# Expressive Map Design Based on Pop Art: Revisit of *Semiology of Graphics?*

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## ABSTRACT

*Is aesthetics an objective in the map design process? This question echoes our long-term research: does aesthetic quality improve map efficiency? In this paper, we discuss the notions of aesthetic response, objective and experience proposed by Kent (2005), and their relevance for making more expressive personalized maps. We first present the state of present research related to these notions and our interpretations. Then we present a systematic approach for rendering geographic data in a cartographic style based on the visual properties of Pop Art; the resulting maps are more vibrant and expressive. We consider this result a first step towards enhancing map quality. The proposition of a Pop Art cartographic style leads us to revisit some theoretical and practical principles of* Semiology of Graphics *(Bertin 1967), considering our experience with color contrasts and new approach for using texture. We conclude that expressive cartographic renderings would be useful for every mapmaker, and in the context of personalized map design, providing more elaborate tools could improve the design process and the resultant maps. Improving map quality is a question of managing visual variables in a traditional way—according to Bertin's* Semiology of Graphics*—but also in a more artistic way, in order to find better cartographic representation according to the preferences, needs, and purposes of the mapmaker.*

**KEYWORDS:** Map Design, Graphic Semiology, Visual Variables, Colors, Texture, Style, Pop Art.

# INTRODUCTION

Contrary to his provocative title, "Aesthetics: A Lost Cause in Cartographic Theory?", Kent (2005) assumes that aesthetics has played and still retains a central role in cartographic theory, and has perhaps been a topic missing from the map design process. He mentions that current maps are tools that "must all function to work and aesthetics are part of, and enhance, their function." Moreover, he discusses the aesthetic response that can be experienced "when something is beautiful," and the relation between a user's confidence in a map and the degree to which they feel it is aesthetically pleasing. Finally he asks us, as researchers in cartography: is aesthetics an objective in the map design process?

All these open issues coming from Kent echo our own long-term research question: does aesthetic quality improve map efficiency? On the one hand, we consider the map efficient if the cartographic message intended by the mapmaker matches what the map user effectively understands when reading the map. Efficiency in map design is currently most related to readability and understandability. On the other hand, aesthetics in map design refers to perception and feelings when looking at a map. This definition implicitly suggests that it has nothing to do with efficiency. To conclude, there seems to be some conflict in map design research between aesthetics and efficiency. Our main long-term purpose is to try to prove that those notions are closer than is currently accepted.

For the moment, we are focusing on a related research topic: proposing sophisticated methods to make more aesthetic and expressive maps in the context of personalized map design. Therefore, we have been searching for sources of inspiration in artistic domains, in order to find ways of enhancing the expressive and aesthetic properties of personalized maps. In earlier work, we used a famous painting to consider color uses in map design (Christophe 2009 and 2011). We now consider Pop Art: a colorful, brilliant, very expressive, and popular artistic movement useful for revisiting the visual and aesthetic properties of personalized maps, and thus revisiting *Semiology of Graphics*.

In this paper, we discuss the notions of aesthetic response, objective, and experience, proposed by Kent (2005), relevant in our context of making expressive maps. We first present a state of the art related to these notions and our interpretations. Then we present a systematic approach to making a Pop Art cartographic style that may be used by any mapmaker to render their geographic data and enhance the map quality. The proposition of a Pop Art cartographic style makes us revisit principles in *Semiology of Graphics* (Bertin 1967) regarding our experience in colors and a new approach to consider the texture. We hope that these considerations may then be formalized to help users of online cartographic tools make better personalized maps according to their purpose. Therefore, we use the notion of "user," implying "user of cartographic tools," (i.e., a mapmaker) whatever his/her level of expertise.

# CURRENT UNDERSTANDINGS OF AESTHETIC CONSIDERATIONS IN MAP DESIGN

Here, we discuss the aesthetic considerations of the map design process as they are presently understood, though we will not be exhaustive; others have magnificently done so (Keates 1993 and 1996, Krygier 1995, Kent 2005, amongst others). We assume that aesthetics enhances the function of a map by making it more easily readable, efficient (as regards an intended purpose or task), and understandable. Therefore, we would like to highlight this role, and our analysis is twofold: on the one hand, aesthetics may be considered an essential characteristic of map quality which must be integrated in the map design process (i.e., "aesthetic objective"); on the other hand, aesthetics is a question of perception for map readers (i.e., "aesthetic response").

