ISBN 978-963-9038-18-9

4D MINE SURVEYING, A NEW CHALLENGE

Dr. eng. Mircea BELDEA, National Hardcoal Company S.A. Petroşani, Romania

ABSTRACT

The main purpose of mine surveying is to create and to update permanently a quatro-dimensional model of the mine area, with all his components from undergroud to surface.

The traditional mine surveying accomplished this mission with his own methods. Thereby a plenty of plans and maps were produced. These represent, in a chronological manner, the mine areas dynamics. But isn't too easy to compare the different stages of evolution using the classical maps, on paper. Different coordinate systems and scales used, and many other reasons, create difficulties, especially for an uninitiated observer.

The actual technics for the georeferencing informations processing offer new tools which make the work of surveyor and also of the user easier.

This paper propose a regard about the organising methods of spacial information inside a 4D system which allows to query and to analyse the mine areas dynamics in his evolution.

INTRODUCTION

A mine configuration is in permanent transformation. Everyday, new sections of drifts are realised, while other drifts are closed. The important volumes from mineral deposit are extracted and are transported to surface, and the rocks above the remained holes become instable, looking for a new stability. Other important volumes of sterile rocks, from underground or from the separation plant are transported to deposits, whose volumes grow-up daily.

All these transformations must be monitorised and the topographic maps updated daily. In this way, a mine topographic map represents a suite of the mine succesive stages, exactly localisated in time. So, in some measure, we can say that the mine topographic documentations are, traditionally, 4D representations. The fact is that the mine topographic maps are only 2D representations, which contain altimetric and temporal localisation elements.

In some situations it's necessary to know what was the mine or part of mine configuration, in past, more or less far from present. In other situations it's necessary to know what will be the mine configuration in a future moment. These informations exist, normally, sometimes on the current topographic maps, sometimes in the mine topographic archives or in the mine development projects. But, rarely, the existent documentation is in the wanted form and represents the exactly wanted moment. Then it's necessary to create new drawings, where the information have the exactly wanted content and form. This supposes a large additional period of time and labour, which can be an important disadvantage.

The geographic informatic systems give to us tools which help us very much in such situations. The large period of time and labour for creating the system (digital maps, databases, links creation etc.) is rewarded later with reliefing the surveyor's work and growing up the quality and speed for obtaining information by the other users.

THE ATTACHEMENT OF TEMPORAL CHARACTERISTICS TO THE DIGITAL MINE MODEL OBJECTS

The geographic informatic systems allow to create a digital model of mine, where each constitutive object is defined by:

- the graphical representation (point, line, curve, etc.) exactly localised referring to an established coordinate system;
- the description who contain numeric or text characteristics and is stored in one or more database records;
- the link between the graphical representation and the record who contain the description.

All the constitutive objects of the mine digital model can be localised at the time scale, only if we added to the database structure one or two column which must contain the temporal coordinate for each object.

Generally, a digital or an analogic drawing contains objects, which can be node, line or text. Also, in a mine topographic map, all the constitutive objects are represented in one of these manners.

We attach a temporal localisation characteristic to each three-dimensional object. These temporal characteristics can have a date form (day – month - year) or a period of timeform (initial date – final date). As a rule, to "node" objects we can attach a date type temporal characteristic. To "line" objects we can attach also a date type temporal characteristic, or a period of timeone.

Therefore, we attach a "date" coordinate to points which represents the succesiv positions of one face drifts. This date define, at the time scale, the moment when the drift excavation reach in the respective point. We attach a "period of time" characteristic to a line which represent a drift section. This period represent the time beetween the moments when the

 ISBN 978-963-9038-18-9

the drift excavation reach the two extremities of drift section. In other circumstances, we attach a date type temporal characteristic to a “line” object. So, we attach a date to a line which represents a coal-face certain position. Two such succesive lines will represent the coal-face advance in the period of time between two dates.

If a geographic informatic system don’t contain temporal positioning informations, it’s possible to modify them so that they will be powerful 4D analyse tools. Therefore it is necessary to change the databases structure, inserting colums for temporal coordinates storing. Sometimes it is necessary to modify the drawing too, breaking some objects in sections, one section for each period of time. The last operation is the update of each link between graphical object and the database records. Such a improvement of the geographic informatic system is laborious, but can be an attractive option thanks to the future important benefits.

