DIGITAL ATLAS USER REQUIREMENTS AND USE SCENARIOS

Ferjan Ormeling
Utrecht University, Utrecht, the Netherlands
f.ormeling@geo.uu.nl

Corné P.J.M. van Elzakker
ITC, Enschede, the Netherlands
elzakker@itc.nl

Abstract

As demonstrated by the Atlas of Canada, the successfulness and usability of atlas products can be greatly improved through the application of a user-centred design approach. In following such an approach in the realization of a digital atlas the first stage in the design is an extensive analysis of the requirements, starting with the establishment of the proposed atlas purpose and contents as well as the business requirements. The next step would be the definition of the atlas users' requirements, consisting of descriptions of the use contexts, user characteristics, the tasks to be performed by these users and their preferences. These user requirements give an indication of the level of complexity and detail envisaged, the level of expertise needed to be able to derive information from the map, and the kind of operations needed to do so. These user requirements are established to serve as a basis for defining atlas use scenarios on which, in turn, the necessary digital atlas functionality can be based. Other design solutions (e.g. map and database design) can be derived from this definition as well, but that is outside the scope of this paper.The main objective of this paper is to propose a way of working in the first (requirement analysis) stage of the user-centred design of a digital atlas. This approach is, first of all, based on the formulation of the geographical questions users would like to have answered by a digital atlas and its constituent elements. Use scenarios may be constructed based on these questions and on the atlas and map use activities that can be executed to answer them.

First we will define the atlas concept, and the steps needed to realize an atlas (purpose, contents and business requirements; section 2). Then we will look into the atlas users' requirements, the use circumstances and context and the kind of geographical information needed (section 3). Based on them an example of an atlas use scenario will be developed (section 4), that may help deciding what atlas functionality is required.

1. Introduction

As indicated in the abstract, the successfulness and usability of atlas products can be greatly improved through the application of a user-centred design approach (see e.g. Kramers, 2007). In following such an approach in the realization of a digital atlas the first stage in the design is an extensive analysis of the atlas users' requirements, consisting of descriptions of the use contexts, user characteristics, the tasks to be performed by these users and their preferences. They give an indication of the level of complexity and detail envisaged, the level of expertise needed to be able to derive information from the map, and the kind of operations needed to do so. They serve as a basis for defining atlas use scenarios on which the necessary digital atlas functionality can be based. The main objective of this paper is to propose a way of working in the requirement analysis stage of the user-centred design of a digital atlas. This approach is, first of all, based on the formulation of the geographical questions users would like to have answered by a digital atlas and its constituent elements. Use scenarios may be constructed based on these questions and on the atlas and map use activities that can be executed to answer them.

2. Defining the atlas

An atlas is a systematic and coherent collection of geographical data in analogue or digital form, representing a particular area and/or one or more geographical themes, together with tools for information retrieval, analysis and presentation (Koop, 1993). In comparison with a GIS, a digital atlas may be defined as a computerized geographic information system, related to a certain area or theme in connection with a given purpose – with an additional narrative faculty in which maps play a dominant role (Van Elzakker, 1993). In a (digital) atlas there would be some added narrative faculty that can be used, for instance, for explanation.

The use of atlases encompasses all the aspects of the use of individual, single maps, but has additional dimensions. By showing different maps in a specific sequence (like presenting arguments during rhetoric) specific points can be made. Because one of the main purposes of atlas production is allowing for the comparison of maps, through this comparison, datasets are linked to one another, and relationships between their resulting patterns may be established. Because the datasets have been processed in a consistent way, different areas may be compared and relevant conclusions drawn from their respective patterns and densities. So the combination of maps in an atlas provides more information than the sum provided by a number of individual maps.

Before starting the actual atlas design, one has to decide on the nature of the atlas to be produced: is it to be a scholarly reference work or is it meant for the popular market; is it

supposed to deal with a single theme such as the distribution of forests or of diseases worldwide, or does it want to portray relevant characteristics of a specific city? And is the atlas content to be made available for free through the Internet, or is the atlas to be sold on a DVD or other digital information carrier? All these questions have a bearing on the possibilities for use, and should therefore be answered beforehand.

2a Establishment of the proposed atlas purpose

The main atlas purposes to be discerned are: reference, education, navigation, management and scientific exploration (by mapping phenomena one also visualizes the gaps in one's knowledge of these phenomena). A general consideration for producing atlases would be their ease of handling (just compare handling topographic map sheets or paper road maps with handling topographic atlases or road atlases or visualizing their contents on the screen of one's laptop!). More important is the general consideration that through atlases one is able to select and compare different views on geographical information: different topics for the same area, different snapshots in time for the same area and topic, or even different areas for the same topic and time frame. This requires representation on the same scale, rendered with the same degree of generalization and with similar cartographic modeling techniques. Selection and comparison can take place during premeditated search activities (for instance when consciously looking for maps of other themes (height above sea level, vegetation, soil) that have similar patterns as a population density map), or during unpremeditated browsing.

