Dubrovnik International ESEE Mining school

DIM ESEE-2: Implementing innovations

Innovation in extraction

18th – 20th October 2023

Dubrovnik, Croatia //
hybrid mode with online participation

Challenges for raw materials professionals in the ESEE region (Eastern and Southeastern Europe)

Lack of lifelong learning courses and other forms of informal education for raw materials professionals in the ESEE region

Higher education system with outdated curriculum offering too much theory and insufficent focus on innovative and advanced tools and methodologies

Expensive lifelong learning courses in Western Europe, often not affordable for ESEE raw materials professionals

DIM ESEE-2 innovative workshops FROM professionals TO professionals

❑ Unique lifelong learning course for professionals working in fields: Geology, Geological engineering, Geophysics, Mining engineering, Applied Earth Sciences, Mineral processing etc.

❑ 3 days of acquiring knowledge and practical work + networking with other raw materials professionals from ESEE region

❑ Best value for money

SAVE THE DATES!

Innovation workshops at the Inter University Center, Dubrovnik

- **Innovation in extraction (18th – 20th October 2023) – hybrid mode!**

- Innovation in ore processing (23rd – 25th October 2024)

eit RawMaterials
Connecting matters

Co-funded by the
European Union

2023 workshop: Innovation in extraction

The workshop will address several innovative extraction methods and review some of the latest future-oriented technologies. The latest achievements in the field of blasting will be presented, such as the use of computer modelling, the characterization of the rock mass for the purpose of optimal fragmentation during blasting, and methods of reducing the unwanted effects of blasting. Innovations related to hard rock mechanical cutting and digitization in the field of exploitation will be presented using examples from practice and results achieved as part of currently ongoing EU research projects.

TOPIC 1
Wednesday, 18th October 2023

Blasting Extraction Methods

TOPIC 2
Thursday, 19th October 2023

Mechanical Extraction Methods

TOPIC 3
Friday, 20th October 2023

Innovative & Sustainable Extraction Practices

DAY 1: 18th October 2023
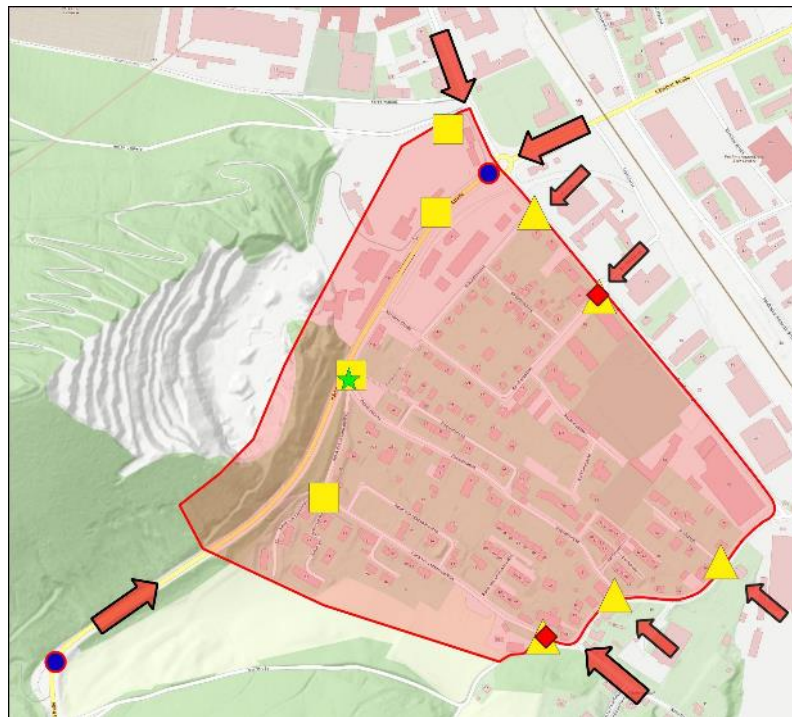
TOPIC 1
Blasting Extraction Methods

- Advanced technologies in blast modelling using electronic detonators

- Case study: Improving mill throughput by blast optimization using advanced technologies

- Safety Concept for production blasting in populated areas (Leitendorf best-practise case)

- How Low Can You Go? - Extra-Low-Profile Equipment for underground mineral extraction (DOK-ING)

