Establishing an Optimized Mine layout

The way an underground mine is designed is a key factor for long-term, successful operation. Put simply, the easier it is to extract the ore, quickly and safely, the more productive and profitable the mine will be.

All mines are unique, and nowhere is this more apparent than in the mine layout. In the same way as the infrastructure mine is designed to enable the ore to be mined and brought to the surface as efficiently as possible, the layout of the mine must also be meticulously planned.

The feasibility phase is always followed by the layout phase in the overall planning work, and it is vitally important to take every possible requirement into consideration, both in the short term and long-term perspective. In other words, the modern mine planner will need to take all potential developments across the mine's projected lifespan into account.

The mine layout is defined as the type and location of operational facilities, i.e. the design and positioning of auxiliary roadways, the placing of workshops for servicing machinery, and the type and proximity of skips, conveyors, ramps, pumping stations and production areas. This is typically done in a collaborative effort among mining engineers, geologists who study the rock and orebody, hydrologists who analyze groundwater, ventilation and mechanical engineers and rock mechanics experts. The starting point is the mining method, and this dictates the foundation of the basic layout. For example, the requirements of drill and blast mining in hard rock formations (igneous rock) differ considerably from the methods used in coal and similar soft rock applications where continuous (long wall) mining is commonplace.

In a typical mine, the layout is developed based on the following conditions:

- Orebody access and mining method
- Geographical location
- Rock characteristics
- Safety
- Production capacity
- Capital and operational costs

Although it may seem obvious to conveniently locate underground workshops to facilitate the regular servicing of drill rigs, loaders, and other machinery, in reality this is far from the norm. Even less commonplace are mine layouts that incorporate transport and communication systems designed specifically to accommodate the increasing use of automated machinery. Figure 1 provides an example of a layout that has taken these factors into consideration. But the situation is changing. Mine layout involves complex calculation which has been made easier thanks to technological developments.

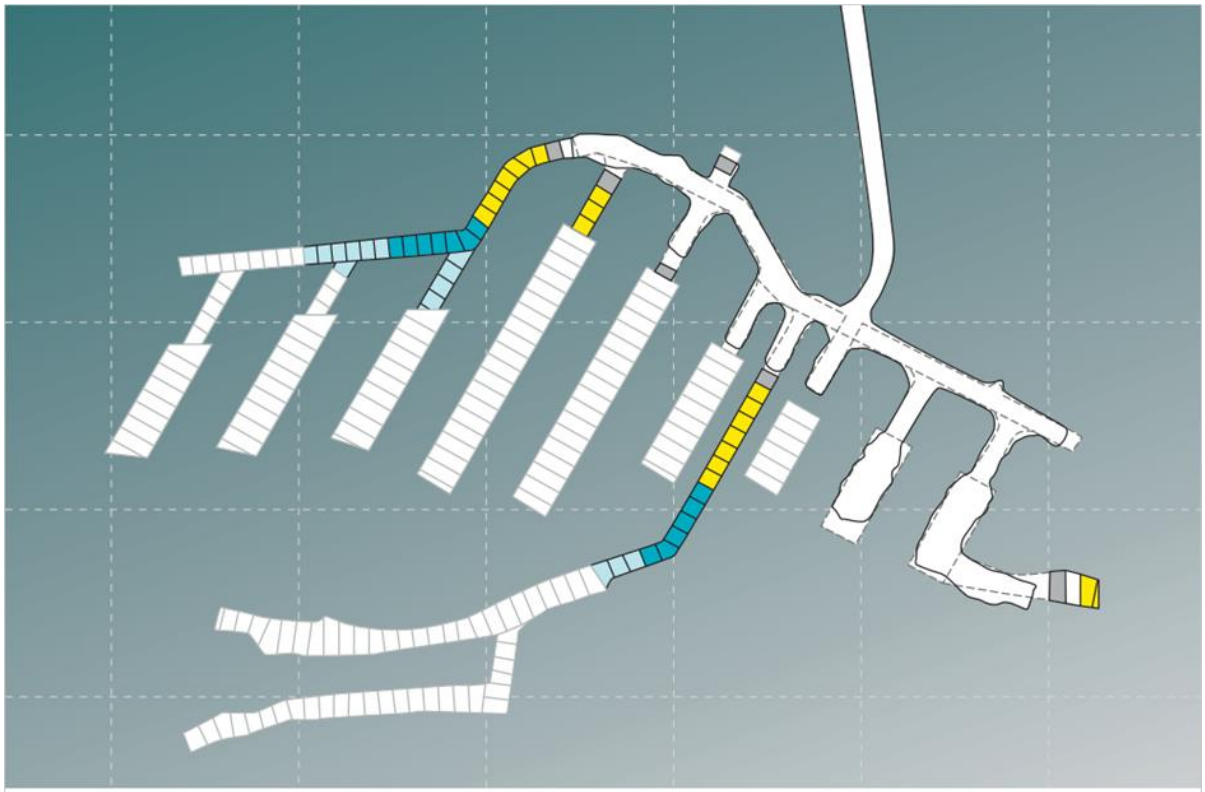

Figure 1: Horizontal view of an open stoping mine layout using backfill. Infrastructure drifts are located in the host rock outside the orebody.

