2017 Annual Conference of the Mine Ventilation Society of South Africa

Closing the gap between mine ventilation/cooling planning and implementation

presented by Raymond Funnell

27 July 2017

BBE CONSULTING

Topics to be discussed

Part A
Challenges in planning mine ventilation and cooling systems

Part B
Challenges when moving from planning to implementation stage

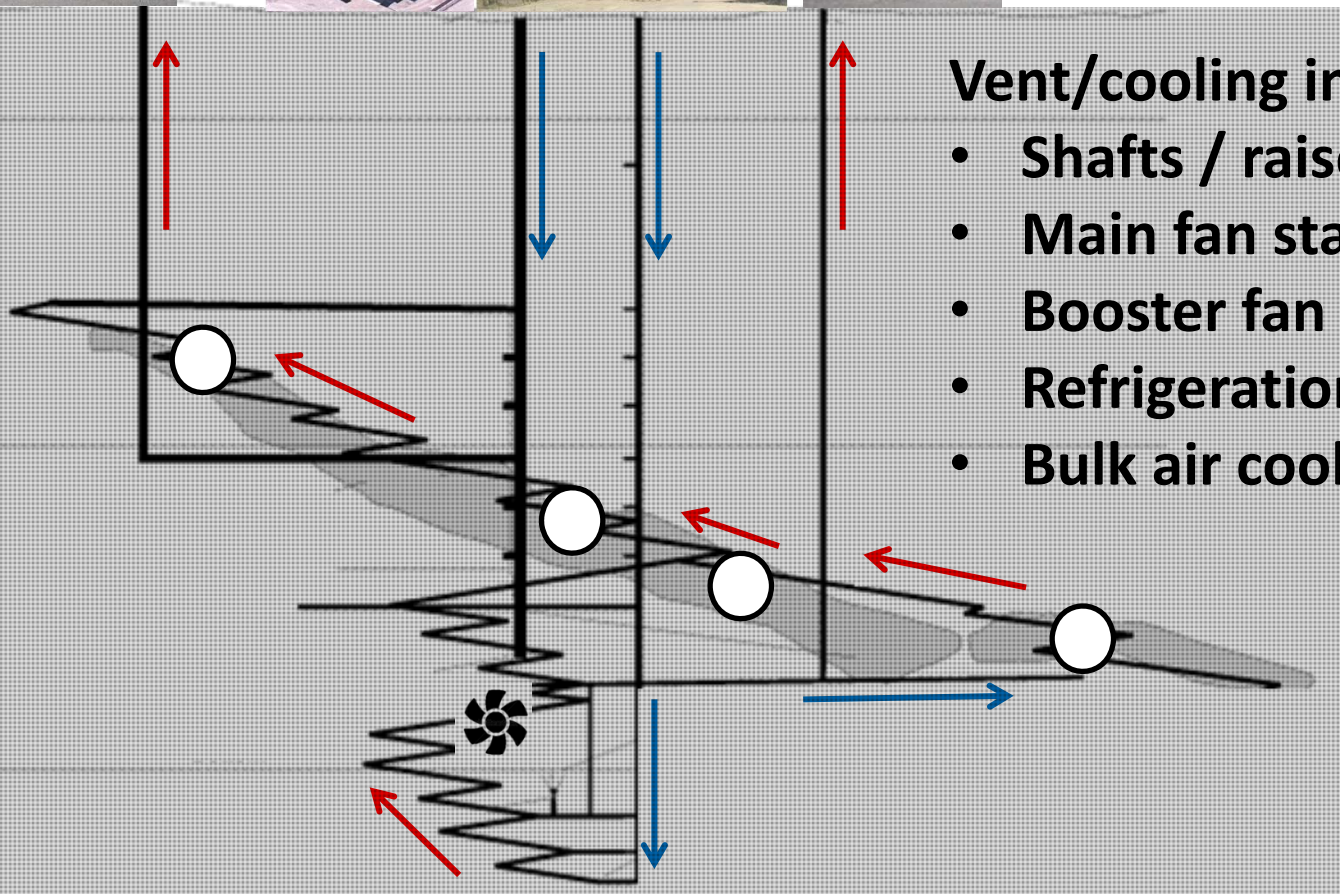
Part A
Challenges in planning mine ventilation and cooling systems

Why does mine planning always change?

