



Customer Success Story

Building green mines to deliver economic and social benefits
Chinese companies employ Thermo Scientific™ smart, digital technology for low cost, high efficiency limestone mining

China is entering its 14th Five-Year Plan period where traditional mining businesses will be tasked with ongoing high-quality development featuring digitization, intelligent manufacturing and 'greening'. In 2021, the Ministry of Industry and Information Technology issued Guidelines for the Construction of Intelligent Manufacturing Standard Systems in the Building Materials Industry (Version 2021) which covers non-metallic mines including limestone. The guidelines present standard construction requirements for intelligent equipment and enabling technologies; the aim is to accelerate the development of intelligent mines and factories and realize the digitized transformation and upgrade of key links and processes. The guidelines will help to ensure the robust and systematic development of intelligent manufacturing and promote the digital transformation of China's mining industry.

In July 2021, Thermo Fisher Scientific and Changsa Digital Mine Technology (Changsa Digital Mine) jointly participated in a digital mine construction project for Zhejiang Chengyu Environmental Protection New Materials Co., Ltd. See the Chengyu control room in figure 1. They worked with the Fuyang Banbishan Desulfurized Limestone Mine to create a model of an intelligent green mine as a benchmarking project for Zhejiang Province and to illustrate the potential for evolving industrial requirements.



Fig. 1: Chengyu Digital Mine system central control room

Evolving from traditional mining in Zhejiang Province

At Fuyang Banbishan Mine the ore body has been progressively damaged by mining. Geological conditions such as fault damage, local uplift of the ore floor, corrosion and collapse, also pose a threat to the reserves and to the quality of ore resources. Before starting the digital, intelligent mine construction, the mine adopted typical, traditional mine management resulting in problems with ore blending and, ultimately, inaccurate control of the downstream limestone grade. To tackle these issues, Chengyu gradually developed the idea of seeking improved efficiency from enhanced, digitized technology.

Investing resources to achieve rational ore blending through intelligent processing and operation not only addresses the highlighted pain points but also the requirements of Zhejiang Province to build intelligent green mines. From 2018 to the end of 2020, Zhejiang Province built a total of 346 green mines in accordance with national industry standards, with the completion rate for green mines reaching 100%. The construction of intelligent green mines has been included in Zhejiang Province's 14th Five-Year Plan for mineral resources.

In 2021, Zhejiang Province started pilot work on the construction of intelligent green mines, using digital technology to promote the upgrade of mining enterprises. The work is an important step toward the sustainability philosophy enshrined in the "lucid waters and lush mountains are invaluable assets" agenda. At the end of 2021, the Requirements for Zhejiang Province Intelligent Green Mine Construction (Trial) were issued. They stipulate that by the end of the 14th Five-Year Plan period, all small-sized mines shall have completed digital infrastructure construction, and large and medium-sized mines shall have fully carried out intelligent construction.

Building a technical management and business processing platform is a highly effective strategy for addressing the multiple issues that established mines face. Such systems integrate the processes of production quality control and production organization, enabling the visualization of mine resources, the optimization of mining plans, refined control, intelligent dispatching, and information-based data sharing.

Changsha Digital Mine, an excellent supplier of the software and hardware solutions required for digital mines, was chosen to implement the digital and intelligent transformation required for the project. Analyzer technology from Thermo Fisher was selected to provide the crucial data required for production quality control. The Thermo Scientific™ CB Omni Agile™ Cross-belt On-line Elemental Analyzer allowed for complete material inspection of the downstream limestone and facilitated the smooth completion of the project. In less than 5 months, a digital mine system with a "3+2" architecture was successfully

built for Fuyang Banbishan Mine, transforming it from traditional production to smart, automated operation. This marked a solid step forward in intelligent mine construction.

Implementing a "3+2" digital mine system architecture

The new digital control and production architecture for the mine combines three platforms (a digital mining software platform, a production execution system platform, and a 3D visualization management and control platform) in two separate but integrated systems (an intelligent dispatching system and a quality control system).

Intelligent dispatching system

The dispatching of transportation equipment is optimized based on the operational plan from the digital mining platform and ore blending instructions from the production execution system platform. (See figure 2.) Voice broadcasts provide ongoing reminders to drivers, reducing safety risks and at the same time improving production efficiency. Well-balanced truck-excavator matching eliminates time delays – "excavators do not wait for trucks, and trucks do not wait for excavators".

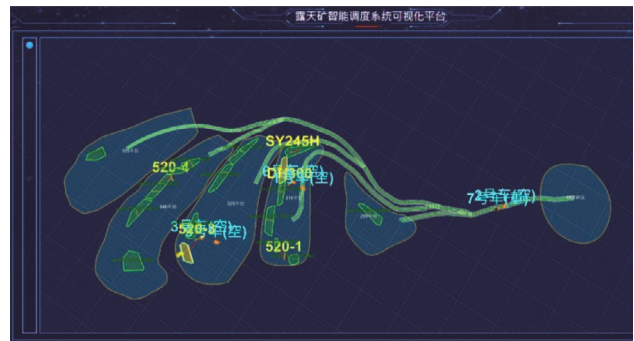


Fig. 2: Intelligent dispatching system showing material flows around the mine

Quality control system

The on-line quality monitoring of downstream limestone is performed by the cross-belt analyzer which displays the real-time grade of each stockpile across every shift. Alarms sound to identify abnormal conditions. Grade information is uploaded to the digital mining platform which continuously revises ore blending instructions, sending them to the intelligent dispatching system to realize unmanned, automated and efficient handling. (See figure 3.)

