generalized maps for screens [Worm 2002]. Today optimal solutions are produced according to the aim of the map and its usage conditions. For example, if hand held devices used for car navigation are considered, although their display media is smaller than the computer screens, it can not be possible to use pull down menus during navigation so voice messages help the map user instead of pull down menus. On the other hand pull down menu technology are generally used while designing maps and the systems for hand held devices used for personal navigation.

Map content completely depends on the map scale. If the screen scale reduced too much it will make the map unreadable so it will be difficult to use such map for data communication. On the contrary, larger scales cause orientation problems (loss of orientation) for the user. Screen scaling solutions (static and dynamic scaling) used for web cartography are used for hand held devices too. Static zooming is mechanical increasing in object size in natural scale. Therefore this kind of zooming can cause orientation and readability problem on larger and small scales. Dynamic zooming is done by server requests by using database. There is a direct relation between the scale and map content. Demanded cartographic symbols can change content based on scale. For example,

a settlement represented as a point in smaller scale can be represented with an area symbol in a larger scale. Dynamic zooming technique is frequently used while designing maps for hand held devices. As a result, a default data representation scale should be determined while designing maps.

Map title and legend are other components that make a classical paper or screen map more understandable. On the other hand, north arrow is used for orientation if there is no graphic scale or grid. Finally, additional information just as projection and bibliographic information are other details that differs a map an ordinary sketch. Although, all of this information is needed for classical maps, a screen map can net represent this amount of information because of display area problems. However this information can be taken from the database. There are more complex problems for hand held devices in this situation. Their usage conditions, aim and display limitations affect all component of the maps and most of these elements are not shown on screen.

4.1 Cartographic Symbolization

Selection of the true symbols for the presentation of the information on maps is related to experience of the cartographer. Data's nature is tried to be transmitted with symbols designed by using graphic variables. The author of the book "Semiologie Graphique" says that *"if ten different cartographers design a same purpose map, all of their solutions are result in ten different maps"* [Bertin 1983, Kraak 2002c]. A symbol should emphasize the basic characteristics of the attribute which will be represented by it. Characteristic of a data is qualitative or quantitative. There is ordered data between them. Ordinary hierarchy is used for classification of the ordered data. While qualitative data is classified on nominal scale, quantitative data are classified in interval and ratio scale [Kraak & Ormeling1996]. Besides other characteristics of the attribute data (being discrete or continuous and absolute or relative) affect the symbol choice while designing maps.

There are point, line and area symbols and texts on a map. Symbols are designed by using graphic variables (position, size, value, texture/pattern, color, orientation and shape) defined by Bertin. Each graphic variable has a different information characteristic. And they are sometimes used in screen and classical map design differently. For example, the texture, which is frequently used for area symbols in classical map design, is not advised for screen map design for area symbols. While designing screen maps two new variables, transparency and shade, is used instead of texture [Bertin 1983, Ed 2001, Kraak 2002c, Ulugtekin and Bildirici 2002, Ulugtekin et all. 2003].

Point Symbols: These symbols are examined in three categories which are pictorial, geometric and alpha numerical. All of these symbols are very simple and understandable. Especially pictorial symbols are frequently used, because they do not need legend. On the other hand geometric (abstract) and alpha numeric symbols need legend. Point symbols are mostly used for the presentation of the qualitative data but it can also be used for the representation of the quantitative data by using them in different sizes. Moreover the graphic variables shape and color, can give qualitative characteristics to these symbols. On screen map design point symbols are produced with greater dimensions than paper map design. The basic problem in this stage is designing these symbols with their all characteristics in minimal pixel sizes because of dimensional limitations of screens. If map design for hand held devices is considered, it is obvious that international and space saving simple point symbols (especially pictorial) should be used for fast recognition [Lahtiranta et all. 2001]. Several point symbols with minimum size of 3x3 pixels are produced for hand held devices in GiMoDig Project [GiMoDig 2003].

