

THE AUTOMATION OF ACTIVITIES IN THE FIELD OF APPLICATION OF TECHNICAL-ENGINEERING PROJECTS USING 3D MODELING

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Abstract: *The paper aims to present the techniques and modern technologies for automation of activities in the field of application of technical-engineering projects, using the facilities of the software "AutoCAD CIVIL 3D" and the "Survey Master -TOPCON".*

1. Introduction

In the process of building design, mining industry, or underground exploration, and the restoration of historical monument, the knowing of the object's geometry is the most important and it is related to a GIS (Geographic Information System). The spatial representation of the object is based on a limited number of shapes such as lines, polygons and bodies, which are represented by using edges, corners, flats and volume elements of the real object; according to the purpose, the model results must correspond to a certain accuracy to the actual subject.

Land application projects requires topo-geodetic activities in the areas of interest. A few years ago the explosive evolution of surveying work equipment and software for processing and interpretation of the data led to unimagined possibilities. No matter how complex, the infrastructure projects can be designed in 3D models and the automation systems can take control of the hydraulic construction machinery and translate them into the ground.

A digital elevation model of the terrain (MDA) is a digital cartographic representation of the topographic surface defined by points evenly distributed and planimetric coordinates X, Y and altitude Z. A digital terrain model (MDT) is a generic term for defining a digital topographic surface of the land. Such a model may include elevation information concerning certain elements that characterize the terrain surface (eg, points of known height and slope break lines), and information on the topographic surface planimetric details.

The term "digital terrain model" (digital terrain model) was first used in 1958 by Miller and Laflamme, which they defined as "a statistical representation of continuous land surface using a large number of points whose horizontal coordinates (x, y) along with the elevation (z) are known, a representation made to the arbitrary coordinate system. "

"Digital elevation model" (CDM) / Digital Elevation Model (DEM), a commonly used term in the U.S. and Canada, generally refers to a digital representation of ground surface through altitude values that are evenly spaced and form a matrix represented by a network of cells with regular shapes, most common being squares and triangles or hexagons. The term „numerical model of terrain" (DTM) / Digital Terrain Model (DMT), used in Europe, currently has a much wider meaning compared to the definition given in 1958 by Miller and Laflamme, besides including altitude data some additional ones are mentioned such as terrain discontinuities (increases, slopes, streams) or values of slope, aspect, visibility, etc .

2. Execution stages of MNT

Developing a numerical model of the land and its future use involves the following steps:

- DTM generation : data acquisition and model building ;
 - Handling MNT : correction of errors and possibility of updating the model, filtering operations , combining multiple sources or models from different periods , the transformation model structure (TIN - raster and the reverse) ;
 - MNT interpretation : the model's analysis and extraction of useful information ;
 - View MNT : rendering of MNT (representations 2D, 3D , animation, etc. .) , Closely related to the previous stage ;
 - MNT operation : developing specific applications for the desired range . Using 3D models of the infrastructure work is more than beneficial, it provides increased automation for the drawing projects and the calculating stage. Making a 3D model of an infrastructure project is done basically in two phases:
 - Developing a digital terrain model which will run the existing infrastructure project ;
 - Making 3D model of infrastructure project in conjunction with the digital terrain model .
- Any infrastructure project is done mainly on the basis of topographic measurements made for this purpose .

The initial position of the land is found in specialty literature as the Original Ground Level (OGL) or Existing Ground Level (EGL) and obtaining a digital model for OGL will allow you not only to build a 3D model of infrastructure project for the existing land but also will allow you to provide an ongoing analysis of changes in the construction of the projected objective , namely calculating volumes .

The OGL digital surveying is done either using classical - total stations , GPS, or using LIDAR system , which can provide the direct digital model .

In case conventional technology will be used for measuring , the next steps are also known , namely:

- Establish support network and lifting ;
- Raising the details (data acquisition) ;
- Data processing and digital model construction .

In order to obtain a digital model according to reality, attention will be paid to obtain all the details of elevation , all the points that in literature are named "breaklines".

3 . The use of Specialized Software products

Once all the details have been collected, we can move to the following step: the switching to digital model construction using specialized software for topographical activities, for example the product ' Survey Master "(company TOPCON) or CAD programs , namely " Auto CAD Civil 3D ", which will convert the model of the terrain in their specific format.

