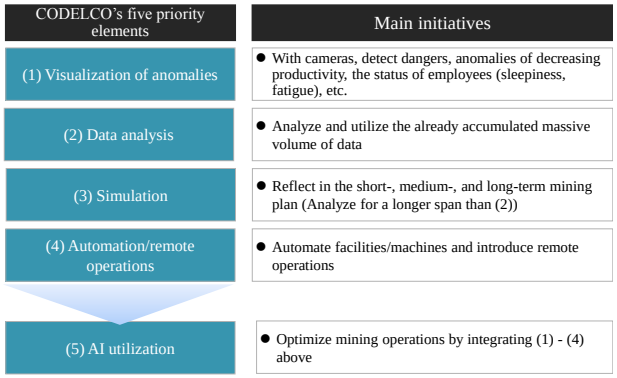
Promotion of IoT for Development of Mines

Minori Kataoka, Researcher, Industry Research Group, 3rd Research Department

In recent years, the trend of improving operational efficiency by utilizing IT/IoT, such as the introduction by major overseas natural resources companies of a mining machine control system with self-driving dump trucks and big data analysis, has been observed. As the background to the introduction of IT/IoT, in addition to the trend of increasing development costs due to lowering mining grades and deeper/more remote mines, solutions have been produced for technological and social issues, such as securing profit by realizing stable operations in mines with severe conditions, including low-grade mines and complex mines, and accepting diversified work styles by improving safety and reducing operational burdens.

Hitachi Research Institute has examined the direction for the optimal introduction of IoT for Japanese mining companies through overseas studies in Australia and Chile as well as review meetings consisting of university researchers, mining companies and others after having been commissioned two research projects: "FY2016 Basic research on measures to improve productivity and safety by promoting IoT in developing mines" (Ministry of Economy, Trade and Industry) and "FY2017 Survey of system development for productivity improvement and energy consumption efficiency in mining operations" (NEDO). [1]

For research and review in particular, we have ascertained the status of IoT introduction at Corporacion Nacional del Cobre de Chile (hereinafter referred to as "CODELCO"), a Chilean national mining corporation that Japanese companies are highly interested in as an advanced example, and compiled the direction for the development of an IoT platform suited to the operational situation of Japanese mining companies.



Material: Prepared based on CODELCO materials and hearings

Figure 1 CODELCO Digital Transformation Five elements

1. Digitalization of mining in Chile

CODELCO is a Chilean national mining corporation and the largest producer of copper in the world. It has strong ties to the Japanese economy, exporting much of the copper it produces to Japan.

Around 2005, CODELCO started a project to promote the digitalization of mining operations called the "Digital Transformation" (Figure 1).

CODELCO implemented "Digital Transformation" at six mines (Table 1). Here, IoT was introduced for a different operational issue at each mine, and later horizontally applied to other mines with similar issues. For example, the "Remote Operational Center" established at the Ministro Hales mine introduced a system for operators to remotely control equipment while checking cameras and instruments from the Center located more than 1,000km away from the mine. According to CODELCO, productivity has improved by about 10% as a result, because the handover of operations and trouble-shooting have become smooth with operators of each department working together in one place and being able to engage in face-to-face communication with each other. Going forward, they plan to introduce it at other mines such as Andina.

CODELCO, which promotes investment in digitalization, raises two points as issues for the introduction of AI, sophistication of company-wide data use/utilization and

Table 1 Digital Transformation in Progress at Each CODELCO Mine

	Mine	Initiative
(1)	Radomiro Tomic	• Introduction of sensors for facility indication maintenance • Bioleaching development
(2)	Gabriela Mistral	• Dump truck automation
(3)	Chuqicamata	• Ore floatation process automation using cameras
(4)	Ministro Hales	• Reduction of the risk of collapse by monitoring geology and water quality • Introduction of a remote operation center • Development of a simulation for torrefaction process
(5)	Andina	• Planning for the introduction of a remote operation center • Development of the automation of dump shovels
(6)	El Teniente	• LHD automation • Planning for the introduction of a remote operation center • Analysis of operational data on mineral ore processing

Material: Prepared based on CODELCO materials and hearings
LHD: Load Haul Dump

[1] Regarding the concept of the general operational process of mines and mine IoT platforms, please also refer to the latest reference watch, "Understanding Mine to Mill by Cooperative Research Centers" (pp.32-33), in "Hitachi Souken" Journal Vol. 12-3 (issued in November 2017).

further improvement of productivity through the expansion of applicable operational scopes: (1) the credibility of data used for big data analysis; [2] and (2) data is too large in volume to be sorted out and effectively used.

