

Layout and design elements in the quality estimation of bi-dimensional Internet based mapping

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Abstract. *The publication and distribution of interactive cartographic products through web pages has recently increased by the success development of Internet applications with mapping capabilities. Using these tools many people can create and publish maps of anywhere in the world. Professional mapmakers have the responsibility to review what kind of on-line mapping products are they delivering. This study presents an evaluation of the layout and design elements included into a sample of bi-dimensional on-line cartographic products, as a simple means to estimate if these products have the minimal elements to be considered really maps, or if there are some attributes impractical for internet publication and dissemination. For these purposes selected examples of on-line cartographic products were evaluated. Layout and design elements were integrated in four groups: identification, mathematic basis, representation and special-complementary. This integration considered some constraints and their relationship (screen resolution and size, bandwidth limitations and amount of data presented). The results show that, accord to the map objective and user, the Graphical User Interface and their exploration tools play a major role in the map inclusion of layout items. In many cases the mathematic basis elements are sub-estimated into cartographic design, or they are used with an inappropriate approach for map reading and interactivity. For example, the north arrows are redundant in documents with grid and north oriented (without rotation); also the grids are not required when there is a tool for identify locations by coordinates. In other elements is necessary to integrate dynamic answers to map user demands. For example, considering the use of a distance measurement tool in reference maps, bar scale graphics have to change their function to support the measurement, for only indicate a dimension of current visualization scale on the screen, in special with each zoom modification. Similar situation is presented in updating current labels for extreme coordinates, in special with each variation in the visualized area. Is evident that the Web expands the access to all cartographic products, but the cartographic communication has to be improved integrating several design changes and adaptations in on-line products, considering map user and mapmaker feedback. Overall is important think about delete unnecessary or redundant elements, reduce the graphic complexity of the items and data, display correct data in function of the visualization scale and data accuracy. Finally, I recommend that Internet based maps should have almost next items: title, place, current extreme coordinates, author, publication date, dynamic bar scale, frame or window for map contents, current legend, source of data and special semantic items for thematic documents. All these elements and more can be retrieval using hyperlinks, as well as integrating metadata and spatial-cartographic metadata services.*

Keywords: *Internet, on-line, mapping, design, layout.*

1. Introduction

The Internet and specially the World Wide Web (WWW) is changing quickly the publication, distribution, creation and use of the cartographic products; integrating new forms of user interaction. Web mapping products are considered now as user interfaces to get diverse information and apply some functions of spatial analysis.

The set of new possibilities for mapping offered by the Web is the result of recent process. Between the main references related to this revolutionary process in cartography are Peterson (2003), Peng *et al.* (2003), Bossomaier y Green (2001) Kraak and Brown (2000), van Elzakker (2000), Gartner (1999),

Crampton (1999), Peterson (1999), Crampton (1998), Harder (1998), Plewe (1997), Green (1997), Kraak and van Driel (1997).

In 1999 were estimated 40 millions of web maps used per day world-wide (Peterson, 1999). MapQuest site is considered as the main web maps provider in the world (van Elzakker, 2000). It is called the biggest mapmaker in history (Crampton, 1998). In 2001 it registered in average 20 millions maps a day (Peterson, 2003). Web maps usage is increasing with a growing rate major than the Internet expansion, e0.8 and e0.45, respectively (Peterson, 2003).

Using new technologies and special software many people can create and publish maps of anywhere in the world. However, the troubles are presented when is necessary create a new cartographic product, because is very often make decisions about the graphic elements of design to be considered. So, a common practice to resolve this situation is a simple copy of the design elements and its format presented in other cartographic product already created. Other practice is accept the automatic design created by the software used or choose one of the available templates. Also is possible to find checklists for graphic elements of mapping design.

Sometimes these decisions cause critical affectations for map reading, spatial communication and map purpose. Bad chooses includes redundant design elements or they omits critical elements for communication and indicators of accuracy.

