Past Projects

Here you will find a selection of recently completed research projects, structured according to the alphabet.

AKUSTAHL

The aim of the AKUSTAHL project is to develop a monitoring system using acoustic emission analysis (AE analysis) for the micro and initial crack prediction of steel structures subject to fatigue loading, such as bridges, cranes, offshore or industrial structures. Existing systems for acoustic emission analysis are thus to be expanded to include the measurement and detection of microcracks for the earliest possible detection of damage events.

Learn More!

AUTOMATED BOLT RELOAD

The aim of the project Automated Bolt Reload was to develop a robust automated system for reloading the magazine with anchors. This process is still carried out manually today. The monitoring of the reloading process as well as the anchor setting was done with a sensor system following three overarching goals: 1) Higher safety and improved working conditions, 2) Increased efficiency through the execution of parallel activities and the shortening of anchorage cycles and 3) Simple implementation of the automated process and integration into existing work processes.

Learn More!

AUTONOMOUS ROBUST TRANSPORT SYSTEM (ARTUS)

The aim of the ARTUS project (Autonomous robust transport system for hybrid, environmentally friendly raw material extraction based on articulated special vehicles) was to develop a system for operating a fleet of autonomously operating special vehicles for hybrid, i.e. surface and underground mining environments. This enables a more environmentally friendly and sustainable extraction of mineral raw materials, as the utilization of the individual machines can be improved, consumption and wear reduced and the productivity of the entire system optimized.

AMT's goal was to implement an open, manufacturer- and interface-neutral communication system for a comprehensive machine-to-machine communication as part of the ARTUS project.

Learn More!

BLUE HARVESTING

The aim of the Blue Harvesting project was to develop a hydraulic collector for manganese nodules from the deep sea. The collector is one of the core components for the industrial mining of manganese nodules, the use of which can contribute to securing the long-term supply of raw materials. In the Blue Harvesting project, a special focus was placed on the development of a collector with the lowest possible impact on the deep-sea environment.

Learn More!

BLUE NODULES

As part of the Blue Nodules project, the Institute for Advanced Mining Technologies (AMT) developed a concept for characterizing the material flow using acoustic emission technology in deep sea environments. Acoustic emission sensors have so far been used, for example, in the condition monitoring of pressure vessels and bridges. In the first preliminary tests at the AMT Institute, the physical phenomenon of acoustic emissions was used to characterize the material flow of bulk material. The AE signals recorded during transport and impact processes are evaluated with regard to characteristic parameters. Characteristic values are calculated and compared with already recorded characteristic values from previous reference measurements. The aim here is to determine differences and thus characteristic parameters for different materials. This concept has now been adapted for use in the deep sea to characterize the material flow of manganese nodules and overburden. The results will be used to determine the process efficiency and, if necessary, to control the process.

Learn More!

COLLISION AVOIDANCE SYSTEM (FEATureFACE)

As part of the EU-funded FEATureFACE project, scientists at the IMR (AMT's predecessor institute) combined the strengths of several technologies to develop a multi-technology collision avoidance system: the world's first fail-safe safety system.

Learn More!

CONCEIVE-DESIGN-IMPLEMENT-OPERATE II

The aim of the CDIO II project was to raise awareness of the principles of good, contemporary teaching in modern raw materials education. CIDO, an international framework program with 12 standards, stands for Conceive Design-Implement-Operate and thus for what engineers should be able to do after their training, namely to solve and overcome problems and challenges in a real, complex, industrial and international environment.

The project was the first to apply the principles to European raw materials education. Faculty

Development courses took place at the participating universities, joint project courses with industry participation were offered, a worldwide overview of the use of laboratories in the training of mining engineers was developed, and guidelines for innovative laboratories as learning environments were developed.

Learn More!

CONDITION DIAGNOSIS OF WIND TURBINES (SimuWIND)

The aim of the project was to develop an integrated simulation and multisensor monitoring system for the dynamic design and condition diagnosis of wind turbines and a comprehensive consideration of the complex interactions between the subcomponents of dynamically highly loaded wind turbines.

Learn More!

CONDITION MONITORING OF ROLLING BEARINGS (MAEX)

The aim of the research project was to improve the condition monitoring of rotating and oscillating rolling bearings using acoustic emission technology. By early recognition of a developing damage suitable maintenance measures should be carried out promptly or larger repairs should be planned according to demand. The direct and indirect maintenance costs saved as a result increase the economic efficiency of the plant.

Learn More!

CUTTING DRUM 4.0

As part of the project Cutting Drum 4.0, steps have been taken towards developing an intelligent cutting drum that is equipped with sensors suitable for mining, so that, for the first time, material recognition can be realized directly during the cutting process. By distinguishing between coal and secondary rock during the cutting process, more efficient extraction can become possible. As part of the development of such a cutting drum, the relationships between different material classes and the AE signals had to be identified and evaluated right at the cutting tool.