Images

- electronic detonators

- Safety Concept for production blasting in populated areas

- Extra-Low-Profile Equipment for underground mineral extraction

DAY 2: 19th October 2023

TOPIC 2
Mechanical Extraction Methods

- Latest developments in hard rock cutting

- The EPIROC Mobile Miner

- Cutting for hard rock development, the MX650 experience from Sandvik

Images

- The EPIROC Mobile Miner

- Cutting for hard rock development, the MX650 experience from Sandvik
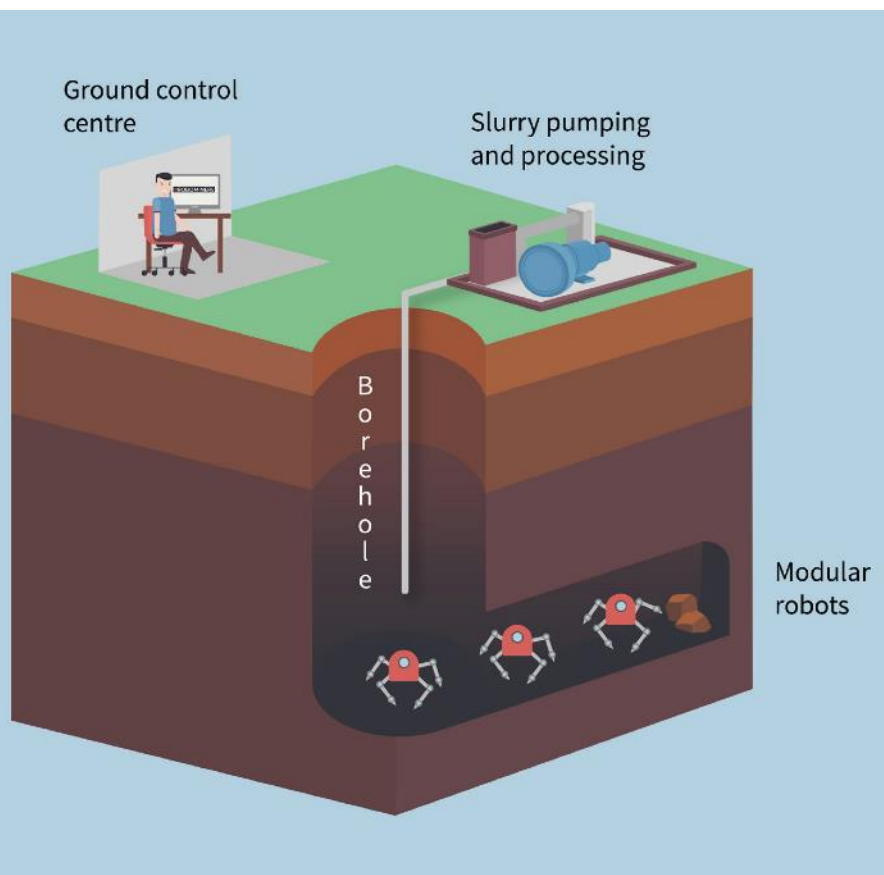
DAY 3: 20ᵗʰ October 2023

TOPIC 3

### Innovative & Sustainable Extraction Practices

- Resilient Bio-inspired Modular Robotic Miners for mining in inaccessible areas - the Robominer project