## *AESTHETIC OBJECTIVE: MANAGEMENT OF VISUAL VARIABLES*

The underlying question of the aesthetic objective of the map design process is: on which variables does the map design process rely in order to make an aesthetic map? Existing methods to manage aesthetics in automated map design or on-demand maps are mainly related to symbol specification—how visual variables are specifically arranged and balanced to make an aesthetic rendering. As cartographers, we benefit from Bertin (1967), whose conceptual framework describes the properties of visual variables and the way they should be used to represent relationships between objects. But, if we consider the aesthetic objective we pursue, we don't know any properties or principles to specifically create aesthetics from visual variables. Instead, many research works on aesthetics focus on color specification. Color choices are mostly driven by theoretical and practical cartographic considerations, based on conventional and contrast principles (Bertin 1967, Brewer 1994, Robinson et al. 1995). In this context, three ways may be explored to manipulate colors to enhance aesthetics.

First of all, the issue of harmony, prevalent but not formalized in cartography, is mostly considered a problem of arranging colors. Brewer (1994) proposes harmonious color schemes based on recommendations similar to Munsell (1947). Christophe et al. (2011) provide a quantitative measure to evaluate color harmony in a given map, based on indicators of balance and liaison between colors, and balance between spatial color contrasts.

Secondly, some theoretical and practical cartographic principles may be ignored, even while making good maps; unconventional uses of colors won't necessarily make bad maps. In that sense, conventions may be bypassed, opening all-new possibilities of color choices and uses. For instance, the color of the sea does not necessarily have to be blue according to the mapmaker's intention, as long as the selected color does not disturb the map reader's perception or create misunderstandings (Christophe 2011). Moreover, the use of contrast to highlight salient objects may be switched (as compared to traditional practices); in order to reduce the energy use of mobile devices displaying maps, Hoarau (2011) suggests that maps should be darker than usual and thus proposes a kind of "by night" map instead of a traditional style, which is too brilliant for this use.

Lastly, it may be interesting to find new color practices coming from other visual domains. Using color from artistic paintings and painters' practices to enhance the aesthetic objective of the map, while improving its quality, has been tested by Feranec and Pravda (2009), Friedmannova (2009), and Christophe (2011)—see Figure 1.

The watercolorization of the Open-StreetMap background (maps.stamen.com/watercolor) is also an attempt to reach new practices in cartography, inspired by artistic practices. In addition to colors, some works explore other visual characteristics. Inspired by hand drawings, Wood et al. (2012) provide sketchy rendering tools to convey the uncertainty of the visualized information and to involve users in a participative annotation task. Jenny et al. (2013) suggest designing digital panoramic maps by applying example-based texture synthesis methods to hand-drawn hiking or skiing maps.



Figure 1: Cartographic and artistic color use from a painting of Derain (IGN Data: BDTOPO®). Note: these maps are made with GeOxygene (oxygene-project.sourceforge.net).
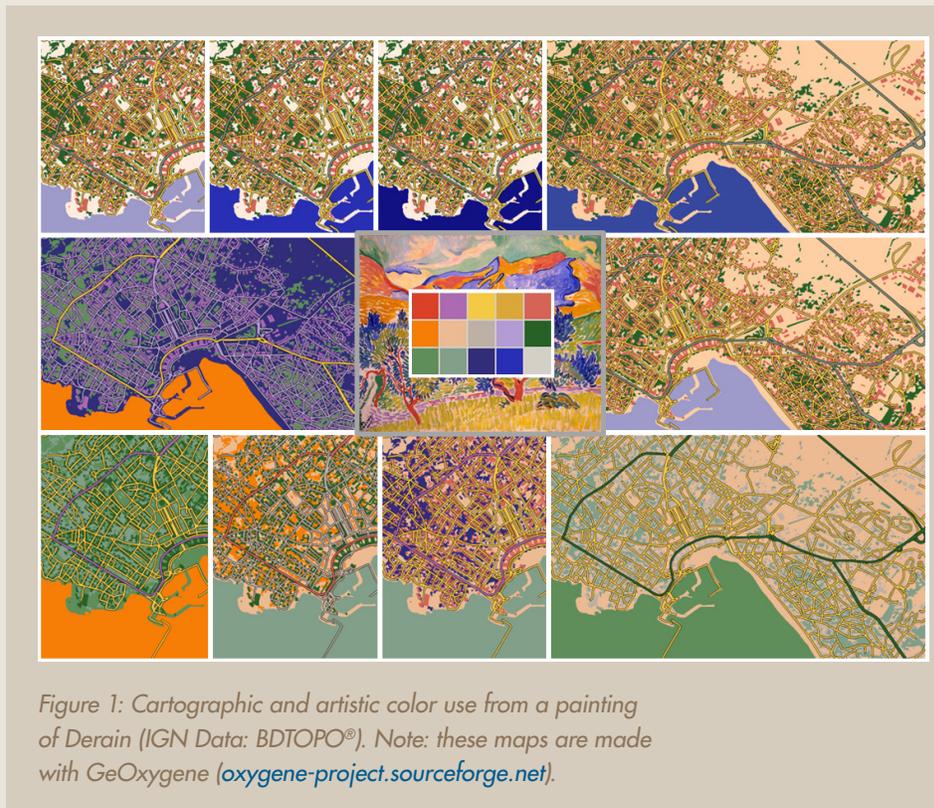
## AESTHETIC RESPONSES IN CARTOGRAPHY: FEELINGS AND PREFERENCES

