Electronic Earth as Methodology and Technology of Our Time

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Key words: Electronic Earth, International Earth Knowledge Management System, Global Base of Metadata, Banks of Geospatial Data, Electronic Maps System.

ABSTRACT

Today, at the boundary of millennia, the Electronic Earth appears as the prior direction of scientific and technical progress. Its goal is the cartographic representation of the real world and creation of the global computer model of the Earth, comprised of millions of space images and electronic maps of various subjects and scales, themes and also reference information. This fundamental problem can be solved by cartographers from different countries, who should meet the 21 century as partners, possessing new ideas, courage and intellectual technologies for creating and application of maps.

In order to implement the main statements the Electronic Earth we solve the following methodological and technological tasks:

- Investigation and generalization of the international experience in Earth mapping and application of geospatial data;
- Development of cartographic thinking, revelation and exploration of objective regularities and features of Earth mapping, formulation of principles of the Electronic Earth on this base;
- Investigation and elaboration of the concepts, intellectual methods and technologies of acquisition, integration, analysis, processing, modeling, displaying of electronic maps, 3D images (3D cadastres), dynamic cartographic models;
- Development of basic categories and notions, international and national standards in the area of the Electronic Earth;
- Creation of the International Earth Knowledge Management System, Global Base of Metadata and Banks of Geospatial Data, telecommunication networks;
- Development and implementation of high-skilled expert cartographic systems and GIS of various intent;
- Increasing professional skill level of the personnel in the area of GIS and intellectual technologies at all educational levels;
- Revelation of contradictions in the area of the Electronic Earth, determination of directions of its evolution, elaboration of the criteria and methods for evaluation of the effectiveness of the new technologies;
- Development and implementation of the international cooperation programs in the area of the Electronic Earth including participation of governmental and private cartographic enterprises of different countries.

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1. INTRODUCTION

The Electronic Earth is a unique multi-dimensional computer model of the structure and development of our planet created on the basis of an integrated analysis of geographic, survey, cartographic, geologic, geophysical and other explorations of the Earth. But it isn't only the matter of modeling of the Earth's surface or objects and phenomena on it. A very important topic is collection and visualization of spatial information on the dynamics of changes in the lithosphere, hydrosphere, atmosphere and biosphere.

But just one or many electronic maps cannot be regarded as a universal tool for all customers who want to see the Earth as it is, solving multi-purpose control and navigational tasks in industry, agriculture, transportation, communication, meteorology, tourism etc. It is necessary to combine different digital maps of various scale, projection, coordinate system, content and layout in system. This means to create a combined computer model of the Earth, which includes thousands of digital maps of various purposes and scales. We speak about the development of the Electronic Maps System that is the aggregate of digital geographic, topographic and thematic maps integrated under a common idea and ordered by geodetic base, content and layout. It also includes orthophoto maps, city maps, aerial and satellite images, and reference information stored in a computer form.

For the creation of the Electronic Earth the international and national standards of spatial data may be used, for example the State Standard of the Russian Federation GOST R 51353-99 Geoinformatic Mapping. Metadata of the Electronic Maps. Composition and Content, which sets the requirements for general, geodetic, gravimetric, photogrammetric and cartographic inforvation.

The elaboration of these ideas is closely connected with the development of methodology that creates a theoretical reserve and, hence, must have a priority.

2. METHODOLOGY

The matter of the Electronic Earth is preparation and fulfillment of measures directed to develop and implement conceptual and methodological basis, normative and legislative documents and standards of metadata for geographic, geodetic, gravimetric, space, photogrammetric and cartographic information, electronic photomaps and 3D terrain models (3D cadastres), formats for spatial data interchange; to develop and implement methods, hard- and software tools and technologies for acquisition, storage, analysis and processing digital cartographic data, creation of usual (paper) and electronic maps; to develop and implement Base of metadata and Bank of spatial data, digital and electronic maps, geoinformation systems of various intent. At the modern stage, the Electronic Earth is closely connected to the development of geography, geodesy, remote sensing, photogrammetry and cartography.

The Electronic Maps System is based on the following principles [Martynenko, 1993, 1996]:

- System approach as the conceptual basis for creation and implementation of cartographic models, as the methodology of research and projecting the System, and as the scientific method of development of effective computer-aided multimedia technologies;
- Principle of mathematical and cartographic modeling as a way to visualize terrain features and objects;
- Principle of rasterized input/output of cartographic data, and processing data in vector form;
- Principle of controllability of digital cartographic data;
- Principle of utmost complete acquisition, one-time exhaustive analytic/synthetic spatial data processing and its use by many customers.