What do we <u>really</u> know about the mine?

BBE CONSULTING

What do we need to plan?

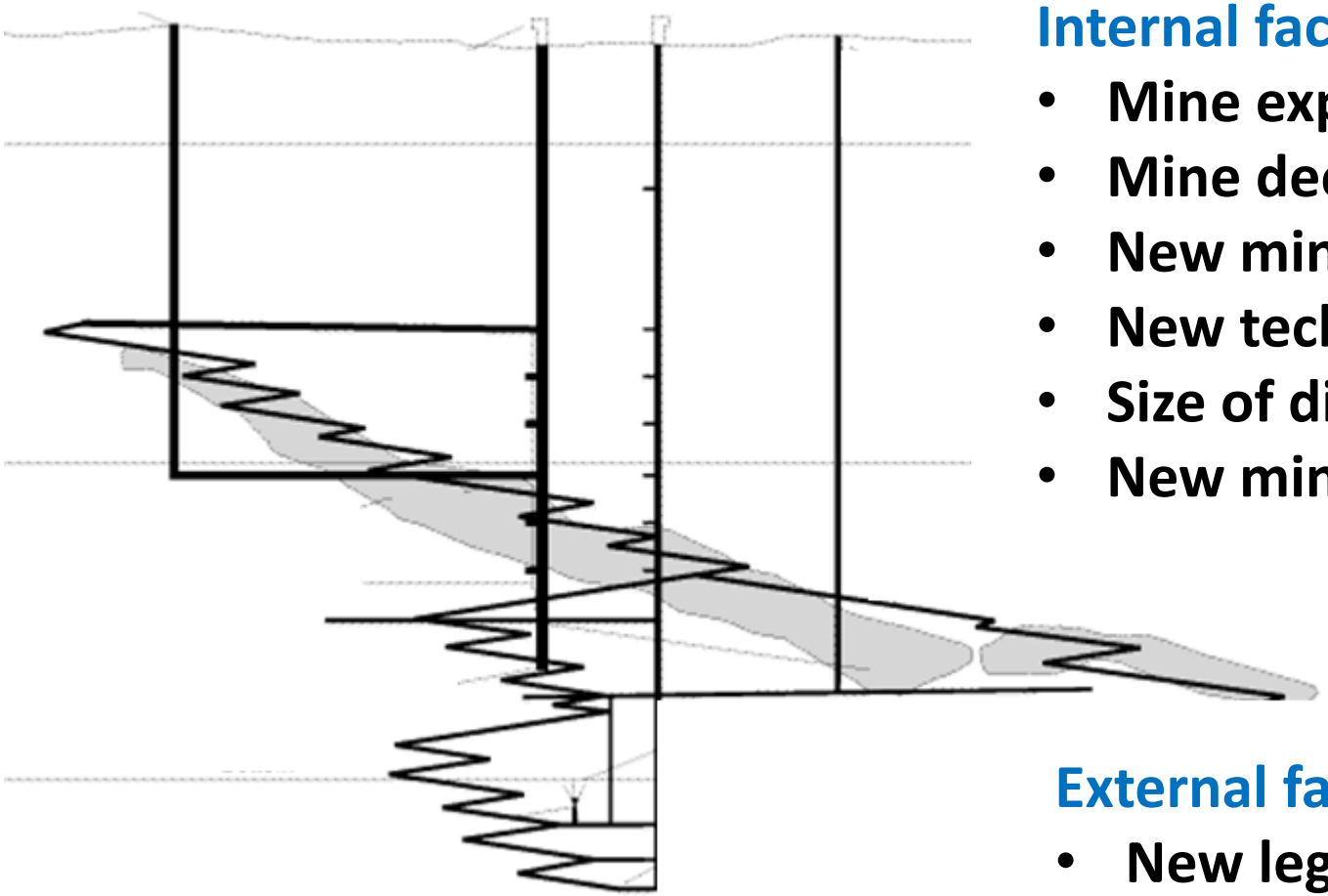


Vent/cooling infrastructure:

