Maps and Design–Influence of Depiction, Space and Aesthetics on Geocommunication

Karel Kriz

Abstract A map is a graphical representation of space exploiting artistic concepts to communicate thematic aspects of geography. In this context design issues play an important role and can be seen within cartography as the art or the action of conceiving an artefact before it is made. However, in order to communicate spatial results efficiently, from a cartographic perspective, both the conception and construction of maps must be well-considered beforehand. The proficiency to communicate lies therefore in how maps are designed and in the way they are realized and reproduced.

Keywords: Design · Perception · Geocommunication · Thematic cartography · Aesthetics

1 Introduction

The saying "*A picture is worth a thousand words*" refers to the concept that complex information can be transported efficiently in just a single image. This has been—and still is—the case in cartography. However, it is important to be aware of the cartographic fundamentals and their utilization. Not all pictures, graphics or maps communicate efficiently. Rules and specifications dominate the cartographic production procedure in general and must be advisedly considered during the design process. Communication is the concluding stage of the map development process and the goal of geographic communication is to transport and exchange information via maps and map-related objects. Whether the process is successful

K. Kriz (✉)
Department of Geography and Regional Research, University of Vienna, Vienna, Austria
e-mail: karel.kriz@univie.ac.at

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or not depends greatly on how design and aesthetic elements are used in combination with cartographic realization. Design and aesthetics should therefore not only be seen as the domain of art, but also in cartography. They play an essential role ensuring that cartographic products communicate spatial information effectively and efficiently. Thus, a map is the outcome of this process and can be seen as a geocommunicator.

This contribution discusses the role of design within the cartographic production process and showcases methods and examples that underpin this task. Various representations are provided to demonstrate both the cartographic principles of knowledge acquisition and the design approach that supports geocommunication.

2 Geocommunication

Communication depends on the capability to understand and to adopt the basic functionalities of information exchange. This assumes literacy—the skill to read, to write and to use language proficiently—numeracy—the capability to work with numbers and to deal with mathematical concepts—and articulacy—the competence of being able to express oneself fluently and coherently. These skills are essential to our society and form the basis of our educational systems as well as being the foundation of communication generally. However, in order to communicate efficiently with geo-related, cartographic information, the receptors as well as the communicators also must have the ability to exchange information via graphics. In everyday life we are constantly confronted with manifold graphic information. This information is filtered, processed and transformed, resulting in a decision that, in many cases, can trigger an action. Much of this information is stored in graphic form. Without (carto)graphic expertise, the dissemination of information in our society would be a very tedious process. Here, it is implied that indispensable structures of our modern communication would fail without the ability to successfully communicate information using graphics, including geo-graphics.

Map interpretation uses graphic communication that is stimulated through our visual sensors. The object of interest is scanned optically then transferred to a visual register before being stored in short-term memory. Thereafter, if the interaction was successful, short-term storage is relocated to long-term memory and sustainable usage is ensured; otherwise information loss occurs (MacEachren 1995). Visual cartographic communication builds upon information retrieval from long-term memory as well as the detachment of graphical layers. This allows the observer to conceive the content. In every map there is at least one defined layer for orientation, the base for locating thematic content in a spatial context. On top of this layer thematic content is defined and communicated. This can vary from a very simple depiction all the way to a multi-dimensional, complex visualization. Objects can be grouped together to create chunks that help structure and organize the overall cartographic representation (Kriz 2009).



Fig. 1 Newspaper advertisement. *Source Der Standard*, Austria 10.10.2009

An example of how delicate communication with cartographic representations can sometimes be is shown in the newspaper advertisement (10.10.2009) in Fig. 1, published in a leading Austrian newspaper. This advertisement was commissioned by a large mobile telephone company and uses a small scale map of the eastern hemisphere to advertise their special worldwide business offer. The depicted geographic space is, interestingly enough, not the whole world, but just a portion—defined from 0° east of Greenwich all the way to the date line at 180°. However, it excludes New Zealand. The message of the advertisement starts with a question: "*We asked 100 people worldwide, where is Austria?*" The answer is then given through the map. The map shows 99 interviewees locating Austria in Australia, with only one respondent giving the correct answer. The conclusion of the advertisement is therefore … "*make it easy for you and your customers. Give them one number and don't bother them with country codes and other unnecessary things*". At first glance the observer is presumably somehow amused or maybe, to a certain extent, even irritated. However, if the message of the map is thoroughly deconstructed then potential customers and, ultimately, all users of that mobile telephone company must be seen as being unintelligent, not knowing the difference between Austria and Australia.