In order to implement the main statements of the Electronic Earth it is necessary to solve the following methodological tasks:

- Investigation and generalization of the international experience in Earth mapping and application of geospatial data;
- Development of cartographic thinking, revelation and exploration of objective regularities and features of Earth mapping, formulation of principles of the Electronic Earth on this base;
- Investigation and elaboration of the concepts, intellectual methods and technologies of acquisition, integration, analysis, processing, modeling, displaying of electronic maps, 3D images (3D cadastres), dynamic cartographic models, virtual maps;
- Development of basic categories and notions, international and national standards in the area of the Electronic Earth;
- Creation of the International Earth Knowledge Management System, Global Base of Metadata and Banks of Geospatial Data, telecommunication networks;
- Development and implementation of high-skilled cartographic expert systems and GIS of various intent;
- Increasing professional skill level of the personnel in the area of GIS and intellectual technologies at all educational levels;
- Revelation of contradictions in the area of the Electronic Earth, determination of directions of its evolution, elaboration of the criteria and methods for evaluation of the effectiveness of the new technologies;
- Development and implementation of the international cooperation programs in the area of the Electronic Earth strategies including participation of governmental and private cartographic enterprises of countries - members of the ICA.

The main scientific discipline in the Electronic Earth is the theory of modeling cartographic design on the base of system projecting of electronic maps and atlases [Martynenko, Nyrtsova, Karachevtseva, 2001].

The modeling of cartographic design based on the system approach allows to increase artistic expressiveness, ergonomics, reliability, technological effectiveness and competitiveness of the fundamental cartographic products. The main attention must be paid to the methods of computer-aided projecting of electronic maps and atlases and methodology of creating problem-oriented GIS intended to model the cartographic design.

The developed methods provide the system approach for projecting functions, images, form, composition of elements of electronic maps and atlases as well as for their engineer-psychological evaluation.

Cartographic design modeling must utilize certain design techniques and principles:

- Classification of map symbols and fonts;
- Correlation between a design and means of expressing the information according to the purpose of a map;
- Accuracy of information mapping;
- Ergonomics;
- Compactness;
- Unification;
- Constructibility;
- Aesthetics;
- Reliability;
- Up-to-date methods.

The key element of a composition is the layout which determines relations between the elements of the design. The relations between the elements ensuring harmony of the composition are characterized by certain properties:

- Replication of the whole in its compounds as the basic feature ensuring composition integrity. It is provided by the shape, size and color;
- Coordination, i.e. the order of all elements or element groups ensuring certain sequence of composition perception;
- Proportionality i.e. establishing a common measure for commensurable symbols of elements or their groups in a composition for true perception of map parts and a whole;
- Balance of every part and the whole about symmetry axes;
- Unity and integrity of a composition as the most generalizing principle and property.

The main means of expressing composition on maps are symmetry (asymmetry), rhythm, contrast, proportion, scale, colour. Each part has its place among the others, and all the parts should match and submit to the main one. All the ideas of a composition structure should help logical organization of the main content and the elements of the arrangement to form a unity, aiming at the best functioning of a fundamental cartographic product. The composition of units of fundamental mapping products is determined by the size and configuration of a represented area.

When modeling it is recommended to select several types of the composite solutions (layout versions of units of the content):

- The map takes up all the working space and is limited by a framework: internal or external. The supporting elements are placed outside the boundaries of the mapped territory. It is the main header that is the integrating element of the map;
- The map is inside a framework, and the supporting elements are wherever available. The external framework integrates the content;
- The map has a free (“floating”) layout within the boundaries of the mapped territory. The remaining elements are placed where space avails.
- Methods of modeling a cartographic design:
- Method of system designing and creation of map symbols;
- Method of art designing using a modular grid;
- Method of a engineer-psychological estimation of visual perception.

The method of system designing is developed on the basis of a system approach and is used for the guidelines on creation of legends of thematic maps. When developing legends it is necessary to keep to the following principles:

- Units of the content of a legend should be systematized;
- They should be placed in the order defined by a theme of a map;
- Basic units should be organized in the hierarchy outline;
- Map symbols are elements of a structure and are in a close intercoupling both with each other and with all the structure of a legend.

