The Future of Mining is Smart

Aarti Sörensen and Elisabeth Clausen of RWTH Aachen unravel the meaning of the term 'smart mining' and explain its potential impact on the industry's future

Digital technologies have the potential to deliver significant improvements in mining by boosting the quality and availability of information which, in turn, can lead to productivity gains. In addition, meaningful digital technologies can help reduce the environmental impact. It is therefore assumed that they will be key to the sustainability of the mining industry or, at least, to enable significant improvements.

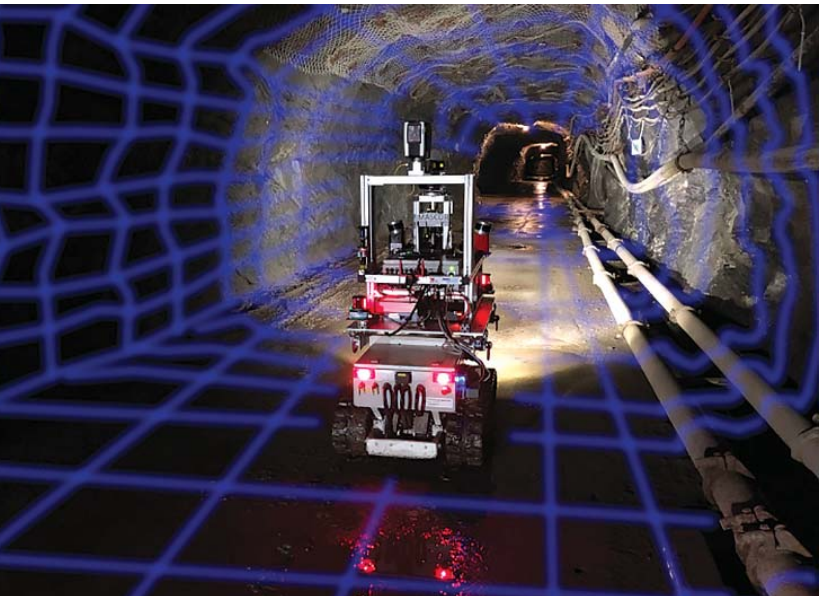
It is widely accepted that the future of mining is "smart." However, as is often the case with popular slogans, the exact meaning is becoming increasingly fuzzy. This article provides an overview of smart mining as a term, concept and global trend.

Defining Smart Mining

Although the term "smart mining" is now widely used, there is not yet an established definition.

Some sources say that "smart" refers to the use of digital technologies to make mining more specific, measurable, accepted, realistic and timed, while others, like Hexagon Mining, point out that the term "smart" began as an abbreviation for self-monitoring analysis and reporting technologies.

As a starting point, it can be stated that "smart" has to do with the digitally enabled processing of data, which is derived from the evaluation of data and information from connected machines, devices and plant components. This data and information flow back into the organization to make better decisions in real time. The successful implementation of an ecosystem of IoT-enabled devices, which enables plant managers and operators to make better and anticipatory decisions, makes a mine "intelligent."



Smart mining in action: Real-time environmental recognition, underground localization and positioning leading to true autonomous navigation are key research areas for the AMT.

At RWTH Aachen University's Institute for Advanced Mining Technologies (AMT), we define Smart Mining as the intelligent connection and integration of mining machines (physical components) using information and communication technologies (cyber-systems) to form so-called cyber-physical systems, where the exchange and transmission of data and information takes place via a platform, the Industrial IoT (Internet of Things).

The intelligent mine of the future thus represents the long-term vision of a digitally connected, autonomous mine in which the connected systems are able to reduce the ever-increasing complexity to such an extent that improved decision-making can be realized in real time. Future mines will therefore not only be digitally integrated, but also flexible and selective as well as dynamically adaptable, robust and reliable.

Components of a 'Smart' Operation

In terms of infrastructure, the main components of an intelligent mine include:

- Automated equipment. For instance, excavators and dump trucks, shearers and conveyors, drilling equipment, crushers, bunkers, skips, etc.;
- Hardware, such as sensors, RFID tags, wireless infrastructure, drones, embedded systems; and
- Software, such as cloud and platform solutions, data analysis solutions, 3D imaging and modeling software, and remote management solutions.

In addition, new technologies such as modular mobile machines and battery-powered electric vehicles (BEVs), the integration of renewable energy sources or even on-site 3D printing can help to make the operation of a mine smarter.