- The Digitaliized Mining Process - IlluMINEation project

- Earth Observation Data for Extraction Planning
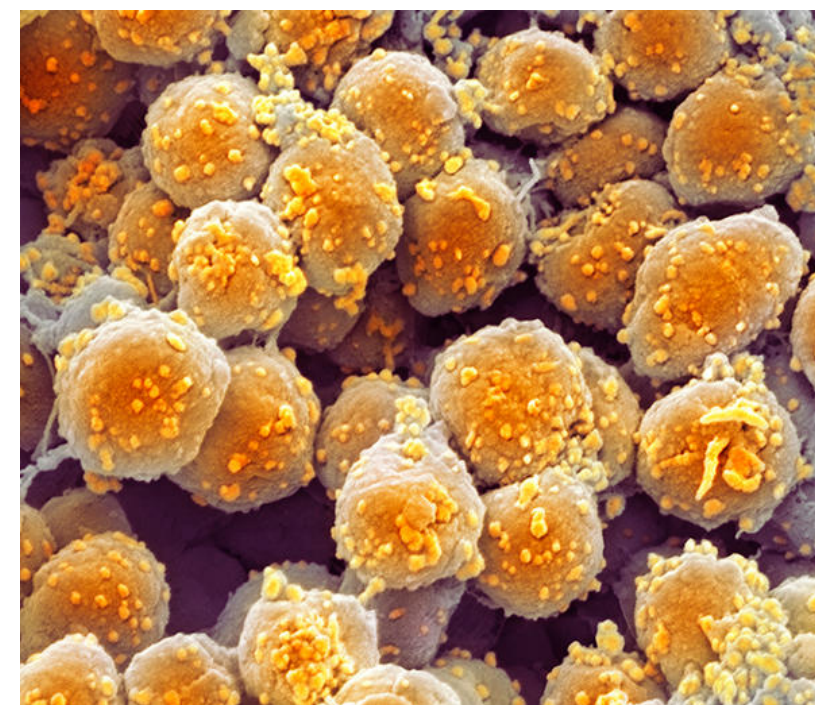
- Future smart mining with micro-organisms

Images

- Robominer
- IlluMINEation
- Future smart mining with micro-organisms

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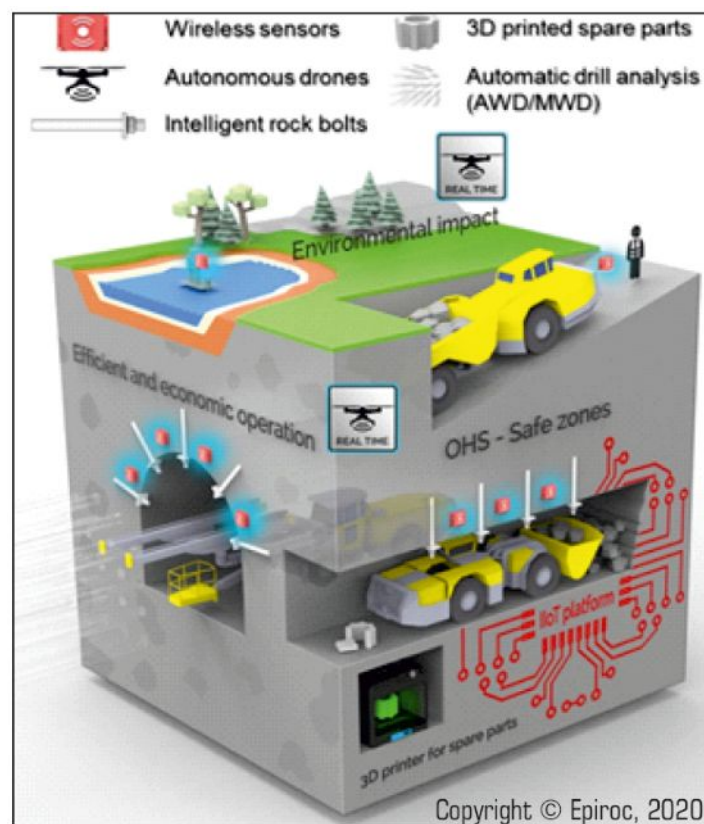
Upon completion of the training programme, participants will:

- Understand the principles of blasting design for safety

- Be able to select the most suitable detonator types to achieve optimum blasting results in relation to the overall excavation and mineral processing process

- Understand the principles of mechanical excavation in underground hard rock mining

- Be able to identify opportunities, strengths and weaknesses of hard rock cutting

- Be able to understand the benefits of Earth Observation data for Extraction Planning

- Be able to identify the opportunities, strengths and threats of a fully digitalized mining process

PLEASE NOTE: FOLLOWING THE GUIDELINES OF EIT RAWMATERIALS PROGRAMME, ALL PARTICIPANTS WILL HAVE TO UNDERGO A SHORT COMPETENCY ASSESSMENT PROCESS AFTER THE COURSE. PARTICIPANTS WHO SUCCESSFULLY PASS THE ASSESSMENT WILL RECEIVE THE CERTIFICATE ON COURSE COMPLETION.

