An Online Research and Education Series 2nd Edition / SS 2021:

SUSTAINABLE DEVELOPMENT APPROACHES IN ENGINEERING RESEARCH & EDUCATION

United Nations
Educational, Scientific and
Cultural Organization

International Competence Centre
for Mining-Engineering Education
under the auspices of UNESCO
Austrian branch

Impressum

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INTERNATIONAL COMPETENCE CENTRE FOR MINING-ENGINEERING EDUCATION

UNDER THE AUSPICES OF UNESCO

AUSTRIAN BRANCH | MONTANUNIVERSITÄT LEOBEN

Established in December 2019, the Austrian branch of the Competence Centre is an integral part of Montanuniversität's strategy of internationalisation.
The Austrian branch participates in the global raw materials initiative under the auspices of UNESCO. In general terms, the International Competence Centre for Mining-Engineering Education is a category II centre of the United Nations Educational, Scientific and Cultural Organisation (UNESCO). It is headquartered at Saint Petersburg Mining University (SPMU).

We aim at drawing attention to the topics of sustainability in the areas of mining, raw materials, materials sciences, recycling, engineering education and raw materials policy.
Our broad range of initiatives targets students (Bachelor/Master/PhD level), researchers and engineering professionals. Further, those are dedicated to engineering education and research in particular in raw materials related sectors as well as the promotion of the Sustainable Development Goals (SDGs) at the national and international levels.

We are offering you access to and collaboration with our network of partners, including Technische Universität Bergakademie Freiberg (TUBAF, Germany), Lappeenranta-Lahti University of Technology (LUT, Finnland) and St. Petersburg Mining University (SPMU, Russian Federation) for international exchange and mutual beneficiation. International joint research activities with publishable results, increase of publications, representation and advertisement of scientific expertise would be further targeted outcomes.

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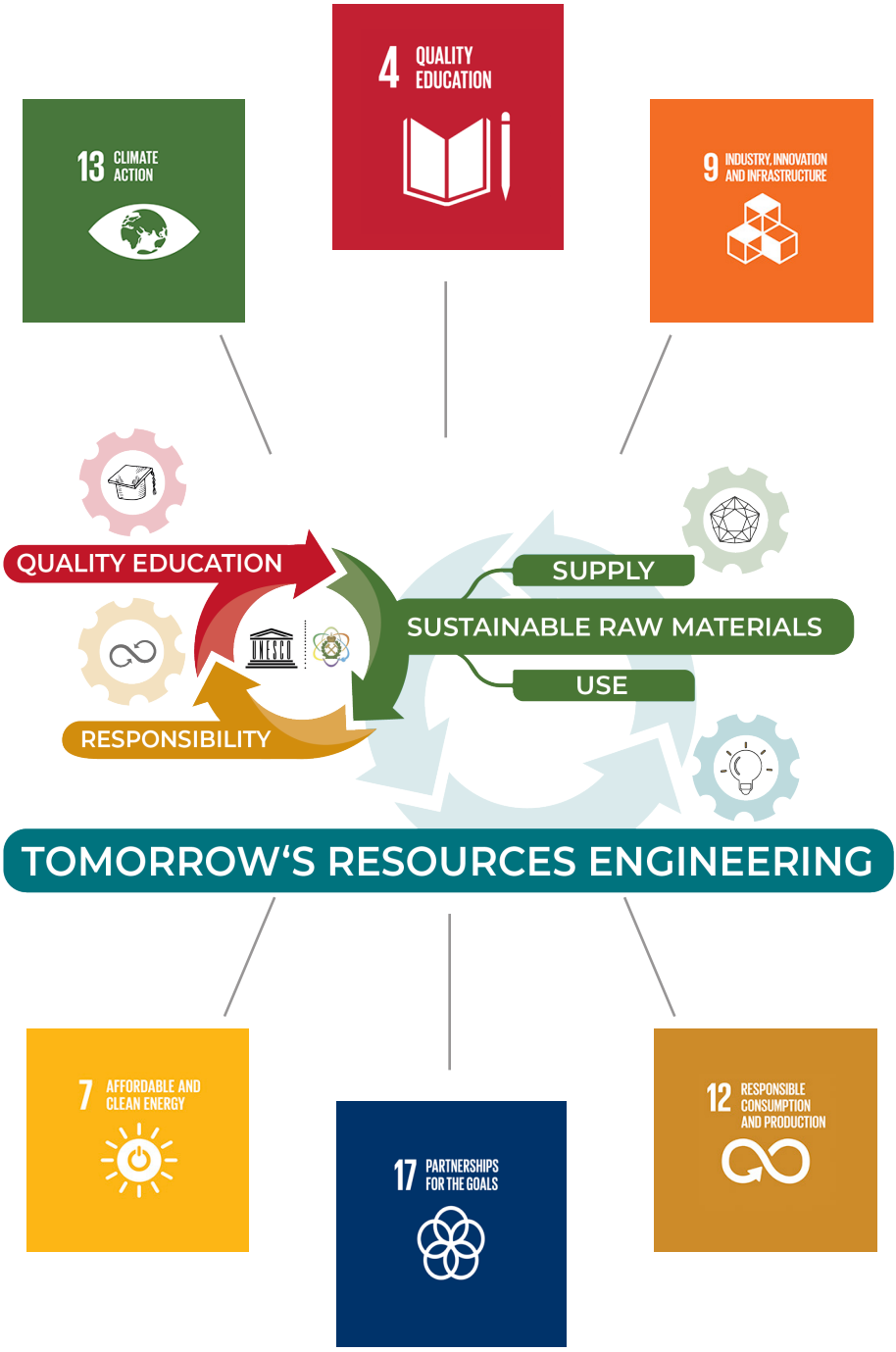
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ONLINE RESEARCH AND EDUCATION SERIES