Such representations show the raw potential, as well as subjective approach, of cartography and illustrate how perception in geocommunication works—knowingly and unknowingly.

Views and proposed activities derived from the interaction with maps can trigger an action and thus effect what we experience. Every observation and interpretation of a map is, therefore, subjective even if objectivity is proclaimed through cartographic standardization. Using visual variables to distinguish cartographic primitives helps keep interpretation, to a certain extent, consistent. This underpins the principles of geocommunication. However, not all objects depicted within the visual field are perceived equally. Discrepancies can direct attention to certain elements on a map that can also lead to controlled or uncontrolled actions. Even though a map reader can sometimes be misled or even manipulated, the result can still result in good communication practice. An example of intentional user manipulation is the cartographic depiction of public transportation networks, such as those depicting the underground railway systems in metropolitan areas. The manipulation of real geographic space into a false geographic space is deliberately employed in order to keep the visual display clear and understandable. Regular geometric design is adopted to avoid distraction of the map user. Colour is used as a dominant visual cue to communicate qualitative information about the transportation system. The communication of geographic reality is, therefore, not the primary factor of these maps. Instead, visual object recognition plays an important role that again utilizes information acquisition through effective graphics.

Various examples of underground maps from around the world can be found at the following locations:

http://www.webdesignerdepot.com/2010/03/design-around-the-world-metro-maps/
http://www.clarksbury.com/cdl/maps.html
http://www.londontubemap.org.uk/london-tube-map.jpg (accessed 28.6.2012)

These and other fundamentals of graphic communication, in relation with visual object recognition and graphic design, play an important role in cartography. They have been part of what can be considered to be ‘good cartographic practice’ since maps have been produced. Essentially, all cartographic artefacts are composed in the same manner. This is done based on the graphic primitives of maps—point, line and area. And, these can vary according to the visual variables—size, shape, value, colour, texture and orientation—to transport graphic elements (Bertin 1982).These principles are ubiquitous in all maps. When combined with syntactic and semantic rules their application contributes to effective geocommunication.

3 Effective Geocommunication

Historic cartographic examples can be employed to showcase the various aspects of mapping that have utilized effective geocommunication. They provide information regarding the heterogeneous nature of maps and how elaborate and aesthetically pleasing they can be.



Fig. 2 Fragments of turin papyrus—an ancient Egyptian mining map (*left half*) for Ramesses IV's quarrying expedition, 12th Century B.C. (New Kingdom). *Source* Museo (2012)

One of the oldest known artefacts that can be seen as a map in a broad sense is the depiction of an underground village that was overlooked by an erupting volcano in Central Anatolia, Turkey. This spatial representation was recorded in the wall paintings of ÇatalHüyük in modern Turkey. It can be dated to around 6,200 B.C. This illustration shows geographic space generalized in a vertical projection with a schematic relief depiction, giving the observer a cohesive view of an area of land that is graphically totally distorted, but nevertheless efficiently communicates reality (Meece 2006; Milestones 2012).

Similar principles of relief depictions are also found in Egyptian documents of the 12th Century B.C. The so called'Nubian Goldmine Map'is an example of a large scale map of an excavation site for precious metals as shown in Fig. 2. Here, mountains are depicted in a vertical projection while the overall perspective is planimetric. The discrepancy in geographic space does not primarily distract the user in utilizing the map, due to the fact that the major focus is on the location of the mine in relationship to the rest of the generalized topographic features (Museo 2012).

