Identification of Styles in Topographic Maps

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Abstract. Great importance is attached to appearance of maps because the look of a map is a great factor of readability. In that sense, we also think that map users are confident of some recognizable styles, in particular in topographic map design. If we could formalize topographic styles, we should be able to propose to users automated methods to apply well-known styles on their data. This paper presents a part of a PhD thesis aiming at formalizing cartographic styles, especially what is meaningful according to related geographical spaces and cartographic practices. A method of comparison of topographic maps, based on French and Swiss topographic maps is detailed: our purpose is to distinguish which parameters and processes in the map design process make a significant visual impact, thus conveying a topographic style.

Keywords: cartographic style, topographic map, visualization, perception, practices, aesthetics

1. Introduction

Great importance is attached to appearance of maps because the look of a map is a great factor of readability. For instance, users want an easy and clear understanding of maps. For their part, cartographers wish to convey a correct and consistent cartographic message allowing a proper map interpretation. In either case, the overall impression is the criteria for judgment of the holistic evaluation. It is in this sense that these recent years, the concept of aesthetics is playing an increasing role in cartography: a part of current research is focusing on these cognition matters and map visualization (Fabrikant 2005, Kent 2005, Fabrikant et al. 2012, amongst others).
In a general meaning, an artistic style may be considered as a particular way to shape things according to specific rules, thus enhancing something aesthetic. Routinely, the term “style” is used in many different domains: writing, fashion, architecture, etc. However, the notion of style uses

different criteria in each domain to characterize the appearance of an object, a movement or a person but also the particular way of giving this appearance. How could we speak of style in cartography to describe a map as we are already talking about writing style, music style, style in fashion, style of architecture to describe a very specific ways of doing? To what extent the techniques choices and the graphics purpose of cartographers play a significant role in the definition of cartographic style? Therefore, we think that it would be interesting to find cartographic criteria to identify one or several styles from maps. Moreover, we assume that the consistent application of stylistic rules may significantly improve the graphic quality of the resulting map. Furthermore, we contend that a specified style may be pastiche to any type of geographic data, and is thus able to create map independent so called stylized maps. That's why, we need exactly to define the term cartographic style in order to formalize and implement stylistic rules with and for existing cartographic design tools[1].

Although some cartographers and researchers in cartography identify the notion of cartographic style as an essential element of geovisualization, it has been few systematically studied. In this paper, we propose a systematic approach to formalize and identify topographic styles. In the first part, we present different research works which address the notion of style in cartography, particularly providing definition and methods used to better understand it. In the second part, we present our approach to build a framework in order to identify styles in topographic maps: this one focuses specially on a detailed description of the semiology and pre-processing of geographic data in order to characterize map topographic depiction. We detail, as a case study, a comparison of two topographic map samples, based on IGN and Swisstopo data and maps. Finally, we discuss about our results.

2. Style in Cartography

In this part, we pay attention to criteria of general definitions of style then we review some cartographic style definitions issued by scientific research approaches.

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[1] The term style is soften used in Geographic Information Systems to describe the rendering of geographic features, coming from the Styled Layer Descriptor (SLD) norm. We do not refer to this definition in our work.

2.1. General definition of Style

Oxford Dictionaries define the term style by three steps:

- "A particular procedure by which something is done : a manner or way;
- A distinctive appearance, typically determined by the principles according to which something is designed;
- Elegance and sophistication. "

Larousse Dictionaries complete and precise this definition of style adding time and geographic details: "The concept of style allows rankings, mostly historical (the Romanesque style, Louis XVI), but also geographic (the Florentine style), or both (the Perpendicular style refers to the production architecture of the last phase of the Gothic period in England) ". Otherwise, in the literary' sciences, Jenny (2011) defines style as an "intentional" and an "individuality built" by a "way of acting". Finally, the architectural style definition stresses the notions of a "way of acting" and "intention": "an architectural style is a specific method of construction, characterized by the features that make it notable. A style may include such elements as form, method of construction, materials, and regional character", (Wikipedia[2]).

We notice that this notion of "the way of acting" brings directly to maps production methods of National Mapping Organizations (NMO's) that use different and singularized cartographic practices to reach their purposes: readability of a territorial complexity thanks to topographic maps. We could also argue that each NMO adds its personal touch as an architect and thus be regarded as a kind of map architect. This view may lead to the assumption there are various styles of topographic maps. However, how can we identify them?