Meticulous planning

It is a proven error of judgment to presume that new facilities can easily be added to the mine layout over time, as and when required. This is a costly strategy and usually the most difficult to implement. Instead, it is important to establish the layout of the mine as one functioning system at the earliest possible stage, with the long-term potential of the mine in mind. What sections of the mine are likely to need wider and stronger roadways and ramps in five years' time? Where are automated drilling, loading and haulage equipment likely to be introduced? How deep are the miners likely to go in the years ahead and how will this impact the layout?

To find models for extracting the largest amount of ore at the lowest possible cost and over the entire life of a mine, a wide variety of mining professionals are involved in the design process. They often have sophisticated computerized models at their disposal with which to optimize the design for the entire mining cycle. Transport is a typical problem in mines where trucking equipment and payloads only allow for a limited incline of roads and ramps.

The benefits of modern software tools include:

- 3D simulation of layout and infrastructure
- Optimum production rate analysis
- Ore and waste transportation
- Fleet tracking with real time reports
- Management of production and environmental issues

Nevertheless, given the rapid advance of mining technology and the constant fluctuation in world demand for metals and minerals, this work also involves a large measure of calculated

guesswork. Furthermore, it is important to remember that human expertise and computerized models are interdependent. One example of this is the Atlas Copco program Care for Mining. When applied, this program, it is set up in close cooperation with customers to avoid any risk of misunderstanding. It consists of a versatile simulation technique which calculates the number of trucks and loaders needed in a mine to achieve a specified level of production.

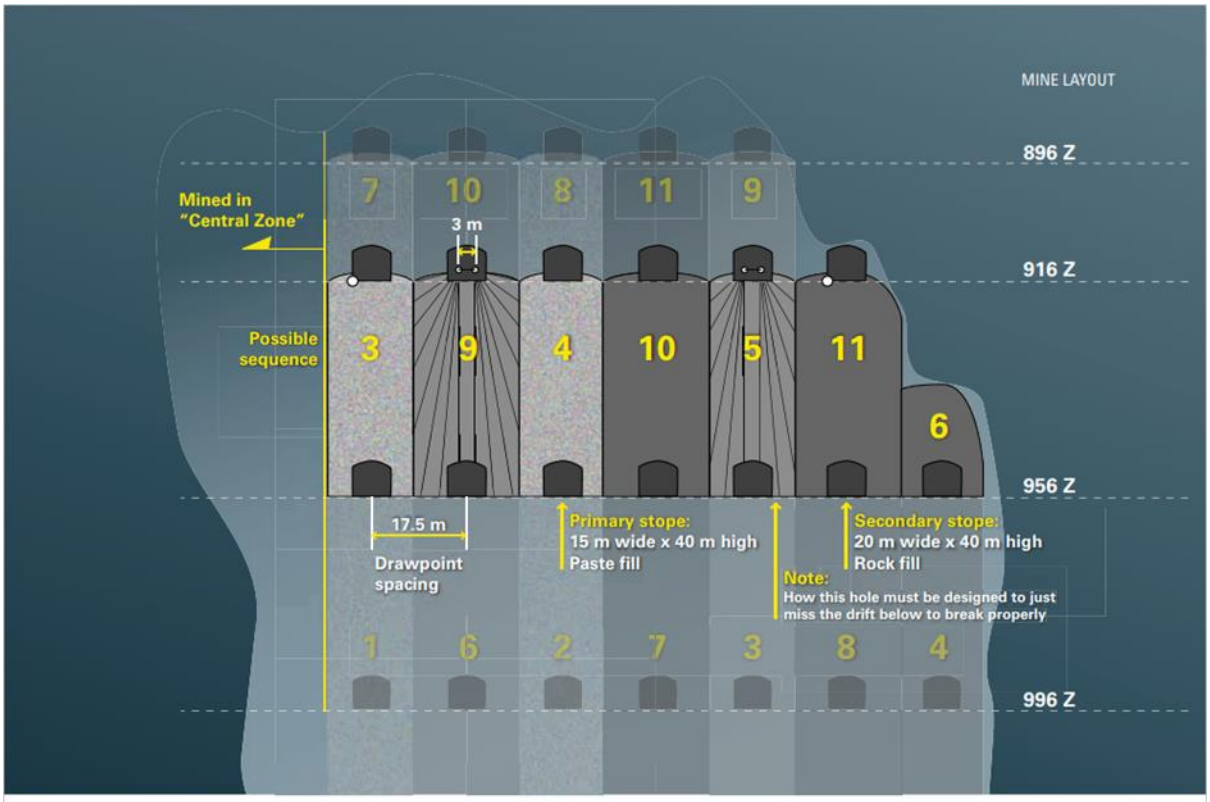

Figure 2: Vertical view of a sublevel open stoping layout showing typical mining sequence and backfill procedure.

