THE EVOLUTION OF MAP LANGUAGE

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The analysis of the map language is one of important issues of the modern cartography. The studies in principles of evolution of map graphical symbols and their combination in course of centuries and in various countries facilitate working out of scientific strategy for the development of cartographic symbols today and in the future.

The history of the map is rather good documented. Remaining map sheets serve as examples showing how the map language "works" in different human cultures and during various periods. They let to distinguish main stages in the map language evolution. Of course, the temporal borders of these stages do not always coincide in different cultures, some stages can not exist. But what is more important, the multiple contacts between peoples, belonging to various countries and cultures, resulted in powerful mutual influence and evolution of the map language, disappearance of its national peculiarities displaying on maps.

It is possible to distinguish the following main stages in the evolution of the map language:

1. The map as a system of natural symbols. Classical examples of such maps are Eskimo maps of Greenland as well as the stick-charts of the Marshall Islands made by aborigines. Natural objects, such as sand, stones, small shells, central ribs of palm leaves, serve as map symbols.

2. The map as a system of iconic signs. The iconic signs belong to visual (imaginative) symbols that were the most common in cartography since primitive times. Because of their similarity with the depicted objects they are easy for understanding by all users, even belonging to different cultural spheres.

The iconic signs were gradually complemented by symbolic signs arranging all icons into a system, that is classifying them into groups and attributing these groups with specific features.

3. The map as a system of conventional signs. As the civilization evolved the iconic symbols were gradually complemented by signs which are conventional and arbitrary. The emergence of conventional signs made it necessary to explain them. Initially such an explanation could be placed either directly beside the depicted object on the map as a commenting inscription, or separately in form of a legend. Later the separate explanation of conventional signs in a special legend became a rule. Thus, the legend is a metalanguage listing all symbols of the system together with real objects depicted by them, regulating possible combinations of the symbols and giving clue to their understanding.

There are intermediate stages between the above mentioned main stages. An interrelatedness of different systems of cartographic symbols and their coexistence on

the same map is one of distinguishing features of the map language evolution. Up to now many modern maps display a sort of "symbiosis" of iconic and conventional signs.

Analyses of cartographic depiction techniques were carried out in some studies, for example, by E. Lynam (1945), F. Dainville (1964), and others. My paper is devoted to the maps analysis in terms of the map language concept. The development of this concept was greatly contributed by the Russian professor A.A.Liouty (1988).

The map language is understood as an objective phenomenon evolved naturally within the social and historical practice of humans, as a core of cartography as a systematic science. A dualism is characteristic of the map language because it consists of two relatively independent sublanguages which distinguish the map language from other languages (script, painting, mathematical graphics, and others). The sublanguage I provides a spatial definition of mapped objects — their geographical position, spatial forms, and orientation. The sublanguage II provides an essential definition of depicted objects, their qualitative and quantitative peculiarity and structure.

While displaying spatial data in cartographic depictions, primitive peoples retained existing topological relations, in other words, they retained mutual spatial relations of depicted geographical objects without exact mathematical parameters. The first Italian and Catalan portolans also had no strict mathematical base. There were nets of compass lines instead of map graticules. As geodetic measurements evolved and knowledge about the Earth as a globe emerged, a transition took place from topological cartographic depictions to metrical ones.

The sublanguage I evolution went and goes on independently, without a close connection with the sublanguage II evolution. It displays and expresses in diversity of cartographic projections used for showing the surface of the terrestrial ellipsoid on flat maps.

As a matter of fact, the map graticule — that is a network of meridians and parallels — serves as a core of the sublanguage I that is needed for representing outlines of the whole cartographic depiction. Abstracting from contents of a map, its outlines are the map sublanguage I. The filling of these outlines with specific contents is the map sublanguage II.

In addition to the map graticule, the map scale is also a manifestation form of the map sublanguage I determining shapes and sizes of depicted features to a great extent.

The graphical scale appeared first on marine navigation charts, or portolans. The place of the scale on maps was rather arbitrary. Map margins have been preferred, but the centers of maps were also used sometimes. One portolan could contain in different places several graphical scales in form of a straight or curved band.

In the first half of the 16th century, in order to expand the demand for maps, the graphical scale began to be shown not in one, but in two, three, or more length measures used in different countries. One of the first depictions of the graphical scale in various length measures (Roman and French miles) is given on the Georg Erlinger's map of the Central Europe issued in 1530.

Besides the graphical scale, since about the mid-17th century, large-scale maps were provided with a transversal scale for exact measurements and setting distances on

a map. Later, in the early 18th century, the numerical scale also appeared on maps.