2b Establishment of the proposed atlas contents (area, theme, scale/level of detail)

Based on the atlas purposes set, the contents of the atlas has to be selected. Is it to be a world atlas, or an atlas of a part of our world, ranging from a continent to a city planning area? Do we expect to compare all kinds of relevant map topics (such as in a national atlas) or a restricted group of interrelated topics, such as in an atlas of the environment? Or do we select a standard set of topics which we map for all the individual areas portrayed? And, very important, do we both want to provide a nation-wide overview of a topic as well as the possibility to zoom in on specific areas, providing an information increase on our topic while zooming in? The latter set-up would call for additional information to be visualized or suppressed when passing specific scale thresholds.

2c Establishment of the proposed atlas business requirements

In the past, when producing paper atlases, the number and size of the map pages and the use of colour or black- and white maps as well as the print run would set the cost price for reproducing the atlas. This aspect can now be disregarded for digital atlases, apart from the production of DVD's or other data carriers. But it is the costs of the drawing of the maps and of the documentation work that has been necessary beforehand which will have

to be recuperated through the sales price of the atlas unless it has been decided beforehand that the information is to be made available for free.

3. Definition of atlas users' requirements

As we want to base this paper on a user-centred design approach, we will first discern a number of atlas user groups as well as a number of atlas use contexts, in order to be able to derive the geographical questions asked by each of these groups in specific use contexts. We will then analyse these questions, find how they are structured or together form higher-order map use steps.

3a Discerning atlas user groups

We start at an early age using school atlases that would become more complex with our age. When we learn to drive we used to learn to deal with road atlases before the advent of navigation systems. And when establishing our own home, we would still consider buying a reference atlas, even if the information contained in the atlas can also be retrieved from the Internet, through Google Earth or Wikipedia. The reason why atlases still provide an essential contribution is because the information in them has been processed in a systematic way, and our success in querying information from the web is based on our learning to deal with geographical concepts through our school atlases. Later, when we specialize either in our work or in our hobbies, we will go for more specialized topical atlases. As professional users we might, for instance, depend on the storage function of atlases, showing all the accessible sand deposits in the underground close to a proposed highway extension; as scientists we would be able to derive knowledge of new relationships between datasets.

So from this biographical interplay we get the following user groups (see also Bakker *et al.,* 1987): a) school children and their teachers; b) navigators; c) interested laymen; d) commercial and professional users and e) dedicated scholars.

In an ideal world we would be able to describe the characteristics and the preferences of these user groups , but these have been insufficiently analyzed. Wright (1999) has given some insight in the user preferences of the on-line National Atlas of America. Kramers (2007) refers to an analysis of user characteristics for the topographic maps contained in the National Atlas of Canada, but not to a more general user group characterization. Clearly more research is needed here.

3b Categorization of digital atlas use contexts

Progressing in a similar biographical way we can start here with classroom use of the atlas, where different concepts are pointed out (world, sea, land, continent, boundary, country) at different scales (zooming out from a classroom plan to the world and beyond) and

landform types identified, and, later, named, by learning topography. Learning these concepts and the provision of a topographic frame of reference would prepare us for individual study and analysis of geographical relationships. Wiegand (2006) has provided insight in map use learning processes for children and Ormeling (1993) has touched upon the specific use of atlases highlighting the teaching of atlas access (through knowledge of atlas structure, geographical names and thematic indexes, map index sheets, legends and glossaries) and map comparison. Paper school atlases still play an important role here, as the teaching of geographical concepts requires a controlled environment, less found in digital atlases visualized on different monitors with different zoom factors.

Next would come way-finding exercises, enabling ourselves to find directions, also when the navigation system breaks down, or when the terrain no longer matches the stored digital map. More complex would be regional exploratory studies in which we try to subdivide an area into more or less homogeneous units we can describe on the basis of numbers of characteristics. We could get an idea of spatial processes, such as commuting or weather fronts moving past, of spatial relationships (dependencies, correlations or conflicts) or spatial patterns (differentiation or anomalies: why is population density much lower there, despite its adjacency to that big city?). Looking into changes over time would add another dimension to these studies.