Web mapping production is severely affected by this problem, because there are not a detail research about required design elements adaptations. Consequently, is very important identify in a reference text the main cartographic design elements, describing their variations, types, functionality, special requirements and constraints related to the web publication. Therefore, mapmaker will have more basis for decision making about map layout, design elements, their styles and modifications.

Choose the appropriate elements and build options of map layout is an easy interactive task using software (free or commercial) for Internet map production and services, but is required always considerer the map function, map user and media available. After Doornkamp (1989) the creation of any type of cartographic product require identify its functionality, as well as their users, because the main cartographic objective is the communication between author (mapmaker) and reader (map user). So, any type of cartographic product has to respond to user demands.

Web map design should be both simple and balanced (Cartwright, 2003), including from most simple design -in initial predefined display- to really complex representations, but only if the user decides participate through interactive process of aggregation. In this way, Mapmakers have the responsibility to review what kind of on-line mapping products are they delivering. After van den Worm (2000), designing Web maps is a challenging task. The cartographer must consider limitations, opportunities and characteristics of the Web. Combining functionality with a high level of visual attraction.

2. Assessment

In this study, selected examples of on-line cartographic products were evaluated for identify cartographic layout elements in, with special emphasis in their properties, styles, types and functions. According to map elements described by Salitchev (1979) and considering the strategy implemented to evaluate the quality of cartographic products by means of their design elements (Origel-Gutiérrez and Cabral-Cano, 2004), I adapted a classification of cartographic elements, originally proposed for paper maps (Salitchev, 1979). Because the evaluation of Web cartographic products is different, in comparison with other computer graphics-produced mapping materials and paper counterparts (Cartwright, 2003), the assessment considered that on-line products have some constraints, such as screen resolution and size. Also, this study take in count that web mapping design has common affectations related to hardware, bandwidth limitations and amount of data presented.

Figure 1 shows the four groups of cartographic design and layout elements evaluated: identification group, mathematic support group, representation group, and special or complementary group.

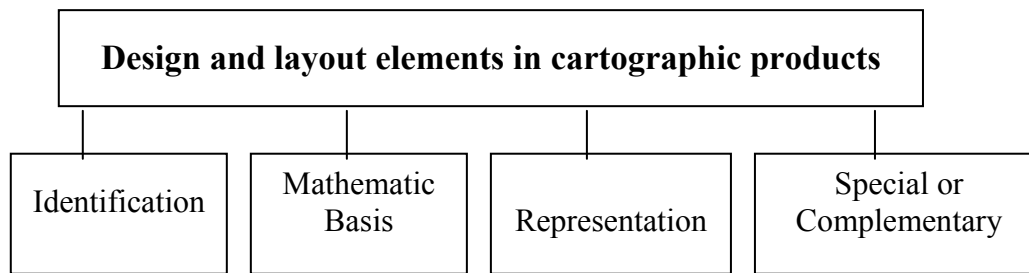


Figure 1. Groups of cartographic design and layout elements evaluated

3. Layout and design elements description

This section presents the description of each element and some considerations for web mapping design.

3.1. Identification and auxiliary elements

This group includes all kind of data and aids for specific identification of the cartographic product.

3.1.1. Project name

It is used when the cartographic product is part of a major mapping program.

3.1.2. Logo

It is used when the item is produced with institutional permission or acceptance. The logo is a key element in web mapping because is the most easy media to associate the product with its producer, and for institutional image.

3.1.3. Title

It is the presentation media of the cartographic product and it can include information about theme, geographic area or temporal context. Cartographic products for web distribution have to consider the best type of title depending if the product is static, dynamic, interactive or smart. In static products the title has not special effects or adaptation, but in dynamic cartographic products, such as gif animations, the title must have consistency with the contents showed in each stage or frame animation. The title of interactive cartographic products have to change as a responds to special user demands or interactions (activation of most important thematic layers, adaptation of cartographic contents and setting of final print). Smart cartographic products automatically offers to user an *ad hoc* title. Also, they include generally the possibility for user typing to specify other title.