The Tabula Peutingeriana, a Roman street map from the late 4th Century A.D., shows yet another fascinating facet of relief depiction. This spatial representation of parts of the northern hemisphere at a small scale is implemented in the form of a list of cities and transportation routes, which is comparable to a topogram. The relief depiction is simple yet very artistically composed and contains a hydrological layer consisting of rivers and lakes as well as outstanding mountain ranges that are visualized in a so-called band, ribbon and ornament style. Even though the geometry is distorted, the overall benefit of the map is to communicate the relationship between cities and their environment (Tabula 2012, see Fig. 3).

Towards the end of the Middle Ages precise geodetic surveying and improved graphic techniques were adopted by cartography. Terrain depiction, for example, transformed slowly from a very elementary style to one having a more complex appearance. The so-called 'mole hill' manner used to reproduce third dimensional



Fig. 3 Tabula peutingeriana, Section XII India. *Source* Tabula (2012)



Fig. 4 Section yirol—Waldseemüller 1513, Tabula Moderna Germanie © Bayrische Staatsbibliothek München. *Source* Tirol (2012)

space was combined with basic topographic attributes such as hydrology and transportation routes as a common method to render mountainous areas utilizing artistic design features such as hachuring (see Fig. 4).

Maps became instruments of power through their facility to record and communicate geographic information. This was not only in association with technological inventions that allowed exact measurements of the earth's surface, but also the use of maps as a source of information about geography. The rise of an educated society, the needs for strategic geographic information by the military, the information being gathered through the exploration of previously undiscovered geographic space, as well as inventions like Gutenberg's printing method were just some of many reasons that heralded the eve of modern topographic mapping (Monmonier 1991; Harley and Laxton 2001). At first, maps had low positional accuracy, but they were designed in a very artistic fashion that was aesthetically pleasing and saw them accepted as useful objects (see Fig. 5). Planimetric views became the standard method employed by cartographers for representing geographic space. This included terrain depiction design methods that were adopted from the artistic sector. The intensive use of colour, symbolization, abstraction and modest attempts at generalization determined the design of large scale topographic maps. Over time precise instruments and

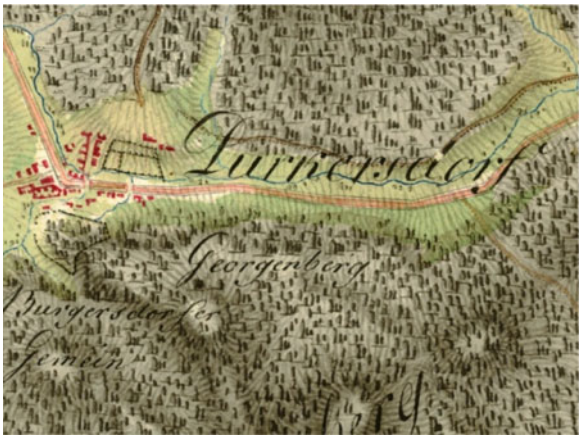


Fig. 5 Section of the historic map BIXa242_section 070c, Josephine Survey (Josephinische Landesaufnahme) from 1764 to 1787. *Source* Landesaufnahme (2012a)



Fig. 6 Section of the map data sheet (Aufnahmeblatt) 4856-1b Weißenbach an der Triesting, Neuhaus from 1872. *Source* Landesaufnahme (2012b)

methods for surveying and for navigation changed the appearance of the map due to the availability of more precisely measured geographic data. Also, the necessity to take measurements from maps in a more precise manner forced cartographers to model the Earth's surface in a more accurate, yet still abstract manner. At first, comprehensive techniques, such as artistic hachure styling to depict and to measure rough terrain, were adopted (Lehmann 1799). These methods were then enhanced (see Fig. 6) and later replaced by contour lines combined with rock depiction and hillshading. These maps closely resemble today's diverse variety of terrain display in topographic maps.

Large scale topographic maps, such as the examples from the Alpine Club Cartography in Austria shown in Fig. 7, communicate the overall outstandingly realistic impression of relief that gives the representation its typical aesthetic as well as artistic quality. The creation of these depiction methods is, however, very time consuming and requires high artistic skills as well as profound topographic knowledge.

