Optimized Tactical Scheduling for Profitable Quarrying

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ABSTRACT

In line with the IQM CONEX theme of “Global Partnerships in Quarrying”, Dassault Systèmes aims to take a partnership approach to the Quarry industry in Malaysia by working closely with Quarry Operators to create robust and practical mine plans to meet production and business objectives. Over the past 20 years, the Dassault Systèmes team (through the GEOVIA mining brand), has been engaged in the Quarry industry across Malaysia. In this region, through the increasing utilisation of mining software in industrial minerals operations, Quarry Operators have demonstrated success in the use of mining software tools to create solutions that deliver the abovementioned robust and practical mine plans.

Through the use of scheduling solutions, our Quarry clients benefit by

- Meeting demand for a range of products specification
- Create accurate operating forecasts
- Scheduling equipment in an optimal manner

These benefits lead to a more profitable quarrying operation.

INTRODUCTION

Effective mine planning aims to maximize the economic rent of a finite natural resource through its exploitation, in accordance with company guidelines. Though the adoption of technology, in particular mining software, the industrial minerals sector can benefit from increased information and visualisation of the mine to bring about improved decision-making to meet these objectives in a timely, cost-effective and in a sustainable manner.

In the past many Quarry operations in Malaysia and in Southeast Asia have used paper-based systems and CAD packages in their mine planning processes. The reasons for the lack of mining software at Quarry operations are varied and can be attributed to issues such as:

- Few skilled mining professionals present onsite such as geologists and engineers; and
- A lack of survey information to base the mine plan on.
However, this has changed rapidly and now the industrial minerals industry has the desire to increase productivity to drive profitability. This is due in part to industry consolidation which has seen larger players acquire smaller companies.

Through our engagements with the industry and our clients, we have found an industry in transition. Amongst our findings there is a need to:

- Gain a better understanding of the geology of a deposit
- Run geology and planning processes from a central location
- Make geological and mine planning workflows consistent
- Improve community stakeholder relations and reporting
- Schedule equipment in an optimal manner

By visualizing the model in the 3D space (see Figure 1 - Geological surface in Surpac Quarry Edition), better decisions can be made on how the deposit will be mined.

![Geological surface in Surpac Quarry Edition](image)

Figure 1 - Geological surface in Surpac Quarry Edition

This paper will now outline some real-life case studies of industrial minerals companies that have adopted these technologies around the world to demonstrate the value of mining software.
A Changing Industrial Minerals Industry

Like many GEOVIA customers, Rheinkalk, a subsidiary of global giant Lhoist, uses geology and mine planning software to model geology, create monthly mine plans, and collaborate across different groups. Through the use of GEOVIA Surpac software, they have enhanced data accuracy, consistency and protection by storing geology, planning and drilling data in one system for use across business units. This data can be utilised by geologists and engineers at a central location and shared with those who will implement the plans at local sites.

At Rheinkalk’s operations, plant personnel manufacture various types of lime in different furnaces or kilns according to customer specifications. Rheinkalk’s limestone rock from the quarry is a chemically composed product derived from calcinations. From exploration work and core drilling, the staff creates geological and geochemical models that exemplify the chemical composition and main structural elements of the limestone deposits. Quarry employees enter the drillhole data from the quarry operation and update this in Surpac software. They distribute that data to the geologists, who conduct their grade control work. From there, the data goes to the purchasing engineers for equipment budgeting, procurement and materials management.

Table 1 –Roles and GEOVIA Functions shows the different functional configurations for each role. This table highlights that all the spatial information is shared and processed in one solution.

<table>
<thead>
<tr>
<th>Position/Licences</th>
<th>Standard Features</th>
<th>Plotting</th>
<th>Plug in GIS Data</th>
<th>Geological Database</th>
<th>Statistics</th>
<th>Solids Modelling</th>
<th>Block Modelling</th>
<th>Pit and Dump Design</th>
<th>Drill and Blast</th>
<th>Survey</th>
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<tbody>
<tr>
<td>Mining Engineer</td>
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<td>Mine Surveyor</td>
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Bringing Consistency to Workflows

Workflow standardisation, through software automation, has also assisted Rheinkalk’s operations. Surpac macros automate input functions such as plan updates, plotting, interrogation of maps by date, count volumes and design forms all at the click of the button. In addition, there are automated procedures to calculate cut-off curves and cycle times for mobile equipment on block models. With workflow automation, tasks are made consistent and even staff with limited software experience can run them with confidence.
The Reserves can be simply be quantified as shown in Figure 2 - Block model showing mineable blocks in GEOVIA Surpac Quarry that forms the basis of the inventory.

![Figure 2 - Block model showing mineable blocks in GEOVIA Surpac Quarry](image)

**Surpac Proven Mining Capability in Quarries**

Surpac has reduced data duplication in mining for many years by connecting to relational databases and interfacing with common file formats from GIS, CAD and other systems in one capable system that includes:

- A graphics interface; the system has a powerful graphical engine that allows users to explore their data in 3D. All Surpac formats such drill holes, geometry and block models can be displayed in graphics and can be edited using editing tools. The geometry includes surfaces, solids, lines and point data types.

