OPTIMISED COAL HANDLING

Peter Mühlbach, ABB Automation GmbH, Germany, discusses a complete materials handling solution for coal-fired power plants.

Even as many industrialised countries are discussing long-term exit strategies for coal-fired power generation in order to meet the challenges posed by greenhouse gas (GHG) emissions, coal will remain one of the most important sources of energy for the foreseeable future. In particular, the economic development of emerging economies, such as China and India, will be based on the use of coal for power generation. The development of new technologies for the handling of coal can thus contribute to making the use of coal more efficient and sustainable.

This article concentrates on automation trends in large-scale coal handling systems based on current and future ABB projects.

From the mine to the plant

Coal handling systems are an integral part of a complete material flow and quality management system (Figure 1). In recent years, the main focus was on the optimisation of single parts of this system, such as mine planning or advanced automation solutions. Now, however, complete system optimisation, including the integration of all subsystems, is required to deal with the increased efficiency of modern coal-fired power plants and secure the coal supply in sufficient quantity and quality.

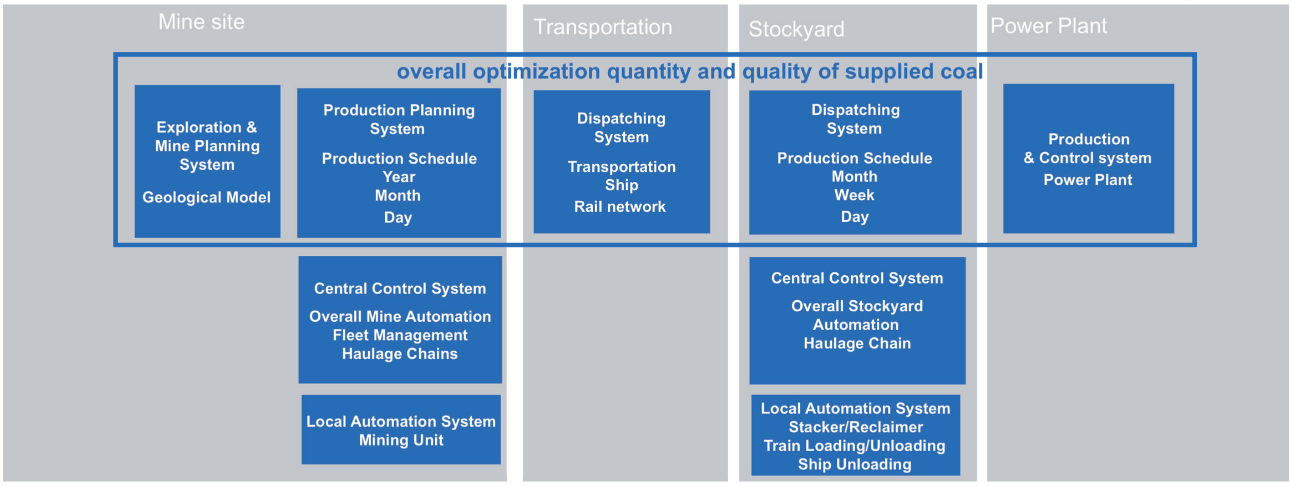

Figure 1. Integrated coal management system.

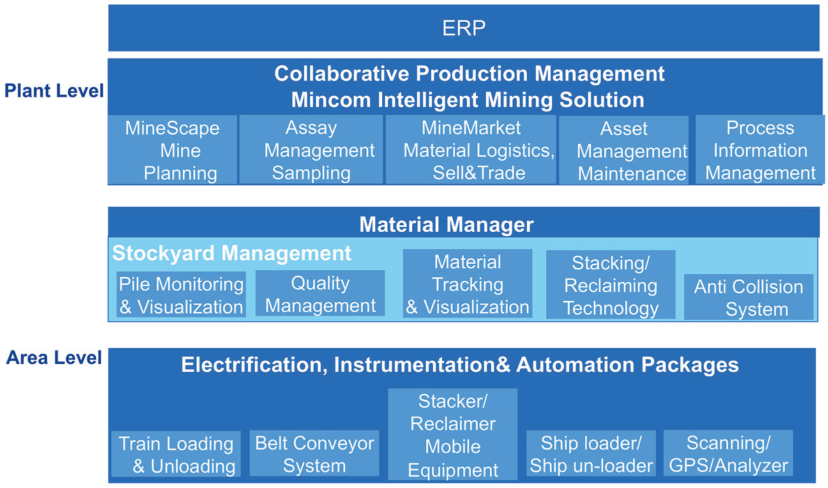

Figure 2. Modular system for bulk material handling.