3.1. Using the software product AutoCAD Civil 3D

AutoCAD Civil 3D can be used for graphical representation of the plan and to create digital elevation model of the terrain. The facilities of the program are extremely high and it offers virtually unlimited possibilities. This software solution creates models that facilitate script analyzes; both in the preliminary stages of the project and the improvement of the performance and the cost appraisal of the project, both during construction phase and in the running phase (Fig. 1).

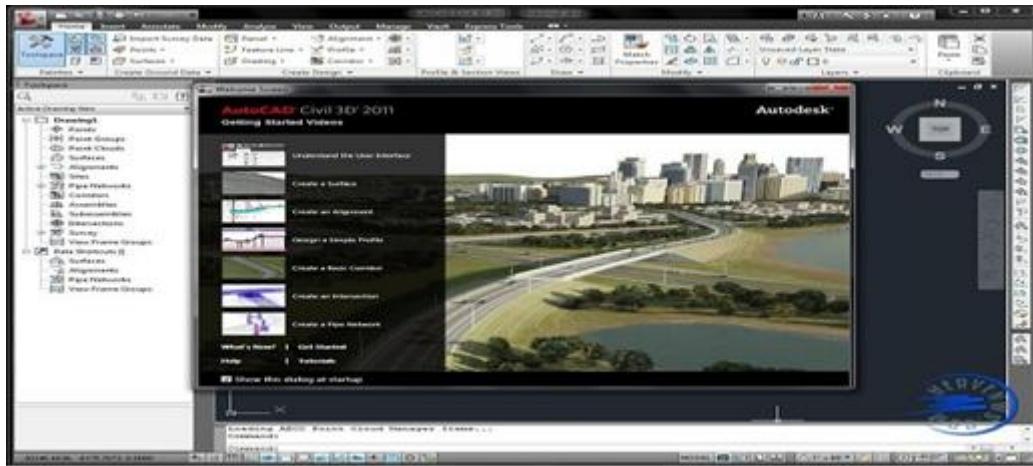


Fig.1 Printscreen of AutoCAD Civil 3D

The steps to achieving a digital model using AutoCAD Civil 3D are:

- Opening a new project;
- Import points;
- Drawing in 3D polylines the boundaries of the studied area and the breaklines;
- Making digital model (Figure 2).

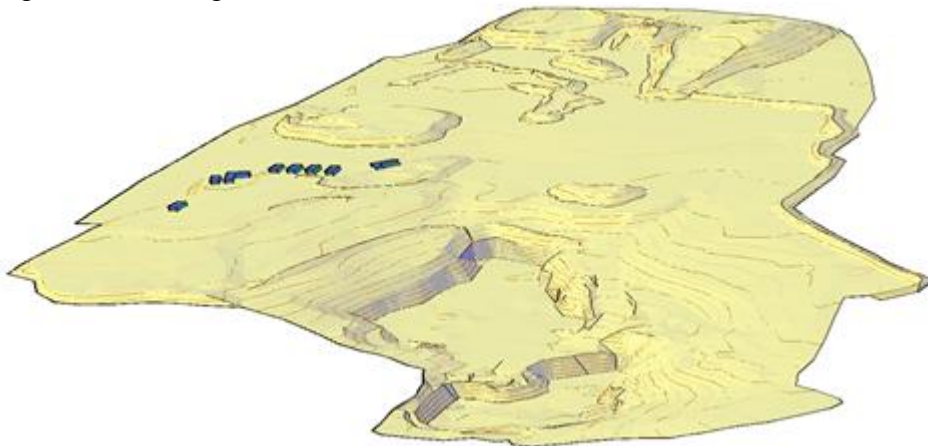


Fig.2 The digital model of a stone pit

Once the digital terrain model has been made, the following step is the construction of the infrastructure 3D model. The construction of a 3D model is a very laborious process and requires several steps, depending on the particularities of each project. During the process, specific issues can be differentiated that can be resolved on the basis of measurements and processing in the CAD environment, such as topographic problems, 2D and 3D analysis and design problems of communication.

Topography

Since the functions for the exploitation of the topographic data are fully integrated in AutoCAD Civil 3D, you can have an integrated working environment for all tasks required for direct import of raw survey data, reducing errors by using the method of least squares, editing of survey observations, automated creation of planimetric detail and relief etc. and what is most important, the results - points planimetric details and surfaces - can be used throughout the design process.