2.2. Attempts to define cartographic styles

Researchers in cartography are few to tackle the issue of defining cartographic styles. Some of them alternatively enrich and shape the definition of a specific manner to render geographical information. For (Kent & Vujakovic 2009), a cartographic style is derived from how the landscape is symbolized, in terms of both "appearance and content", dependent of the geographic space represented in the map. They study particularly topographic maps and stress the influence of the specific history and cartographic practices of each NMO. For them, to try to identify the "Swiss manner" is probably the best example to characterize a topographic style. Beconyte (2011) emphasizes the complexity to formally define the structure of the employed

[2] http://en.wikipedia.org/wiki/Architectural_style (visited, Friday 5th April 2013)

style. As (Kent & Vujakovic 2009), she is convinced that a cartographic style can be influenced by geographic space, time and culture. She characterizes a cartographic style as a sum of "parameters" independent characterizing some components of the map (lines, color, textures, lettering, etc.). She defines it by general degree of graphic enhancement of visualized data. She also argues that "the concept of style is applicable to every type of maps". These authors suggest that it is possible to distinguish different cartographic styles, according to a set of criteria: kind of map, symbol specifications and map aesthetic.

2.3. Approaches to characterize cartographic styles

Various methods have been embraced to analyze and characterize cartographic styles of maps. Some of them are only descriptive, a "verbal approach" of how the map is. Petchenik (1974) proposes some pairs of verbal descriptors in order to criticize cartographic design. We consider this approach as a qualitative one: it allows addressing the notion of style in categorizing the different maps per group according to different criteria (emotional reactions, spatial characteristics, data qualities, etc.). This approach seems interesting when we face a set of heterogeneous maps. For instance, Beconyte (2011) uses it to categorize and classify many different maps: topographic maps, thematic maps, digital maps, paper maps, etc. Her method is based on various parameters like "decorativeness", "expressiveness", "originality", which are applied at four visualization types that she calls "minimal", "standard", "conventional" and "conspicuous". (Renard 2008, Jolivet 2009, Bucher et al. 2010) extract nineteen European symbol specifications and applies them, always on the same three IGN[3] datasets (urban, mountain, plain spaces, *Figure 1*): their purpose is to make users validate their global feeling regarding the resulting maps, with the help of some predefined couple of verbal descriptors ("realistic/artistic", "ugly/attractive", etc.). Their research put forward that each European symbol specification have a singular visual impact and emphasize the primordial role of some layers: built up areas, transportation network in the assessment of the map quality.

[3] IGN, French NMO: Institut National de l'Information Géographique et Forestière.

Figure 1. United Kingdom (paper map) (A), Netherlands (digital map) (B) and Finland (digital map) (C) symbol specifications applied to an IGN dataset (Renard 2008).

Others existing methods are quantitative and based on different quantifiable parameters. Furthermore, some of them are systematic ones, applicable to various samples. For example, Kent & Vujakovic (2009) use a "cluster analysis" to define the style of topographic maps in European countries. They review thoroughly many various sets of symbols and lettering of typography for each layer, content in twenty European topographic maps (road, rail, paths, cycle tracks, hydrology, vegetation, relief, and administrative boundaries).

Christophe (2012) summarizes these approaches to characterize and identify styles in cartography. She distinguishes three different types of approaches: visual map categorization to make different styles, map specification analysis to make a related style, and artistic styles characterization to make new artistic cartographic styles. The visual categorization consists in categorizing different maps on a visual assessment and feeling, as the research works of (Beconyte 2011). The map specification consists in identifying how exactly the map is built in a production process: data and map specifications come from relevant visual characteristics of the style of an artwork to reuse rules on geographical data.

2.4. Our purpose

In our view, definitions above provide insufficient clarification of the notion of cartographic style, which hinders at this time a use of this concept in automated cartographic systems. Our long-term purpose is therefore to exhaustively formalize this notion of cartographic style. We consider that a cartographic style refers to "appearance and content", related to a specific geographic space (or context) and to related specific cartographic practices. We thus would like to propose a systematic approach to identify a cartographic style with the help of these parameters. We chose topographic maps for our research, because they aim at effectively depicting territorial complexity and as says (Kent & Vujakovic 2009), "topographic maps are among

the most familiar and most trusted of all cartographic products". Against this backdrop, we are persuaded that describing and comparing topographic maps from their map specifications and their map design processes may allow us identifying factors of their visual impacts.