Aside from the often-discussed reluctance to implement new (risky) digital technologies, the two biggest challenges when it comes to the implementation of these components seem to be what and how?

Deciding which technologies should be used in a particular operation, requires a solid analysis of the existing problems as well as tailor-made solutions based on the results of the evaluation. In addition, a robust and functioning IT infrastructure is an important basis for ensuring secure communication between different systems and types of equipment.

In this context, ensuring the interoperability of systems in particular is the key to integrating machines and processes throughout the mine and the entire value chain. At present, however, this is still difficult to implement due to a lack of standardization. One contribution to solving this problem is, for example, the Open Platform Communications Unified Architecture (OPC UA).

In order to bring about a fundamental change in this context, the IT components must be adapted to each mine site and implemented there. However, this is exactly where many companies have problems. Although they have taken individual measures, be it condition monitoring or the location of people using sensors, they do not implement them at every mine site.

How to introduce technologies refers to the entire process of implementation and integration, often into an ongoing operation. This includes personnel management, the adaptation of management systems and changes in corporate culture, as well as a proactive approach to the changing work requirements and the changing qualification needs of the workforce and the new employees to be recruited. Great importance must therefore be placed on their training and to ensure long-term loyalty and retainment to the company.

The Role of Research and Innovation

Although much progress has been made over the last decade and a wide range of "smart" technologies are now widely available, there are still challenges that need to be addressed through research, innovation and cooperation.

One area that can help to further develop digitally supported autonomous systems will be the increasing use of artificial intelligence (AI), machine learning, robotics-based process automation, sophisticated system analysis and modelling. This will enable us to understand the data and thus develop a situation awareness, and to gain insights into the overall processes in near real-time (in time) and determine which possible courses of action need to be considered.

The complexity and harsh conditions, especially in underground mining, require technological developments, supported by additional research, especially with regard to the development of autonomous systems underground. While the location of personnel and equipment in some mines has been realized with the help of Wi-Fi networks, the underground autonomous localization, positioning and navigation of machines as well as machine-to-machine communication systems still requires research and innovation.

The AMT is one of the few research institutes worldwide that conducts applied research on alternative sensor technologies, such as ultra-wideband technology (UWB) and sensor fusion to further advance the development of automated and autonomous machines for use in the demanding conditions of raw material extraction.

Another important aspect is the further development of an interoperability standard for safe and reliable data exchange between machines through OPC standards for mining machines. The OPC UA is a manufacturer and platform-independent, service-oriented communication standard that will play an important role in promoting autonomous developments in mining.

VDMA Mining is taking a leading role in the development of OPC UA CS Mining, the adapted OPC UA standard for the mining industry. VDMA Mining cooperates with a number of companies that are actively involved in the development of the OPC UA CS Mining. The AMT supports VDMA Mining in this process, and representatives of the existing International Rock Excavation Data Exchange Standard (IREDES) also participate in the process.

In addition, VDMA Mining is in contact with the Global Mining Guidelines Group (GMG) to ensure the standards are globally compatible and are disseminated at international level.

Another area in which forward-looking research into new methods and technologies can contribute is the further development of selective and low-impact mining methods in order to increase resource efficiency and safety while reducing the amount of overburden or waste material produced during production.

Much progress has been made in primary processing with the aim of consuming less energy, water and chemicals while at the same time increasing the proportion of valuable rock extracted. In terms of selective extraction, advances in real-time material detection (e.g., during the conveying process and/or prior to processing) can further contribute to reducing the amount of waste material to be processed, thereby further optimizing resource efficiency and energy consumption. In this area, AMT is pioneering the use of infrared thermography as an imaging method and acoustic emission technology for process-integrated material characterization.

Time to Get Smart

While research and innovation play an important role in making the mining industry fit for the future, if the benefits of smart mining are to be fully realized, they must be accompanied by a clear vision for reducing the environmental impact of operations while improving productivity and safety.

The AMT, in cooperation with VDMA Mining and DMT GmbH & Co KG, organizes the Smart Mining Conference every two years to promote cooperation within the industry and provide a platform where new technological advances can be presented and discussed with an international audience. The next event will take place in November, and will provide industry experts, startups and technology providers with an opportunity to present new solutions and promote cooperation at national and international levels.

Read more at www.amt.rwth-aachen.de/en/conferences.html.

An extended version of this article first appeared in Mining Report *magazine.*

AMT together with AMR wins the raw materials efficiency award 2020 for demonstrating an online material recognition application in an industrial environment using acoustic emission technology — digitalizing material information along the way.