3.1.4 Place

This element is included in some products when the title not refers directly to geographic zone represented. In web mapping products the place is a simple means to reference local or common areas using search engines.

3.1.5. Extreme Coordinates.

It is require to identify in an index all zones covered by the spatial database linked to cartographic products. Web products with variations in visualized geographic area require dynamic updating to current labels of extreme coordinates. In some on-line mapping sites there are search engines to recover the cartographic product using the extreme coordinates. This is the Online Map Creation (OMC) case represented in Figures 1 and 2 (<http://www.aquarius.geomar.de/omc>, Weinelt, Martin, 2002).

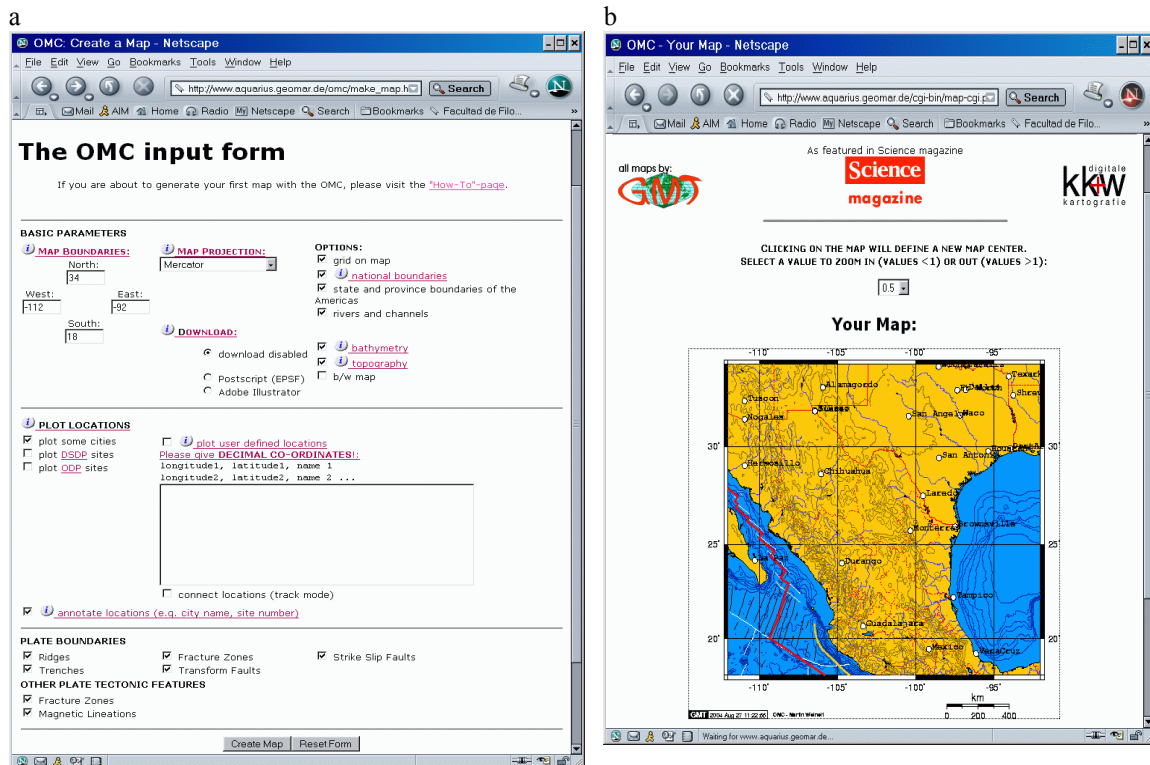


Figure 1 a. Presents the Online Map Creation input form showing the research criteria using geographic coordinates. Figure 1 b. Presents the map resulted with the criteria defined in a.

3.1.6. Author(s).

It is a basic element for citation and indexing.

3.1.7 Reviewers or Referees.

It is a cartographic element useful when the cartographic product was submitted to systematic process of review and it counts with the final acceptance.

3.1.8. Publication date, edition or last modification.

Important element for citation and indexing. Also in web mapping services is recommended report the last modification using standard ISO recommendation to avoid confusions between different formats used in the world.