Learn More!

ELECTRO-MECHANICAL SIMULATION MODEL (GrobaDyn)

The aim of this project was to develop an electromechanical simulation model that simulates all components of a large belt system from the drive motor to the conveyor belt in one simulation model and thus makes the interactions between the individual components calculable.

Learn More!

ELMAR

The objective of the ELMAR (Integration and Demonstration of the Use of Electric Heavy-Duty Transport Machines in the Raw Materials production) project was to investigate the fundamental effects of the use of electric automated transport vehicles in the raw materials production on the entire operation.

Furthermore, technologies and solutions for the utilization of electric mobile machines have been developed and their integration into existing and planned operational environments have been developed and tested in real-world mining environments.

The overall objective of the contribution AMT made to the project was to investigate the electrification of raw materials extraction in order to generate a detailed understanding of the upcoming transformation of mine operations. For this purpose, a mine plan for optimized energy deployment, a holistic concept of energy design for raw material operations, and an IIoT gateway for decentralized machine communication were developed within this project.

To achieve these respective goals, model-based applications for mapping raw materials extractions have been developed and transferred into methods and procedures that enable optimized long-term and short-term planning and control of operational processes with respect to energy and resource use.

Learn More!

Enhancing Digital STEM

As a response to the COVID pandemic, universities around the world have rapidly adopted online and blended models of teaching and learning within STEM. This has seen considerable investment in supporting systems but has highlighted a lack of an accessible evidence base to inform educators' decisions within these systems. Currently, educators practicing within digital STEM environments face an unreasonably high barrier of entry to the evidence base as it is fragmented across dozens of potentially relevant sources containing 100,000+ potentially relevant papers.

This project created a Digital Short Course that will develop participants' ability to identify, implement and evaluate evidence-based practice within digital STEM environments.

Learn More!

HEET II

The HEET II project aims to develop the innovative high efficiency power system for machines and devices, increasing the level of work safety in underground mining, in potentially explosive conditions such as coal mines. The system will consist of four critical subsystems:

- transmission of electricity with single-wire technology,
- transmission of electricity with wireless technology,
- integration of the rail of the suspension monorail and
- monitoring and control system of the power supply network.

The AMT will implement a platform to monitor the parameters of the system and the environment and send them to the surface of the mine. These subsystems will be developed and implemented by a collaboration with an interdisciplinary consortium from Germany, Poland and Romania.

Read More!

INCREASING EFFICIENCY AND SAFETY IN MINING TRANSPORTATION

The project INESI (Increasing Efficiency and Safety Improvement in Underground Mining Transportation Routes) has three project objectives, in which sensor methods developed at AMT are used:

- to increase safety in underground mines by using a precise Ultra-Broadband Radio Localisation System (UWB)
- to increase efficiency by determining the position of monorails and the resulting optimisation of transport logistics using ultra wideband radio technology.
- to enable the detection of persons on belt conveyors in hazardous areas by means of infrared thermography (IR)

Learn More!

MAINTAINED MINE AND MACHINE

The goal of the project MaMMa (Maintained Mine & Machine) is to improve the availability, efficiency and safety of machines and mines through the use of an intelligent, integrated and holistic maintenance system. Unexpected and unplanned machine and infrastructure failures are the main cause of costly underground failures and are to be minimized by the software system developed in the MaMMa project. At the same time, the system enables employees and consultants to better and more efficiently plan maintenance work based on real-time data on the condition of machines and equipment underground.

Learn More!

MEASURING SYSTEM FOR CONDITION MONITORING (i-MaSS)

Unplanned shutdowns or sudden plant failures in mining plants quickly cause very high costs, which must be avoided. Although the measuring systems used for condition monitoring cover a wide range of possible applications, they reach their limits in special areas. The i-MaSS research project addresses exactly this problem. An interdisciplinary consortium from the fields of raw material technology, mechanical engineering and electrical engineering developed a cost-effective, miniaturized, adaptive and self-sufficient measuring system for improved condition monitoring.

Learn More!

NEXGEN SIMS

The objective of the NEXGEN SIMS (Next Generation Carbon Neutral Pilots For Smart Intelligent Mining Systems) project was the further development and advanced demonstration of technologies for future-oriented sustainable mining in Europe. The consortium, which was funded by the EU within the framework of Horizon 2020, involved well-known partners from research and industry from all over Europe. The project was the successor of the EU-funded project SIMS (Sustainable Intelligent Mining Systems), in which the AMT was also involved.

Learn More!

