Current State of Integrated Software Solutions for the Mining Industry

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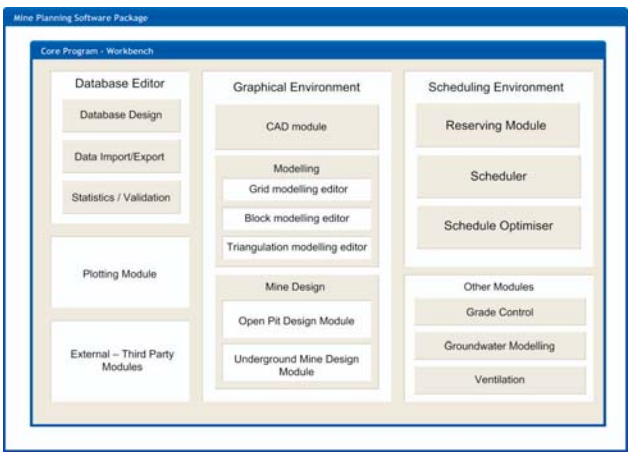
Modern mine planning software plays a crucial role in the operation of many of the world's mining operations. Mine planning software provides the mining industry with a fast, accurate, cost effective and efficient tool in order to manage their business interests worldwide. Every aspect of the mining industry is today using some form of mine planning software. From exploration to rehabilitation, the use of software is becoming more and more widespread. This paper discusses some of the most important new tools and technologies incorporated in modern mine planning software and presents potential areas of improvement and further development.

The evolution of mine planning software started in the 70's with a focus in operative gold mines where it was crucial to avoid any wasteful mining. A number of software packages have evolved to carry out most of the functionality required on an operation or project, such as VULCAN, SURPAC, GEMS, Datamine and others. The development of mine planning software has gone through many changes in hardware compatibility, software tools and users expectations. These changes have impacted on management decisions as to the most cost effective approach to providing the users the applications they need. The major objective remained the same through out this development: to provide users with tools that allow quick and accurate management and assessment of the value and risk associated with the exploration, feasibility and production of mineral resources.

Software Structure

It is a common trend in most of the advanced mine planning software packages currently available to have a modular structure based on a core program that controls other modules and enables communication of information and data between them. In some cases, this core program also incorporates the graphical environment. Several modules are normally available, each with specialized functionality. Such modules can include:

- Samples database editor,
- Geological interpretation and modeling,
- Statistics and geostatistics
- Grid modeling editor
- Block modeling editor
- Reserving module
- Open pit design
- Underground design
- Open pit optimizer
- Production Scheduler
- Production Schedule Optimizer
- Plotting utility



Modular structure of modern mine planning packages showing high level of integration.

Other more specialized modules can include groundwater and geotechnical modeling, surveying, and ventilation. This architecture provides a range of functionality including:

- A powerful, intuitive and interactive user interface, which minimizes user requirements to understand the workings of the computer and maximizes user ability to get close to their data and the models produced.
- A full range of sophisticated estimation and modeling algorithms for geological interpretation.
- A wide variety of mine design tools that generate the layout of the pit, analyze the economic limits, analyze slope conditions, plan ventilation requirements etc.
- Operational controls and monitoring systems are linked to design steps for areas such as survey, grade control, slope monitoring, truck dispatch etc.

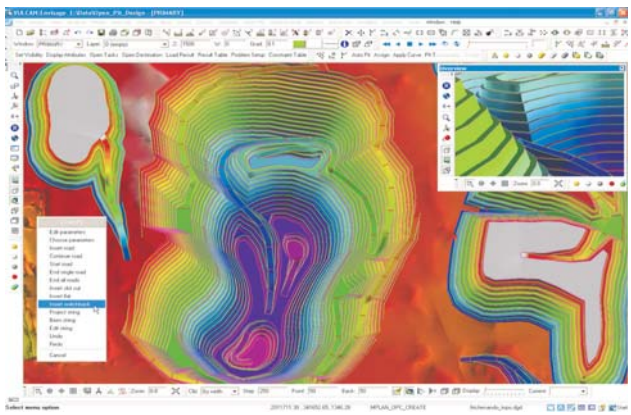
Graphical Environment and User Interface

A very important part of today's mine planning software, the graphical environment controls all aspects of visualization and graphical editing and analysis of data. Information from various sources such as samples databases, vector data (strings), block models, etc. are visualized in 3D within the graphical environment. Most of the on-screen interaction with the user is provided through this environment and for this reason most of the user friendliness of the entire package derives from this part of the software.