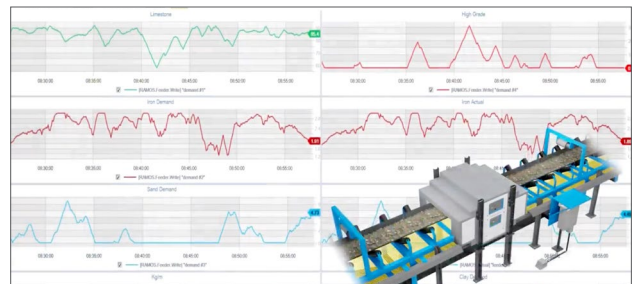


Fig. 3: Data from the cross-belt on-line elemental analyzer drives continuous, optimized ore blending

Together the two systems form an automated solution for real-time analysis and control. The on-line analyzer provides real-time, accurate measurements of key elements in the ore. The dispatching system uses that data to guide the prompt, dynamic adjustment of the production process, responsively changing excavating time, excavating load, and excavating loading position to optimize ore blending. The result is less fluctuation in material composition, improved product consistency, and stability. The quality control needs of different customers for different limestone products can now be met.

See figure 4 for an image of the cross-belt online elemental analyzer. Key features of the analyzer underpin the gains seen in Zhejiang Province. Using the non-contact non-destructive analysis technique of prompt gamma neutron activation analysis (PGNAA) and located directly on the conveyor belt, the analyzer:

- Eliminates sampling errors
- Determines the elemental composition of bulk raw materials in real-time
- Provides continuous on-line analysis and monitoring of raw material composition, including grade and gangue composition. This high frequency analysis is very important for mineral mining and processing, enabling responsive, real-time feed-back and feed-forward process control to maximize resource utilization and increase ore recovery efficiency.
- Can penetrate the entire cross section of material flow to provide minute-by-minute uniform measurement of the whole bulk material flow. In contrast, surface analysis techniques such as X-ray fluorescence (XRF), X-ray diffraction (XRD), and other spectroscopic techniques are limited with respect to measurement depth and surface area, and may not provide a reliable representation of all the material on the belt.

Core advantages of the “3+2” digital mining system

The digital mining solution installed at the Fuyang Banbishan Mine has transformed the operation, delivering many important gains. Key benefits include the:

1. Ability to support the deployment of a 5G network base station in a mine, in line with the China Mobile Industrial Internet 5G+ mine application scenario, to demonstrate the benefits of 5G+ industrial application
2. Automation of the mine to a level that is conducive to excellent product quality control, sound environmental protection management and control, and which meets the requirements of intelligent green mine construction in Zhejiang Province
3. A significant reduction in the incidence of excessive SiO₂ in delivered limestone. The fines and returned deliveries associated with excessive SiO₂ have been eliminated
4. The addressing and solution of important pain points such as difficulties with ore blending and the control of downstream limestone grade. The new solution delivers improved production efficiency, increased and comprehensive resource utilization, and reduced operating costs, while at the same time mitigating safety and environmental risks. It provides a solid foundation for a smaller staff and, ultimately, unmanned intelligent mines

The world today is undergoing more profound changes than have been seen for perhaps a century. China has entered a new stage of social and economic development characterized by the phrase “lucid waters and lush mountains are invaluable assets” which underlines a commitment to more sustainable practice. For mining companies, digital transformation is no longer a choice, but a must-do activity related to their survival and long-term development. It is a powerful tool for delivering both economic and social benefits.

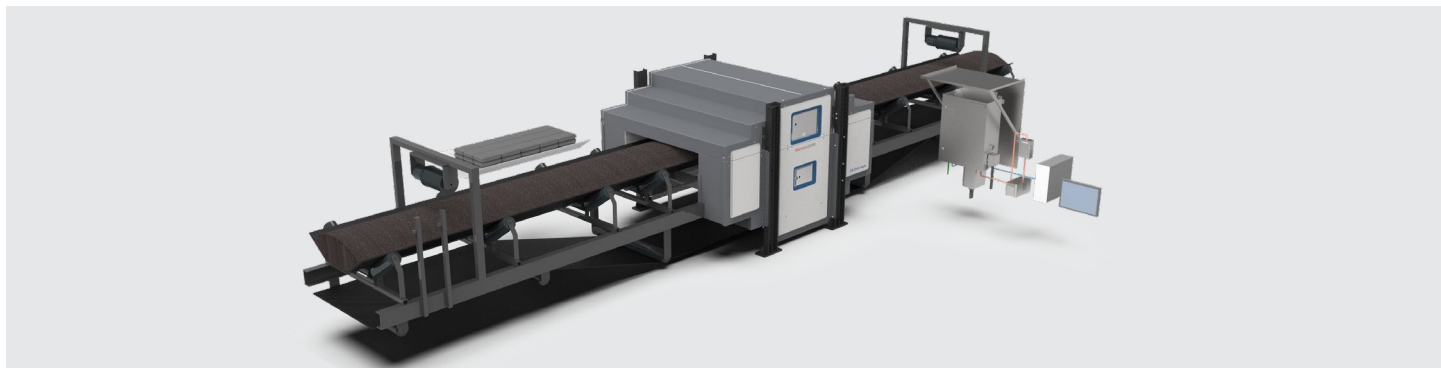


Fig. 4: The Thermo Scientific™ CB Omni Agile™ Cross-belt On-line Elemental Analyzer

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