The method of art designing with a modular grid uses the concept of a module as a certain unit of measurements of cartographic and other (textual, photo, illustration) information. The correctly selected value of a module ensures structural exactness and regularity of data positioned. The modular system helps organized arrangement of a material on the working field. The composite modular construction having symmetrical design is considered classical; it provides for orderly arrangement of the elements of the content and speeds up extracting information. The asymmetric arrangement of modules requires the presence of several vertical axes and gives dynamism to the compositions; it provides for active perception of the information. The rhythmic connection of modules shows when moving from section to section in colour decision, arrangement of headers, illustrations, schedules and pagination.

The method of an engineer-psychological estimation of visual perception is called to attract attention of the readers of a map. The efficiency of obtaining cartographic information depends on methods of representation of units of the content on a map and their features. The different means of mapping allow a cartographer to influence the process of reading of a map. A general estimation of perception of a map is made using certain criteria: readability, conspicuousness of elements, visual response to colour\background and their matching. Reading of the cartographic information is a complex psychological process including sensation (nebulous vision), perception (discrete vision), recognition of a form (shape). The estimation of this complex psycho-physiological process of visual perception of maps should follow certain rules: the law of contrast, the law of harmonic ratio of part as whole, law of apperception, figure and background phenomena. Estimation of visual perception of electronic maps requires new methods and non-traditional means of representation of the cartographic information: animation, pulsation, dynamic colour changes and disappearing symbols.

For modeling a cartographic design in problem-oriented GIS it is necessary to use general principles and methods of modeling. So far GIS has no sophisticated tools for map design. As for cartographic requirements until recently little attention has been paid to the problem of qualitative visualization of data. Instrumental GIS often contain built-in editors for creation of user's electronic libraries of map symbols, but their capabilities are rather limited or have inconvenient interfaces so to use them for creation of complex symbols is impossible. For solution of this problem some GIS are capable of importing symbols created in other programs, which makes developing complex structural elements of a design possible.

Thus there are not very many sophisticated means for modeling a cartographic design in various GIS. On the other hand, GIS gives a number of valuable advantages for designing maps:

- Creation of electronic libraries of map symbols;
- Ranking elements of a design by themes;
- Creation of new symbols on the basis those in libraries;
- Saving certain sets (combinations) of symbols (legend) as separate files to be automatically used for any other data sets;
- Modeling 3D surfaces using natural textures;
- Ruling the layout of units of a map with automatic generation of a legend;
- Creation of separate units of the model - frameworks, headers, text boxes, tables;
- Sewing together and cutting cartographic data in any format;
- Generation of different types of legends on the basis of sampling from databases;
- Insertion of multimedia units in an electronic map - video, audio, photo histories;
- Control of the cartographic map with the help of functional GIS-toolkits;
- Integration of maps having different scales;
- Control of one map as being an attribution to another.

Creation of fundamental cartographic products, meeting all the requirements to modern maps results in that the map is created within the frames of an integrated technological complex. Thus the use of combined methods of modeling a cartographic design is recognized most effective. At creation of electronic products the designing methods back up on general principles which have been worked out when developing traditional maps and (or) their computer variants, intended to be electronically stored. At the same time there is a number of differences connected with the type of the carrier of an electronic map (screen monitor) and the sphere of its application. Apart from the differences in ways of colour perception of a map on the screen monitor and on the hard carrier (additive/subtractive synthesis), the virtual use by a map has essential meaning. So, in these conditions the way of layout of the content and its units is determined by a dynamic plot and ways of navigating through the content. The ways of navigating reflect dynamic links between different structural units of the content, which consist of a set of components (text descriptions, animations, video, sound). Similar multimedia in modern cartographic products requires special approaches.

Navigation methods and areas of transitions are part of user's graphic interface. The navigation structure should have logically clear denotations, so that actions were intuitively clear to the user of an electronic product. It is achieved using symbols (icons) or explanatory comments. There are several basic types of areas of transitions: dynamic and static. Dynamic areas of transitions use radio-buttons, selection indicators, animated buttons. For decorating areas of transitions various representational means are used:

- Textual - various text formatting tools are used (colour, text adjustment along the curves, torsion, three-dimensional text);
- Graphic - contain the specific pictures or their parts;
- Icons - are the main character graphic objects for denotation of operations or objects.