REGISTRATION

Participation fee covering accommodation, meals and all workshop activities:

500 euros + VAT 25%

Online participation fee:

100 euros + VAT

(mandatory payment by 3rd October for all participants)

Applications are encouraged particularly from RIS countries: Armenia, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Georgia, Greece, Hungary, Italy, Kosovo, Latvia, Lithuania, Malta, Moldova, Montenegro, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Turkey, Ukraine.

Apply here: https://dim-esee.eu/registration-and-fees/

The workshop will be held at the IUC Dubrovnik and via online platform in parallel.

2022 edition: Innovation in process-oriented orebody characterization

- 38 participants in total (22 on-site and 16 online)

- PhD candidates and postdoctoral researchers employed at universities or in industry, engineers from various companies, representing 21 different institutions from 18 different countries
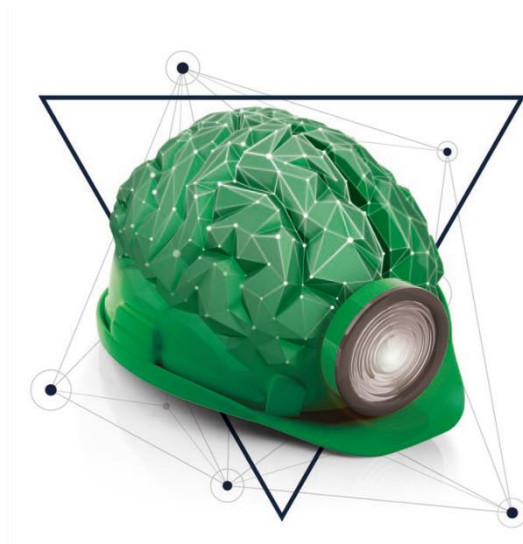
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Dubrovnik International ESEE Mining school

DIM ESEE-2: Implementing innovations
Innovation in Extraction
18th – 20th October 2023.

2023 PROMO BOOKLET

Dubrovnik, Croatia /hybrid mode

REGISTRATION:

https://dim-esee.eu/registration-and-fees/

CONTACT INFORMATION:

info@dim-esse.eu

Abstract

The Innovation in Extraction workshop will address several innovative extraction methods and review some of the latest future-oriented technologies. The latest achievements in the field of blasting will be presented, such as the use of computer modelling, the characterization of the rock mass for the purpose of optimal fragmentation during blasting, and methods of reducing the unwanted effects of blasting. Innovations related to hard rock mechanical cutting and digitization in the field of exploitation will be presented using examples from practice and results achieved as part of currently ongoing EU research projects. Participants will be given a unique opportunity to interact with some of the leading specialists and innovators in the field.

Lecturers

- *Mark Ganster (AustinPowder)*
- *Christian Heiss (Montanuniversität Leoben)*
- *Luka Petro (Dok-Ing)*
- *Nikolaus Sifferlinger (Montanuniversität Leoben)*
- *Marcus Lundbergh (Epiroc)*
- *Hubert Kargl (Sandvik)*
- *Nikolaus Sifferlinger (Montanuniversität Leoben)*
- *Philipp Hartlieb (Montanuniversität Leoben)*
- *Rushaniia Gubaidullina (Montanuniversität Leoben)*
- *Robert Obenaus-Emler (Montanuniversität Leoben)*

Prerequisites

Degree in mining engineering / geological engineering/ mineral processing/ geology or geophysics/ chemical engineering with a good command of English

Learning Outcomes

- *Understand the principles of blasting design for safety,*
- *Be able to select the most suitable detonator types to achieve optimum blasting results in relation to the overall excavation and mineral processing process,*
- *Understand the principles of mechanical excavation in underground hard rock mining,*
- *Be able to identify opportunities, strengths, and weaknesses of hard rock cutting,*
- *Be able to understand the benefits of Earth Observation data for Extraction Planning,*
- *Be able to identify the opportunities, strengths, and threats of a fully digitalized mining process.*

PRELIMINARY PROGRAM (AUGUST/SEPTEMBER 2023)

DAY 1 (18th October) – *BLASTING EXTRACTION METHODS*

Mark Ganster: *Advanced technologies in blast modelling using electronic detonators*
<u>Case study</u>: *Improving mill throughput by blast optimization using advanced technologies*

Christian Heiss: *Safety Concept for production blasting in populated areas (Leitendorf best-practise case)*
Luka Petro: *How Low Can You Go? - Extra-Low-Profile Equipment for underground mineral extraction*

