MGIS (MINING GEOGRAPHICAL INFORMATION SYSTEM) A NEW CONCEPT FOR THE INFORMATIZATION MANAGEMENT ON MINING COMPANIES. SOME CONSIDERATIONS ON THE MGIS FIELD

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ABSTRACT
MGIS (Mining Data Bank Geographical Information System) is a new concept for the informatization of mining activities by creating a mining database combined with a GIS platform. MGIS includes activities from both the inside of mining activity and from outside it, referring to either the environmental impact on mining but also to the influence of mining on the environment. MGIS is also launched in a Web platform, which is www.mdbgis.ro which will be loaded and updated with data related to the concept and its components. The basic idea of the new concept is geo-referencing all data introduced in the system, starting from finding that any information happened somewhere (in a 3D space) and sometime (T-time component). MGIS is a modular system which, once developed and implemented in an organization, can be supplemented with other modules, databases, software, actors, links, information and decisions.

Keywords: MGIS (Mining Geographical Information System), mining database combined with a GIS platform

INTRODUCTION
Currently, no industrial sector can progress without a management system based increasingly on the informatization of business and its management and coordination. As the leader of the world’s economy, the extractive mining industry cannot be an exception to this rule in any part of it, from the exploration phase to the delivery of extracted materials to processing industries [5]. One can see that the largest mining companies use specialized software for certain activities, that very few companies have implemented a GIS system, including only some activities, that there is mining software, some very powerful and widely recognized by major companies in the industry and that, at conceptual level, large GIS software manufacturers are prepared to enter the mining market, to the extent that it is ready for major changes in organization management.

MATERIALS AND METHODS

1. Short analysis of the current computerization state of mining activities
The most complete mining information system was designed by IBM (Indian Bureau of Mines) at the order of the Indian government, originally entitled Mineral Information System (MIS) [8], supplemented subsequently and renamed Technical Management & Information System (TMIS), which contains a number of databases among which also GIS. Niche information systems in the mining field or in complementary fields were created and work very well, for example in the geological field GeoGRAFX GDMS [9], in the mining field Mining Information System, created by Trimble. Currently, in mining companies in Australia and Canada, the most computerized organizations in the industry, over 60% of information is analog, while in mines in Romania, for the activity still surviving, the rate is much higher, more than 90-95%.

All these data must be digitized, and here is where the material and time costs to create a mining databases, with GIS, will be, as the main operating axis or not. Each company will decide the form and time frame through which this expensive information operation shall be activated and
solved. In this case, this paper cannot provide solutions, but simply suggest instruments, because the aim is to create a new concept for mining computerization, the so-called MGIS [3].

2. MGIS, Mining Geographical Information System – some considerations

MGIS history, or its roots, can be assimilated with GGIS history and its achievements, GIS geo-sciences through the contributions of Burroughs 1987, Aranof 1989, Tolin 1990, Maguire 1991, Carter 1994, or with the first ESRI application in geo-sciences in 1993 [2]. As a general theme, name and specific concerns, the field is very new, probably somewhere between 2004 and 2006. Based on the few achievements to date in MGIS, we shall present some considerations on the field.

1. Support system in underground mining [4], it has three components that must be considered when setting MGIS:
   a. Surface support system,
   b. Underground support system,
   c. Relation between the surface and the underground support system.

   The purpose of the third component is to ensure compatibility between the first two components; if this stage is appropriate the two systems merge into one, the surface one. A first conclusion here would be that the transmission of the surface system into the underground must be made while ensuring that the surface system extends vertically, so that virtually the entire mine has a single coordinate system.

   2. The support system in underground mining can be the national one, namely the Cartographic stereographic projection system 1970, for Romania, or it may be a local system. As in our view MGIS will include not only mining information layers but also others, referring to mining environmental influences, such as a layer on pollution or environmental influences on mining such a layer with the mine power supply, using a local coordinate system is out of the question. A second conclusion, because it works with information from various industries, related to the direct mining activity, MGIS will operate only in the national coordinate system of the state in which it is applied, coded STEREO70 (below) for our country.