For creation of an ergonomic interface the following artistic techniques are used:

- Symbolic denotations for the main theme of each unit;
- Creation of contrast (large - small, thin - thick, heavy - easy);
- Simple and light screens with large areas of white background;
- Special symbols-characters such as drop caps;
- Light and shadows of different shades;
- Gradient fills;
- Negative maps and text for allocation of important information-semantic units;
- Two-dimensional and three-dimensional objects and text;
- At development of a design of the interface for data management it is necessary to avoid:
- Usage of too many paints and fussy frameworks on a screen;
- Redundancy of screen objects (dense screen);
- High speed of displaying important plots or messages;
- Bulky text messages - they should be divided into parts (semantic units).

Having created a certain set of map symbols in graphic applications, they are stored in user's electronic libraries of characters based on TrueType fonts. Such character sets then are used for extension of means of design in GIS-applications. Universal electronic libraries of map symbols allow to reduce costs of a design, to automate engineering process of designing production maps, to unify user's libraries for thematical maps. Apart from just libraries of symbols there are libraries of basic structural elements and sets of their possible combinations on the basis of language cartographic rules.

The language of a map enables:

- Compact coding of large volumes of the cartographic information;
- Estimation of informational significance (self-descriptiveness) of a map;
- Economical way of storage and information transfer;

– Creation of means of automatic recognition (identification) of symbols.

Thus there are using new methods of artistic construction of cartographic products. They include methods for computer-aided projecting of variants of compositions, optimal formats, map symbolization systems, elements of outer appearance as well as engineer-psychological methods and approaches for creating cartographic products. The industrial-implemented computer-aided technologies give us the great advantage in comparison with traditional ones that concludes in fact that they allow to operatively carry out modeling of cartographic design for the development of cartographic products using basic models and problem-oriented GIS. These methods can be implemented on the base of modern computer techniques, high-resolution scanners, software, basic information maintenance. The backbone of such technologies are interactive workstations and expert systems. The results are planned to be used by cartographers from various countries in their scientific researches and practical work in the area of creation of fundamental cartographic products (electronic maps and atlases).

3. TECHNOLOGY

For the creation of the Electronic Earth may be applicated the new State Standard of the Russian Federation GOST R 51353-99 Geoinformatic Mapping. Metadata of the Electronic Maps. Composition and Content.

Standard provides cartographic representation of the real world and creation of the Electronic Earth that is based on strict geodetic base by means of using millions air- and space high-resolution images, electronic maps of various intent and scale, and textual reference information.

GOST R 51353-99 allows to synthesize the digital (electronic) image of Earth as a spatial and temporal representation of our planet. This representation is based on mathematical and semantic modeling of spatial data changing dynamically and is realized as the aggregate of distributed electronic cartographic libraries (Electronic Maps Libraries) united in whole system by means of telecommunication technologies.

The statements of this Standard are liable to application by all authorities and organizations located in Russian Federation, independently of their form of government and subjection, which are engaged in acquisition, systematization, analysis, processing and transfer of spatial data, creation and application of electronic maps, organization of bases of metadata and digital cartographic databanks.

GOST R 51353-99 establishes the requirements to the composition and content of common, geodetic, gravimetric, photogrammetric and cartographic metadata used for creation (updating) and application of electronic maps.

Metadata of electronic maps is data that allows to describe contents, spatial extents, quality (accuracy, complexity, consistency and actuality) and other characteristics of electronic maps.

Common metadata corresponds to the top level in metadata hierarchy and must reflect the most common characteristics of spatial geodetic, gravimetric, photogrammetric and cartographic information.
Common metadata:

- Name of metadata;
- Information about organization - metadata provider who is responsible for the maintenance of data dictionary (name and address);
- Information about organization - developer of electronic map, license, registration number of the electronic map, name of fund where it is being registered;
- Encoded description of cartographic product, including two sections: identification section (code of production type) and information section (codes of attributes and their semantic values);
- Identification information (data description, temporal period, status, keywords, limitations of data acquisition and usage);
- Date (year) of electronic map production and/or update, state of terrain (year);
- Information about country (territory); publication language; author(s) and editor;
- Quality information (attributive and positional accuracy, data completeness, criteria of data generalization, lineage);
- Spatial query information (coordinate systems, projections, grids, parameters of figure of Earth);
- Date of metadata preparation (month, year);
- Security limitations;
- Characteristics of data storage and movement: address of storage organization; address of sender; mailing date and number; address of the recipient; receiving date and number;
- Price list;
- Contact information.