Surfaces

Surfaces can be achieved in traditional survey data such as points and linear discontinuities form field . Surface simplification tools enable the use of large data sets , such as the integration of aerial photogrammetric images in digital elevation models . Also, you can view the surface as contours or triangles , or generate complex analysis mapping elevation and slope . One can also view water drainage area studies and books digitally drainage basins . It also can be used as a reference surface to generate profiles, sections , plans of the earthworks and objects represented in 3D technology.

Calculating the volume of the embankment. The average projected surface method represents a software solution that allows the evaluation of the quantities of earth occupied by the buildings in a shorter time.

The Toolbox used for the communication lines’ specialized design. The specific design tools for the infrastructure provide a more efficient design of roads and highways. You can build interactive models of intersections of roads, which is updated dynamically.

The CAD software presents drawing standards to control many aspects of the form and content of drawing, colors, linetypes, contour increments, labeling and many other functions that are fully controlled by styles.

AutoCAD Civil 3D includes geospatial analysis functions and digital cartographic production necessary for the engineering work processes . It is possible to analyze spatial relationships between drawing objects .It can also retrieve or create new information by super impositionning two or more topologies . The generation and use of a buffer zone created at a certain distance from the other entity is performed in order to select the entities containing therein. Also , you can create detailed maps using geospatial information publicly available .

3.2.The usage of the “Survey Master” software product

The product Survey Master is the CAD solution of the company TOCON and has the both components: traditional drawing tools - layers, points, lines and so on, and automatic construction opportunities geometric elements: COGO functions, alignments, sections, etc. (Figure 3) .

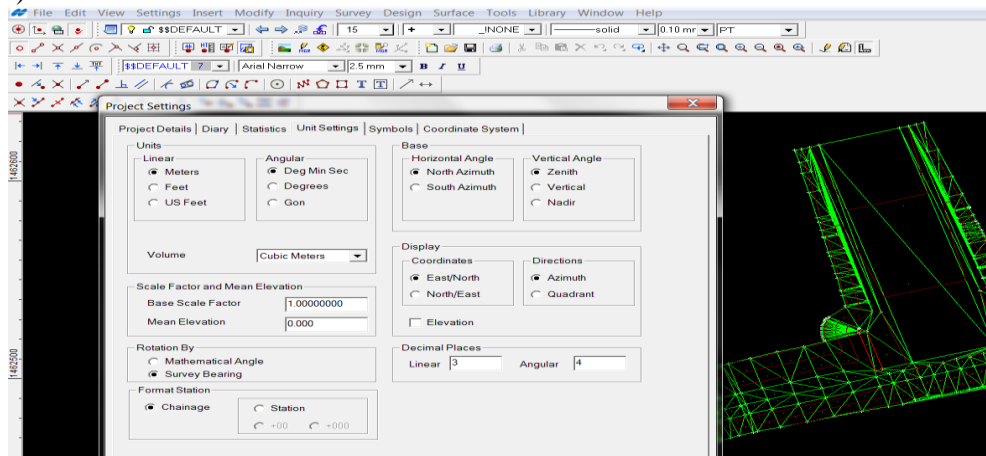


Fig.3 Print Screen of Survey Master screen

Besides the drawing functions, the program application can be used for topographic calculations. Note that Topcon has recently integrated all software applications into one: Magnet Office.

3.3. The practical use of the "AutoCAD Civil 3D" and "Survey Master" software

In principle, based on geometric elements provided by the designer (peaks of alignments, types of standard sections, etc..) using the functions offered by the 3D CAD software solution we can proceed to the construction of the projected model.

The AutoCAD Civil 3D provides functions for constructing the alignments (Fig. 4), the longitudinal profiles (Fig. 5) and cross sections (Figure 6).