Care for Mining can simulate any underground mine with precise distances and declines of roads and ramps. It focuses on the haulage capacity of the entire fleet and provides the best layout scenario for haulage based on production and current working conditions. In addition, the program simulates the effects of availability and preventive maintenance.

Safety First

An overriding aim in planning the mine layout is to continuously strive for increased safety and productivity. Both things go hand in hand and may require successive improvements. However, no mine plan should ever proceed without carefully defining the risks to personnel in any given operation. With increasingly stringent health and safety regulations worldwide, mine planners are using advanced assessment models where high, low, and medium risk levels are identified.

Ground instability, atmospheric contamination, mine shaft construction, transport, seismicity, rockburst, explosives, and fire hazards are just a few examples of factors that must be fed into computerized risk assessment programs and extensively evaluated. A typically challenging scenario is when mines go deeper to recover additional ore. In this case, the planner has to identify areas of increased seismic activity and make sure that all facilities are placed out of harm's way.

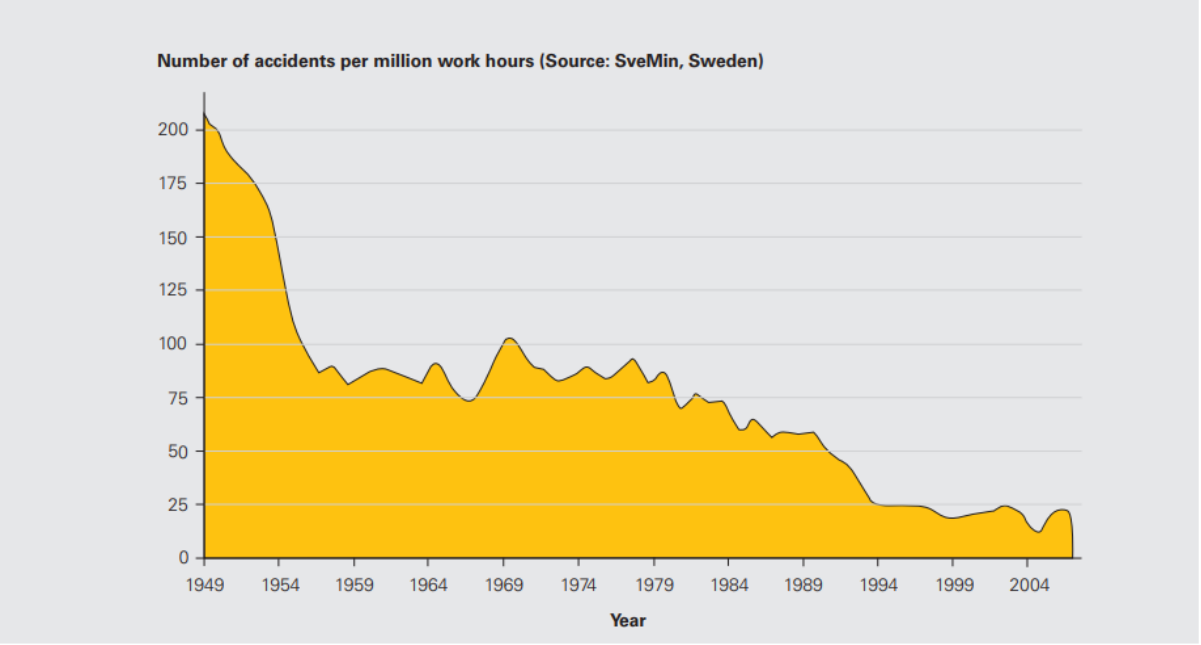

Figure 3: Mining related accidents have significantly decreased thanks to stricter health and safety regulations – a key consideration in the mine layout process.

When developing the mine layout, as with infrastructure, it is advisable to adopt a proactive approach at every step. A detailed design will encompass factors such as ore recovery-to-cost ratios over time, equipment selection and infrastructure, mine development and safety issues. These are the crucial parameters for solving problems and defining the path to a sustainable, optimized, long-term model for mining.