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INTRODUCTION

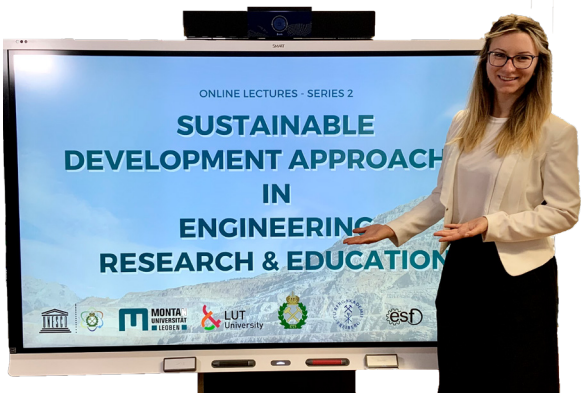
We are very glad that more than 330 people from over 20 different countries have signed up for one or all of our lectures. Each lecture was attended by around 100-160 participants. This is a remarkable success." - Peter Moser, Vice-Rector and Director of the Austrian branch.

The current situation of uncertainty is an important opportunity to learn from this exceptional situation to adapt to changes and enable continuity.

Higher education institutions all over the globe have accelerated the implementation of modern learning methods and created new opportunities with partner institutions, such as virtual mobility, shared resources, networking and joint online activities.

Within the network of the Centre for Mining Education UNESCO, the Austrian branch proposed the implementation of a series of online research and education lectures.

"We are delighted that after successfully holding this series last semester, the lectures this semester were attended with even greater interest." – Anna Voica, Communications & Partnership Manager who coordinated the lectures.



We were pleased to showcase international experts representing our partner institutions:

- From the Centre for Mining Engineering Education under the auspices of UNESCO:
  - the headquarters at Saint Petersburg Mining University (SPMU), Russian Federation;
  - the Finnish branch at Lappeenranta-Lahti University of Technology (LUT), Finland;
  - the German branch at Technische Universität Bergakademie Freiberg (TUBAF), Germany;
  - the Austrian branch at Montanuniversität Leoben (MUL), Austria.
- Mixed Reality Handbooks for Mining Education (MiReBooks), Europe;
- Engineers for a Sustainable Future (ESF), Austria;
- UNESCO Global Geopark Styrian Eisenwurzen (Geopark), Austria.

The lectures were held under the umbrella title:

"Sustainable Development Approaches in Engineering Research and Education."

Goal

The aim of the establishment of a series of online research and education lectures was to build up and promote networking among researchers, which would lead to the facilitation of future joint research activities.