Thus, the map sublanguage I evolution has manifested in the development of various map projections and in compilation of maps on different scales.

The evolution of the map sublanguage II displays the subject matter of the depicted features and phenomena. I shall consider the evolution of some iconic and conventional signs used for the depiction of hydrographic features (seas, rivers, lakes), topography, vegetation, and settlements.

Depiction of hydrographic features

From the earliest times, for the depiction of large lengths of seas, the iconic signs were used resembling water color and sea waves. Seas were painted blue. The only exemption was the depiction of the Red Sea that was traditionally painted in red-and-brown. The most common were special hatchings that resemble visually cross-sections of various sea wave types — ripples, simple waves, swell, surfs. The iconic signs for the depiction of the sea surface were superseded gradually by a conventional sign in form of specks. By the late 16th century, specks were used for the depiction of both sea surfaces and inland water bodies. Besides that, in order to accentuate the sea/land division, the coast "shading" in form of straight-line tint was used. This straight-line tint covered the sea surface along the coast but on navigational charts it was used to fill the coastal strip of the dry land.

Rivers were also shown with the iconic sign of two lines; therefore their actual width was significantly exaggerated. The space between the side lines was filled with various hatchings resembling, for example, water flow, or with straight parallel lines drawn perpendicularly to banks, or with specks or dashed lines along the current, or painted in blue.

Since the mid-15th century, for the depiction of water surfaces (rivers, lakes), the ribands were used. It was a method of graphical depiction of waters on maps when water surfaces were shown with the help of lines running parallel to coasts. Wolfgang Lazius was one of the first cartographers who employed this technique while making the map "Marchia Orientalis" (1561). As a matter of fact, these lines running parallel to coasts of water bodies, if considered as map language signs, occupy an intermediate position between the iconic and conventional signs.

Perhaps, this method influenced the emergence of such conventional signs as isolines — initially as lines of equal depths and then used for the depiction of the dry land topography. Nicolaas Samuel Cruquius was known to have made one of the first attempts to employ water depth lines on maps while compiling his isobathic chart of the Merwede River in 1729.

Relief representation

The representation of mountains is one of the most important problems in cartography. Approaches to its solving have modified to the greatest extent in comparison with the evolution of depiction methods for other terrain features. Up to the mid-17th century, the attention was paid mainly to the representation of mountainous and hills. In iconic signs, used for their depiction, it is easy to recognize mountains

profiles. Up to the late 18th century, it is possible to distinguish three principal approaches concerning the use of various combinations of the iconic signs for mountains.

The first approach was such a combination of mountain signs which formed a chain showing the mountain range. Such signs combinations initially resembled cock's combs. Then depictions of mountain chains became increasingly realistic and more and more resembling mountain ranges in bird's eye view. Of course, a graver's skill was the main factor determining how much reality-like was the representation of mountain ranges. In the second half of the 18th century, some map-makers began to depict mountain chains so that they looked like "hairy caterpillars".

The second approach was characterized by the depiction of isolated (not connected into a chain) iconic signs for mountains in form of simple vertical profiles. Like in the first approach, there was a notably great diversity of artfully drawn iconic signs.

Finally, the third approach was the most progressive; it is a planimetric and perspective representation of iconic signs for mountains within the whole mountainous area on the map. The topography in such depictions was displayed not in form of single bodies but as a surface. This planimetric and perspective relief representation gave an impetus to the development of principally new methods. These were methods of orthogonal representation of topography.

Drastic changes in mountain representation took place in the early 1640s; it was a transition from perspective pictures to a planimetric (orthogonal) depiction when Johann Morell showed topography with the help of vertical shading on his map of the town of Lindau at the Bodensee (Lake of Constance) in 1642.

This method of the topography depiction made a breakthrough in the cartography and the map language. There was a transition from iconic signs for mountains to conventional signs in form of vertical shading, from a random distribution of "hills" on a map to the strictly fixed, localized depiction of topography as a continuous surface. Further development of this method and its mathematical grounding were found in a work of the Saxon map-maker Johann Georg Lehmann (1799) and in the proceedings of the Military Topographical Department of the Russian Army General Staff (1832).