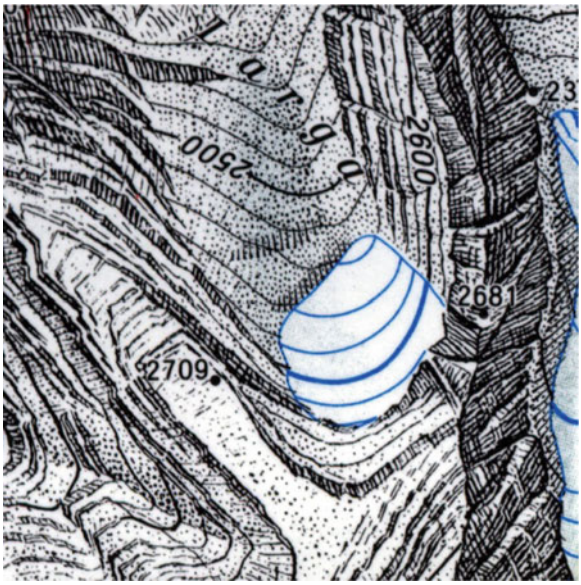


Fig. 7 Section of the Austrian Alpine Club Map, Alpenvereinskarte 51, "Brentagruppe des Deutschen und Österreichischen Alpenvereins" (original scale 1:25,000). *Source* http://www.alpenverein.at/portal/

Other methods of cartographic depiction provide maps that accommodate non-geographic space. They follow the same principles of graphic communication. A remarkable example that documents the use of such non-spatial data is illustrated through a familiar topographic map style in the Map of the Swiss Political Landscape by Michael Hermann and Heiri Leuthold (sotomo—Research Lab at the University of Zurich). This representation portrays the Swiss political mentalities in three dimensions: the x- and y-axis represent ideologies from left to right and modernist to traditionalist, respectively; and the z-axis corresponds to the population density and utilizes contour lines as well as hillshading to imitate the third dimension. Furthermore colouring—using shades of red, green and orange—represents the spoken language of the region (see Fig. 8).

4 Principles of Cartographic Design

The principles of cartographic design are manifold and can be seen as a standard within the design process. They play an important role during the deployment and creation of maps. Cartographic design principles are based on the fundamentals of visual perception and their appropriate applications have a strong impact on how interaction, communication and interpretation in maps work.

The expected and unexpected in maps is often used to stimulate attention and transport messages. The Isolation Effect, also known as the Von Restorff Effect, is a phenomenon of memory in which noticeably different things are more likely to be recalled than common things (Lidwell et al. 2003). The effect is based on

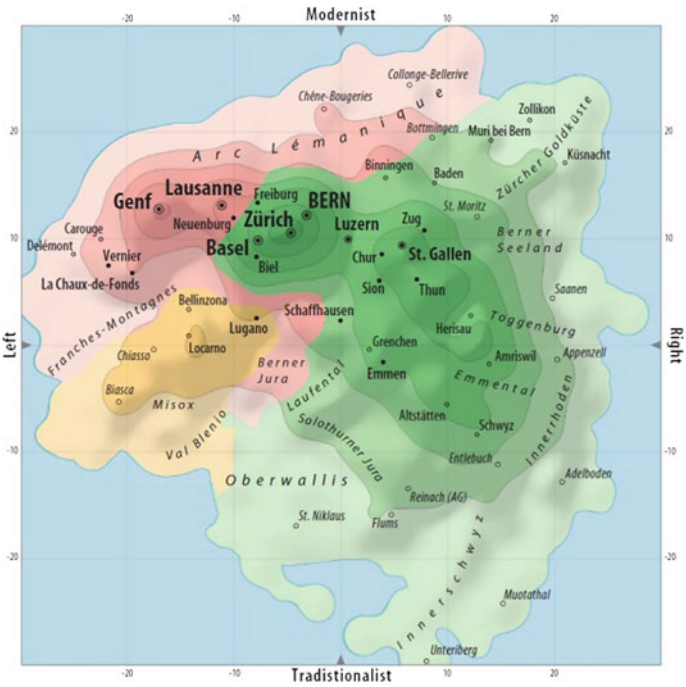


Fig. 8 Map of the Swiss political landscape. *Source* http://www.sotomo.ch/

distinctive encoding, difference in context and difference in experience. In other words, if something should be communicated then it should stand out.

one
two
three
four
five

The chances are high to remember 'two' in the listing above because it stands out. The map of the regional avalanche warning bulletin, shown in Fig. 9, is also a good example of the Isolation Effect. In the map the visual variables (colour and texture) are used to highlight areas of attention. Critical situations can be thus transmitted efficiently to the map user.