THE ACHIEVEMENT OF TEMPORAL ANALISIS

After we link objects in the drawing to information in external tables, we can use the information in the table to find the objects we want in the drawing. To locate and receive objects, we must create an SQL condition. An SQL condition looks for specific values in an external table, then finds and displays all the objects linked to those values.

We can search for all records that exacly match a specific value or a range of values, or that do not match the specific value.

Once the drawing attached databases contains temporal informations, we can impose SQL conditions, which filters out the drawing component objects so that will be exposed only the objects which respect the temporal conditions. In this way, we can identify and they can be displayed, into a new drawing, the mine workings which exist in a certain date in the past. In a same manner, we can obtain the mine image in a future time. Also, it can be realised a drawing which contain the workings from a period of time, between two different dates.

For exemplification, we will use the map of Livezeni Mine from Jiu Valley, Romania, where is extracted hard coal for more than 30 years. This mine is relatively new, because the hardcoal exploitation in this zone have more than 150 years of old. The mine configuration, less complicated, was one of the reasons why it was the first mine of Jiu Valley where the whole topographic documentation was transferred in digital format.

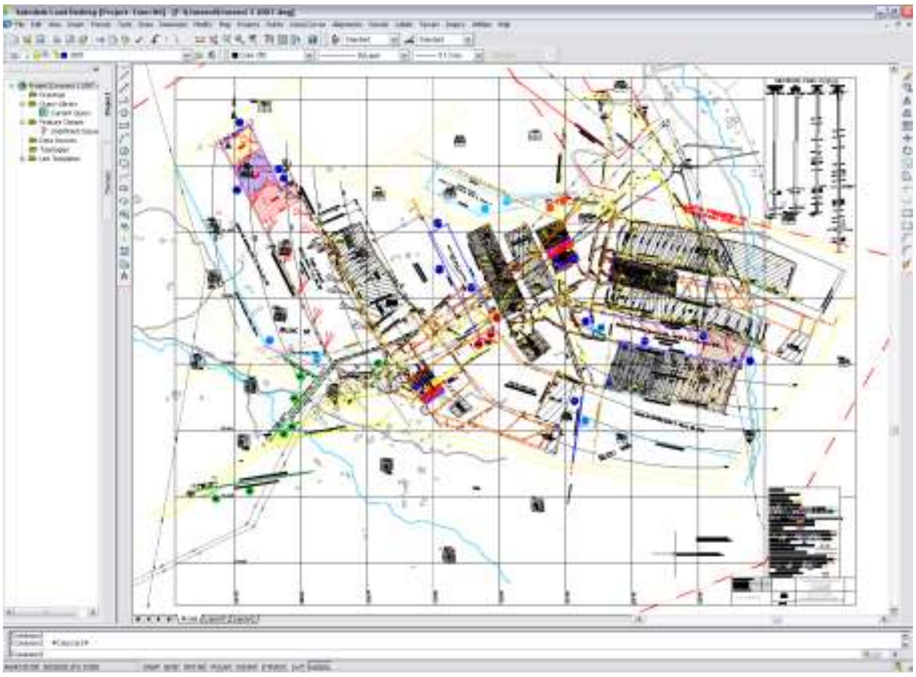

Fig. 1 Livezeni Mine topographic map

Figure 1 represents an image of the East part of the mine, where apear all active workings which were existing at 01.01.2007, at the main seam level.

Now, we look to the South-East part of the area, where was located coal-face no. 6 (fig. 2). The drawing presents all working face drifts, exploitation workings and closure ones, realised until now.

