Virtual Planning Room, intelligent cloud software platform for mine planning

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People at Delphos Mine Planning laboratory at Universidad de Chile [1] has been working last four years in a R&D project along with ProactiveOffice.com [2], a software developing company, in the creation of a *cloud* software platform to integrate their and other developers mine planning applications, within an intelligent data base system, designed to manage input and output information used in mine production plans and to ease workflow modifications.
First prototype of Virtual Planning Room (VPR) is already implemented and integrates, as a demonstration case, the Delphos Open Pit Planner - Doppler [3]; a tool that incorporates state of the art Direct Block Scheduling [4] and other standard methods for open pit planning.
The cloud software platform includes a web based interface, which allows to visualize files and variables, as commodity price or transportation cycle times, used for any number of versions of a mine production plan, in an historical order. The platform allows to combine different applications, normally used in a mine planning workflow, and is able to deal with input - output format management among them, as well as to storage all of the in a logical order.
Paper describes Virtual Planning Room platform design and performance, the research and development process, including the initial product research.

VPR Project Background

Delphos mine planning laboratory software tools

Delphos researchers have developed software tools that implement state of art mine planning methods. A comprehensive and modular software library for open pit planning have being created, as well as a multi-purpose scheduling and sequencing tool, that has been used in massive underground mining scheduling and to open pit long term scheduling problems. A material handling systems simulator has been created as well, that allows to evaluate multiple scenarios and to create interest variables distributions, that can be used as input in other planning stages of the process, when uncertainty is taken under consideration.

Delphos mine planning laboratory research

Delphos lab's main research area is to incorporate uncertainty in mine planning processes. Part of this work is to solve algorithmical and computational problems raised from multi scenario and stochastic variable handling. Other research line is to incorporate geometallurgical, and geomechanical variables into mine planning, considering multiple origin and destination.

ProactiveOffice.com software developer company as partner

ProactiveOffice.com is a software company. They develop and customize their project management software for diverse applications and industries. Specially in mining, they have client companies in tunnel construction and in project development at underground mining. Partnership with them it is the key element to support the conceptual design for the platform. They have a mature cloud Software as a Service - SaaS [5] that is modular and can be integrated partially to other application as VPR. Data model, web interface, data base, user client and remote utilities have been developed in house by ProactiveOffice.com.

Virtual Planning Room

Motivation

Our group realizes that to make possible the transit towards a more complex, multivariable and stochastical mine planning, which incorporates geological and geometallurgical uncertainty and operational variability, it is relevant to consider the information management and visualization problem and to have a hierarchical and historically organized mine planning activity data model. Here is the main motivation for the Virtual Planning Room - VPR project.

Conceptual design

Virtual Planning Room is a software platform for mine planning. It has three main objectives: first is to provide order and access to information that is used for mine planning. Every file used in every planning cycle, in every time horizon (long, medium, short term), as input or output has a place in a data base. Data is organized in order to help access to variables and to report their values through time or plan versions through a graphical interface. Second objective is to be adaptive and be able to synchronize and manage information in every workflow followed by mine planners, even if application used is not open or modular as Delphos tools are. Each individual use case will have a consultive adaptation process, starting from a modular philosophy. Third is to provide capacity to manage several scenarios in every workflow that industry partner needs, with special attention to attend uncertainty and give more robust results. The platform is conceived to reside in a cloud server, to process heavy routines remotely and to allow multi user workflows.

VPR was conceived after more than fifteen focus groups and semi structured interviews, with industry mine planning professionals. Concepts that raised were: information integration and mining plans having intelligent backup and reporting, would allow for mine planners to have more time and resources to think and analyze diverse scenarios or to develop sensibility analysis about critical variables. On the other hand, it was found that planners don't change their methodologies, due to hard work planning cycles. In every time horizon of mine planning, as middle term plan, for example, planners have very straight time slots to deliver or to report their results. They found there is no time to analyze, or to test other methods or software applications and to compare their results.

The first design for the VPR was a software platform, with intelligent repository (system that includes data model, a data base accordingly and a graphical interface) and a methodology manager, which would allow to use diverse applications or software modules within a workflow, with less user effort, due to a higher level of abstraction through an interface.

Improvements for client would be access to historical information (variables used as input for an annual production plan or budget, for example), as graphics, curves or time lines; a storage for all input and output files of each plan run or version and finally a data model, designed especially for mine planning activity. The platform would be tested through Delphos software tools being integrated to VPR platform.

After three years, in 2017 Virtual Planning Room has one realization as prototype with Delphos Open Pit Planner - Doppler integrated. System can synchronize Doppler's final pit and annealed pit modules, production plans generation, including an intermediate *"Milawa"* style case, which is implemented using mathematical programing algorithm. All mine planning stages or actions are registered in a graphical time line, which is multi-user and has a web interface.

VPR prototype design and implementation

Design

The VPR system was designed considering ProactiveOffice software basic SaaS modules as core components, which ensures that VPR would have a tested functional support. Besides, the project produced new developments; one of them is an Application Programming Interface - API that allows to connect to core ProactiveOffice modules from two main client applications. In figure 1 a diagram shows two main group components: above is client side of VPR, including web interface, and up is server or *cloud* side.

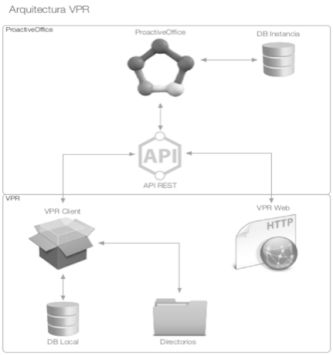

Figure 1: VPR architecture design, top side shows ProctiveOffice SaaS modules and API, above is VPR client which resides at user computer and Synchronizes mine planning apps folders.