Our analysis of aesthetics considerations in map design was twofold; we previously detailed the aesthetic objective, now we present the aesthetic response as a question of perception for map readers. Several issues about the aesthetic response, regarding the question of what is beautiful, are still at stake: which form does this response take (emotion, perception, feeling, preferences)? how could it be analyzed and measured? how is it perceived by map readers and also mapmakers? The classical approach aims at considering users' feelings, mainly through the knowledge of their preferences. The question, "which map do you prefer?" or "which map is the most beautiful?" is often used in visual tests to gauge feelings and/or preferences (Ortag 2009, Christophe 2009 and 2011, Christophe et al. 2011, Jolivet et al. 2009, Fabrikant et al. 2012, amongst others). The difficulty lies in the possible interpretations of the question and also of the answers. In some studies, descriptors are provided to help users specify their feelings (Dominguès and Bucher 2006, Jolivet 2009, Dhee 2013). Christophe (2009 and 2011) highlights the difficulty in directly asking users their color preferences. Her proposition consists instead of providing sources of inspiration for color choices and color uses (existing topographic maps and famous paintings) that users may like or dislike:. Thinking by analogy, they may transfer the visual impact and the general feeling of the color composition of an inspiration source into their maps. What is relevant here is that an aesthetic

response may be stimulated by both classical topographic maps (perceived as beautiful; see Kent 2005, 2010) and by famous colorful paintings.

In order to better understand the aesthetic response, Fabrikant et al. (2012) attempted to physically measure it with the help of a body sensor capturing skin measurements, combined with an eye tracker. They provide a protocol to measure emotional response while looking at different traditional and original topographic maps coming from their previous research work. Results of their measurements were validated by a final ordering of previously presented maps, according to the preference of the user.

### CARTOGRAPHIC STYLES: A WAY TO STEER THE MAKING AND PERCEPTION OF AESTHETICS?

The two previously discussed aspects of aesthetics, the aesthetic response and objective, are difficult to independently explore, analyze, and formalize because they feed each other. Therefore, we think that they are strongly gathered in the notion of cartographic style. This term is still being defined, though it is described and approached in some recent works (Kent and Vujakovic 2010, Beconyte 2011, Christophe 2012); cartographic style may convey an aesthetic experience that we would like to formalize. Plus, an interesting aspect of topographic styles may be that "finding the maps aesthetically pleasing is thus derived from (our own) representation of the landscape" (Kent 2005). As does Kent, we believe that the perception and the (re)cognition of a territory play a great role in the notion of cartographic style. Ory et al. (2013) try to formalize these aspects based on a study of French and Swiss cartographic practices and related geographic spaces.

These considerations of aesthetic response, objective, and experience introduce an aesthetic experimentation with the help of sources of artistic inspiration applied to topographic maps.

## A SYSTEMATIC APPROACH TO MAKING A POP ART CARTOGRAPHIC STYLE

We aim to make an artistic cartographic style involving an aesthetic response and enhancing the aesthetic objective of resultant maps. Our first task is to find representative images of an artistic movement from which we can extract some of its salient visual characteristics. We then draw a parallel between these visual characteristics and the visual variables we may handle in a map. Here, we focus specifically on the Pop Art movement, manipulating its characteristic, brilliant, easily recognizable colors. Some aspects of making Pop Art maps have previously been presented in Christophe et al. (2012); we describe here our systematic approach to making a Pop Art cartographic style with the purpose of making more expressive and aesthetic topographic maps.[1]

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1. In our research work, we mainly handle topographic data and maps related to the national mapping agency in which we are situated. It is a very relevant place in which to consider traditional and original cartographic practices in the context of personalized map design and geovisualization.