 ISBN 978-963-9038-18-9

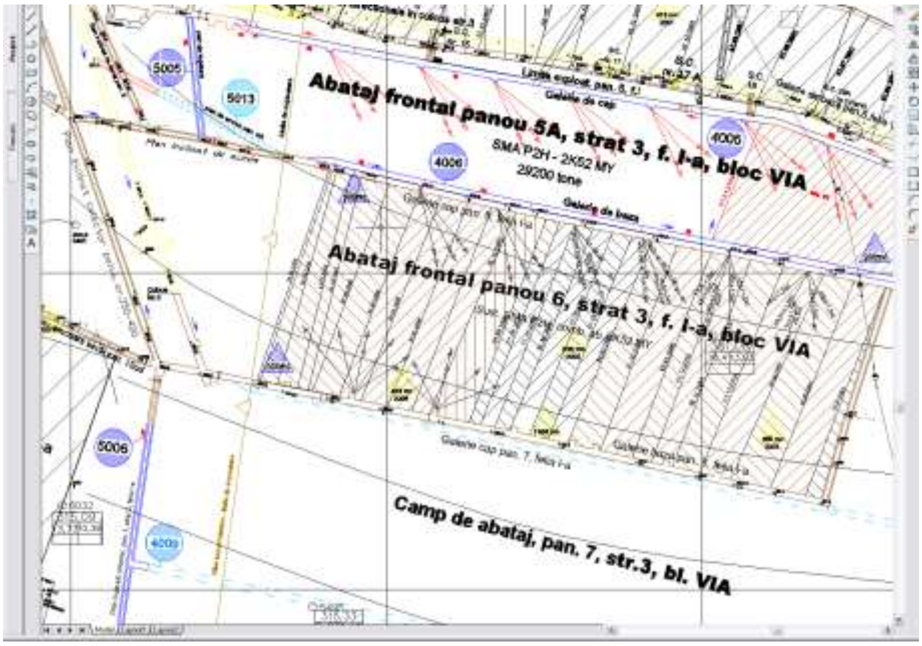

Fig. 2 Coal-face no.6 topographic map

We suppose that we are interested in workings configuration in this area how they were four years ago. Because GIS system contains temporal information attached to all drawing component objects, the desired image can be obtained by a SQL interogation, which will extract from the source-drawing only the objects that existed at 01.01.2003.

SQL condition will have this form:
SELECT * FROM WHERE DATAF <=TIMESTAMP '2003-01-01 00:00:00'
where DATAF represents the section finalisation date.

The obtained result is the one presented in figure 3.

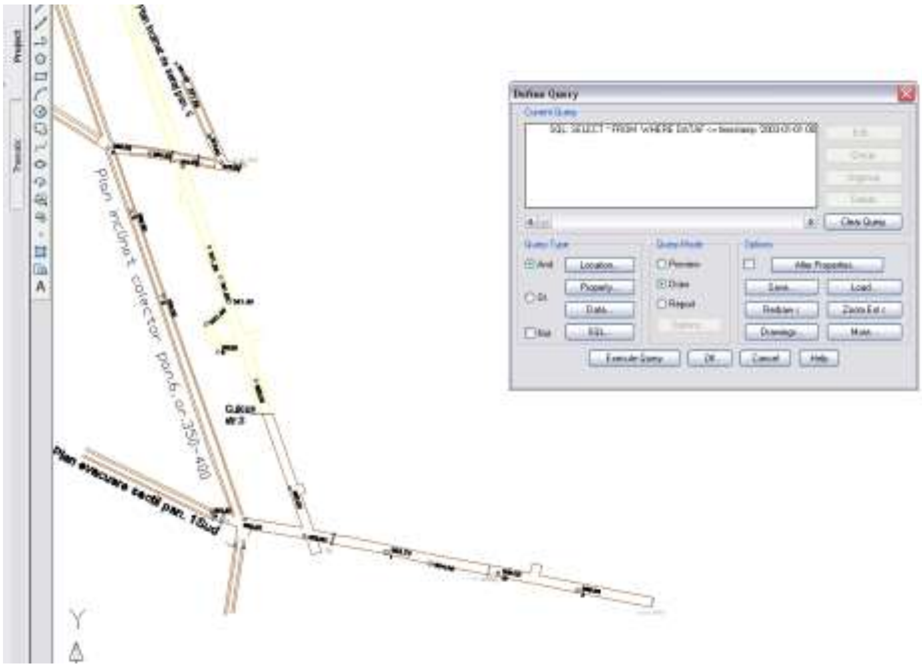

Fig. 3 Temporal query result: the position of working face drift at 01.01.2003

If we wish to obtain the exploited areas into certain period of time (initial date – final date), we must write a SQL condition, in the following manner:
SELECT * FROM Abataje WHERE DATA0 >= TIMESTAMP '2004.07.01 00:00:00' AND DATAF <= TIMESTAMP '2004.11.01 00:00:00'
where DATA0 = initial date (01.07.2004) şi DATAF – final date (01.11.2004).