First application is called VPR Client, which is a local (user) computer software module, that is constantly synchronizing mine planning applications project folders - for example, Doppler's folder. Second one is a web interface that shows contents from system data base using graphics that shows block model variables or economic variables evolution in time (from one mine plan version to another), or that relate two or more block model columns, as the well-known Grade/Ton graphic (figure 3). There is a graphical "Time Line" where all actions of all users are registered though time, as can be seen in figure 2.

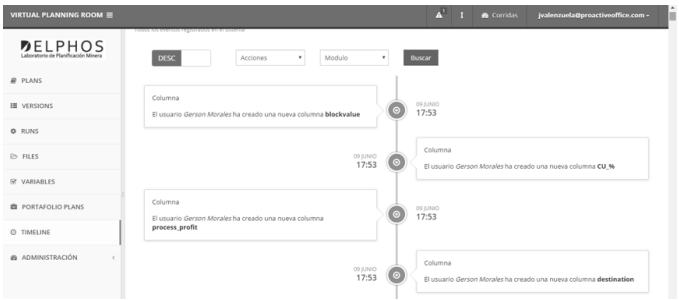

Figure 2: Timeline functionality that makes tracking to any change on the data use for one “run”. The system even allows to track any change on columns on the block model. This is abled thought the implementation of a driver library that informs to the system how the data should be interpreted on the planner software (i.e.: Whittle [6], Doppler).

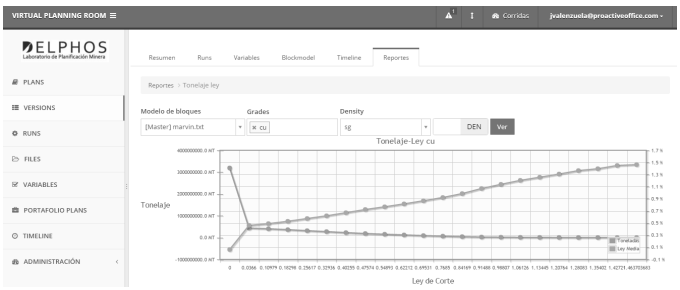

Figure 3: Visualization of a Ton-Grade curve on a test block model. The system allows to easily visualize the data on the system for any ore types included in a block model.

A data model has been designed to support block models and other mine planning process input and output files as equipment availability or process plant tonnage. Diverse variables, as cost or transport cycles time are tracked and shown graphically through time periods or from one plan version to other.

VPR first Prototype

As a first prototype, researchers and development team decided to implement core modules to fulfil the requirements of an open pit long term plan, from nested pits calculation to production plan, with different sequencing options, including worst, best and intermediate cases.

In the planning functions are Doppler modules. VPR then synchronize with Doppler project folder and have a communication protocol with Doppler that work when software actions occur. Some changes in Doppler to implement communication lead to a special version of that desktop application.

The prototype has the complete set of modules implemented to have long term mine plans, with all their inputs and outputs registered in the *cloud* data base and all actions done by planners go to the Time Line register.

VPR support Doppler's Direct Block Scheduling - DBS module as well, to create a long term plans using same stages that mine planners normally use, including annealed pit methodology and pushback selection; but instead of Lerch & Grossman [7] approach, using DBS to generate different pushback set to look for higher business value.

Data Model for VPR

The Virtual Planning Room data model considers three categories of a mine planning project; first and most abstract one is the Plan that defines a type of mine plan, including time horizon and period, among other parameter. For example, a Life of Asset (LOA) type of plan. Then there is Version which is what mine planer's workflow is intended to produce for a period, for example, "*2016 LOA*"; it includes a base block model, economic parameters like costs and prices and geotechnical parameters. The Run is set of actions and input/output files for each software utilities used for one run or plan generation process. Data model consider how to organize block model columns and their change along time due to users Runs, how to store economical parameter, geomechanical parameter or formulae to calculate block values.

Doppler for VPR

The Delphos Open Pit Planner is a software that makes use a set of open pit mine planning tools developed at Delphos Lab that are put together in a software library called MineLink [8]. For VPR, Delphos Lab developers have created a special version of Doppler that communicates with VPR Client, giving information about user actions that allows a better synchronization. For this version a new development has been carried on to generate an intermediate case for production plan sequence, based on the UDESS [9] tool, a Delphos tasks optimal scheduler, based in mathematical programming.

Conclusions

Delphos lab and ProactiveOffice have delivered proof of concept for a useful methodology in which mine planning information is managed, in order to help analysis prior to a mine planning cycle and to allow the implementation of multi scenario technics used to incorporate uncertainty and make more robust production plans for mining activity.

The ProactiveOffice SaaS platform used as base for VPR ensures successful technology transfer process, from research institution to the mining industry, for the new development, since all modules that make possible cloud and multi user utilities are industry tested.

Future Work

Research and development group will continue to integrate more mine planning applications to VPR workflows, based in study cases with industry clients. Besides, as part of a new project related with VPR, research group is developing an underground scheduler based in UDESS tool to combine construction and production planning through integrated

optimization. UDESS has the mathematical programming tool that generates a model and an external solver delivers optimization results. In this project a specialized solver will be implemented for the particular case problem. But most important a new model for production and construction joint planning will be delivered, and this will help to manage with operational uncertainty. This tool, inside VPR, will allow to run several scheduling instances and to manage different scenarios.

Acknowledgements

Authors would like to acknowledge to CONICYT basal grant FB0809 (Advanced Mining Technology Center) and CORFO project code 14IDL2 30132.

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