First, we tried to specify what is representative of the Pop Art movement for us and, if possible, for people at large: mostly brilliant complementary color contrasts, visual effects of relief or serigraphy, cartoonish writing, Benday dots[2] and finally, the idea of an image reproduced with many color schemes. Our idea was to select a set of very famous images or images which make people think of Pop Art. We thus selected a Marilyn Monroe portrait by Andy Warhol (1962; Figure 2A), a piece by Roy Lichtenstein (1965; Figure 2B), and a famous imitation of Warhol, representing Che Guevara, by Gerard Malanga (1968; Figure 2C).
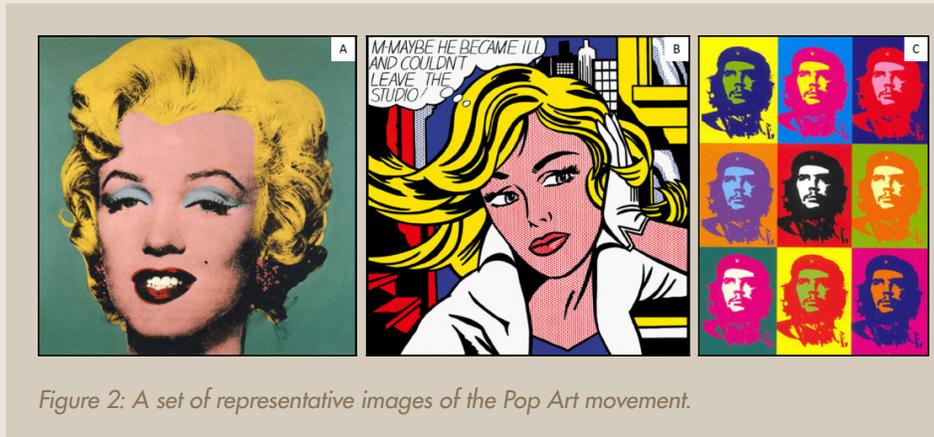


Figure 2: A set of representative images of the Pop Art movement.

We assumed that people may recognize a Pop Art style while looking at these images; we make the hypothesis that they may recognize this Pop Art style when it is applied to geographic data. This selection of representative images may be subjective, but subjectivity is inherent to aesthetic and artistic perception.

Our objective was to determine the visual characteristics of the Pop Art style that may be applied to geographic data. Christophe et al. (2012) make recommendations regarding how to manage colors, color contrasts, typography, and stroke thicknesses, according to various data selections. With the help of these guidelines, many Pop Art maps are possible.

### THE MAKING OF POP ART MAPS

What is relevant when using the three inspiring images is that it is not necessary to use all specified visual characteristics to think about Pop Art; it is possible to select some visual characteristics from one or several images and to combine them to reach a Pop Art cartographic style. Therefore, using only one Guevara from the first image makes a first map, "Che Guevara" style, with typical complementary and brilliant contrasts and highly saturated colors (Figure 3A). Using textures made of Benday dots, cartoon typography, bright colors, black outlines, and the specific color contrast of the Marilyn Monroe image makes a second map, a more "Lichtenstein" style (Figure 3B). In mixing inspiration sources, a third map may be obtained, with the typical blue-green (background)/pink (skin) contrast from Marilyn, bright colors from Malanga, and Benday dots, black outlines, and typography from Lichtenstein (Figure 3C).

Even if aesthetically evaluating artistic renderings is obviously quite subjective, we conclude that Pop Art maps have a great potential to enhance aesthetics and readability. This statement has to be considered always according to the user's need,