OBSERVER-BASED CONDITION MONITORING SYSTEM

The research project "Observer-based Condition Monitoring System for Main Transmissions in Wind Turbines (BCMS)" was carried out within the framework of the 6th Energy Research Programme of the Federal Government with the focus on an environmentally friendly, reliable and affordable energy supply.

The research project dealt with the development of a novel, integrable condition monitoring and prognosis system for main gearboxes of wind turbines. In order to achieve sufficient reliability in the prediction of component damage and failure, the observer-based methodology was used, in which data from simulations running parallel to the measurement are used to map a fault-free WTG system. Deviations of the

measured, real plant behaviour compared to the simulation are used for fault detection and condition prognosis. Thus, the accuracy and the scope of information of condition monitoring systems on WTG main gearboxes could be increased and an automated and reliable damage reporting system could be made possible.

Learn More!

ONLINE-ANALYSIS IN RESOURCE EXTRACTION

As part of the project "Online Analysis Methods for the Extraction of Mineral Resources" (OFUR) funded by InnoNet (Promotion of Innovative Networks), the IMR, in cooperation with several small and medium-sized companies and the Fraunhofer Institute for Laser Technology (ILT), developed a system for real-time elemental analysis of raw materials during the extraction process.

Learn More!

ONLINE-MATERIAL ANALYSIS (LEX)

The LEX project served to expand basic scientific knowledge in the field of real-time material analysis and automation of extraction machines in explosion-proof atmospheres.

Learn More!

ONLINE MATERIAL CHARACTERIZATION

The goal of the project OMMA is the development of an online measuring system for material flow characterization in processing plants of the gypsum industry. The background for the need of such a system is the necessary quality assurance of the products in companies of the primary raw material industry. A precise knowledge of the composition of the raw materials to be processed is crucial. The aim of the OMMA project is therefore to implement a real-time measurement system integrated into the preparation process for inline characterization of the material flows.

Learn More!

PAM 4.0

In PAM4.0, "The intelligent deslagging machine for hot operating conditions", the AMT, together with TML Technik GmbH, developed the sensor and actuator systems for the first automated, newly designed and optimized deslagging machine on the market.
On the one hand, this machine is equipped with a sensor system suitable for the steel mill environment, which detects the floating slag on the surface of the molten steel, which is up to 1500°C hot, and automatically carries out the deslagging movement. On the other hand, a teleremote stand was built from which the deslagging movements can be monitored and, if necessary, supplemented by human intervention so that the control stand in the immediate vicinity of the dangerously hot melting ladle is no longer required. The aim of the project was to increase occupational safety and comfort and, at the same time, to produce more resource-efficient steel by increasing the efficiency of the deslagging process. In this way, a step towards the automation and digitalization of dangerous and difficult work processes is to be realized towards a safe, efficient and responsible supply of raw materials.

Learn More!

PARTIAL AUTOMATION OF CONCRETE SPRAYING EQUIPMENT

Today, concrete spraying processes in mining and tunnelling are still carried out manually. The shotcrete application and the quality control are subject to the subjective impression of the operator. A sufficient examination of the quality of the working process cannot be guaranteed in this way. In order to support the operator and increase the success of the process as well as the quality control, GTA Maschinensysteme GmbH together with the Institute for Advanced Mining Technologies of the RWTH Aachen University developed a novel concrete spraying vehicle equipped with various sensors. This made it possible to record

the tunnel profile, monitor the application of the shotcrete slab and carry out a final, data-supported quality control. In this project, AMT was responsible in particular for the development of the localisation technology consisting of Ultra-Wide Band (UWB) and INS, including skilful sensor data fusion. In addition, the laser scanner technology and the associated software were developed at AMT. Special attention was paid to the algorithms and time synchronization of the UWB modules.

Learn More!

PREP FOR INNOVATION: LIVING LAB NIVELSTEIN

The goal of the project was to create a basic infrastructure that will enable and support the partners of RWTH Aachen University and the Nivelsteiner Sandwerke to jointly work on innovative research projects in the areas of raw material extraction, integration of renewable energies and process optimization by means of digitalization and AI in the Living Lab Nivelstein. As a result of the Prep Fund funding, a basic infrastructure was established at the Nivelstein site, with the help of which the processes of extraction and processing of mineral raw materials can be mapped on a pilot scale, both physically and digitally (e.g. with the implementation of cyber-physical systems), close to reality and according to an innovative utilization concept. Research and development are thus brought closer together in the living lab, shortening iteration loops and alloweing for synergies to be used effectively.

Learn More!

PROGNOSIS OF MAINTENANCE REQUIREMENTS (SESI)

The aim of the SESI research project was to enable manufacturing companies and industrial service providers to improve the reliability of plants by forecasting maintenance requirements and times, to increase availability and to minimize direct and indirect maintenance costs by means of demand-oriented maintenance and thus to increase their competitiveness.