As result of this query we obtain the drawing presented in figure 4, where they were extracted only the exploited areas between two indicated dates.

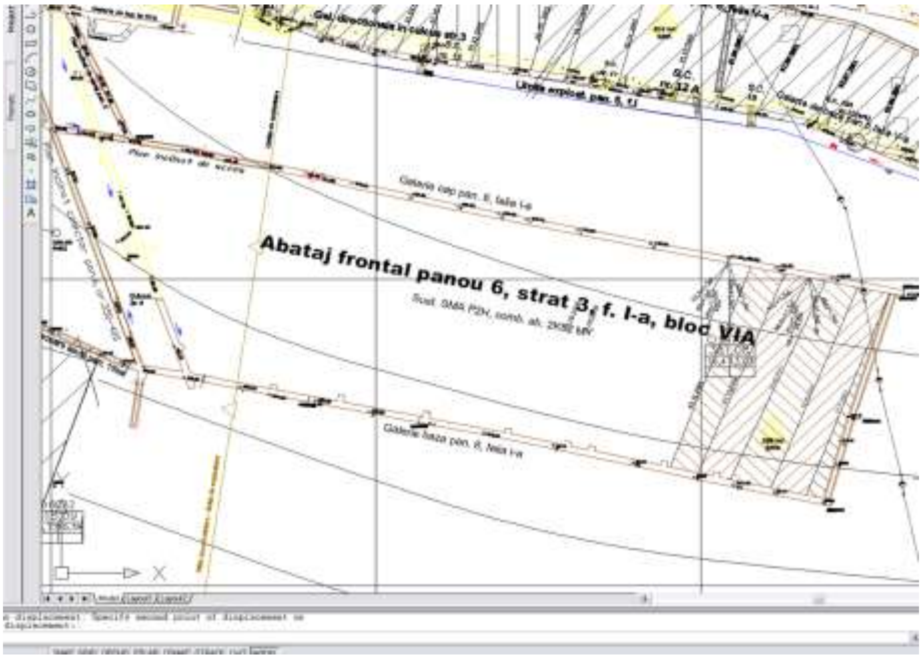

Fig. 4 Temporal query result: the exploited areas in coal-face no. 6 in the period from July to November 2004

Temporal analysis series like the presented ones, which can be realised by a GIS system, is practically unlimited and it can be helpful for the mine managers. The images presented in fig. 2 – fig. 4, represents three different stages of a mine part, in three different moments of time, which, helped by a 4D informatic system, can be obtained in few minutes.

CONCLUSIONS

Mine managers always needed informations about chronological and spacial evolution of the mine. "What it was, or what it will be, in certain place, in certain moment of time?", are frequently asked questions from mine specialists. And they are looking for the answer to these questions on the topographic maps.

Traditional surveying give these answers, using analogic tools, but not always with a satisfactorily speed and accuracy.

Digital technologies give tools that allow to obtain faster and exactly answers. These technologies help the surveyor and the information user, in the same time. The complexity of spacial and temporal analysis possibilities offered by the digital technologies permit to obtain development stages of the mine, in few minutes and from any point of view, exactly determined in time. The representations accuracy, from temporal point of view, depends only of the data collecting and storing frequency. If this frequency is good enough, the traditional topographic maps will be replaced with movies, which present more accurate and comprehensible the mine evolution.

The main problem consists in the very large volume of time and labour necessarily to convert the existing analogical information, in digital format, in one quatro-dimensional informatic system structure.

Putting in balance the work and time costs necessarily for creating and making functionally the system, with the coming advantages in the expoitation period, is a real challenge for the mine surveyors now.

REFERENCES

[1] Beldea Mircea, Integrated Informatic System for Mine Surveying Activities, Doctoral Thesis, Petrosani University, 2003;

[2] Beldea Mircea, National Hardcoal Company from Petrosani choose Autodesk Way, MaxCAD Revue, no.7, Bucharest, 2001

[3] ***, Autodesk Map. User's Guide, Autodesk, Inc., March 22, 1999