3. An approach to Identify Topographic Styles

The topographic maps of each NMO depict clearly a unique space, the national territory. The topographic maps put also forward also particular cartographic practices, from data selection and specification, geo-processing treatments (generalization, schematization, etc.) to graphic semiology choices (colors, thickness, shapes, typography, etc.). We are persuaded that singularized styles result of technical choices made by each NMO. We aim at setting-up a detailed framework to specify systematically and visually the characteristics of different topographic maps samples, in order to identify main parameters or criteria of related topographic styles.

3.1. Topographic style: influence of cartographic practices and geographic context

We distinguish two dimensions in an approach of topographic styles. On the one hand, a topographic map is an observable graphical depiction that expresses in a way NMO's history and practices. On the other hand, appearance of a topographic map, as a picture of reality, is also conditioned by the depicted geographical space. Topographic maps represent effectively various and different geographic areas with specific and individual characteristics. We consider that the topographic style has a geographical space-dependency and also related data-dependency: we call this, the geographic context: rural area with scattered settlement, costal area, and dense urban area (*Figure 2*).

Figure 2. Three different geographic contexts with the same symbol specifications (IGN topographic map 1:25000).

3.2. Method: Visual comparison of maps

When we visually compare two topographic maps coming from two different NMOs, different cartographic practices may be immediately identified. On *Figure 3*, two topographic symbol specifications coming from Norway and Estonia NMOs are applied to the same IGN dataset: resulting renderings are very different and provide different general feelings. We notice that the author takes only into account the symbolization of geographic features (colour choices, symbol choices, etc.), but ignores the generalization process.

Figure 3. Norway (A) and Estonia (B) legend styles on a geographic IGN France dataset (Renard 2008).

In order to go beyond, we propose a systematic visual comparison of maps, based on knowledge of the map specifications, i.e. data specifications, data processes and map design processes. We compare two topographic maps built by two different NMOs and depicting the same geographic context at the same scale. These two last items are important in our method, because they allow us fixing by now the parameter of the geographic context and focusing our effort on analyzing others factors (selection, categorization, generalization, etc.). To summarize, our method consists in visually comparing two topographic maps, systematically, one to one, and each layer one to each other.

Factors analysed

This comparison method examines thoroughly many various parameters impacting visual cartographic results:

- Data specifications, data selection and data categorization

We have some specifications documented of each data contained in each map. For Swisstopo, it is possible to find some of data specifications[4] directly online. Concerning IGN specifications, we obtain directly them from the agency. These two documents list a set of data contained on the map, and provide also a set of keys to understand the geographic feature definition.
The design of geographic databases is based on conceptual models that are complemented by textual specifications. These specifications contain information related to the semantics, the expertise and know-how on the data acquisition. It serves us as the guideline to understand comprehensively the data definition and the terrain criteria taken into account within the geographic data definition.

- Pre-processing data: generalization, amongst others

We put great value on data generalization in the visual impact of the resulting map. Indeed, the NMO use some methods of generalization in line with their purpose. We are persuaded that this cartographic process is an important parameter within identification of cartographic styles. Therefore we have to learn about the specific generalization methods of each NMO. The COGIT laboratory has strong skills in cartographic generalization and agent systems, on which we will support.

- Symbolization (color, texture, point symbol, line symbol, etc.)

As explained previously, the choices of colors and symbols produce a singularized visual impact, that's why a special emphasis is obviously given to the symbolization and the labeling of geographic features (graphic representation and typography). At the COGIT laboratory, many works has gone into this area of research on geographic features symbolization.

3.3. Case study: area, data and map samples.

We apply our approach of map comparison in handling two topographic maps, on a same geographical context, but produced by two different national producers, IGN[5] and Swisstopo[6]. Each depiction is built from data acquired by each related agency. We don't own these geographic data (of each map), that's why all of our researches work is only based on the map depiction. In summary, we analyze therefore two mapping practices, depicting the same territory.