Effective user interfaces reduce the amount of training required for a new user, however there will always be a significant training or learning overhead with all mine planning software packages. Users of mine planning software come from different fields and have very different perceptions as to how computers work (or should work) and this is why user interfaces must be adaptive and customizable. Serious efforts have been made in the last few years but there is still a lot to be done. As an indication of what is available to users regarding user interface customization we mention the following available functions that can be found in some of the most sophisticated mine planning packages:

- Customized toolbars: users can create new toolbars combining existing functionality that they use more frequently. This can also include extended functionality provided through scripts. Custom icons can be chosen and used to represent functionality through scripts.
- Context menus: different options that depend on the object/model that is being edited can be chosen to be accessed through simple mouse or keyboard keys.
- Customized GUI (Graphical User Interface) layout: users can change the position of toolbars, the size and position of the various windows.
- Customized GUI behavior: users can change the way the GUI operates. For example, following a certain operation, the GUI can open the same pull-down menu that was used to access the particular function.
- History menu options: users can access using the mouse or a special toolbar a certain number of the last menu options that they used. This is very useful when repeating similar modeling steps.

It is essential that the user is able to interact with software easily and effectively. Modern software packages encourage users to customize their GUI to contain the options that are used most frequently. The various graphical environments give the user the visual capabilities to work with the data. True 3D graphics editors available in some of the more advanced packages provide the necessary CAD functionality as well as 3D visualization.

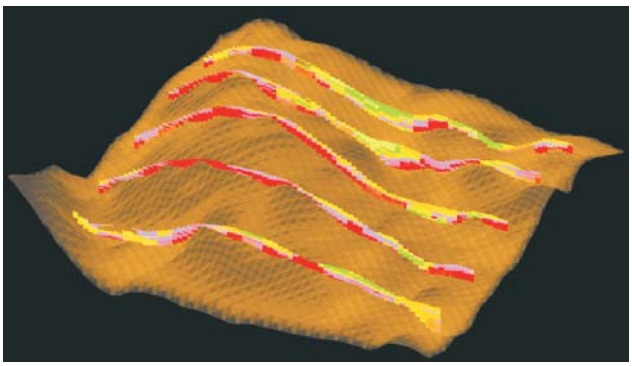


Screenshot from VULCAN™ 3D Software graphical environment showing details of a modern graphical environment (Maptek Pty Ltd).

The interactive nature of the software can be taken one stage further by representing data in a dynamic setting. By dynamically "slicing" a block model, for example, the user can drag through from one block model extent to the other, on any axis. This particular function highlights the relationship between block model variables and triangulated workings, geological or orebody models.

Models and Algorithms Integration

There is a number of existing model structures used in mine planning software, such as grid and block models, triangulations (surface and solid), and vector based models usually in the form of strings. The basic assumptions made by these models remained constant throughout the years of development. What changed is their flexibility and adjustability to more complex and realistic geological and extraction scenarios.



Block model sections showing grade estimates following a tetrahedral model of the ore body deformation.

A modern mine planning package can contain an extremely large number of different algorithms providing the basis for most of its functionality. From geostatistics to pit optimization and from triangulation model editing to mine reserves calculations, the integrated algorithms bring to the users a range of options that define the levels of automation, functionality and user friendliness. Generally, the presence of certain algorithms and their sophistication can control the time required to achieve a certain modeling step or to edit an existing model. All this is hidden behind the GUI and users commonly take for granted what required years of research and money in the making.

Interfacing GIS & Scripting

A common scenario in many projects is the combined use of GIS and mining software. By providing an interface for leading GIS programs (such as ESRI's ArcView™), modern software packages enable the importing and exporting of GIS formats (for example, shape files or TINs). The advantage is that registered images can be brought into the mine planning software environment (such as geological maps) and integrated further with other data being used.

Several scripting languages have been developed in the computer industry enabling advanced users to automate repetitive tasks and software producers to rapidly respond to new functionality demands. Perl, Tcl and Python are the most common examples of scripting languages adopted by today's mining software. These scripting languages are usually extended to include more specialized functionality and give users access to the various file types and model structures available with the mine planning software.

Looking to the Future

Looking to the future, the mining industry will become increasingly reliant on software. As deposits become more marginal, new features and procedures will need to be developed to make these marginal deposits economic. To do that, software must provide platforms that are cost effective and extremely efficient. Already, remarkable achievements have been made in a short space of time. Large datasets will continue to get larger, calculation times will continue to take less time to complete and designs will become increasingly interactive.

The complexity of mine planning software will continue to increase with the requirements of problems that need solving. Integration of different software applications and data transfer between them continues to be vital to the efficiency of such systems.

The increase in the volume of data through modern exploration techniques and real-time

monitoring systems requires that computers must be used to a large extent at all stages of the mining process. The data processing and analysis cycle may need many iterations if the mining company is to cope successfully with the changes in unforeseen geological conditions, changes in planning and environmental controls, and changes in the commodity price during the life of a mine. Those companies that achieve effective integration of computer systems are those that are most likely to cope with these changes and remain competitive.

Mine planning software, on the other hand, must continue to develop and adapt in form and functionality to satisfy current requirements and provide new methods for solving existing problems. A closer relationship between end-users and software developers will help achieve this target and ensure the future of mine planning software. □