A map is a priori neither good nor bad, nor is it beautiful or ugly. An appealing and effective cartographic representation is compiled of many singularities that, in combination, produce the overall composition. Maps are like music. They consist of single notes. When correctly combined they can produce harmony or disharmony. Symmetry is one of many graphic principles that assist visual equivalence among elements in a form. It can be considered as the most basic and enduring aspect of beauty, conveying balance, harmony and stability (Lidwell et al. 2003).

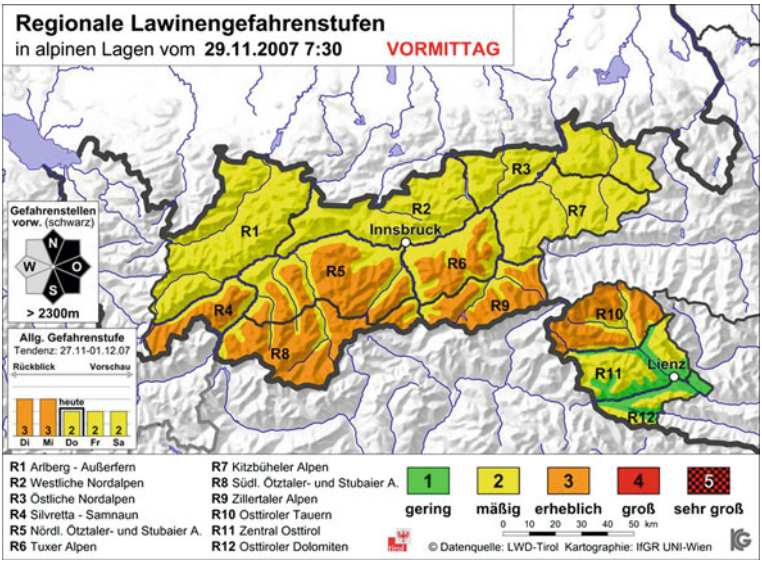


Fig. 9 Isolation effect—avalanche warning map of tyrol, Austria. *Source* http://lawine.tirol.gv.at/. Accessed 28.6.2012

The basic elements of symmetry are reflection, rotation and translation. These are often found in monumental architecture around the world such as Notre Dame in Paris (see Fig. 10). Combination creates harmonious, interesting and memorable design. In maps, symmetry plays an important role mainly in symbol design and is a form of similarity. It assumes that there is a connection between the parts (see Fig. 11).

In everyday life many of our activities require decision support that is assisted by communication and interaction. Correct and comprehensible perception is a prerequisite for such tasks. Elements that are similar are perceived to be more related than elements that are dissimilar, and they help us judge more effectively. The grouping of elements reduces complexity and follows the Gestalt principles of perception. The visual variables colour, size and shape assist the phenomenon of grouping. A low number of colours results in the strongest grouping. When employing size for grouping, they must be clearly distinguishable in order to achieve best results (Lidwell et al. 2003). A TV remote control is a good example of the applied employment of similarity in daily life. In maps, the grouping of objects to higher-ranking coherent categories is also a common task.(Figs. 12 and 13)

Given a choice between functionally equivalent designs, the simplest design should be selected. Efficient and simple design is a key factor to coherent geocommunication. The quotation "*Everything should be made as simple as possible, but not simpler*" attributed to Albert Einstein (http://en.wikiquote.org/wiki/Albert_Einstein accessed 28.6.2012) hits the spot precisely. Unnecessary features should be



Fig. 10 Symmetry—notre dame, Paris 2011. Photography: Kriz (2011)