- Drill hole database; Surpac has its own drill hole database and processes these drill holes by compositing samples, displaying drill hole data and allowing drill hole management by updating and adding holes as well as extracting sections and flitches and auditing.

- Geological modelling; supported by drill hole display and editing tools allows geologists to create wireframes of the mineralisation. These wireframes are validated using rules to check the integrity of the solid.

- Block modeling and geostatistics; used mainly in Resource development has estimation tools that code block centroids with the interpreted grade. It achieves this by industry standard geostatistics like inverse distance and kriging and is applied by understanding the primary and secondary trends that are derived by variogram modeling.
- **Mine Design:** Open pit design tools that enable engineers to design walls and ramps. The tools work in a way that allows engineers to create entire mine designs of a mine or update an existing design as in Figure 3 - Phased pit design in Surpac Quarry.

- **Survey:** Survey reduction of total station readings and management of survey data enable surveyors to maintain up-to-date data of the mine.

![Figure 3 - Phased pit design in Surpac Quarry](image)

Surpac is used globally and the interface can easily be configured for English, Chinese, Russian, Spanish and French.

**Ensuring Product Quality**

Limestone customers have individual needs and strict quality requirements. With complex deposits, Nordkalk is another example of an industrial minerals company using software to control quality and manage its deposits. The company uses Surpac software for calculating ore reserves, generating geological and grade control block models, producing maps, surveying daily blasts, and managing its daily quality control stages.

Nordkalk staff classifies impurity content and grade frequency of the limestone using drillhole databases and block models. Geology, surveying and quality personnel manage a large number of quality parameters in the software, including geological, chemical and physical properties. This helps them control and optimize the different quality classes so they do not mine more than is needed at a certain time. As an added benefit, daily blast control – from measuring to reporting – is streamlined, reducing the amount of time spent on the task by 1,000 to 1,500 work hours per year.
An Integrated Solution for Mine Planning, Scheduling and Optimisation

Integrated software solutions are growing in use at industrial minerals sites. Clay producer Imerys Minerals Ltd. use GEOVIA MineSched to link geology, optimisation, and scheduling together at its St. Austell Kaolin Quarries. With this system, Imerys can make better decisions about how to plan its operations to meet customer demand and to improve the economic return they deliver.

After mine planning in Surpac as shown in Figure 4 - Mine Planning Workflow, the engineer uses MineSched to provide easy to use optimal equipment scheduling through its interactive and automated scheduling method. A schedule can be automated from the day the survey data collected. This provides the operation the most accurate prediction for materials to be mined for a chosen planning horizon.

With the adoption of survey drones and their speed to obtain up to date survey information, a Quarry operation can easily schedule equipment on a more regular basis.

As seen in Figure 5- MineSched interface, MineSched provides the tools Quarries need to create a schedule and then run modified scenarios to find a solution that meets an objective. This objective can include a blended material specification that needs to be extracted for a client order. The schedule is robust and practical as it mines within given constraints that can have parameters applied to it and can be updated by the mine planner.

Once the schedule has been setup with the current information from Surpac, the mine planner can easily move a dig unit into a location or increase production for a given period. The schedule quickly produces a block by block schedule that has all the practical constraints like equipment size and rates.
We all recognise that many industrial mineral operations must be backed by the support of the local communities they intend to operate in. Geology and mine planning software can be used to demonstrate what the quarry or mine will look like throughout its period of development, during production, and ultimately reclamation.

Additionally, in an age of smart phones and tablets, Quarries can show these visualizations in the local communities in a convenient format to illustrate what the site will look like now and throughout its mine life, including if a pit can be seen from a housing development. With this visual data, stakeholder engagement is made easier.

Statutory Reporting Requirements

With more industrial mineral and aggregate companies now publicly traded and acquired, professional resource and reserve reports have become standard requirements. On the permitting side, companies need to be able to identify geotechnical problems, deleterious elements in ore and waste material, and what is remaining in the pit walls that may produce problems in surface runoff and groundwater supplies. These are all items which can be accounted for with GEOVIA software.

Technology is also playing an environmental management role by ensuring companies find the most effective way to mitigate their environmental impact whilst communicating these impacts with stakeholders. Using
GEOVIA software, mines can schedule acid-forming waste more efficiently during mining, design improved waste dumps, monitor water usage, record environmental activity in real-time and prepare mine closure plans.

GEOVIA offers an end-to-end solution that enables our clients to plan, act and record environmental mitigation measures.

CONCLUSION

As global partners to the industrial minerals industry, it has been GEOVIA’s experience that quarries benefit from the use of mine planning software. In this, industrial minerals operators are creating opportunities for owning their mine plans and increase profitability. Compliance to plan is one of the greatest challenges today in mining and quarries. With new survey drone technology, industrial minerals operations will be able to survey and then schedule on a more regular basis. We believe this will provide quarries operational stability by an accurate planning process.