In addition, we wanted to connect lecturers/researchers with students (PhD/Master's level/Bachelor's level) through knowledge sharing and interaction, the goal of which was to encourage debate and the exchange of experiences.

Format

Alternating every week, a speaker from MUL/LUT/SPMU/TUBAF/MiReBooks/ESF/Geopark gave a keynote speech within their area of expertise and/or presented ongoing research projects, followed by a lively discussion in the Q&A session moderated by our communications manager Anna Voica.

With the goal of opening the lecture series to the wider public, registration was free of charge and available at Eventbrite, an event management and ticketing website, via https://unesco_mining_aut.eventbrite.com.

Agenda

Thematic area 1: Sustainable mining aspects

- Responsible Mining Approach – Basics
  Prof. Carsten Drebenstedt (TUBAF)
- Life Cycle Assessment in Mining Engineering
  Prof. Jan C. Bongaerts (TUBAF)
- Mechanical extraction methods and technologies for deep-sea mining
  Dr. Taras Shepel (TUBAF)
- Mining technologies and sustainable development: modern challenges and prospects
  Prof. Oleg Kazanin (SPMU)

Thematic area 2: Digitalisation in mining

- Digital competencies as a basic requirement for modern mining and energy:
  Dr. Yuriy Zhukovskiy (SPMU)
- Measurement and digital analysis of mining processes
  Dr. Philipp Hartlieb (MUL)
- Emerging role of robots in mining
  Prof. Nikolaus Sifferlinger (MUL)

Thematic area 3: Sustainability & circular economy

- Sustainability issues in mining - what needs to be made „sustainable?“
  Dr. Michael Tost (MUL)
- Circularity of Critical Metals
  Dr. Sami Virolainen (LUT)
- Sustainable Development & Circular Economy
  Industry Prof. Jutta Nuortila-Jokinen (LUT)
- Competing land-uses and public interests: The role of minerals safeguarding and possible land-use planning instruments
  Dr. Katharina Gugerell (MUL)

Thematic area 4: Projects and initiatives

- Mixed Reality Handbooks for Mining Education
  Manuel Labrador Ortega MSc (MiReBooks)
- The role of engineering in tackling climate change
  Dr. Christoph Ponak (ESF)
- UNESCO Global Geoparks: Sustainable development in former mining regions across Europe
  Oliver Gulas-Wöhri, MSc (UNESCO Geopark Styrian Eisenwurzen)

Professor Carsten Drebenstedt

Responsible Mining Approach

TU Bergakademie Freiberg, Germany

On 9 April 2021, the online lecture series was kicked off under the title “Responsible Mining Approach” by Professor Drebenstedt from the German branch.

Carsten Drebenstedt is a professor of surface mining, the former vice-rector for research, the former dean of the Faculty of Geoscience, Geoengineering and Mining, a member of the senate and the director of the Institute for Mining and Special Civil Engineering at TU Bergakademie Freiberg. He teaches and organises programmes and conferences nationally and internationally. He has also published numerous books and papers and worked on over 100 scientific, educational and industrial projects.

He started his presentation by drawing our attention to the fact that due to the growth of the population worldwide, the desire for better technology and the increase in the standard of living, the need for more raw materials is expanding. Steady growth is the common tendency for global raw material consumption. Not only the amount of materials has increased, but there is also a greater diversity among the required minerals.

In his lecture, Professor Drebenstedt addressed the social challenge the mining industry is facing: a poor reputation. The field of mining is often perceived as environmentally harmful and greedy for profit. In his opinion, it is important to counteract and ensure that the mining industry has and receives public acceptance.

He pointed out that it is essential to continue developing and advancing mining techniques and procedures to reduce risks to health, safety and the environment.

As a result of the above-mentioned considerations, he went on to compare two different mining approaches. The first one is based on maximum profit, where mostly high-grade ores are mined. This strategy leads to a high volume of waste materials; in addition to overburden, low-grade ores are not processed, which also leads to a loss of valuable components.

The second approach is based on moderate profit with more environmental and social considerations. The extraction level of the main product is increased and the lower-grade ores are processed. The waste rock is repurposed, creating a second source of income. Reclamation plans are considered and planned in the budget during the entire life cycle of the mine.