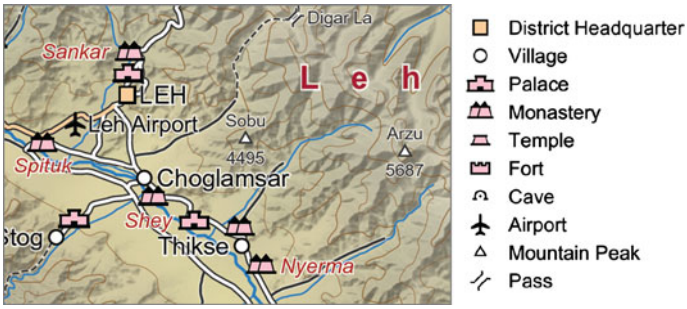


Fig. 11 Symmetry—section of the Himachal Pradesh topographic overview map, 1:500.000. *Source* http://www.univie.ac.at/chis. Accessed 28.6.2012

decreased in order to underpin the tendency to perceive a set of individual elements as a single, recognizable pattern. A good example of simplicity preferred to complexity is currently the omnipresent search engine Google™. The result is high performance paired with ease of use, or, in other words, simple and efficient. The principle of simplicity, also known as Ockham's Razor, is an integral component of cartographic



Fig. 12 Similarity—TV remote control. Photography: Kriz (2012)

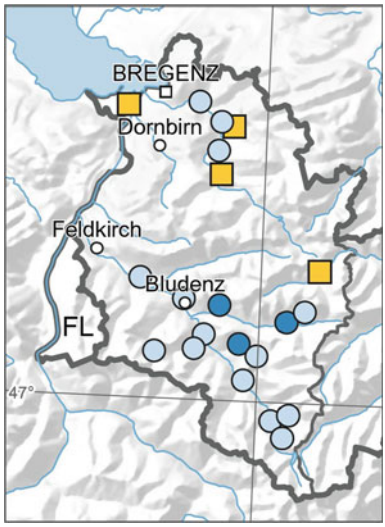


Fig. 13 Similarity in maps through strength of colour as a grouping strategy relative to shape and size. *Source* http://www.oerok-atlas.at/. Accessed 28.6.2012

design (Lidwell et al. 2003). Edward Tufte states that it is important to make all visual distinctions as subtle as possible, but still clear and effective (Tufte 2003). For instance, choropleth maps that use visual variables proficiently are a good example of

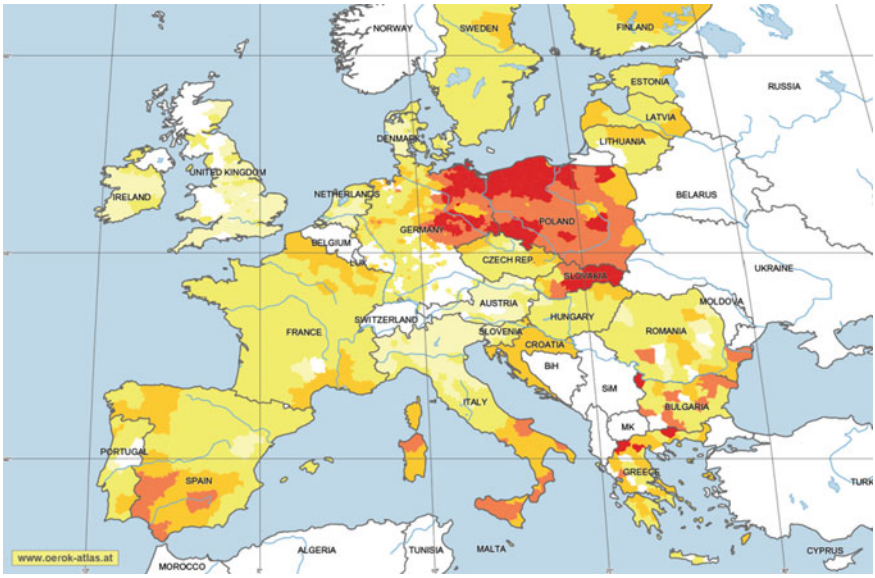


Fig. 14 Ockham's Razor—map of unemployment in Europe 2005. *Source* http://www.oerok-atlas.at/. Accessed 28.6.2012

geocommunication. Within a short interaction time with the map, complex topics can be communicated efficiently to produce spatial connectivity. The red and orange colouring in Fig. 14 attracts attention and indicates regions of high unemployment. The yellowish pale colours are more subtle and are merged into the graphic background. These areas display places of low unemployment. The message of the map is to answer the question: "Where are major hotspots of unemployment in Europe?"