DAY 2 (19th October) – *MECHANICAL EXTRACTION METHODS*

Nikolaus Sifferlinger: *Latest developments in hard rock cutting*
Marcus Lundbergh: *Mobile Miner, accelerating the transformation to a more sustainable mining*
Hubert Kargl: *Cutting for hard rock development, the MX650 experience*

DAY 3 (20th October) – *INNOVATIVE AND SUSTAINABLE EXTRACTION PROCESSES*

Nikolaus Sifferlinger: *Resilient Bio-inspired Modular Robotic Miners - the Robominer project*
Philipp Hartlieb: *The Digitaliized Mining Process - IlluMINEation project*
Rushaniia Gubaidullina: *Earth Observation for Extraction Planning*
Robert Obenaus-Emler: *Future smart mining*

Name of the lecturer: Mark Ganster

Name: Mark Ganster
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Mark Ganster is Manager Blasting Technology by Austin Europe GmbH, Austria. He holds a master's degree in applied Geosciences from the Montanuniversität Leoben. Mark started as a Blasting Engineer at Austin Powder Austria in 2004. He took over the responsibility of the Blasting Service Division for Austria in 2005 and was managing a Team of Blasting Engineers over 10 years. In 2015 he took over the position as Manager Blasting Technology for Austin Europe. The responsibility included 9 countries where Austin Powder is operating in Europe regarding blasting, explosives, initiation, fragmentation, vibration control, use of underground bulk emulsion and optimization of blasting results in all terms of using technology.

He was involved in projects in Pipeline Blasting (Austria & Germany), Underground Bulk Technology in Mining & Tunneling (Hongkong, Argentina, USA, Austria, Germany, Norway, Sweden, Slowakia), Open Pit Blasting (LKAB – Sweden, Ellatzite- Bulgaria) & lots of Quarrying around Europe.

He also carried out special blasting projects like liquefaction of water saturated sands in the Lausitz area in Germany with 350m long horizontal holes. This was unique worldwide.

LESSON: Advanced technologies in blast modelling using electronic detonators

Austin Powder will present the newest blasting material and technology available on the market, that allows to select the most efficient and safe blasting method design. A software program which integrates most of the surveying tools in the market in combination with the latest modelling algorithms creates one of the most powerful tools in the industry. The implementation of various modelling opportunities allows to model:

- 3D Blast Planning and transfer of data to the drill rig
- Optimized Timing Features
- accurate vibration impacts using electronic detonators in combination with Seed Wave Technology
- generate accurate fragmentation estimation using geological information and a modified version of the Swebrec function, finetuned with live fragmentation measurements.

- Comparison of different models
- Flyrock & Overpressure prediction based on coordinates and terrain
- Presplit Designer
- Quality Control

CASE STUDY: Improving mill throughput by blast optimization using advanced technologies

The Phu Kham Copper-Gold Operation (PKM) is a large-scale open pit mine located in northern Laos. It was developed and is operated by Phu Bia Mining Limited (PBM) a Lao-registered subsidiary company of Australian incorporated, PanAust Limited. Production commenced at Phu Kham in 2008. Since the second half of 2016, there has been a significant increase in ore hardness and this has negatively impacted the PKM concentrator and resulted in lower SAG mill throughput rates. Over the remaining life of mine, the changing ore body and increase in ore hardness is forecast to continue as the pit deepens and the availability of softer blending ores reduce. To manage this risk, PKM initiated a Hard Ores Management Program to determine the most effective way to improve the mill throughput of harder ores. This involved conducting a number of innovative and process control driven blasting trials to optimize run-of-mine (ROM) fragmentation and other blasting outcomes. From 2016 to 2017, the performance of high powder factor blasting, electronic detonators and fast timing, high velocity of detonation (VOD) explosives, double-priming, and deck blasting, were individually and systematically assessed. The success of each blasting trial was then based on a 'value for money' criteria. Electronic and high VOD 90:10 emulsion:ANFO blasts were determined to have the best value for money, achieving an increase in mill throughput of 54% compared to baseline

Name of the lecturer: Christian Heiss

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E-mail: christian.heiss@unileoben.ac.at

Christian Heiss is a senior researcher and head of the laboratory at the Chair of Mining Engineering at Montanuniversität Leoben. His main research areas are surface mining, process, and occupational safety as well as risk management in mining operations. Amongst his activities are also blasting technology, the development and testing of falling rock protection systems and slope stability evaluation.