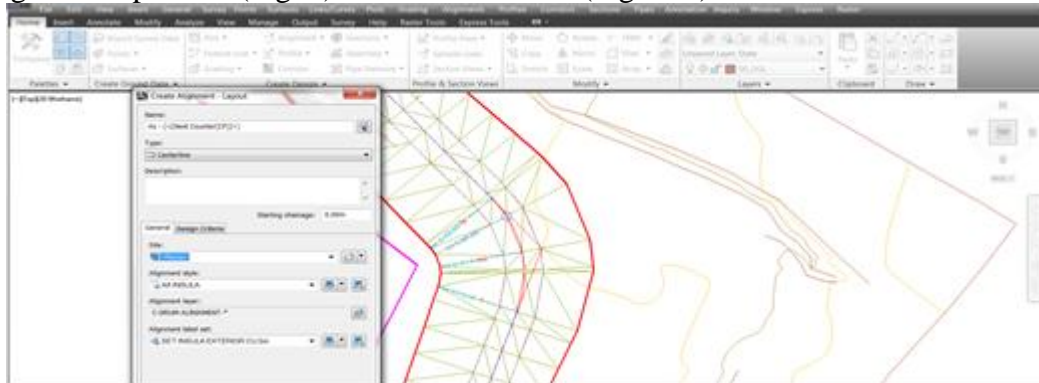


Fig. 4 . Construction of alignments

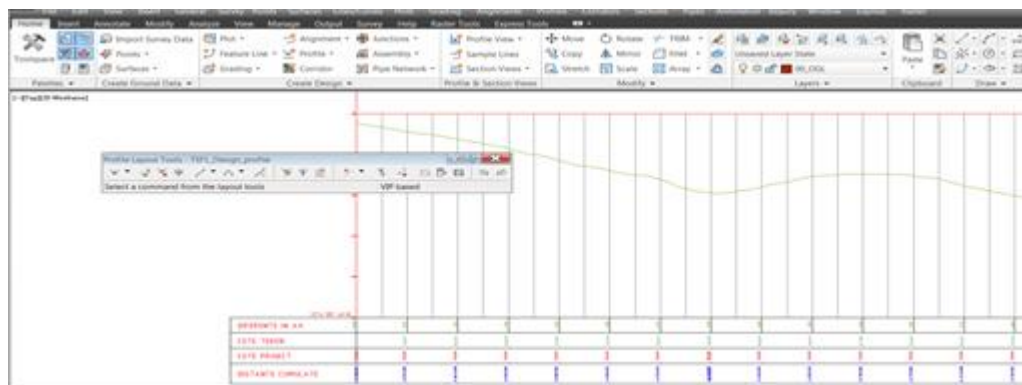


Fig. 5. Construction of longitudinal profiles

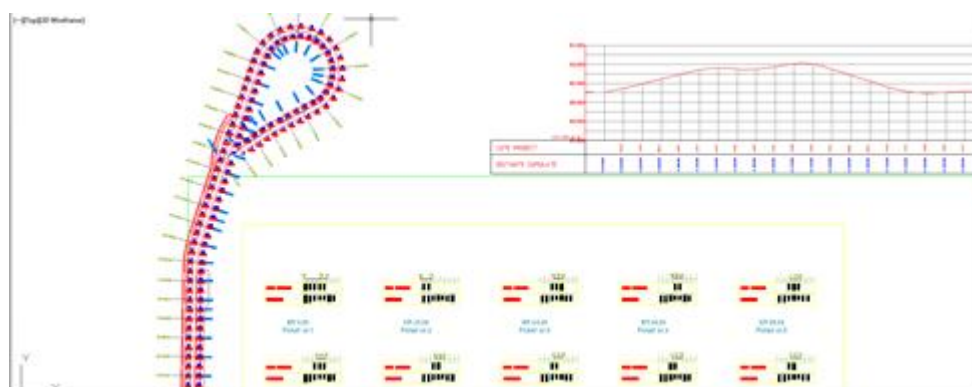


Fig. 6. Construction of cross sections

The 3D model is then built based on the section that will apply on the geometric elements horizontal - vertical alignments respectively - designed longitudinal profile (Fig. 7) .