3c Geographical questions posed

We presume that digital users, even when they are merely browsing a digital atlas, are always busy trying to find answers to the geographical questions they have (wittingly or unwittingly). These questions may have a different level of complexity and may be coupled to specific *use tasks*, which may be expressed by means of verbs. For example, for the specific purpose of regional exploratory studies (gaining understanding of, and insight in, the geography of a particular region, cf. section 2a) Van Elzakker discerned the set of geographical questions and related use tasks shown in Table 1.

In essence, the use tasks distinguished in Table 1 are already *map* use tasks, i.e. tasks that can be executed once a user already has a map display in front of him / her. It should be realized that, in the context of a digital atlas, these tasks are preceded by a number of atlas use tasks, based on user questions which are usually NOT of a geographical nature. For example: Is there a digital atlas that can help me answering my geographical questions? Where is that atlas? How can I get access to it? What information does that atlas contain?, etc. Examples of the way these geographical questions and the tasks needed to answer them are given below. A more complete description is found in (Ormeling, forthcoming).

Question I: What is there / What occurs at a specific point location?

Why would we bother to look for that specific point location in a digital atlas? Because it would be a place where the most detailed information on that country/area could be found. Very detailed spatial information would also be retrievable from the primary dedicated datasets on which the map data were based (such as statistical tables), but in the atlas this kind of information can be found quicker as it allows for geographical searches. So, starting from a feature or object with a specific location on the map, which can be assessed in geographical or map coordinates, we are able to retrieve the information valid for that location from the symbols or signatures present at that location, and retrieve their meaning from the legend. Here we must take account of the map scale, as because of generalization the detailedness and accuracy of the information read from the map decreases with the map scale. Example of a required functionality would be to show the geographical coordinates of the cursor position.

Table 1 Use tasks with relation to the geographic questions addressed

Geographic questions	**Tasks**
Elementary	
What is there?	1. to **recognize** objects (external identification)
At a given place, what is there?	2. to **identify** objects (internal identification)
At a given place, ho much is there?	3. to **estimate** amounts
Where is that geographic object?	4. to **locate** an object
Intermediate	
What is near that geographic object?	5. to **position** with respect to other objects
What is the distance to similar/other objects?	6. to **define** relative / absolute distance
Is that geographic object linked to other objects?	7. to **encounter** spatial linkages
Why is a geographic object there?	8. to **explain** a location
What is the spatial distribution of that object?	9. to **find** order, patterns or spatial anomalies
Where is the most / least?	10. to **quantify** spatial anomalies
Where are the limits of a spatial distribution?	11. to **delimit** a distribution
What comes in / what goes out?	12. to **connect** a region to the outside world
Temporal	
Has that geographic object always been there?	13. to **determine** changes

Have the spatial distribution patterns changed?	14. to **establish** trends
Which spatial processes are taking place?	15. to **detect** processes
Overall	
What are the influences from outside the region?	16. to **contemplate** spatial context
What relevant patterns are there?	17. to **recapitulate** the found patterns
Are there relationships between spatial patterns?	18. to **discover** correlations /
dependencies / conflicts	
Which factors cause the regional structure?	19. to **structure** the geographic
information	
Can different (sub-)regions be identified?	20. to **regionalize**
What are the region's geographic characteristics?	21. to **obtain** insight into and overview
of the region	

Question II. What is the overall pattern of that phenomenon?

Here we start again from the phenomenon instead of from the location. First the kind of information searched for is defined and translated into a map topic and scale. When the relevant map has been accessed the extent or shape of the distribution of our phenomenon can be assessed and its pattern can be described. The smart legend functionality named in example 1b would assist here as well.

Important questions here are how the various regions can be delimited (subregionalization), what the spatial anomalies are, whether there is a spatial structure or hierarchy, and where the highest or lowest values or densities are located. This can also be termed its horizontal relationship.

Question III. What are the relationships between these patterns?

Here we turn to vertical relationships. For assessing them we should first define the datasets needed and find the corresponding maps at the required scales or resolution levels, zooming in on the area studied. Then the datasets are combined from the map sheets and their correlation or their degree of overlap is measured, and one checks whether the phenomena show the same trend from high to low values. One would be interested in dependencies here, and in finding out whether phenomena have similar distributions. The functionality required here would consist of correlation computing.

In order to answer the question we have to define the relevant area (a natural, administrative or economic unit), draw all the data pertinent to this area from the various atlas sheets or underlying datasets, combine and characterize these data, taking account of the diverse characteristics of the boundaries used, and the different weights assigned to them.

