# Research for the mine of the future

On this page you will find information about our research areas and projects in the context of the Human-Centered Climate Smart Mine. Our work focuses on developing novel approaches and technologies to make the mine of the future sustainable, efficient and human-centered. Find out more about our interdisciplinary approaches, the integration of climate-friendly technologies and the development of innovative solutions for the core areas of modern mining.
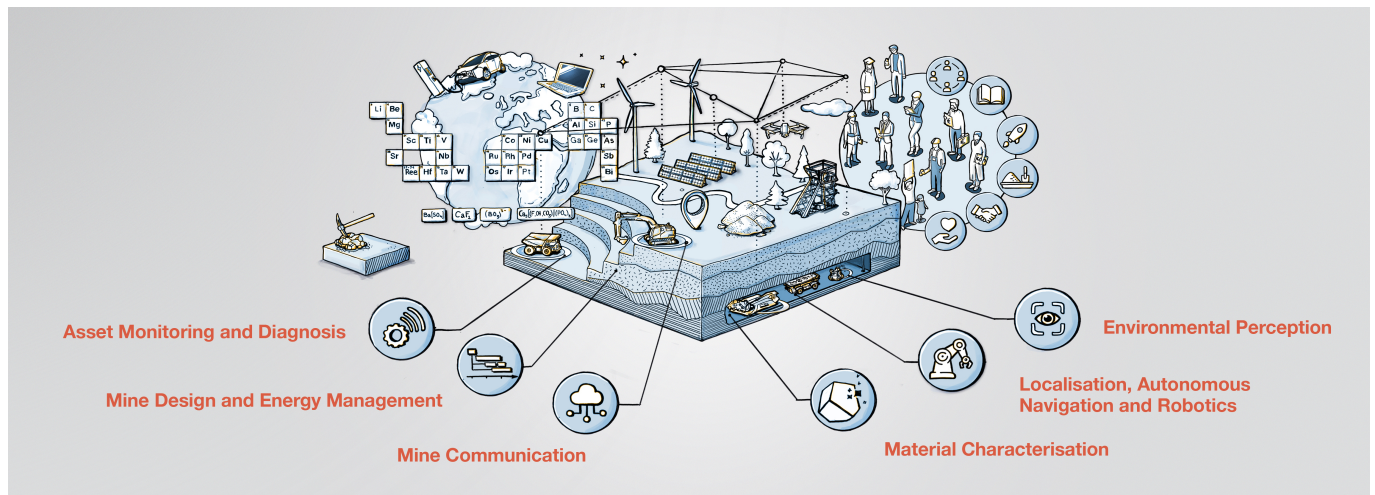
Asset Monitoring and Diagnosis

Efficient asset monitoring in mining reduces costs and boosts productivity. Our research develops real-time condition monitoring systems for machinery and vehicles, using data analysis to enable predictive maintenance. This helps detect wear and damage early, minimizing downtime and maximizing operational efficiency.

[Learn More!](#)

Mine Design and Energy Management

Mining operations are crucial for the energy transition and the achievement of climate targets as they provide raw materials for key technologies, such as battery technology and robotics. The aim of the research area 'Mine Design and Energy Management' is to develop a low-emission and autonomous mine with safe, energy- and resource-efficient processes. By using the latest technologies and integrating renewable energies, sustainable raw material extraction is targeted.

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Mine Communication

As mining advances toward automation and digitalization, robust communication is key. We develop solutions for asset monitoring, long-distance data transfer, and autonomous driving, using Ethernet, optical fibers, Bluetooth, Wi-Fi, LoRa, and 5G networks. These technologies enable real-time data transmission, remote control, and integration of autonomous vehicles, enhancing safety and efficiency in mining operations.

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Material Characterisation

The research area material characterisation is about the development and application of sensor-based methods for the identification of relevant material properties in the context of mining processes in order to contribute to improving safety, process automation or increasing efficiency. Thus, material characterisation forms the bridge between excavation and mineral processing.

The main goal of the research area is the identification of process-relevant material properties using sensor-based methods in the context of mining processes. The information is generated in the process and made available in real time.

Topics addressed in this research area include, for example the detection of loose rock, boundary layer detection, the characterisation of material flows or material characterisation in the context of the cutting process.

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Localisation, Autonomous Navigation and Robotics

In recent years we have witnessed increasing interest of the mining industry in automation and robotics solutions. The key drivers are often increasing pressure from the lack of skilled personnel, stricter regulations and of course the requirement for more efficient and productive mining processes. Within the research area "Localization, Navigation and Robotics", we are addressing these issues by advanced automation and robotics solutions for the mining industry, concerning for example special machinery or safety in mixed autonomous traffic scenarios.

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Environmental Perception

The research area is dedicated to the development, identification, selection, implementation and use of sensor technologies for environmental perception in raw materials extraction and related industries.

The technologies used are partly in-house developments of the AMT as well as sensors from the areas of laboratory measurement technology and factory automation, which are adapted to the challenging environmental conditions in mining, tested in feasibility studies and implemented for long-term use.

The data obtained from the environment serves as a basis for mapping, detecting people, analysing vibrations, measuring gases and beyond.

With our research, we enable machines to see, hear, feel and smell, which is essential for safe and efficient automation and digitalisation of mining machines and processes.

[Learn more!](#)