TU Bergakademie Freiberg

Reclamation and the cultivation of mining areas come with considerable costs that many companies unfortunately try to avoid. He emphasised that this would play a vital part in regaining social acceptance of the mining industry.

He suggested that considering standards vary a lot depending on the production country and governments are taking too long to issue regulations, consensus within the mining industry should be found.

In the following Q&A session, questions were asked concerning the profitability and position of the mining industry in the media, among others.

Professor Jan C. Bongaerts

Life cycle assessment in mining Engineering

TU Bergakademie Freiberg, Germany

On 14 April, the second unit of the Austrian branch's online lecture series, with the title "Life Cycle Assessment in Mining Engineering," took place.

The lecture was held by Professor Jan C. Bongaerts, who is an emeritus professor of environmental and resources management. He is still affiliated with the Faculty of Business Administration and the Faculty of Geo-Sciences, Geo-Technics and Mining. In his lecture, the audience could catch a glimpse of his extensive experience in teaching issues related to environmental protection, environmental technologies, environmental risk management and renewable energy technologies, amongst others.
Professor Bongaerts has widely published in books and refereed journals and has managed several international education projects. Currently, he teaches several courses related to mining economics, mine planning, the financing of mining operations and mining and stakeholder analysis and management.

Professor Bongaerts introduced the attendees to the concept of the life cycle assessment (LCA), which is a method to systematically identify environmental and human health impacts of a product or technical process across all stages, such as extraction of primary resources, development, manufacturing, use and after-use treatment and recycling.
LCA is used to get an overview of environmental and health impacts of a product, service, or process, and identify stages of

a process with high or low environmental and health impacts. It can then be used to compare different products and processes, identify optimisation potential and develop concepts for environmental and health protection design.

Professor Bongaerts recommended that the purpose and extent of an LCA should be defined at the start and that it is important to define the system boundaries correctly in line with the purpose.

He underlined the possibilities of using LCA in mining with three case studies.
The first case study concerned ferronickel mining and processing, estimating the impact of switching partly to green energy or utilising waste, compared to the current state. The study concluded that the impact of mining was comparatively low.
The second case study dealt with drilling and blasting for overburden removal in an open-pit coal mine. The study covered nine different categories for LCA and therefore generated many possible outcomes.
The third and last study focused on the flooding of a closed open-pit mine with either groundwater from nearby, freshwater from a distant source or pumping and haulage of saline water for underground storage. It was shown that the freshwater solution had more impacts than the groundwater solution, due to the complexity and the necessity of construction.

The lecture was concluded by showing the benefits of using LCA for mining operations. It is an opportunity to identify aspects of mining operations stage by stage to a wider extent than what is required in feasibility studies. This can then lead to better mine planning, choices of mining technologies and energy sources. He did, however, emphasise the necessity for good data, which is sometimes difficult to acquire.

In the following Q&A session, many questions were asked, especially about the limitations and possible difficulties of the application of LCA in mining.

Dr. Taras Shepel

Mechanical extraction methods and technologies for deep-sea mining

TU Bergakademie Freiberg, Germany

On 21 April, the third instalment of the online lecture series on "Mechanical Extraction Methods and Technologies for Deep-Sea Mining" was presented by Dr. Taras Shepel.

Dr. Shepel is a research associate at TU Bergakademie Freiberg. His PhD thesis was related to the investigation of the process of digging marine sediments. In 2013, he took part in a marine expedition in the Black Sea, during which he investigated the dynamic and kinematic characteristics of a drag-bucket dredge while sampling sapropel sediments at a water depth of 2000m.
He is certified in computer modelling, analysis and the optimisation of machine design. He is the author of 30 scientific publications, including 2 patents. The development of technologies for the extraction of raw materials under extreme environmental conditions is part of his research interests.

Dr. Shepel started by setting the scene: due to the growing demand for raw materials driven by global trends such as population growth and the rise of the global middle class, mining will not disappear. In addition, a transition to a climate-friendly, low carbon economy will require a huge quantity of raw materials.