   3. Elevation - in the underground, as in surface topography, a single elevation system is used, namely the national Black Sea in 1975 system. A third conclusion is that all rates from the surface and from the underground shall relate to that system mentioned, coded as RMN - BSM, (Reper Marea Neagră - Black Sea Mark 1975).

   4. Mining topography operates with two basic layers: the one for the underground called the general layer of the mine and the surface one called for the situation layer (surveying)[6]. The first one, encoded TOP012 and drawn to scale 1:1000, and the second encoded TOP010, will represent the origin information floors (layers) for MGIS. The fourth conclusion is that, unlike the traditional GIS, MGIS will operate with two "0" layers: Layer TOP010 for surface and Layer TOP012 for underground. Layer TOP010 will include all data with respect to the surface, both for mining and for those related to mining, from networks and infrastructure to vegetation or urbanism. Layer TOP012 will include underground information, from geological data to mining horizons.

   5. Underground mining involves understanding the deposit, the railways and all the mining works in detail, both horizontally, operation solved by reference to the TOP012 Layer and vertically under TOP014 codes, Longitudinal sections and cross sections through the deposit at intervals not exceeding 100 m, scale 1:500 - 1:5,000; TOP018, Bank layer for every layer, stock, vein, scale 1:500 or 1:200; TOP020, Longitudinal profile of the main transport routes, horizontal and inclined, supplemented periodically according to the needs of operation; TOP021, Longitudinal profile of the wells, complete with cross sections, indicating the installations in the well and in the ramp for each
horizon, updated after periodic checks provided in this Regulation; TOP022, Layer and sections of water hollows, pump installations, underground chambers, underground deposits; some of the documents displayed and viewed vertically. Although they are all perpendicular to the TOP012 layer, and although they are vertical layers, they are found in different orientations, or in the case of the CF longitudinal profile, which is a vertical surface, although transverse profiles are vertical layers. Optionally, one may choose two vertical surfaces intersecting at a point considered the center of the mine, with the orientation of the longitudinal layer either zero either a direction considered important for that mine, which we encode VER001, for the longitudinal layer and VER002 for the vertical layer, the other vertical layers receiving codes following their appearance in the MGIS design: Layer VER003, etc.; curved vertical surfaces can be coded by Layer SUP001, etc. and those inclined by Layer ICL001, etc. It is possible to give up the vertical calibration, each layer above being analyzed in relation to the information in the horizontal layers with which they are connected. **Fifth conclusion:** at the two basic information layers – origin – Layer TOP01 and Layer TOP002, two more, possible, Layer VER001 and Layer VER002 are added, thus defining a system with four layers, two horizontal and two vertical in MGIS; depending on the needs of each mine one can add an infinite number of other layers or reference surfaces (fig. 1). This will be the real challenge in MGIS design for each case.

![Fig. 1. Layer structure in MGIS](image)

6. Structuring of information entered in MGIS) will be done, as a first classification [5]:

A. **Thematic structuring of information:**

1. **Direct information**
   1.1. Structure and content of topo-geodetic information;
   1.2. Structure and content of geological, hydro-geological information;
   1.3. Information on the current context of exploitation.

2. **Information on the influence of mining on the environment**
   2.1. Structure and content of environmental monitoring information;
2.2. Management of mining waste;  
2.3. Management of surface emergencies;  
2.4. Stability studies of the land above and surrounding the mining area, subsidence  
analysis, earthquake history, landslides;  
2.5. Register of the rehabilitation and consolidation works of the areas above and  
surrounding the mining area, embankments;  
2.6. Situation of groundwater, discharge of groundwater in surface waters.