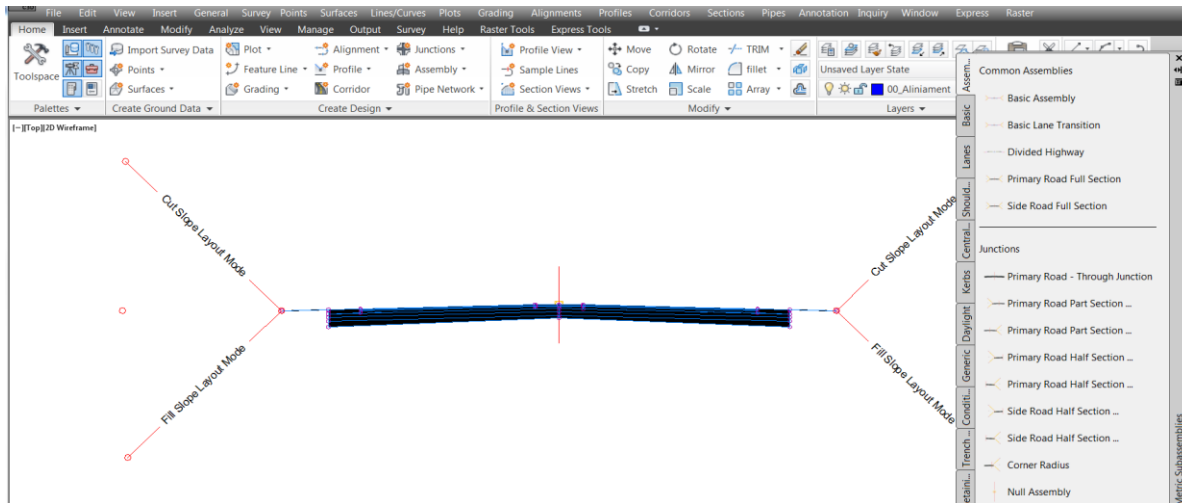


Fig. 7. Construction of cross sections

No matter which software we will use, we will obtain spectacular 3D models(fig.8).

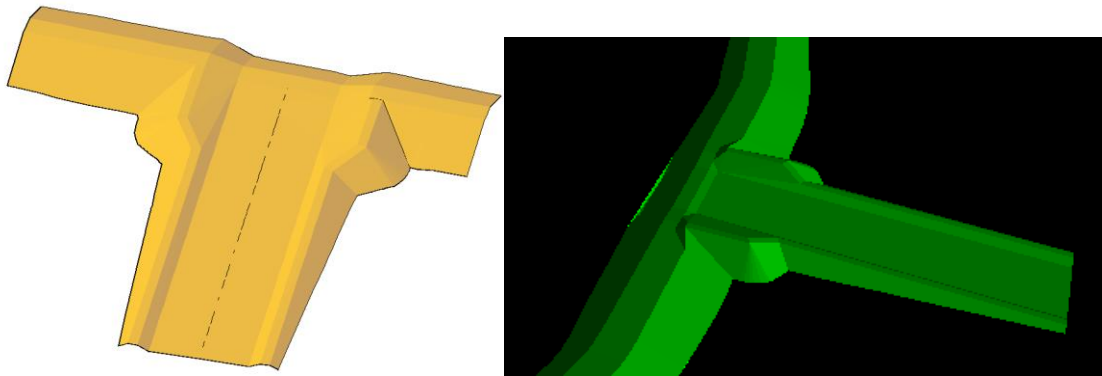


Fig. 8. Construction of Spatial Patterns

3D digital models constructed can be used successfully in terms of efficiency, to:

- Automatic generation of coordinates needed to draw the buildings (Figure 9).

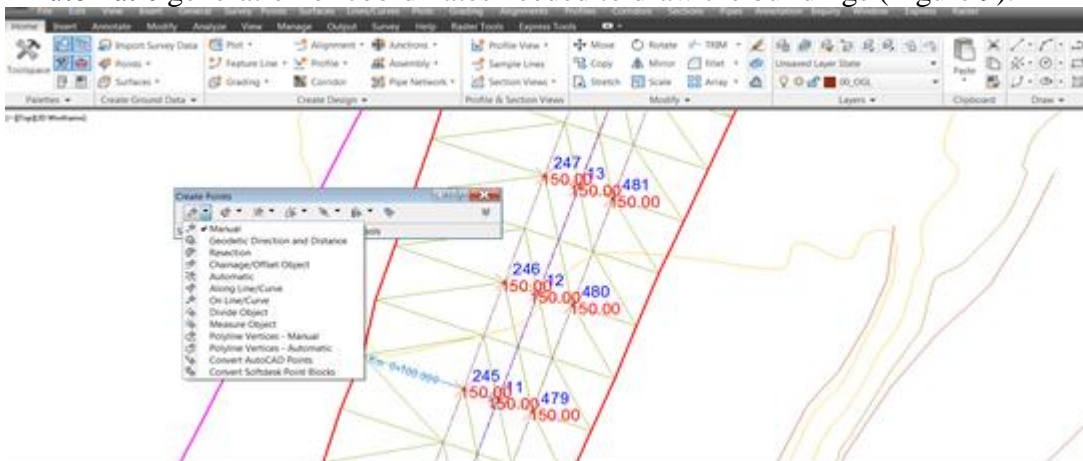


Fig. 9. Automatic generation of characteristics coordinates

- Loading 3D models directly into the surveying instruments (GPS or total stations) and their use for stakeout(Figure 10).