2. Benday dots are a printing process, coming from the illustrator and printer Benjamin Henry Day; they consist of a field of colored dots closely or widely spaced, providing a visual effect.
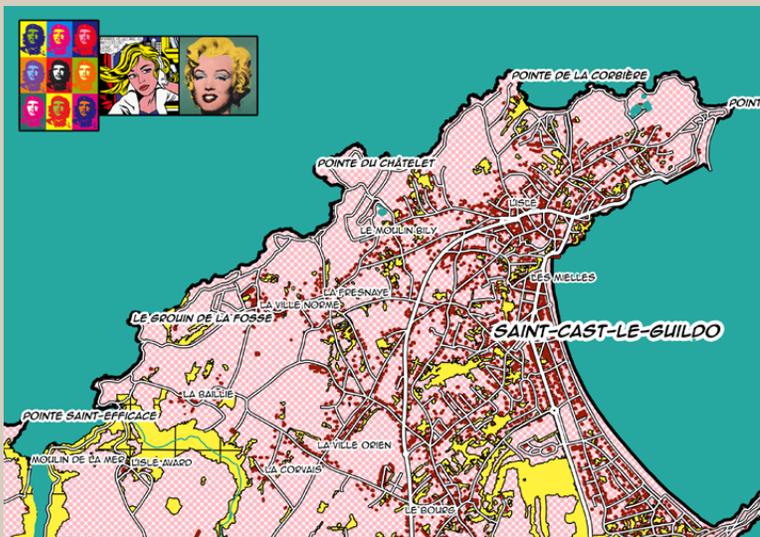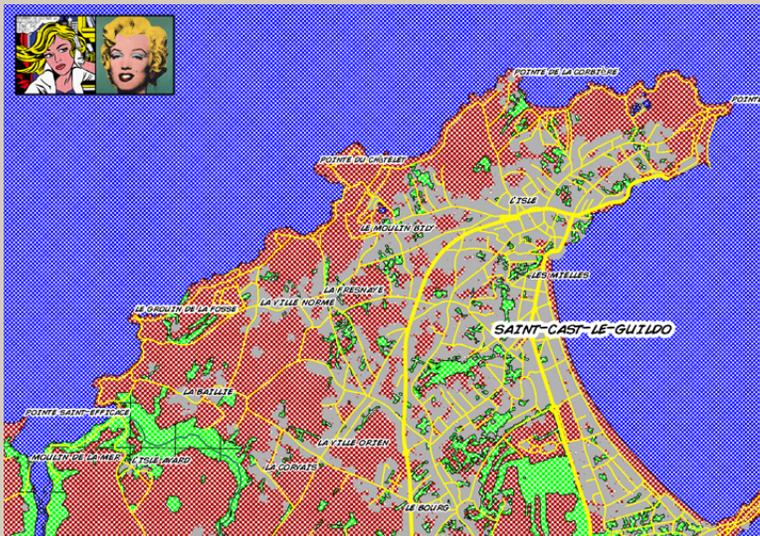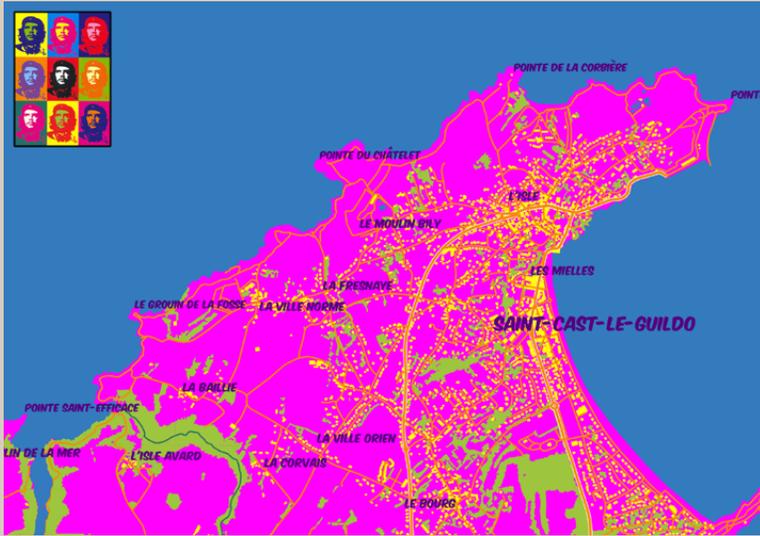
Figure 3: Three examples of Pop Art maps, from Christophe et al. (2012) (IGN Data: BDTOPO®). Note: all maps are made with QuantumGIS (qgis.osgeo.org)

taste, and purpose in our context of personalized map design. We present here only three possible resultant maps, but there are many possibilities for using Pop Art properties to make maps more expressive, more artistic, and thus more aesthetic, according to the mapmaker's wishes. We personally find that the third map (Figure 3C) conveys something particularly aesthetic in highlighting the sea-earth frontier; the black line and the opposition between a large blue area and a large field of pink Benday dots makes the map more vibrant. Moreover, Pop Art maps may also be more readable and efficient, depending on the mapmaker's purpose. The mapmaker may play with levels of color contrasts in order to manage a global impression or feeling, or to increase visual contrast between map features (for instance, with the complementary contrast). With the help of Pop Art properties, mapmakers may also highlight some geographic features over to others, according to what they need to make salient. It is our goal to be able to parameterize and control Pop Art properties in order to provide methods to mapmakers that manage various levels of reading and various kinds of visual saliency, while respecting their purposes.