In order to meet these requirements, ABB has developed a modular system (Figure 2).

With its acquisition of Mincom, ABB will integrate Mincom's Intelligent Mining Solution (IMS) into an overall mining and material handling system. The production management level includes the tools for managing the mine, the haulage and trade process to fulfill contracts (quantity and quality), and production, maintenance and assets. This level also provides necessary interfaces for ERP systems, such as SAP and others.

The stockyard management system (SMS), which will be described in more detail later in this article, enables a fully automated operation of the whole stockyard from a central control room and consists of the following modules:

- Pile monitoring and visualisation.
- Material tracking.
- Quality management.
- Autonomous stacking / reclaiming.

The local automation level covers all basic control functions, mostly implemented on the stockyard equipment itself. It includes instrumentation, electrification and automation on a local PLC for operator controlled stockyard machines. This system can also be customised to the needs of determined projects such as:

- Stockyard systems for lignite power plants (connected with the mine by rail or an overland conveyor system).
- Export or import coal terminals with ship and train loading and unloading.
- In-plant coal handling systems.

Stockyard management description

In order to achieve a fully automated operation from a central control room the operator must know how much coal, and of what quality, is at what place, and when – whether it is in a surge bin, on a belt or on the stockpile.

These requirements can be met by an exact database of material quality information in the transportation and stockpile model, which monitors the material flow online. The necessary input for the model is delivered by laser scanners and positioning systems mounted on the stockyard machines, which also allows the autonomous operation of the machines. The scanners provide surface information from their environments, which will be used to recalculate the model.
This solution enables a near real-time update of the pile surface, even after material movements due to environmental influences, such as storms or heavy rain, or due to the use of mobile machines, such as graders or dozers.

Pile monitoring and visualisation

The stockpile monitoring and visualisation module records material movements to and from a stockpile and calculates the material distribution on a stockpile accordingly. The module supplies information about the material on the stockpile and its shape, as well as the different properties (quality) of the material. Material distribution on the stockpile is calculated by a computational module based on information from the material tracking and stacking/reclaiming modules and the 3-D laser scanning results. The stockpile visualisation component offers a graphical presentation of the information stored in the stockyard management system. The visualisation shows an overview of all stockpiles onsite, displayed in 2-D or in 3-D.

For a detailed analysis of the stockyard, it is possible to zoom and turn the view. The view can be adjusted from different viewpoints, and separate piles can be selected. Stockpiles can be split into small individual virtual piles. These sections are shown with their borders (Figure 4). Additionally, pile areas with its properties, slice or cut views can be shown.

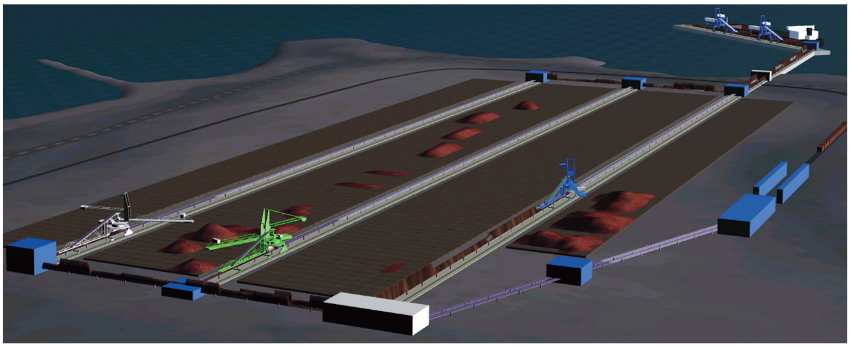

Figure 3. Stockyard overall view in 3-D.