Geodetic and gravimetric metadata characterize systems of geodetic parameters of Earth, ellipsoids, coordinate and elevation systems, catalogues of geodetic stations and leveling points, formula for normal gravity acceleration, gravimetric systems, catalogues of gravimetric stations, models of gravity field, catalogues of average gravity anomalies.

Photogrammetric and cartographic metadata describe materials of survey (including digital images), digital terrain elevation matrices, digital terrain models, digital orthophotos, electronic topographic and thematic maps and orthophoto maps.

So the Electronic Maps System has been creating as the whole base of spatial data which is described by metadata. In reality, GOST R 51353-99 provides creation of the Electronic Earth [Martynenko, 1997, 2001].

The area of GOST R 51353-99 application are as following: information and analytical supply of state authorities, GIS, systems and tools for communication, business, transportation, navigation, ecological monitoring, state and private cartographic enterprises, defense. The particular importance is attached to the cooperation and collaboration between governments, governmental and non-governmental organizations, international organizations and institutions in creation of the Electronic Earth and its application for social, economic, scientific, educational and technological development.

In Russia the Electronic Earth is synonym of Digital Earth [Lyuty, Martynenko, Zatsman, 2001]. But it is unique multi-dimensional computer model of the structure and development of our planet designed on the base of integrated analysis of geographic, surveying, cartographic, geologic, geophysical and other researches of Earth. There is not only a subject of modeling of Earth surface as well as the objects and phenomena on it. The very important topic in this concern is collection and visualization of spatial information in the dynamic of its changes in the lithosphere, hydrosphere, atmosphere and biosphere as well as in their patterns.

In future works the new high-precision technology of creating electronic orthophotomaps will play very important role [Eliushkin, Martynenko, 2001].

This technology provides for the use of high-resolution space photos and various maps. It includes creation of geodetic basis, digital data processing, recognition of images, producing digital orthophotos and maps, digital models of terrain features, digital terrain elevation models, spatial terrain models, electronic topographic and thematic maps, electronic city maps. Its important part is improvement of quality of source images and supervision of production quality.

The technology provides for the use of Russian space survey source materials (high-resolution space photos) and various maps. It includes creation of geodetic basis, digital data processing, recognition of photo images, producing digital orthophotos and maps, digital models of terrain features, digital terrain elevation models, spatial (three-dimensional) terrain models, electronic topographic and thematic maps, electronic cadastre maps and electronic city maps. The improvement of quality of source images and supervision of production quality is one of the most important part of the technology.

Digital orthophotos serve as the main carriers of terrain information. The main function of them is to provide maximum amount of data. In contrast to maps, they are not a work of art, and so they have not any cartographic design. A digital orthophoto can contain cloudiness and other defects. The main features of electronic maps is their obviousness and think-through contents that can be achieved by means of symbolization system and methods of cartographic image generalization based on theory of visual perception, engineer-psychological evaluation and modeling. Electronic maps are free of any defects.

The totality of digital orthophotos brought together within the frames of the mapping terrain serve as the high-precision coordinate basis. The most optimal way is to use photos with high terrain resolution. Such a coordinate basis allows to mount digital photo images of higher resolution either for local areas or for the whole terrain depending on customer's requirements.

Space survey is characterized by such advantages as the ability to obtain image of any point of the Earth and large field of vision. But it also has some deficiencies: considerable amount of time, especially if meteorological conditions are inauspicious; irregularity of overlaps, different photometric characteristics of photos caused by various lighting of surveyed regions.

The specificity of obtaining space survey materials affects the peculiarities of processing them: there is no need in field operations and geometric corrections of images using special algorithms. Spatial triangulation can be carried out for the whole mapped region. On-board measurements are used as a source geodetic data. Terrain elevations data, as the result of photos stereo processing, provide the high precision of geometric transformations. Using GPS provides conditions for the increase of image processing accuracy and simplification of the technology.

The existing technology allows to create and update topographic maps up to scale of 1:25 000 (1:10 000). It provides mapping of hydrography, terrain relief, roads, settlements and standalone buildings, soils and vegetation, as well as registration of attributes and state of terrain objects (including evaluation of land-improvement installations, agricultural lands and forests).

In comparison with traditional technologies, the problem of mapping is being solved with much less financial and temporal expenses, with better quality and reliability. The most favorable conditions for the opportune and high-quality work with new space photos are preliminary placed orders for necessary space images (not later than one year before anticipated date of accomplishment) and payment for the photos before the beginning of the survey.