A great contribution to the realistic depiction of sea coasts was made by the Dutch naval surveyor Lucas Janszoon Waghenaer. In the sea atlas "Spieghel der Zeevaerdt" (The Mariners Mirror) (1584-1585) all the coasts were depicted for the first time with the help of coast profiles facilitating navigation[1]. Some profiles were given within maps as well. The atlas was such popular that it was issued in different

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[1] It is also possible to find earlier attempts to depict coastal profiles in the Piri Reis' book on navigation «Kitab-i Bahriye» (1521-1526).

languages. The same technique for the coasts depiction was used later by other map-makers. In terms of the map language theory, the coast profiles can be regarded as conventional signs despite the facts that there were no vertical scale yet and the physical parameters of coasts were presented through use of such topological notions as "higher" and "lower".

Depiction of vegetation

The representation of vegetation cover on maps concerned primarily characteristics of forests. For the depiction of forests the iconic signs were used resembling deciduous or coniferous trees. These signs were placed either at a distance from each other, or touching each other, or locking into each other with crowns in form of a "forest carpet" looking like a real forest in bird's eye view. These three main distribution patterns of the iconic signs allowed to present such forest characteristics as its density and accessibility. Besides that, the iconic signs indicated dominant species of a forest and its age. Of course, it was impossible to show forest borders exactly enough with the help of the iconic signs because the size of these signs were rather large. Technically, a graver was not able to repeat a sign several times identically. Because of all these a search for new linguistic means to depict forests was needed; it made necessary to replace the iconic signs by conventional ones.

One of the first attempts to depict forests by conventional signs instead of iconic ones was made by the German map-maker Nikolaus Person from Mainz. On a map of the district of Erfurt published in 1675 he has used dense hatching to show an area covered by dense beech forest. Unfortunately, this conventional sign for the depiction of forests was neglected for a long time. Its application resumed as late as in the 20th century, this time in form of color background (usually green one).

Depiction of settlements

As a matter of fact, up to the 16th century the settlements were represented on maps without any classification, for example, according to their position in administrative hierarchy, type of community, number of inhabitants, dominant religious affiliations, etc. When there was no classification of represented settlements, of course, it was not necessary to explain especially the signs used for their depiction. The settlements were shown with the help of three main types of signs: an iconic sign in form of a castle, fortress, or church drawing; a conventional sign in form of a circle; or a sign combining features of an iconic settlement depiction with the conventional sign (circle). Community names inscriptions confirmed additionally that the signs in question represented settlements. Sometimes, in order to accentuate the size or administrative importance of towns, the iconic sign was enlarged or its drawing was supplemented with additional towers, spires and houses. There were also attempts in the 16th century to display the size hierarchy of communities through using of profile-plans of settlements without special explanations in legends.

The emerged need to distinguish settlements on maps according to some classificatory parameters resulted in a breakthrough in the cartography in form of a

gradual transition from iconic signs to conventional ones.

Cardinal qualitative changes in the map language were brought about by the need to develop a map metalanguage in form of a legend. The use of new cartographic symbols, the design of which did not permit to understand their meaning certainly enough, required special explanations and they emerged in form of legends on map margins.

One of the first legends containing explanation of four settlement symbols was designed by Oronce Fine in 1525; it was placed into the map supplementary text. As for a separate legend for settlement signs, it seems to be the German humanist Sebastian von Rotenhan who has introduced it for the first time on his map "Das Francken Landt ..." in 1533. For settlements depiction he used five different signs explained in a separate legend. These signs were not obviously conventional in their character. On the contrary, they looked like common iconic signs used on contemporary maps for the depiction of castles, villages, or towns. The first attempt to apply new conventional signs for the depiction of settlements seems to have been made by Sebastian M⇩nster in Ptolemy's *Geographia* (1545). He showed on the map the settlements classified according to the prevailing confessions.

With the advent of the map legend, there was a spectacular progress in the development of the map language as well as in the cartography as a whole; new perspectives and opportunities has opened thanks to virtually unrestricted possibilities to depict any characteristics of geographical features which were traditionally shown on maps as well as for the depiction of new objects and phenomena with their properties and functions.

Since then, the development of a legend became a necessary, important, and responsible proceeding in course of any map compilation. The legend determines to a great extent the purpose and contents of a map, methods of its use, as well as scientific and applied aims that can be achieved with it.

The map analysis allows to conclude that the map language follows the general laws of evolution of the sign systems generated by the human society.

Refrences

Dainville F. (1964) Le langange des géographes: termes, signes, couleurs des cartes anciennes 1500-1800. Paris: Éditions A. et J. Picard & Cie.

Liouty A.A. (1988) Map Language: Essence, System, Functions. Moscow (in russian).

Lynam E. (1945) Period Ornament, Writing and Symbols on Maps, 1250-1800. The Geographical Magazine. Vol. XVIII, No. 8, 323-326, and No. 9, 365-368.