3.1.9. Key code and product's name.

It is an element used in topographical chart series related to official survey and mapping programs. This element can be used in web mapping services of geographic chart series to organize the database and recover the corresponding cartographic product.

3.2. Mathematic basis elements

Type of cartographic product and tools implemented in, as well as its GUI define the elements that can integrate this group.

3.2.1. Numeric scale and scale latitude

In web mapping derived from print maps this element is required to estimate permissible errors according to the original cartographic product. In some projections the scale is not uniform and it change according to the latitude. So, in maps or charts representing big areas of the world is recommended indicate the latitude of the parallel corresponding to true scale.

3.2.2. Bar scale graphic

The main function of bar scale graphic is the distance measurement. In paper cartographic products, it element always is maintained in relative form to the document, inclusive with the reductions or amplifications applied. So, it is the unique true reference of the scale, contrasting obviously with numeric scale. There are several styles of graphic scales. In reference products, such as exploratory maps (DiBiase, 1990), is often required the measurement of distances. Consequently, detailed models with extension on the left part are more used, because the small divisions increment the measurement precision. However, in exploratory on-line cartographic products the graphic scale, as spatial referencing aid, is required only if this element changes as a part of interactive demands and analysis procedures (MacEachren, 1994). Even for presentation maps (DiBiase, 1990), particularly small maps of large areas, an indication of scale can be omitted from cartographic products of a well known place for which distance measurements are unlikely to be attempted (MacEachren, 1994). Also, bar scale graphics are a good example of design elements presented into interactive cartographic products, integrating dynamic answers to map user demands. Considering the use of a distance measurement tool available in the GUI of web reference maps, bar scale graphics have to change their traditional function to support the measurement, for only indicate a dimension of current visualization scale on the screen, in special with each zoom modification. Thus, in web mapping products the use of simple line as bar scale, without extension to the left, is the most adequate. But, it should change and update the distance labels according to current zoom.

3.2.3. Projection

Advanced web mapping services have the power to create totally new cartographic products by user settings and specifications. This is the OMC case (<http://www.aquarius.geomar.de/omc>). Advanced user of web mapping services can choose the best projection according to spatial requirements of representation (area, distances, form or directions). In pre-existent cartographic products a specific projection is defined by the web mapmaker. So, metadata about projection adopted can be recovered by simple link to description.

3.2.4. Geographic grid (*gradicule*)

In paper products used as exploratory maps the geographic grid is needed for identify any site into the map. Projection used is determinant for choose if total grid is represented, because generally it is integrated by arcs. In thematic products used as presentation maps the geographic grid can be represented crossing intersections between parallels and meridians; or in the margin including the respective ticks and labels. On the other hand, in Web mapping products the geographic grid is not required, because the major mapping GUIs contain an interactive tool to identify the specific coordinates of any site. In advanced web mapping develops is possible to add an user specified gradicule. This function is useful before print a map displayed. A geographic grid available only as a responds to users demands offers major legibility and clearness of the map contents. The report of location using geographic coordinates is more clear for any person that the use of projection coordinates.

3.2.5. Projection grid (*reticule*)

The projection grid or reticule is mainly used in geographic charts. Cartesian grid (in ortographic projection) is common used in local plans. Generally is represented using continue lines. All comments related to gradicule can be applied for reticule, but the report of location using projection coordinates is an special option available for demands of advanced users.

3.2.6. North arrow and orientation indicator

This element is well documented like unnecessary, inclusive for paper cartographic products. After MacEachren (1994) for exploratory maps this element is required only if the product orientation change as part of dynamic analysis procedures. So, directional indicators are needed on presentation maps only when directions are not obvious or an unusual orientation is applied. North arrows should only appear on relatively large scale products for which they are applicable everywhere. Products with full geographic grid not required any kind of orientation indicator. Web products of 3D cartographic initiatives are good examples about the necessary use of orientation indicators.