- Shafts / raises
- Main fan stations
- Booster fan stations
- Refrigeration plant
- Bulk air coolers

BBE CONSULTING

How likely are changes?



Internal factors:

- Mine expansion
- Mine deepening
- New mining method
- New technologies
- Size of diesel fleet
- New mine standards

External factors:

- New legislation
- Energy/water crisis

Strategies to help cope with changes

1. Adequate sizing of fixed infrastructure such as shafts
2. Use of temporary fans and refrigeration plant
3. Phased approach with modular main fans
4. Phased approach with modular refrigeration plant
5. Methods to control main fans

1. Adequate sizing of fixed infrastructure

- Shafts must be constructed early in project
- Not practical to increase size of shaft
- Therefore any overdesign must be applied during the planning stage
- Don’t design to the absolute limit!!
- It is suggested that sizing of the shaft is based on a nominal air velocity of 10 m/s (even if higher velocities are technically feasible)
- Provides buffer for possible future changes

2. Use of temporary fans and refrigeration

- Fit-for-purpose
- Low capital cost
- Rapid implementation
- Low energy efficiency
- Relatively high maintenance

Figure - Example of temporary bulk air cooler

Figure - Example of temporary refrigeration plant (water chillers)

3. Phased approach - modular main fans

- Delay investment as late as possible
- Phase-in additional modules when needed
- Fan stations generally comprise 1 to 4 fan modules
- Modules size is important decision, more modules provide:
  - Greater flexibility
  - Capex premium
  - Operational stability
  - Start-up issues
  - Maintenance issues