LESSON / CASE STUDY: Safety Concept for production blasting in populated areas (Leitendorf best-practise case)

For the local supply of the region with construction raw materials, Leitendorf-Bergbau GmbH operates a quarry in the urban area of the city of Leoben. This paper describes the rigorous safety concept for the blasting process and communication methods to inform residents in case of blasting activities.

Name of the lecturer: Luka Petro

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Luka Petro is Mining Program Manager at DOK-ING, Zagreb, Croatia. He holds a Master of Business Administration (MBA) from IEDC-Poslovna šola Bled and a master's degree in petroleum engineering from the University of Zagreb. Luka started as a field engineer for Nabors Industries in the Middle East where he collected a lot of field experience in optimization, equipment maintenance, and failure analysis. Over the years in Oil and Gas industry, he held several supervisory positions in drilling operations and technical support as well as coordinating business development activities in the Kingdom of Saudi Arabia. He has led several Land rig and Offshore Jack-up refurbishment and commissioning projects.

From 2016 he was part of several departments in DOK-ING including Sales and Head of Project Management Office. DOK-ING is an engineering powerhouse of heavy-duty robotics & autonomous systems, founded in 1991. For the last 3 years, Luka is managing DOK-ING underground mining program with a mission to develop Ultra-low profile, remote-controlled, electric mining machines.

LESSON / CASE STUDY: How Low Can You Go?- Ultra-Low-Profile Equipment for underground mineral extraction

Based on experience with drilling, dozing and roof bolting machinery in South African narrow reef mines, DOK-ING has developed a series of ultra-low mining equipment. These machines are being used to increase the safety and productivity in areas that are traditionally worked manually under harsh conditions. The DOK-ING NRE Fleet is currently unique on the market and represents future mining technology. NRE machines operate between 0.9m and 1.7m panel width at 22° slope (dozer up to 25° slope), are remote-controlled, fully automatic with tracked undercarriage, and are zero-emission due to electric drive. NRE Equipment is the only equipment available for mechanised production of reefs thinner than 1.7m and the only equipment that can mechanize production from reef dip's higher than 14deg.

Name of the lecturer: Nikolaus August Sifferlinger

Name: Nikolaus August Sifferlinger
Academic Title: Prof. Dipl.-Ing. Dr.mont.
Institution of employment: Montanuniversität Leoben
Relevant website: https://bergbaukunde.unileoben.ac.at/about-us/team
Contact number: +43 66488989605
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Nikolaus Sifferlinger is professor at the Chair of Mining Engineering at Montanuniversität Leoben. His main research areas are mining systems, safety, excavation and conveying technology, robotics in mining.

1989-2006 in research and development of mining and tunneling systems, automation at VOEST ALPINE Bergtechnik GmbH.

2007-2011 Vice president R&D and Engineering at Sandvik Mining and Construction GmbH.

2012-2016 independent consultant for mining and tunneling systems with own company Dr. Sifferlinger Consulting e.U.

Since 2016 Universitaetsprofessor at Montanuniversitaet Leoben. Amongst his activities are also projects in mine digitalization, mining safety, education, and automation and robotization in mining. European Mining Course https://www.emc-master.eu/

LESSON / CASE STUDY: Latest developments in hard rock cutting

This lecture will provide an overview of developements in hard rock continuous mining. Many companies have been trying hard to introduce the benefts of continuous mining (well established in coal and salt mining) into underground hard rock mining, and encountered a multitude of technical challenges. Discussion of R&D in conic pick tools and disc cutting tools. What are the present limitations and challenges? Case study: Could robotization of machinery and process help to overcome the present bottle neck?

LESSON / CASE STUDY: Resilient Bio-inspired Modular Robotic Miners- the Robominer project

ROBOMINERS is a project funded under the European Union's Research and Innovation programme Horizon 2020 (grant agreement n°820971) within strategic objective to facilitate EU access to mineral raw materials. ROBOMINERS' innovative approach combines the creation of a new mining ecosystem with novel ideas from other sectors, in particular with the inclusion of disruptive concepts from robotics.