Digital orthophotos serve as the main carriers of terrain information. The main function of them is to provide maximum amount of data. In contrast to maps, they are not work of art, and they have no cartographic design. Digital orthophoto can include cloudiness and other defects. The main features of electronic maps is obviousness and think-through contents that can be achieved by means of symbolization system and methods for cartographic image generalization based on theory of visual perception, engineer-psychological evaluation and modeling. Electronic maps must have no defects.

The use of space technologies in mapping provide an unlimited review and acquisition of huge bunk of multi-purpose terrain information. In comparison with traditional technologies, the problem of mapping can be solved with much less financial and temporal expenses, with greater quality and reliability. The process of mapping the difficult-to-access regions is now solving only by means of space technologies.

The huge bulk of multi-purpose terrain information allows to realize an effective method of mapping according to the principle «from general to individual» (like the globe of Bulgakov’s Woland). Wide-range space information gives an opportunity to represent long-area terrain features, pick out the necessary objects and phenomena on large areas.

The advantages and distinctions of space information in comparison with usual (air and land) are the result of space flight peculiarities: height and speed of spacecraft movement. Space information allows to create new, more informative types of cartographic products - digital orthophotos and electronic orthophotomaps. Space survey allows to update existing cartographic materials with any desired periods of time. The spatial resolution of obtained information becomes the most important factor for solving most of the problems, including creation of maps.

In whole, the technology includes complex amount of operations: preparation and analysis of source data; digitizing source data; creating digital terrain elevation model; transformation and correction of single photos; building mosaic plan; obtaining digital data of the electronic orthophotomap [Sharavin, Martynenko, Vorobiev, 2001].

Implementation of the technology may be realized by creating of the searching Internet server for the electronic libraries of maps and geospatial information metadata which is considered as a new scientific and practical problem raised due to the integration of huge balk of various information resources (including geospatial information) within Internet [Martynenko, Lyuty, Zemlianov, Serdyukov, Lunyova, 2001].

Solution of this problem allows to increase the effectiveness of information supply of fundamental researches in the area of sciences about Earth. It also will promote to form the united geoinformation space and develop its infrastructure.

The development of searching Internet server, structure and content of maps and geospatial information metadata, its modeling, encoding, marking, methods and algorithms for metadata indexation and search as intellectual technology carried out on the Project No. 00-07-90154 under the aegis of the Russian Fundamental Researches Foundation.

One of ways of providing of access to the saved up information resources can be creation of metadata of maps and the geospatial information storehouse. Creation of the centralized, high available metadata of maps and the geospatial information storehouse the will allow to solve a problem of fast search of the required geoinformation usage of the advanced system of construction of complex retrieval searches. The basic requirements to centralized storage of a metainformation.

For development of the server the following tasks were solved:

- The analysis of national and international metadata standards for the cartographical information, choice of the most suitable for the purposes of creation of a search site.
- Development of the formalized description of the query language.
- Designing of database structure for storage of the metadata fast and effective search of the required information.
- Development of specialized user query interface.

For creation of a Internet - server the following program and means were used:

– Unix server with FreeBSD operation system;
– Postgre SQL database management system;
– Apache WWW-server;
– HTML and JavaScript language for client programming.

As a basis for creation of the interface of construction of query to base of the metadata, intended for unskilled users, the metaphor of "a base map" is accepted. The user has an opportunity of navigation on a site with use of a set of base maps of different scale. Consistently passing from a survey map of globe to maps of fineer areas of Earth, the user has an opportunity to determine geographical region on which will be is prospected in library of metadata. At the lowermost level (now such levels three) the user has an opportunity to choose the concrete area limited to the next lines of a geographical grid. The choice of this area unequivocally determines coordinates of a trapeze inside which search in library will be carried out. The user may specify parameters of a trapeze manually having corrected the appropriate values in the form of query.

The received results may be used for the further development of an Internet server for the electronic libraries of maps and geospatial information metadata for the purposes of the Electronic Earth.

CONCLUSION

The implementation of these measures, based on the new cooperation principles, will provide more closely collaboration and fruitful contacts of cartographers throughout the world, and allow to realize a breakthrough and move up. The cartographer must become a God who creates the Electronic Earth by means of fantasy of electronic images.

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BIOGRAPHICAL NOTES

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