3d Atlas and map use activities

In order to answer the geographical questions posed in section 3c, specific activities have to be undertaken. For the use of maps not combined into an atlas, van Elzakker (2004) distinguishes here between selection activities, reading activities, analytical activities, adjustment activities and construction activities.To these can be added the functionalities of digital atlases, as distinguished by Simon van Leeuwen (1996): atlas functions (comparison, find map with largest scale where a specific name occurs), database functions, cartographic functions, educational functions, navigation functions, general computer functions (import, export, print), map functions (pop-up legend, highlight legend class, link to hotspots) and map use functions (annotate, measure, buffer, overlay).

This combination may result in a list of atlas and map use activities as shown in Table 2. This list of use steps is more or less sequential, although in practice the individual order of execution may be different and loops (going back to earlier steps) are possible as well. It should also be noted that we do not consider this list to be a generic and complete one. Like Table 1, this Table 2 has also been drawn up with the example of regional exploratory studies in mind. It is also assumed that the digital atlas itself has already been selected.

Table 2 Atlas and map use activities for regional exploration

Stages	**Activities**
Searching	to search for a geographical object (index, gazetteer)
	to search for a particular theme (list of contents)
	to search for a moment in time (date / year)
	to search for a particular map
Selecting	to select from maps available (browsing)
	to select a theme
	to select a moment in time (date / year)
	to select an aggregation level
	to select a geographic extent
	to select a map scale
	to generate a map from a spatial database
	to import data / map from elsewhere
Reading	to look at the map title / legend
	to view the map image
	to click on a map symbol (to retrieve attribute data)
Analysis	to measure on the map
	to count symbols
	to annotate a map
	to highlight a(n) (category of) object(s)
	to buffer
	to juxtapose and compare map displays
Adjustment	to overlay (to add layer(s) to a map display)

	to switch off a layer
	to change the method of classifying attribute data
	to pan
	to change the level of aggregation
	to zoom in (make the map scale larger)
	to zoom out (make the map scale smaller)
	to change the map projection system
	to change the map orientation
	to change the snapshot in time
	to change the symbology
Construction	to change the mapping method
	to generate a new map
	to export data / map
	to print a map

4. Deriving digital atlas scenarios

The atlas and map use activities presented in section 3d and the use tasks listed in section 3c can be combined into a kind of digital atlas use scenario by linking the activities with the tasks (and related questions). The idea is that first the questions that need to be answered by the digital atlas to be designed are formulated and listed, together with their related use tasks and that they are opposed to the atlas functionalities and map use activities that need to be carried out in order for the digital atlas users to be able to answer their geographical questions / execute their use tasks. In this way, a digital atlas designer will know which functionalities are required. It is also possible to prioritize between functionalities.

By means of example, a use scenario for regional exploratory studies is presented in Figure 1. The first matrix in this use scenario links the essentially non-geographical questions of prospective atlas users to atlas use activities (functionalities) that precede map use proper, or come after that map use (e.g. exporting a map). The second matrix links map use activities with the use tasks based on the geographical questions to be answered. Symbols in the

Figure 1a. Digital Atlas Use Scenario linking non-geographical questions to atlas use activities

A. Atlas use activities		Demands re. overall atlas functionalities
Searching		
geographical object (gazetteer)	●	Is this geographical object stored in the atlas database?
theme (attribute)	●	Are there geographical data on this particular theme?
date / year	●	Are there geographical data of this particular date / year?
map	●	Is this particular map readily available?
Selecting		
browsing: random	●	Is it possible to randomly browse through the maps and select?
browsing: structured	●	Is structured browsing possible (narrative / hierarchy)?
theme	●	Is it possible to select a theme from a list of contents?
date / year	●	Is it possible to select a date / year from a list of contents?
aggregation level	●	Can I select a particular data attribute aggregation level?
geographic extent	●	Can the geographic extent be defined with a bounding box?
map scale	●	Which pre-defined map scales can be selected?
Cartographic visualization		
generate map from database	●	Can the user produce his / her own map from the database?
animations	●	Is it possible to produce cartographic animations?
Import / export		
import of other data	●	Can the user import his / her own data?
export		Is it possible to export maps / data for use in other applications?
printing		Is it possible to print a map?