2. IoT required for Japanese mining companies

With the largest operations in the world, CODELCO can improve management efficiency by horizontally applying the technologies/know-how being demonstrated at each mine to specific targeted operations. However, Japanese mining companies do not hold majority interests in multiple mines, and therefore, there is limited room for improving productivity through the horizontal application of know-how across multiple mines. Accordingly, when considering the introduction of IT/IoT by Japanese mining companies, it is realistic to pursue efficiency in a series of processes within one mine.

What is of importance here is the construction of a system to share information between individual operational processes. However, in mining operations, individual departments manage information and seldom share information with other departments, with the geology department conducting exploration, the mining department conducting mining, the mineral ore processing department conducting mineral ore processing, the maintenance department conducting maintenance and the production planning department conducting planning, and even if an attempt were to be made to share information, information could not be easily communicated due to differences in the respective data output formats.

When constructing a system for information sharing, it is important to introduce it to the narrowed-down cost effective operations for investment. As a result of discussions during the review meeting, it turned out that there were many requests from mine development companies regarding the two points of (1) improvement of the mineral ore processing recovery percentage through the utilization of ore properties and mining information and (2) cost reduction through an improved operational rate, which were set as the themes for technological development.

Thereafter, we examined the specific content of the "Mine IoT Platform," which will be the foundations of information acquisition, sharing and analysis.

3. Examination of requirements for the Mine IoT Platform

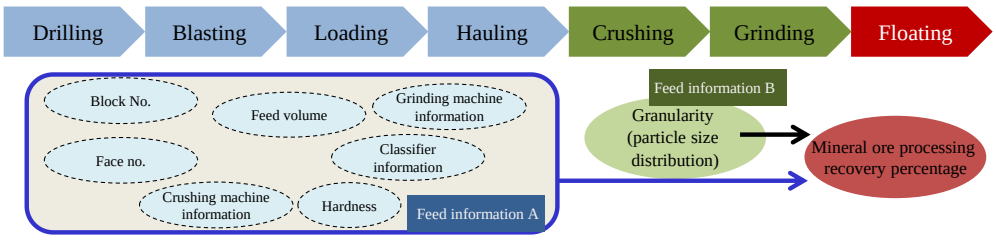
Regarding the Mine IoT Platform, we have examined functions to meet the above two proposals for technological development with minimum specifications and costs. Specifically, to sort out the requirements for the functions of the Platform, we have sorted out what should be solved and which data should be used therefor.

(1) Improvement of the mineral ore processing recovery percentage through the utilization of ore properties and mining information

With the continued lowering of mineral ore grades, for the stabilization and improvement of the recovery percentage, it is important to utilize available data in upstream operations such as drilling and blasting (Figure 2). By analyzing the effect on KPIs, such as the mineral ore processing recovery percentage in the Mine IoT Platform based on these data, it is likely to become possible to improve productivity by reflecting them in the equipment control and fine-tuning of chemical inputs, etc. in mineral ore processing.

(2) Cost reduction through an improved operational rate

If operation is suspended for one process, slippage will also be incurred in the preceding/following processes, affecting overall operations substantially and lowering the operational rate. While efficient recovery work is required for mine operations, in many cases, the efficiency of recovery work depends on the instructions of operators, which, in reality, depend on individual experience and intuition. In contrast, by using the Mine IoT Platform to accumulate anomaly occurrence data in each process and records of recovery work as well as analyze the correlation with time required for recovery, etc., it will enable the extraction and categorization of effective methods for giving work instructions and result in the standardization of work procedures and support for effective instructions.



Material: Prepared by Hitachi Research Institute

Figure 2 Image of the correlation between the mining process and mineral ore processing recovery percentage

[2] Manually sampled data are affected by the judgment of operators, and therefore, their acquisition conditions are not uniform. Accordingly, CODELCO is considering the automation of sensing, etc.

4. Future prospect

From the series of studies and research projects, we have identified issues for processing and utilizing the massive volume of data accumulated in each process from the upstream to the downstream of mines, as well as the needs for the introduction of IoT by mining companies in Japan and abroad.

Hitachi Research Institute will substantiate the direction for Mine IoT Platform development in response to these needs.