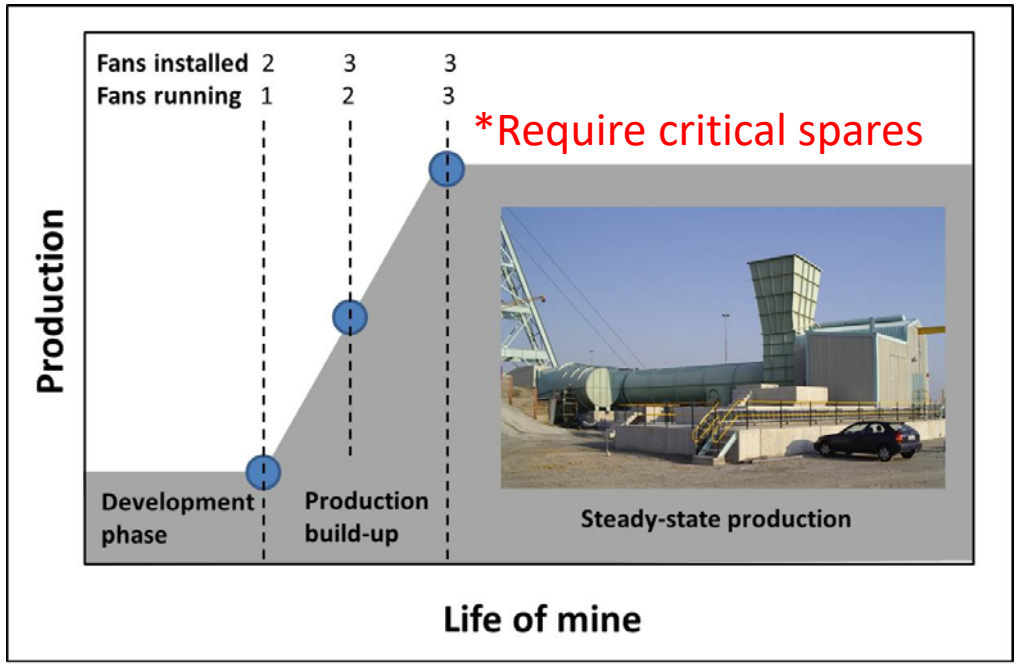


Figure - Typical phase-in of fan modules with 3 fans

4. Phased approach - modular refrigeration

Figure - Surface refrigeration plant

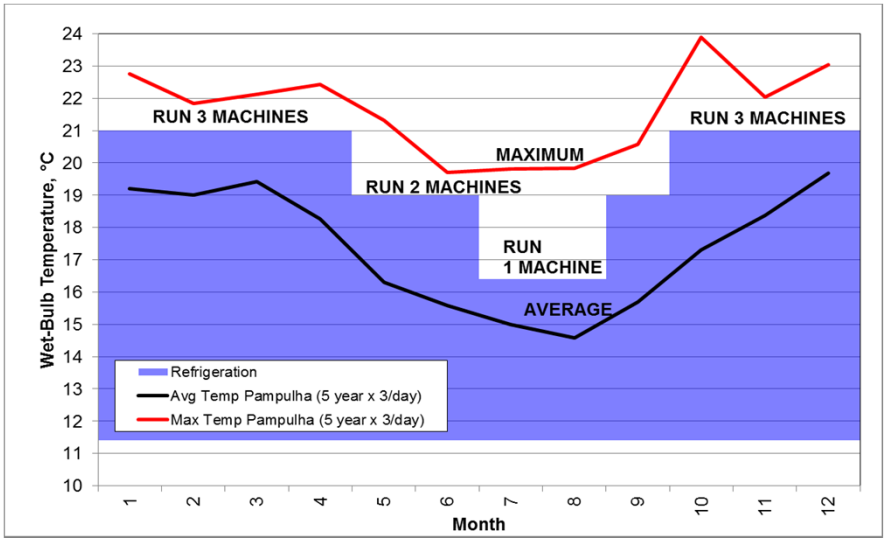


Figure - Seasonal operation of plant

- Number of modules is generally between 2 and 6 units
- Phase-in additional modules when needed
- Seasonal operation of modules when needed
- Carry-out maintenance in winter (can eliminate standby machine)
- Underground refrigeration plant has space constraints which impacts module size, so generally have lower cooling duty per module

5. Methods to control main fans

- Inlet guide vanes (IGVs) is a simple method to control the fan and is energy efficient in a narrow band close to design point.
- Variable speed drive (VSD) system is a more energy efficient method to control the fans over a wide range of conditions. This requires a larger investment.

Opportunities with VSD:

- Early project requirements
- Energy management
- Reduced starting load
- Matching of fan power to available power source