Figure 1b. Digital Atlas Use Scenario linking map use activities with the use tasks

	Use tasks																				
	Elementary				Intermediate								Tempo-ral			Overall					
	recognize	identify	quantify / estimate	locate	position	define distance	encounter spatial links	explain location	find pattern	quantify spat.	delimit distribution	connect to outside	determine changes	establish trends	detect processes	contemplate context	recapitulate patterns	discover correlations	structure information	regionalize	obtain insight
B. Map use activities																					
Reading																					
look at map title / legend	●	●	●																		
view the map image	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
click on map (symbol)		●	●																		
Analysis																					
measure on the map					●	●				●											
count symbols			●							●											
annotate map							●				●	●								●	
highlight object(s)				●																	
buffer					●	●															
juxtapose / compare map displays																	●	●	●	●	●
Adjustment																					
overlay							●	●					●	●	●			●		●	
switch layer on / off	●				●			●					●	●	●			●			
change classification method			●							●							●				●
pan					●	●					●	●				●					
change aggregation level										●											
zoom in		●	●	●	●																
zoom out				●		●	●		●	●	●	●				●					●
change map projection system						●															
change map orientation																					
change snapshot in time													●	●	●						
change symbology				●	●	●	●		●	●											
Construction																					
new mapping method										●							●			●	●

matrices indicate which activities are required for meeting the desired atlas purposes. Prioritization would perhaps be possible as well. It should be clear that Figure 1 is just an example to demonstarte the approach. Similar matrices may be drawn up for different overall atlas purposes and the way the matrices are completed will to quite a large extent be based on decisions by the atlas producer / designer.

5. Conclusion

The main objective of this paper was to suggest a more systematic way of executing the requirement analysis stage in the user-centred design of a digital atlas. We by no means pretend that the lists of use tasks and atlas and map use activities are complete. They are just presented here as exemples. Our main message is that more usable digital atlases can be made by first formulating the questions, geographical and otherwise, the atlas should provide answers to. These questions, as translated into atlas and map use tasks, can be coupled to required atlas functionalities and map use activities in typical use scenarios. In addition, these questions will also have consequences for the nature, resolution and accuracy of the data in the atlas database and on the cartographic visualization. We also plea for more and better user research, not only for requirement analysis but for evaluating prototypes and testing our hypothetical matrices of digital atlas use.

6. Literature

Bakker, N.J.; C.P.J.M. van Elzakker & F.J. Ormeling (1987), National atlases and development. *ITC Journal*, Vol 1987-1, pp. 83-92.

Board, C. (1984) Higher-order map-using tasks: geographical lessons in danger of being forgotten. *Cartographica* 21, 1, Monograph, Vol 31, pp. 85-97.

Koop, R.O. (1993), Tools for the Electronic Production of Atlases In: Klinghammer, I.; L.Zentai & F.J.Ormeling (eds.) *Proceedings of the Seminar on electronic atlases* held at Eötvös Lorand University, Visegrad, Hungary, April 27-29, 1993. Budapest: ICA.

Kramers, R.E. (2007), The Atlas of Canada – User Centred Development, In: W. Cartwright; M.P. Peterson & G. Gartner (eds.), *Multimedia Cartography*. Berlin: Springer. Chapter 11, pp. 139-160.

Ormeling, F.J. (1993), Teaching Atlas Use. In: Klinghammer, I.; L. Zentai & F.J. Ormeling (eds.) *Proceedings of the Seminar on electronic atlases* held at Eötvös Lorand University, Visegrád, Hungary, April 27-29, 1993. Budapest: ICA, pp. 71-78.

Ormeling, F.J. (1997), Functionality of electronic school atlases. In: Köbben, B.J.; F.J. Ormeling & T. Trainor (eds.), *Proceedings ICA Commission on national and regional atlases workshop on electronic atlases: from CD-Rom to Internet*, held in Prague, July 31-August 3, 1996. Utrecht/Washington: ICA, pp. 33-41.

Ormeling, F.J. (forthcoming), Scenarios for national atlas use. *Historic-geographic linguistic Journal West University*, Timisoara.

Simon van Leeuwen, W. (1996), *Evalueren van geografische software*. MSc thesis, Utrecht Univ.

Van Elzakker, C.P.J.M. (1993) The use of electronic atlases. In: Klinghammer, I.; L.Zentai & F.J.Ormeling (eds.) *Proceedings of the Seminar on electronic atlases* held at Eötvös Lorand University, Visegrad, Hungary, 27-29 april 1993. Budapest: ICA, pp. 145-155.

Van Elzakker, C.P.J.M. (2004), *The use of maps in the exploration of geographic data.* PhD thesis, Utrecht University. Utrecht/Enschede: KNAG/Utrecht University/ITC. Netherl. Geogr. Studies 326.

Wiegand, P. (2006), *Learning and teaching with maps.* Routledge

Wright, B. (1999), The national atlas of the United States. In: Gylfason, A.; B.J. Köbben; F.J. Ormeling & T. Trainor (eds) *Proceedings of the Seminar on electronic atlases and national atlas information systems in the information age*, held at the Univ. of Iceland. Enschede: ICA, pp. 35-40.