Many maps can be created using the guidelines detailing how to manipulate visual characteristics found in Christophe et al. (2012), with many possibilities for selecting and combining those characteristics. Guidelines are not meant to constrain users during map design but rather help them enhance visual effects, the expressivity of data and map, and creativity—and thus the aesthetic experience.

## HOW DOES THE POP ART STYLE REVISIT *SEMIOLOGY OF GRAPHICS*?

The resultant Pop Art maps made us revisit *Semiology of Graphics* (Bertin 1967) and related design principles both theoretical and practical.

### *COMPLEMENTARY COLOR CONTRASTS*

The two visual variables, color hue and color value, very powerfully achieved our aesthetic objective

during the map design process. Bertin's
definition of color in the *Semiology
of Graphics* now has to be extended;
Bertin was not very explicit about
colors, as he was more driven by black-
and-white issues and necessarily thrifty
regarding the printing of colors. More-
over, the representative images of the
Pop Art style testify that bright colors
and complementary color contrasts are
two relevant visual characteristics of
Pop Art. Both considerations of color
uses invited us to manipulate the colors
of a topographic map based upon the
complementary contrasts of the Gue-
vara painting (Figure 4). We aimed to
convey a visual impact similar to each
Guevara in each mini-map. Conse-
quently, we tried to preserve comple-
mentary contrasts, color proportions,
and arrangement in the masterpiece
when producing each mini-map:



Figure 4: Che Guevara-inspired mini-maps (IGN Data: BDTOPO®).

- The color of the Guevara back-
  ground is used for the sea (for
  example, bright yellow for the left
  top mini-map).

- The color of the Guevara silhou-
  ette is used for the map back-
  ground layer (for example, navy
  blue for the left top mini-map).

- The color of the Guevara face is
  used for the vegetation layer (for
  example, apple green for the left top mini-map).



Figure 5: The same artistic style applied to different map extents (IGN Data: BDTOPO®).

The use of complementary contrasts allowed us to achieve a maximum effect of
color and light. The human eye, when looking at a color, tends to perceive its com-
plementary color (i.e., simultaneous contrast): when two colors close to each other
on the chromatic wheel are juxtaposed, this simultaneous contrast is enhanced,
making the composition very vibrant. The bottom right Guevara image presents a
blue-orange complementary contrast that has been described by Chevreul (1839):
"Once you put together a blue area and an orange area, it is obvious that the colors
of both objects purify themselves and become brighter." In the related mini-map,
the vegetation is subsequently enhanced. Complementary contrasts may thus be
useful for highlighting data on a topographic map; we could have used the orange
color for the building layer in order to contrast it with the background layer. It
would deviate from the Guevara image, but it could be a way to design a more

efficient map, depending on the cartographic purpose. Moreover, this example is also an opportunity to show a landscape with various impressive colors inspired by the Guevara image. The Pop Art concept of easily reproducible images is quickly applicable to vector data, allowing the design of a set of maps with various color specifications. This could be useful in providing different views of a given landscape depending on a given user's need.

The application of artistic characteristics to a fixed geographic dataset is a specific stage of the map design process. The features represented in a map have a given shape and geographic location, though they are sometimes modified a little in order to generalize the information and improve the readability of the map. But this process is limited because of another relevant objective of the map: accuracy. Consequently, the distribution of colors in a map is driven by the location, shape and size of the represented features. Christophe (2009) provides guidelines on applying some artistic color composition to geographic data; for example, if a color is used for little spots or small spread-out little objects in the inspiration source, it could be used to render the building objects, as "spots" at this scale, related to their shapes and sizes. We followed these principles in designing the mini-maps inspired by the Guevara painting (Figure 4), in order to preserve color proportions and distribution.

Another issue is to choose an adapted footprint for the map. For example, different options may be proposed to reproduce the Che Guevara style, as illustrated by Figure 5.

Figure 5A shows mini-maps of the same extent with different color specifications. As we previously stated, it provides different views of the landscape, and could be useful for highlighting different information in each. But the mini-maps are not very readable due to a level of generalization that is unsuitable to the scale. Figures 5B and 5C are graphic experiments in which the whole landscape has been divided into nine parts in order to convey the nine color compositions of the Guevara painting. Here the maps have an acceptable scale and may still convey the Guevara visual impression. Mini-maps are clearly examples of what could be done; now they must be associated with specific users' needs. They are a first attempt to reconcile our aesthetic objective and response, making a cartographically correct map without losing the expected Pop Art visual impression. This method is adaptable to making more efficient personalized maps, for instance, suitable to the space being represented.