Line Symbols: They are used to represent line objects. Line symbols should be easy recognizable for each line objects (like road and railway) by using shape and color. Cartographers do not prefer using orientation and pattern while designing very thin and diagonal line symbols. Besides

animated line symbols are used to show traffic flows. Minimum size of linear object types is defined to 10X1 pixel for hand held devices in GiMoDig Project [GiMoDig 2003].

Area Symbols: These symbols used to represent the area objects and the data based on area. They are designed by using color, pattern, shape and orientation. However unconscious use of these graphic variables causes semantic errors and huge file sizes. So this kind of symbols should be used carefully while designing maps for hand held devices. In GiMoDig Project minimum size of area object types is defined to 8X4 pixels, except buildings in outline as template which minimum size is defined to 4X2 pixels [GiMoDig 2003].

4.2 Color

Color is an important component of the map design to make it more understandable because it bridges the map features with real objects by using natural colors. However there are several problems on color while designing screen maps. First of all, computers show the colors depend on its graphic card, screen resolution and other hardware quality so hardware affects color choice [Ulugtekin et all. 2001]. On the other hand, making a "good" designed map is not using lots of colors [Ulugtekin and Bildirici 2002, Ulugtekin et all. 2003]. Although a narrow color palette has 256 colors, only 10-12 of them can be used at once instance. "Contrast" is the key word in this stage. All information has a different importance on a map so they should be visualized based on their importance level and this affects color choice too. Besides, map user is very important for color choice so some issues should be considered when symbolizing maps for screen displays. For example, lighter color for the background and darker one for the text should be used for visually impaired people [ESRI 2004, Murad-al-shaikh 2003]. These attentions become more important for small display cartography. Because the screen resolution of the hand held devices are lesser than computers and it dramatically affects the colors. Optimal amount of color should be used for these kinds of devices for solving this problem.

4.3 Text and Fonts

A map without text can not be thought. At least place names, elevation values and similar textual information should be used other graphic symbols. Otherwise it will be impossible to understand that map. However there are several rules and conventions for using text on maps. For example the difference between the natural and artificial objects is obtained by using italic characters for natural ones. But it does not give good results on screen maps. Besides it is difficult to label features without introducing a shadow around text because the background color of the map is mixed in with the foreground colors of the text but this method increases the file sizes. The smallest readable text on the screen is 10 pts. So this is what is recommended. Text up to 8 pts can be used while labeling minor features. However, visually impaired persons require minimum 12-14 pts [ESRI 2004]**.**

Although these rules are used for screen maps size of display limits can affect them. Especially for hand held devices voice can be used as a graphic variable instead of text. On the other hand viewing distance affects the text size and font too. This should be considered as an important detail for hand held devices used for car navigation systems.

5. CONCLUSION

The map maker must produce the map, which is understandable for the map-user. A map is a form of graphic communication designed to convey information about the environment. A major function of map is to assist in the determination and understanding of geographical or statistical phenomena located in their spatial relationship.

Most important web sites related to cartography are about weather forecast, traffic, navigation and positioning. Because they present temporal data, they should be updated regularly. Hand held devices are generally used for these kinds of applications so associations for online or offline updating should be established. The expression of "data" will leave its place to simple maps. On the other hand costs of geographic data and maps on internet, security and privacy will become immediate problems.

Hand held devices are very special hardware with their display media. Because they are in small dimensions, the maps that they used for different purposes should be specially designed. Besides, they are used for spatial applications just as navigation so they should be updated regularly. Although there are some works for small display design and solving update problems, serious works should be started and implemented.

As mentioned before the hand held devices have difficulties for displaying data effectively due to small screen size, resolution and other factors. However, there are ways to expand the design possibilities and overcome some of the restrictions by using techniques just like use of color, generalization of data to be displayed and using audio.

Small screen maps will be the display media of geospatial data in the future. Although today's limitations can be solved, new ones will be added to list based on personal demands. Technology will go on giving new advises on design to cartography. "Dynamic interactive multidimensional maps" will join the cartographic theories as new facilities.

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