In the framework of the ROBOMINERS project, the partners are developing a set of modular collaborative robots that can perform mining operations. The purpose of this work is to face the challenge of taking modular robots out of the academic context and to provide robotic miners with the needed resilience which will be based on four pillars: redundancy, physical reconfiguration, adaptive behaviour, and system reconfiguration. To do so, we are working on a scaled prototype based on a highly configurable modular robot that allows the connection between several autonomous robots (modules)

and functional submodules (e.g., sensors, mining tools, locomotion devices) where resilience, energy sharing, self-reconfigurability, modularity, and self-awareness capabilities will be tested both in simulation and real-world scenarios.

https://robominers.eu/

Name of the lecturer: Marcus Lundbergh

Name: Marcus Lundbergh
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Relevant website: www.epiroc.com
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Marcus Lundbergh has a B.Sc in mechanical engineering from the University of Örebro, Sweden and has during his 20 year long career in Epiroc held different positions within marketing & product development. In marketing he spent several years as responsible for both underground loaders as well as underground haulage trucks. Marcus has also extensive experience running large new development projects of various types of Epiroc's underground mining machinery. Since 2018 Marcus is leading an international joint development project with one of our partners in developing a continuous mechanical rock cutting machine, The Mobile Miner 40V for a specific mine in North America.

LESSON / CASE STUDY: Mobile Miner, accelerating the tranformation to a more sustainable mining

The world needs metals and minerals for the energy transition, and we need cities that can cope with a growing population in a sustainable way. To succeed we need to speed up the shift towards a more sustainable mining and construction industry. We at Epiroc accelerate this transformation. Using design elements from the original Robbins Mobile Miner Epiroc has together with our partners developed the concept to a machine capable of cost efficiently cutting a variety of horizontal tunnels, tight curves and cross-cuts, a self-propelled unit capable of handling very high in-situ rock stress, with the highest possible safety.

Continuous mechanical rock excavation offers many advantages compared to traditional drill & blast and the Mobile Miner, in contrast to the round tunnels drilled by conventional TBMs, excavates a tunnel that is rectangular in shape; this is important for roof stability, and it also provides the flat floor needed by mine vehicles. It is capable of advance rates of 10-12m per day depending on the rock type. Another big advantage is its mobility and manoeuvrability as it excavates a tunnel that is bigger than itself.

This lecture aims at telling the story of the development of the Mobile Miner, the drivers, the journey and where we are today. The challenges we see and what the future looks like.

Name of the lecturer: Hubert Kargl

Name: Hubert Kargl
Academic Title: Dipl. Ing.
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Study of Mechanical Engineering / Metallurgical Machinery at Mining University Leoben. Since January 1994 employee at "Sandvik Mining and Construction G.m.b.H. Zeltweg", which belongs to the "Division Mechanical Cutting" at the "Business Area Sandvik Mining and Rock Solutions" of Sandvik. Hubert started as engineer for structural strength calculation and collected a lot of field experience at measurement missions with operating machines in mining and tunnelling applications. Over the years Hubert got more and more involved into investigation and development of different rock cutting technologies. An essential mission has been to find a good balance between theoretical investigation & simulation and practical testing in different scales and environments. The scope of activities is concluded by integration and verification of new cutting technologies at different machine concepts. Hubert's current role is Manager for Technology and Concept development at SMC Zeltweg.

LESSON / CASE STUDY: Disc Undercutting Technology – Concept and verification in lab and machine environment

Many underground mines are looking for continuous mining methods to raise their daily advance rates at drift development above the limits of current drill and blast operation. Machines with mechanical rock cutting concepts could satisfy these needs: But especially in hard rock conditions there are still significant challenges left. Existing conventional disc cutting concepts need very stable machines (like TBMs), which again are limited in turning radius and place change capabilities. Flexible part face mining machines, like roadheaders, are very limited at cuttable rock strength and they are not able to supply necessary stiffness and forces for disc cutting technologies. That's why disc undercutting technology has been developed, tested and optimized at Sandvik over several years. After first design concepts a series of cutting tests has been performed with the aim to find the best ring designs and to quantify the influence of cutting parameter and rock strength onto the contact forces between cutter and rock. Finally, two different undercutting concepts have been integrated in two new machine types which have been tested in prototype applications. The lecture shall give an overview about technology development, testing in laboratory environment and testing at the machine prototypes for both designs.