### BENDAY DOTS AND THE TEXTURE OF BERTIN

Using the typical Benday dots of Pop Art made us revisit the texture visual variable and the dot grid maps proposed by Bertin originally in a black-and-white context. These design processes were once hard to carry out manually, but Bertin anticipated the automation of graphic representations which is now possible in GIS applications and computer graphics tools (Emery 1975). Therefore, we explored the recovered potential of these old-fashioned map design processes in the context of color, in order to assess the value of using them not only to convey a Pop Art style, but also to improve the quality of the map.

Dot textures were used as background layers in order to assess their visual impact (Figure 6). Figure 6A shows a map with a plain tint background layer. This map presents a relevant Pop Art complementary contrast between the turquoise blue of the sea and the light pink of the background layer. This contrast is recommended by our guidelines inspired by the Marilyn painting, and very well conveyed by the map. But the induced contrast between the light pink and the burgundy red of the building layer is very strong, and may be too saturated in red, pink, and warm tints. This conflict could reduce the efficiency of the map. Dots provide a great opportunity to soften the pink background color and its contrast with the building layer by using a white background. Moreover, the dots allow conveying a visual effect similar to the Pop Art Benday dots. Graphic experiments seen in Figures 6B and 6C aimed at testing different sizes of dots, which must be chosen carefully. Indeed, dots which are too large or too salient could affect the desired Benday effect and the readability of the map (Figure 6B). Figure 6 allows a study of the impact of the size of the dots, but it could also be interesting to further experiment with other variations of the texture such as the disposition of the dots (in quartering, in staggered rows, etc.), the spacing between them, or their shape.

Finally, dots were used to convey quantitative information. Figure 7 provides examples of a texture map (on the left) and dot grid map (on the right) designed with QuantumGIS (**www.qgis.org**) and the Kartograph framework developed by Gregor Aisch (**kartograph.org**), respectively. Both maps represent the population of the departments of France. Both cartographic techniques were very hard to manually create in Bertin's time. Here, they are an interesting way to provide thematic information, and the use of pink dots with a white background, inspired by Figure 6, allows a softening of the contrast between the background color and the sea, and in so doing, creating a subtler potential background layer.

Both examples show the visual importance of the sea and background layers and their potential for conveying Pop Art complementary contrasts. They are elements relevant to our aesthetic objective. Both map design processes allow us to keep this contrast, but softened, as we see in the graphic experiments of Figure 6. Thanks to these examples, we can assume that designing Pop Art thematic maps is also possible. The texture variable and the grid dot map method are interesting alternatives for representing quantitative information without using the size, value, or color visual variables. Using other visual variables, such as size, value, or color, to represent quantitative information could have been difficult with respect to our Pop Art guidelines and would have weakened the resultant aesthetic response.

## CONCLUSION

In this paper, we discussed aesthetic objective, response, and experience and our interpretations of these notions in topographic map design. Though these concepts are mainly studied independently, we believe they should be analyzed together in a notion of cartographic style. We have searched artistic domains for sources of inspiration, seeking to enhance the expressive and aesthetic properties of personalized maps. In earlier work, we used famous paintings to consider color uses in map design (Christophe 2009 and 2011). Here, we have used ideas from Pop Art—a colorful, brilliant, very expressive, and popular artistic movement—to revisit the
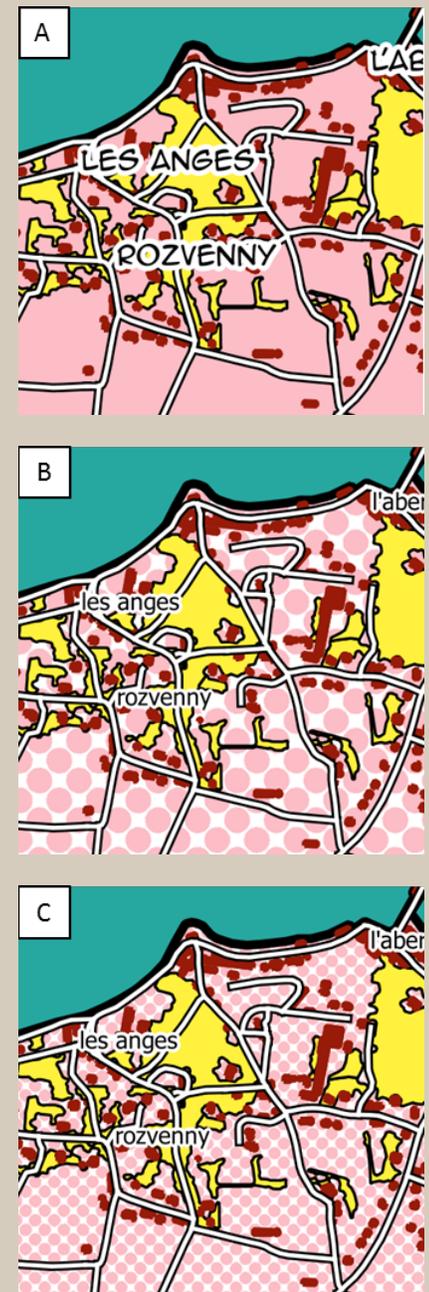