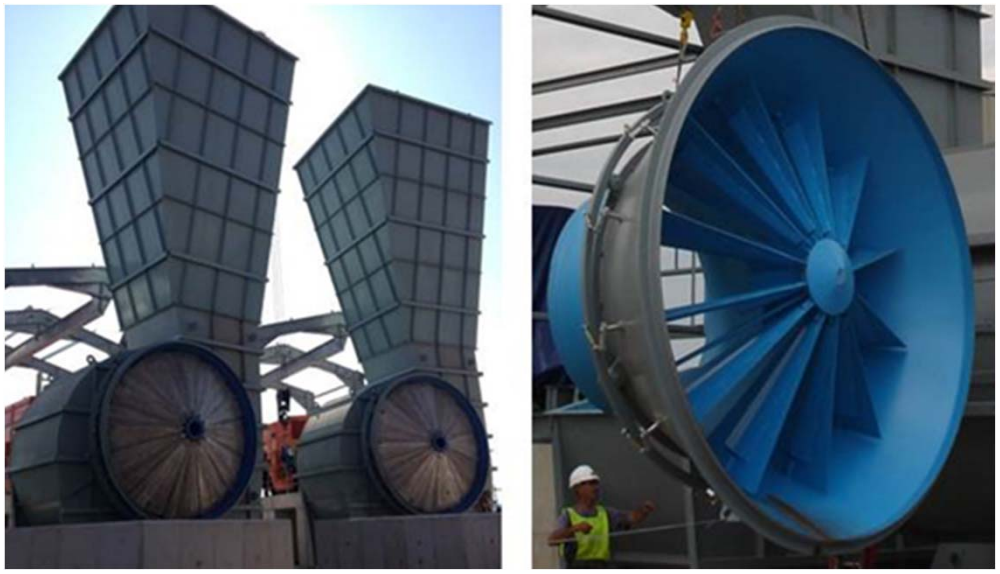


Figure - Centrifugal fan fitted with IGVs

Part B
Challenges when moving from planning to implementation stage

1. Incorrect use of feasibility documents during implementation stage
2. Lack of continuity of design team during construction stage
3. Inadequate performance testing of new main fan and new refrigeration plant
4. Lack of regular Life-of-Mine ventilation and cooling planning studies

1. Incorrect use of feasibility documents during implementation stage

- Using feasibility documents during implementation stage can result in serious Errors and Omissions.
- Whilst reasonably detailed, feasibility documents may not be optimum or sufficiently accurate. For example, documents are based on typical equipment layouts and may not correspond to final selected equipment.
- The objective of feasibility stage is to present a sufficiently accurate cost estimate (and related backup documents) for funding approval.
- Therefore, it is important that the EPCM team carry out a full detailed engineering design and specification before proceeding to construction.

2. Lack of continuity of design team during construction stage

- It is common that the detailed engineering design is carried out by a consulting company and then site construction work is managed by the mine team.
- The handover from the design team to construction team can result in serious errors. For example misinterpretation of drawings may go unnoticed until it is too late.
- Therefore, it is good practice to retain the input of the design team throughout the construction stage, such as:
  - Regular site visits and meetings with construction team
  - Design team to establish key hold points (SOP, final equipment selections)
  - Sign-off of any site changes
  - Produce As-Built drawings

3. Inadequate performance testing of new main fan and new refrigeration plant

- Poor equipment performance may result in inadequate ventilation and cooling to sustain the production target.
- Performance testing should be carried out on all new main fans, booster fans and refrigeration plant to ensure that equipment operates according to the OEM specification.
- Performance testing should ideally be carried out on site during commissioning by the OEM or third party.
- It is good practice for the supply contract to include security bonds guaranteeing the performance of the equipment. It is also important to agree on a test method.

4. Lack of regular Life-of-Mine ventilation and cooling planning studies

- Mines are constantly changing and evolving which can have a profound impact on the original ventilation and cooling design
- It is important to track any changes to the original design criteria.
- It is good practice to carry out an updated Life-of-Mine ventilation and cooling planning study whenever there are significant changes (but minimum of every 5 years).
- It's important to identify new infrastructure as early as possible considering the required lead time, see below:

Ventilation raises	1-2 years
Main fan station	2-3 years
New refrigeration plant	3-5 years

Conclusions

- Mine ventilation and cooling systems must be designed to be flexible in order to cope with changes in mine planning.
- Temporary fans and refrigeration plant can be used during the mine development phase.
- Modular fan stations and refrigeration plant allow phase-in of requirements when needed.
- It is good practice to retain the input of the design team throughout the construction stage.
- Performance tests should be carried out on new fans and refrigeration plant.
- Regular updates to Life-of-Mine ventilation and cooling requirements will ensure that the planning is aligned to implementation.

Questions?

BBE CONSULTING