3. Information about external influences on the mining industry  
3.1. Situation of general, mining, agriculture, forestry cadastre, land rentals and  
concessions;  
3.2. Weather conditions  
3.3. Hydrological conditions, waters, underground water;  
3.4. Construction and infrastructure works, channels of communication, works of art;  
3.5. Utilities, water, gas, electric and telephone networks;  
3.6. Urban area, PUG, PUZ, PUD, RGU, RLU.

Information which is usually included in topographical designs enters this classification. A  
second classification of information is:  

B. Structuring the information in the report according to the area they come from:  
1. Information regarding surface data;  
2. Information regarding underground data.

The third classification concerns the free movement of information.  
C. Structuring information in relation to their free movement:  
1. Public information;  
2. Restricted information;  
3. Secret state information, classified information.

A fourth classification is made according to the nature of information and how they are  
integrated (or not) in the system.  
D. Structuring information in relation to access and destination into MGIS:  
1. Non-graphical analyzed information which will not enter into MGIS (neither in MBD  
GIS);  
2. Graphical analyzed information which will not enter into MGIS (neither MBD GIS);  
3. Non-graphical analyzed information which will not enter into MGIS, but will enter the  
MBD GIS databases;  
4. Non-graphical analyzed information which will enter into MGIS, as attribute data;  
5. Graphical analyzed information which will enter into MGIS, forming layers.

The fifth and sixth classification refers to the degree of information updating in MGIS.  
E. Structuring information in relation to the novelty it represents:  
1. Updated information;  
2. Outdated information, which requires refreshing to date;  
3. Historical information that is stored in this form.

F. Structuring information in relation to how and when it is updated:  
1. Information with continuous synchronous non-stop update;  
2. Hourly updated information;  
3. Daily updated information;
4. Weekly updated information;
5. Monthly updated information;
6. Annually updated information;
7. Multi-annually updated information;
8. Variably updated information;
9. Information that does not require updating.

7. The 1:1000 scale will be only representation scale for the entire system. There may be documents surveyed, such as the base map at a scale of 1:25000 or smaller scale maps; they are externalized to MGIS, have an advisory nature, and can be analyzed in parts which are surfaces from the perimeter or proximity of the mine.

8. “The Geographic Information System is one of the computer based technologies with the fastest growth. These systems are used in various fields related to the resources field such as resource management, environmental monitoring, utilities, financial planning, transport and market research. The use of GIS has expanded in society over the past decade, faster than any other analytical information technology [1]. This trend was not directly reflected in the underground mining resources sector. Most information technology investigated by mining professionals focuses on the descriptive aspect of the data, although large amounts of mining data can be spatially referenced” [2]. Based on this quote and studying a vast bibliography we have identified the main problems of implementing GIS technologies in the mining industry (becoming MGIS):

1. MGIS can help solve a major current information issue in mining, although most data being used can have a spatial representation; focus is now on the descriptive aspect of the data.
2. MGIS, as an argument, having the opportunity to present data in the form of layers and maps, can provide better aid in decision making for the people responsible in mining, than tabular information or, as stated previously, descriptive information.
3. MGIS has had a very slow evolution in comparison to the explosive development of GIS, because software exists and is applied, basically computer packages for the mining industry, which have sufficient modelling resources for the demand of spatial information in this industry [7].
4. MGIS has had a more difficult entry into the mining industry also because of the CAD technology which was very cheap (some of it), so it expanded, and then operators were familiar with these operating modes which could be interfaced to the aforementioned mining software relatively easily.

CONCLUSIONS
MGIS is currently underused! Following research we have found that, in the field approached here, the situation worldwide was and remains the following:

- Unreasonable, GIS has a hard time getting into the mining industry;
- The concept of Mining GIS was defined several years ago, there are several applications, very different, and it was concluded that a concept was not defined, only the idea that MGIS label mining can be applied to GIS applications;
- There are positive signs: some producers of mining software have gone to configuring GIS interfaces, general software manufacturers have created interfaces with mining software and two or three producers of GIS software have created interfaces with software from different categories.
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