Name of the lecturer: Philipp Hartlieb

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Dr. Philipp Hartlieb is a senior scientist at the Chair of Mining Engineering at Montanuniversitaet Leoben. His main research areas are dealing with sustainable and environmental mining technologies, reducing the energy consumption and environmental impact of mining operations, mainly in mechanical excavation and drilling & blasting. Amongst his activities are also projects in mine digitization, raw materials policy, education, and extra-terrestrial mining (in-situ resource utilization). A special focus of his research is set on alternative fragmentation methods (i.e. microwaves) in order to decreasing the specific energy consumption of mining operations.

LESSON / CASE STUDY: The Digitaliized Mining Process- IlluMINEation project

Europe urgently needs to reduce its import dependency in respect to a multitude of raw materials. In order to do so, Europe's mining industry must completely redesign the process of traditional mining via the adoption of pioneering innovations, accompanied by extensive use of data analytics and new types of Industrial Internet of Things (IIoT).

Under the coordination of the Montanuniversitaet Leoben, the EU-funded *illuMINEation* project highlights significant aspects of digitalisation in underground mining activities with the core objective of improving the efficiency as well as health and safety of European mining operations and its personnel. The project establishes a robust multi-level distributed IIoT platform including cloud/edge computing and distributed data-management, with data sourced from large sensor networks. Advanced user interfaces, dashboards and AR/VR applications will allow for an optimised information flow. A rigorous cyber security approach ensures that all data is properly protected.

Via digitization of important mining aspects, such as the mineral deposit, rock mass stability, equipment condition monitoring, safety of mining personnel as well as the working and mining environment, the *illuMINEation* project addresses all of the three key factors that influence the sustainability and profitability of mining operations: Occupational Health & Safety performance (incl. health & safety aspects of the nearby community), environmental impacts and efficient resource extraction.

This lecture will provide an overview of the project developments and their implementation in the mining environment. I.e. the collection, evaluation and usage of data will be explained in detail.

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Rushaniia Gubaidullina is a Senior Scientist at the Chair of Mining Engineering and Mineral Economics at Montanuniversitaet Leoben, Austria. She graduated from Saint-Petersburg Mining University with a major in Applied Geodesy (2017) and held a PhD in Engineering, in the specialty of Geodesy (2020). She has four years of teaching and research experience, specializing mainly in applied geodesy, photogrammetry, and satellite remote sensing technology. She has participated in 2 publicly funded international projects. She is currently working on two EU projects, including the S34I project, which aims to research and implement new methods to analyse Earth Observation data, supporting systematic mineral exploration and continuous monitoring of extraction, closure, and post-closure activities.

LESSON / CASE STUDY: Introduction to Earth Observation for the mining industry

Satellite remote sensing data is a powerful tool to support mining activities during the whole mining life cycle since it is an accessible source of information for creating and updating maps, monitoring mine subsidence and ground surface deformations, volume calculations, and monitoring the ecological environment. However, each task has its own criteria, affecting the choice of data to be analyzed (types of sensors, spectral characteristics, spatial resolution, etc.) and processing methods.

In this lecture, you will learn about the fundamentals of remote sensing and digital imaging, the history and development of Earth observation technology, the physical principles underlying remote sensing, such as the interaction of electromagnetic radiation with the atmosphere and surface, spectral signatures, and their use as a basis for distinguishing various surface features, the concept of active and passive remote sensing systems and their potential and limitations for applications in the mining industry, platforms for data acquisition. You will also become acquainted with various levels of satellite data processing and specific practical methods of preliminary computer processing of remote sensing data. A general overview of commonly used image processing and analysis techniques will also be given. Besides that, modern satellite missions and their use as early warning tools to avert hazards will be considered.

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Robert Obenaus-Emler is Head of Innovation and R&D Portfolio Management at the Resources Innovation Center (RIC) at Montanuniversität Leoben. His main research areas are in the field of hydrogen and carbon as the main elements of the transition to green energy. Amongst his activities are also projects in the area of sustainable mining and use of secondary resources

LESSON / CASE STUDY: Future smart mining with micro-organisms

Using an innovative approach, this lecture will present how archaea can enhance valuables recovery and increase the valorisation potential of mine tailings, that otherwise would remain useless.