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[4] http://www.swisstopo.admin.ch/internet/swisstopo/en/home/products/maps/national/25.html
[5] http://www.ign.fr/
[6] http://www.swisstopo.admin.ch/internet/swisstopo/fr/home.html

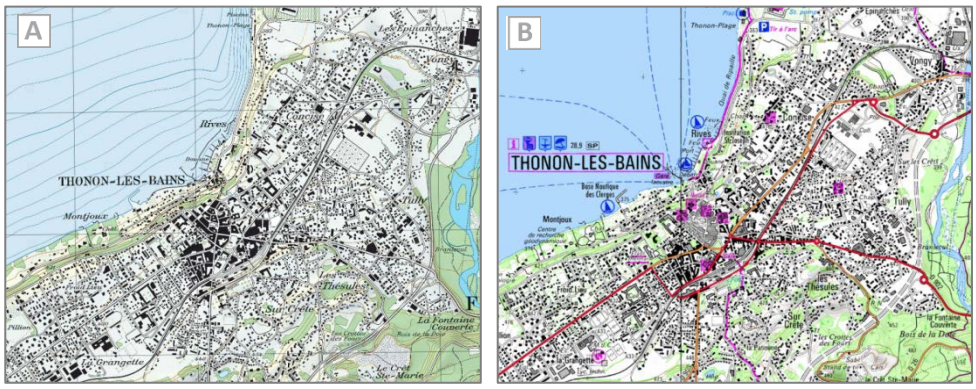

Figure 4. 1:25000, Swisstopo topographic maps (A), IGN topographic maps (B)

We sought a territory containing diverse landscapes: both urban and rural area, near sea, lake or river in order to manage various geographical objects (built up areas, transportation network, ground cover hydrology, and orography). Consequently, we have chosen the French city of Thonon-les-Bains and surrounding areas, as experimental site for our research. *Figure 4* presents two map depictions at 1:25000 of this French City and its surrounding areas, the left thumbnail (A) shows the Swisstopo depiction and the right thumbnail (B) shows the IGN depiction.

3.4. Results of our comparisons

At first glance, we note that the map depiction produce two different visual impacts. At the first time, we note particularly impact of various feature colors (the lake, build areas, roads and vegetation). In a second time, we note that the typography (font types) of labeling is really different from Swiss map to French map. As we know, we notice that French people qualify their national topographic map as colored flaming depiction while they qualify the Swiss topographic map as a polished and better map.

Even so, we note quite similar choices of data selection: the two agencies make almost the same choices on the information mapped. We thus see the presence of roads network, building, various type of building, river and lake, vegetation covers and orography. Then a detailed analysis of the data specifications shows similar definitions of many geographic features.

With a particular attention, we distinguish some particular characteristics on each topographic map. For instance, some information are only depicted on Swiss map like gravel and isobaths, in the same way touristic information are only depicted on the French map. Furthermore, the feature symbolization is different between the Swiss map and the French map, for instance:

- **Color :** vegetation (forest), hydrology (surface), built
- **Patterns :** sports ground, cemetery, built
- **Points Symbols :** trees
- **Shade :** relief

Finally, we think that different cartographic treatments have also been applied on the two geographic dataset. For instance, the contour lines are smoother and the shape of built home feature appears more angular on the Swiss map.

IGN France and Swisstopo are two NMOs with a long-standing mapping tradition. Our comparison method reveals different cartographic properties of each map, which are probably closely linked with their historic practices. Most noteworthy is that these different cartographic practices produce two different visual impacts. This comparison provides us a graphic detailed insight of two topographic maps samples and allows identifying some graphics characteristics of their styles. We note that the generalization of the built areas, the color symbolization of road network and the lake appear to be major parameters of topographic IGN and Swisstopo styles.

4. Conclusion and outlook

Many definitions of style exist in various domains (writing, architecture, art, etc.). Among all these definitions, a convergence point appears around the idea that: on the one hand, the style expresses a particular way to create or to act and on the other hand, it conveys something recognizable with the help of some visual criteria. Therefore, the definition of a cartographic style may involve a method of design using various visual criteria, from geographic information to the map depictions. In this paper we propose a method in order to identify styles of topographic maps. After highlighting the complexity of this identification problem, by exploring various approaches, we choose to work with some important criteria such as, data selection, data categorization, data generalization and symbolization. All these characteristics have been taken into account in the creation of the framework proposed in this paper. Our identification method is based on a comparison of topographic maps, on the same geographic context, that highlights the various data processes and data symbolizations underlying both resulting maps. Thanks to a case study between French and Swiss topographic maps, our method appears as a useful framework using guidelines and giving detailed descriptions of maps specificities.

We think that these visual specificities may be recognizable by main users and allow identifying easily cartographic styles. However, we need to make a further investigation of all these visual characteristics. Our research purpose is to find criteria qualifying coherently a cartographic style. We are currently also considering thematic maps, such as subway maps and ski

trails maps, in order to obtain a broader understanding of cartographic styles.

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