It is easier to remember a face but sometimes difficult to recall the name of the person. This is due to the fact that recognition is obtained through exposure, not necessarily involving memory about origin, context, or relevance. The memory for recognizing things is better than the memory for recalling things. Recall memory is obtained through learning. Decision-making is strongly influenced by recognition, and it merely needs the choice of an option to satisfy the condition for making a decision (Lidwell et al. 2003). In order to recognize, however, information has to have been already learnt, respectively stored and made available in memory. Maps utilize this principle and highly depend on the cartographic knowledge of users and their ability to recognize familiar structures in order to make decisions. Therefore, the act of storing and encoding information in memory is essential (Straker 2010). Once this information is stored, recognition and recall can be evoked. According to Kolacny (1969) cartography can be seen as a communication science utilizing information retrieval and exchange from cartographic products. Thus, it is essential that both the map creator—the cartographer—as well as the map beneficiary—the user—is knowledgeable in cartographic communication.

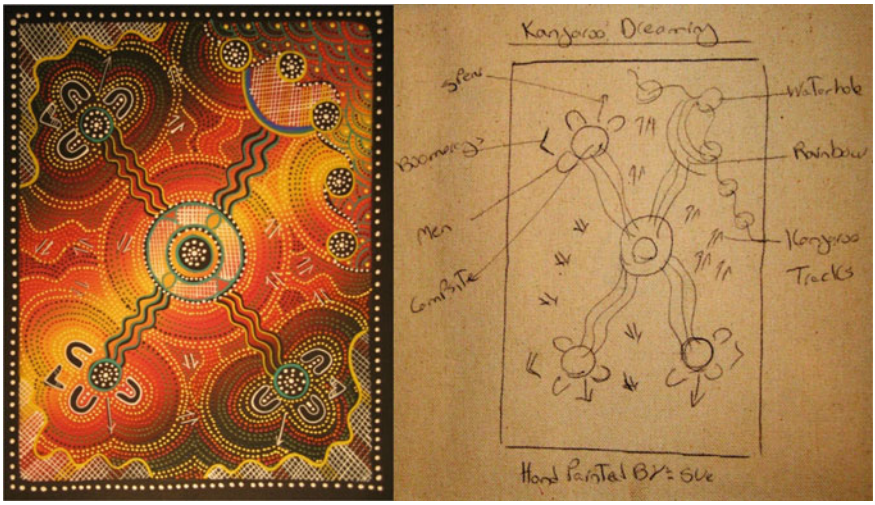


Fig. 15 Storytelling with maps—Kangaroo dreaming, Australia. Photography: Kriz (2012)

Maps tell stories of spatially relevant issues. They are used to transport complex as well as less complex information in a generalized and comprehensible fashion. Storytelling with maps is therefore a prevalent method of creating and communicating imagery, emotions, and the understanding of spatial events through an interaction between a storyteller (map maker) and an audience (map user). Storytelling is uniquely human and represents an effective method of passing information and knowledge on to a receptor. The fundamentals of visual storytelling coincide with the principles of cartographic communication. Figure 15 shows a narrative from aboriginal Australia. This map combines reality with fiction and uses standardized symbology to communicate the plot of the story. The setting orients the audience, providing the sense of time and place (Lidwell et al. 2003). Maps tell stories of imaginary as well as real space.

5 Conclusion

Maps and their design have a strong influence on how geocommunication functions. Performance is effective if the principles of cartographic design are taken into consideration, and consequently carried out in combination with the elaborate use of visual variables. The cartographic process, therefore, embraces design, cognition and communication equally in order to stimulate interaction, interpretation and reaction. Hence it is important to be aware of the principles of design and their application. Maps are more than just an accumulation of graphic symbols. They have an essential impact on how we perceive our world and influence our performance as well as our way of thinking. So be aware of the power of maps!

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