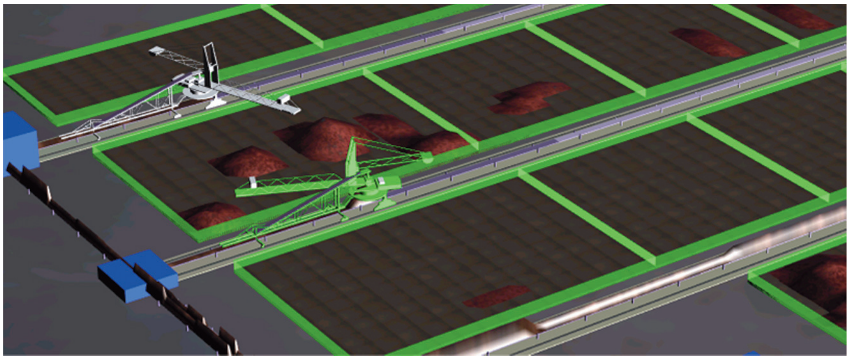

Figure 4. Indication of virtual piles.

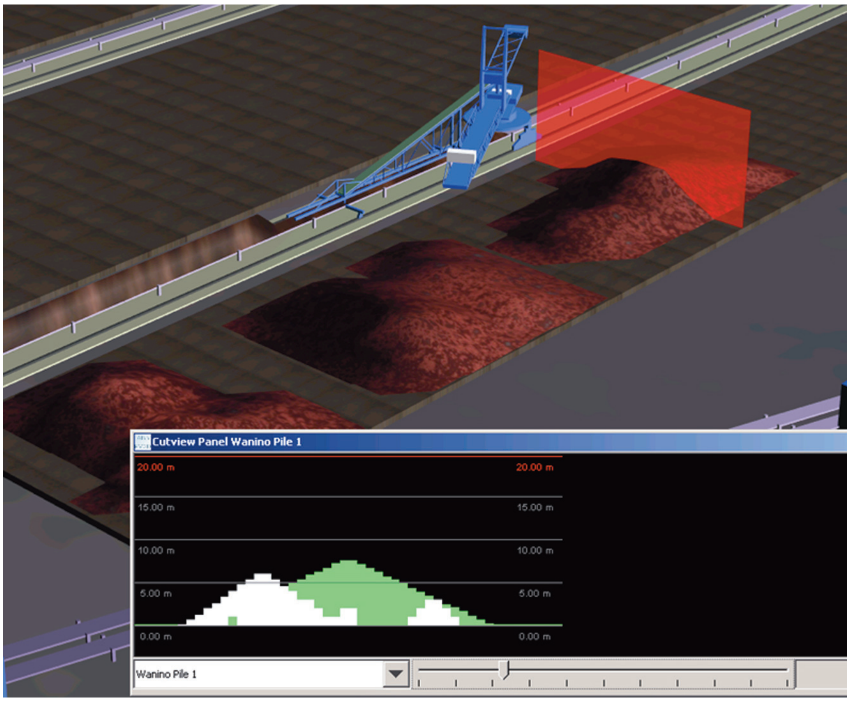

Figure 5. Selection of a cut view.

Material tracking

The material tracking module supports the operator in monitoring the material flow of bulk material, and supplies real-time stockpile tracking by tonnage and quality. The main functions are:

- Gathering information of material type, quality and its specifications at the inlet of the stockyard.
- Monitoring of masses/volumes on the way to the stockpiles via belt conveyors.
- Tracking of materials to the discharge point.
- Dynamic display of belt load with colour coded information about material properties.
- Balances of input, stored and output material mass/volume.
- Data exchange to overriding MES systems.

The module also manages distribution on the stockyard to enable an efficient usage of the complete area with determined coal quality in every stockpile.

Coal quality

An integrated coal quality management system is in particularly important when power plants are supplied by different minesites with variable coal parameters such as:

- Calorific value.
- Density.
- Ash content.
- Moisture content.
- Content of sulfur, silicon, aluminum and potassium.