3.2.7. Geodetic network

This element is integrated by a set of geodetic vertex, level monuments, GPS stations and other ground control points data. Geodetic network as spatial database is very important for estimate map errors and accuracy. In web map products this element is optional and can be retrieved by a link.

3.2.8. Internal Frame

This element is delimited by extreme coordinates, it represents the real limits of geographic area and is required in products with irregular area. In web mapping products with rectangular area represented, this frame can be associated to specific area, that can be adaptable in size, optimizing the display use and its current setting. This function is named in the Web terminology as “liquid design”, because the product is adaptable to the container.

3.2.9. External Frame

This element is required to enhance the covered area in the map, and is useful to organize other elements of the cartographic product. In Web develops is very common to evaluate different layouts.

3.2.10. Margin.

This element is also required to enhance the covered area in the map.

3.3. Representation elements

This group is integrated by the semiologic and semantics contents of the cartographic products. So, it explains all details and specific significant of geographic and thematic symbols of the map. Consequently this is a critical group for map reading an interpretation.

3.3.1. Key or Legend

This element explains each class or category, as web as special symbols. Because constraints related to screen area, is recommended avoid the use of traditional headers of legend or key, changing them directly by thematic content. Interactive web mapping products frequently integrate a layer control box with possibilities to turn on - turn off the layers (for visualization) and activation (for apply queries or identify features). This is the case of standard ArcIMS services.

3.3.2. Conventional symbols or geographic legend

This element explains each general geographic symbol of the map and other features of location. Some web map services use animation in this element to visualize the features in the map by user demands in each legend item.

3.3.3. Source of information.

This marginal element is mandatory when the cartographic product is crated by a compilation of diverse data and information already published. Web develops can easily apply links to data producer or metadata descriptions.

3.4. Special or complementary information

This group contains descriptive information or special semantic elements of the cartographic products, they can be mandatory in function of map user, map purpose, theme, area, cartographic scale, etc. Examples included in this group are geological sections, profiles, figures, inset maps, scroll maps, 3D view, block diagrams, images, photos, tables, graphics, text box, animations, movies, sound effects, sound explanations, field reports, copy right information and many others using multimedia properties of the web mapping.

Groups of design and layout described are not excluding, because some elements can to be part of two or more groups. A good example of this situation are extreme coordinates that can be considered in both identification and mathematic basis. In the former case because the cartographic product can be recovered using only its extreme coordinates. In the second case because the extreme coordinates are normally included into the network of coordinates (reticule or gradicule).

4. Conclusions

The evaluation of the presence and style of design elements described was successfully used as simple technique to identify basic and some specific adaptations required by web mapping products. Also this

work is a first approximation to classify the web mapping products identifying if they have the minimal elements to be considered maps (Table 1). However, final category is a complex function of map objective, map user, geographic area, projections and other attributes. As a results some elements can be complementary in specific map but it can be mandatory in other.

Table 1. Minimal elements to considerer web cartographic products as a web maps.

Title
Place
Current extreme coordinates
Author
Publication date, edition or last modification
Dynamic bar scale
GUI Tool for identify geographic coordinates
Internal frame or window for map contents
Projection
Current Geographic legend or Thematic legend
Source of data
Specific or Complementary elements in function of map type (semantics).

Contrasting with paper cartographic products, in web mapping develops there are not clear indicators to estimate the quality of web mapping design using specific combinations between elements.

Automatic design functions implemented in Internet Mapping products, as well as the standard guide lines or checklist to generate cartographic representations are not recommended for web publication. However, they can be used changing default preferences according to user, objective, application and function of the cartographic product.

The Graphical User Interface and their exploration tools play a major role in the map inclusion of layout items. In many cases the mathematic basis elements are sub-estimated into cartographic design, or they are used with an inappropriate approach for map reading and interactivity

Finally, when the Internet is used for cartographic purposes, the conditions for designing maps have dramatically changed. So, web require smaller maps with simpler designs. The impact of web map publication is incremented with more and different users, additional information can be easily implemented into the cartographic products. Also is increased the accessibility to data.

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