Figure 6: Using dot texture as a background layer (IGN Data: BDTOPO®).
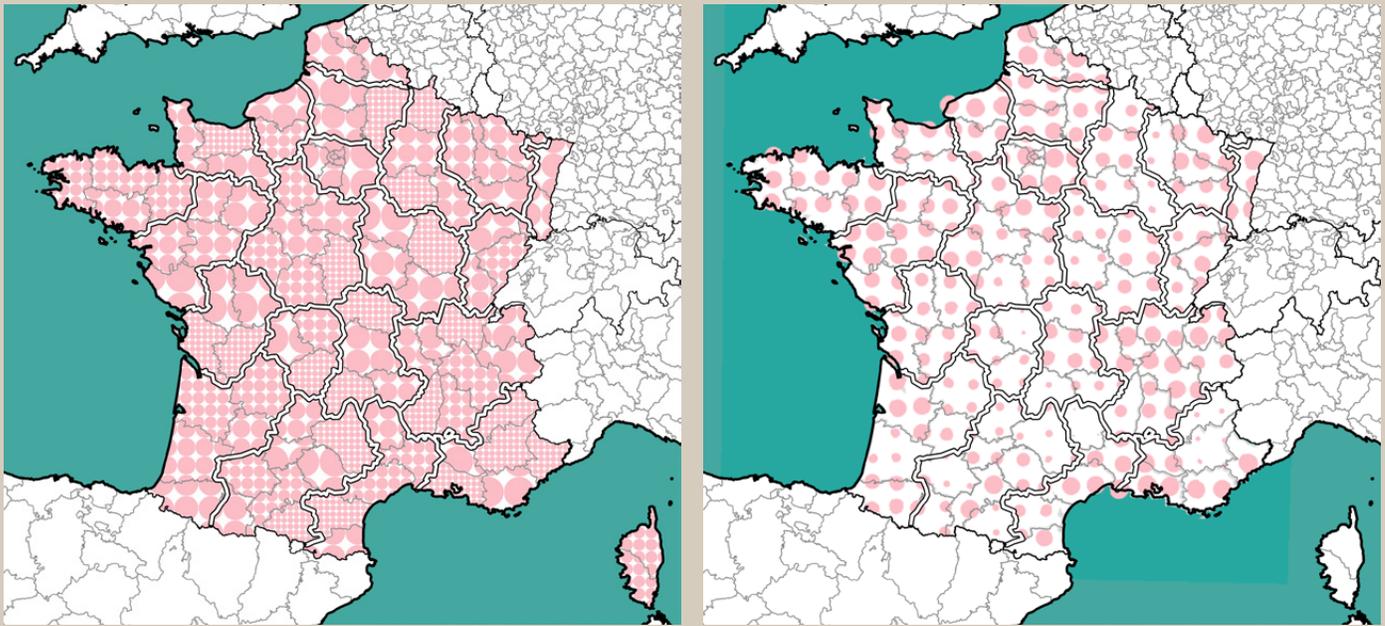
*Figure 7: Using dots to represent quantitative information in a Pop Art style (IGN Data: BDTOPO®, GEOFLA®; ©EuroGeographics).*

visual and aesthetic properties of personalized maps. We propose that a Pop Art cartographic style will improve their expressivity and aesthetic quality. This aesthetic experience has also made us revisit *Semiology of Graphics* on the subjects of color contrasts and texture.

Our long-term purpose is to validate that idea aesthetic quality improves map efficiency. We test methods to enhance aesthetics step-by-step in the map design process. But we often face difficulties with automatic design techniques that should be parameterized by the mapmakers themselves in order to make more satisfactory maps. We assume that the expressivity of maps—coming from expressivity of visual variables—if well-managed, would be very useful for every mapmaker. Actually, in the context of personalized map design, providing more elaborate tools could improve the map design process and the resultant maps. Improving map quality is a question of managing visual variables in a traditional way—according to Bertin's *Semiology of Graphics*—but also in a more artistic way, in order to find better cartographic representation according to the preferences, needs, and purposes of the mapmaker.

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