Learn More!

REAL TIME PROCESS CONTROL IN MINING

As part of the Real Time Mining project, a real-time system was developed over 48 months as part of a Horizon2020 funded project, which enables process control of the entire mining process. The focus was on the collection of material, location and machine information during the extraction process in order to sequentially optimize the deposit model developed from the exploration. With the help of this information, it is possible to adjust the long-term and short-term planning of the extraction in real time.

Learn More!

SAFE AND INNOVATIVE MINE TRANSPORTATION

The aim of the project BUSDUCT (Increase of mines efficiency and health protection through the innovative transport system based on BUSDUCT) was to develop a prototype of a suspended monorail locomotive (SML) which is powered with electrical energy via a busduct. This electrically powered locomotive was designed for the use in potentially explosive areas of the Polish coal mining industry. The electric drive enables the SML to run at higher speeds, which increases the efficiency of the mine's logistic processes.

Learn More!

SCALE SENSE

The ScaleSense project aimed to develop a sensor-based system for the detection of loose rock within the scaling process and to integrate the system into a scaler. This innovative system will be used in underground mines within the scaling process. It is intended to meet the increasing demands on the raw materials industry. This will assist the operator in identifying loose rock and making the scaling process safer and more efficient.

Learn More!

SMART DEEP MINE OF THE FUTURE (I^2Mine)

The I^2Mine project was an extensive project for the development of innovative technologies and concepts for the design of the intelligent underground mine of the future. The project comprised different components, from the development of software and hardware for improved rock control and mining technology to new digital recording systems and management tools to improvements in occupational health and safety. The AMT (then IMR) developed, among other things, a method for boundary layer detection to enable a more mechanised mining process.

Learn More!

SMART TELESCOPIC BOOM (TS4.0)

The aim of the project "The intelligent telescopic boom for extreme operating conditions" was to develop a robust, self-monitoring and 360 degree endlessly rotatable telescopic boom for adverse environmental conditions in the extractive and related industries. The new development is intended for underground use in gypsum-anhydrite mines around the world for depletion of roadways and mining sites.

The telescopic boom enables the use of new, particularly efficient tools such as the "Xcentric® Ripper", which requires special design consideration due to its high-frequency mechanism. At the same time, the radius of action of the telescopic boom is increased by extending the telescopic stroke.

Learn More!

SMART TOOL FOR PROGNOSIS AND ANALYSIS (SiZu)

The aim of the SiZu research project was to develop an integrated forecasting and analysis tool for assessing machine conditions. For this purpose, the AMT (at the time IMR) for the first time combined condition monitoring and real-time simulation in a single system and made them jointly evaluable.

The System Condition Analyser provides a comprehensive and meaningful database, on the basis of which the project team was able to develop new maintenance strategies. With the development of the Condition Analyser, the AMT pursued two core objectives:

- The development of a condition forecast oriented maintenance strategy
- The Development of an Automated Failure Cause Analysis

Learn More!

SUSTAINABLE INTELLIGENT MINING SYSTEMS (SIMS)

The aim of the project SIMS (Sustainable Intelligent Mining System) was to sustainably improve mine safety through a higher degree of digitisation, automation and robotics, to reduce the environmental impact of mining and to increase the overall efficiency of mining operations. In addition, SIMS aimed to identify direct and measurable factors influencing sustainable mining and to sensitise the wider population to the need for mining.

Learn More!

UNDERGROUND ROBOTIC SYSTEM (UNDROMEDA)

The project UNDROMEDA (Underground Robotic System for Monitoring, Evaluation and Detection Applications) contributed to the development of a robotic underground measurement system for autonomous 3D mapping and monitoring. The system is based on a mobile, wheel-driven platform, which is additionally equipped with a flying drone, in order to access particularly unknown, inaccessible or dangerous areas in underground mines and other underground environments, such as tunnels or canal systems. UNDROMEDA was a milestone project in the current development of the springboard for the

"invisible, pollutant-free, intelligent, safe and fully autonomous" mine and will enable us to meet the associated challenges for future mining in terms of social and ecological acceptance and economic efficiency.

Learn More!

UNDERGROUND 4D+ POSITIONING, NAVIGATION, MAPPING SYSTEM

UPNS 4D+ stands for the development of an underground 4D+ positioning, navigation and mapping system for the highly selective, efficient and highly secure extraction of economically strategic raw materials. The aim of this research project was to enable the highly selective, efficient and extremely safe extraction of mineral raw materials. The main focus was on the extraction of rare earths from "domestic" existing deposits and the use of the system for the exploration of new deposits. Within the framework of the project, an underground deposit positioning, navigation and mapping system in the form of a mobile autonomous and intelligent robot system was successfully developed for the first time.

Learn More!