Modern generating units need a certain coal quality with little variation in order to ensure an efficient burning process. Significant deviations can cause slagging, which in turn can cause unscheduled downtime for the

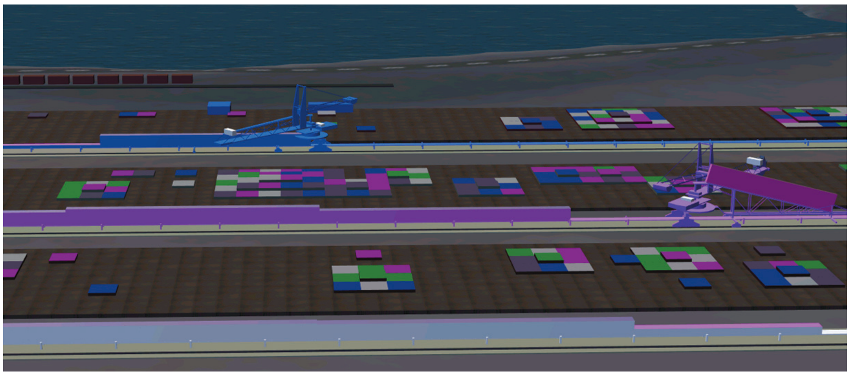

Figure 6. Material tracking system visualisation in boxed mode.

Figure 7. Stockyard at the Schleenhain lignite mine.

whole unit with consequent loss of production.

The coal quality parameters can be detected in the following ways:

- Offline by drill samples and laboratory analysis
- Online with radiometric methods.

For the quantity measurement, belt scales or belt volume scanners can be used.

Quality information (e.g. RFID, Bar Code, electronic transmission per file or freight papers) has to be handed over by the supplier or/and can be measured online right away the loading point and often verified after the discharge point.

The quality can be assured by blending the coal within the mine (combination of mining units, shifting heads and coal lines), on the stockyard during the stacking or reclaiming process, or in the in-plant storage and feeding system.

Autonomous stacking and reclaiming

The coal can be stacked and reclaimed by various methods in order to provide an adequate treatment of the material and perform the mixing and blending process.

Predefined stacking and reclaiming methods include the following:

- Windrow stacking.
- Chevron stacking.
- Cone shell stacking.
- Strata stacking.
- Block stacking.
- Long travel reclaiming.
- Block (bench) reclaiming.
- Pilgrim step reclaiming.

These ensure the requested quality of the mixing and blending process. These methods are contained in a control library and can be selected by choice or automatically.

Yard machines are running without any local operator and are only supervised by one operator in the central control room. This operation mode has the following advantages:

- Constant and optimised belt load, and consequently optimised material throughput.
- Less equipment wear due to fewer stress factors (no system overload).
- Less faults and damages triggered by operator failures.
- Cost savings due to fewer operators.
- Energy savings by smooth and continuous operation.

A collision avoidance system is necessary in order to prevent any injuries or equipment damage, whether the machines are handled by operators or not. Pile height sensors on both sides of the boom help to avoid collisions between boom and pile in addition to the collision control by laser and GPS.

During fully automated operation, access to the pile area is restricted to trained people in safe areas only.

Stockyard systems Schleenhain, Germany

The development of the above described system is based on the experiences ABB gained during the project execution of the automatic operation for the stockyard system of the Schleenhain lignite mine in Germany, which feeds the Lippendorf power plant (2 x 993 MWe).

The stockyard system comprises of a stacker (4200 tph) with tripper car, two portal scrapers (2 x 2400 tph) and a conveyor system, including the conveyors from the mine to the power plant. The piles have a capacity of 400,000 t.

The stockyard system, as well as the belt conveyor systems, are operated automatically by an ABB Advant OCS system from a central control room and have been in operation since 1999. Recently, ABB executed a complete upgrade to an ABB System 800xA. The experience has shown that an integrated fully automated stockyard system can contribute to a safe and efficient coal supply of modern power plants.