Fig. 10. Loading 3D models directly surveying instruments

Loading the special device models in automation of heavy machinery (bulldozers, excavators, etc.) and their use for control in order to carry out infrastructure projects (fig. 11, 12, 13).



Fig. 11. Machines equipped with GPS technique (automatic control)

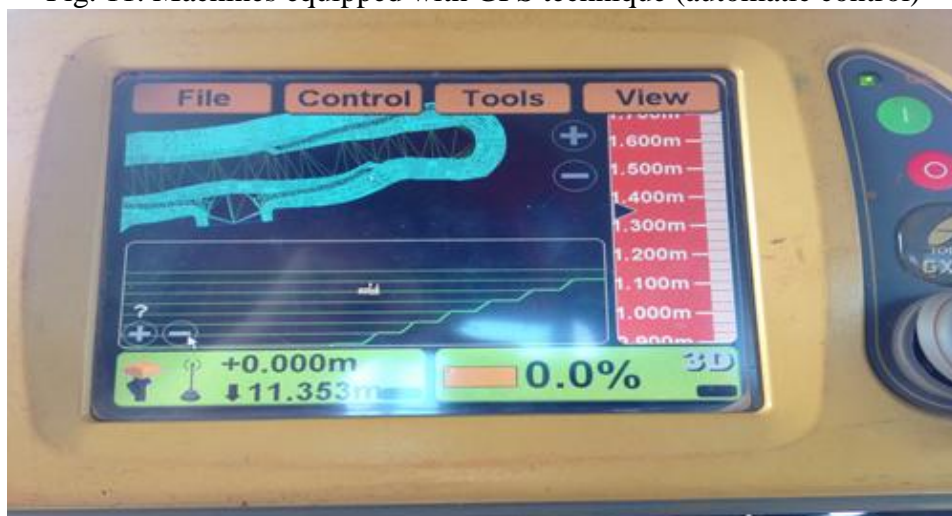


Fig. 12. Loading 3D models directly in routing tools

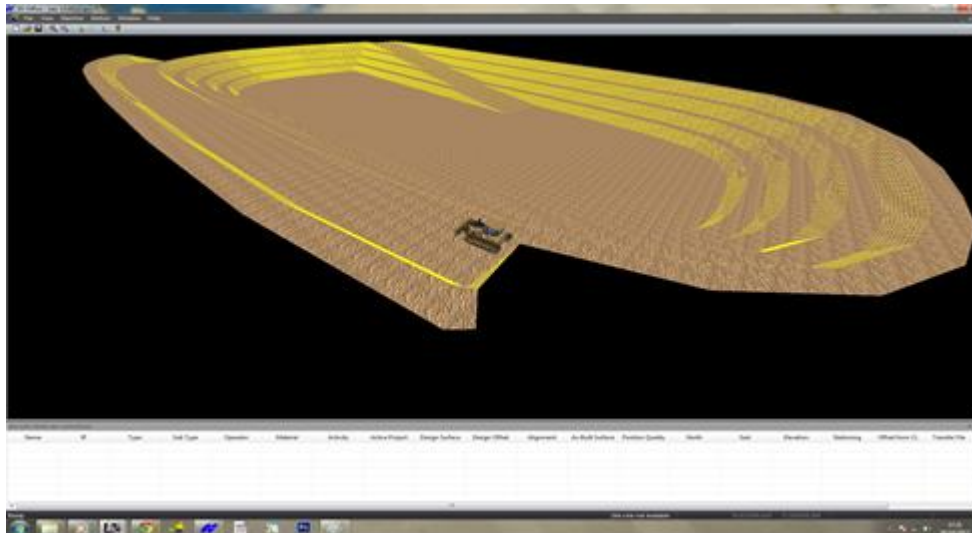


Fig. 13. The Digital model

4. Conclusions

The technical progress in both the design and execution of the technical-engineering and in the construction of specific equipment, enabled the specialists involved in the transposition of field projects to achieve superior results and efficiency.

Although the initial costs for purchasing modern technical equipment and software products are considerable high, the obtained effects, both economically and technically ones, justified the use in practice of this modern techniques.

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