Seabed minerals are becoming an important strategic alternative for establishing a more diverse import market to secure domestic industries against market shocks and increased prices. At the same time, the most valuable marine minerals such as polymetallic nodules, polymetallic crusts and seafloor massive sulphides

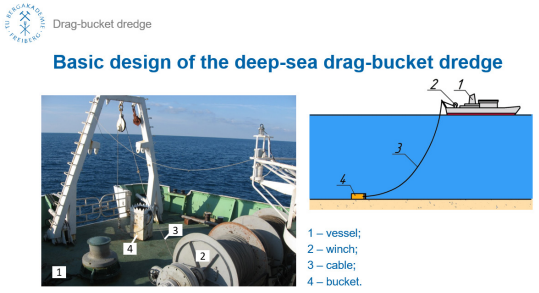
are located at great water depths and their recovery is extremely challenging. Mechanical extraction technologies for deep-sea mining are distinguished by their relatively simple design and flexibility.

However, they have several disadvantages constraining their widespread use for mining seabed minerals.

In his lecture, Dr. Shepel focused on different mechanical dredging methods considered for deep-sea mining applications. He explained the functionality of a drag-bucket dredge, clamshell-dredge and continuous-line bucket system. He discussed the disadvantages and limitations of a drag-bucket dredge compared to other options, which have a relatively low productivity due to the limited maximum bucket size, lack of control over the bucket, risk of cable entanglement and a possible negative environmental impact.

He then went further into the comparison of a drag-bucket dredge, the CLB system and a hydraulic dredge for the case of mining sapropel sediments in the Black Sea. This comparison provided very good results for the hydraulic dredge regarding annual capacity and costs per tonne, but the technical feasibility is unfortunately low.

During the Q&A session, the participants were especially interested in the environmental impact of deep-sea mining, which is an aspect that has yet to be investigated since the marine environment is, to this day, very much unknown. It showed that this is the reason why at the moment no deep-sea mining activities take place, but extensive exploration activities and tests of the excavation machines.



Professor Oleg Kazanin

Mining technologies & sustainable Development: challenges and prospects

Saint Petersburg Mining University, Russia

On 30 April, the fourth unit of the Austrian branch's online lecture series, entitled "Mining technologies and sustainable development: modern challenges and prospects" took place.

The lecture was held by Dr. Oleg Kazanin, Professor and Dean of the Mining Faculty at Saint Petersburg Mining University. Professor Kazanin is a member of the Research and Technical Council of the Coal Mining Industry and an expert in the research and educational sphere of the Russian Ministry of Science and Higher Education. He has published over 140 research works, including 9 patents.

Professor Kazanin started his lecture emphasising that the mining industry is the basis of almost every business value chain and that therefore, mining production plays an inevitable part in sustainable development.

He continued to show some challenges that mining technologies are facing nowadays, such as fluctuating mineral prices, different geological conditions, low ore grades, isolated mine sites that come with infrastructural challenges, and, lastly, often adverse community reactions to mining projects.

Considering global growth and regarding the general technology targets for 2030, there are some strategies in place to ensure that the future demands for mineral resources can be met:

This includes reduced consumption, using alternative materials, design and recycling of the products. Another important factor is the development of modern technology to improve efficiency, increase productivity and sustainability.

In the next part of his lecture, Professor Kazanin focused on the perspective of mining technologytrends. He mentioned that the choice of mining equipment and the continuing improvement of automation in mining machinery play a vital role in terms of efficiency. In addition, the change and adaption of mine layouts should be considered to increase productivity. He did, however, point out that these choices can be very different for each mine, since one solution does not fit all, and it has to be chosen accordingly to fit the geological, technical and civil circumstances.

This was followed by a segment about safety and risk assessments. Safety measures and possible hazards have to be considered throughout the entire life cycle of a mine. Multifunctional safety systems should be in place and continuously updated, as well as the ongoing training and development of personnel.

The following part of the lecture dealt with intelligent mines, in which 3D models of deposits and the processes are used to optimise the design of mining operations. In this context, IT technologies are used through all stages of modelling, resulting in a complete digital representation of the real production facility. During the production process itself, this concept is based on autonomous equipment, off-site services for machine diagnostics, remote operating centres with fewer operators, but more highly skilled employees.

Lastly, Prof. Kazanin touched on the topic of invisible mines. The implementation of this concept for large-scale mines still lies in the future. The lecture ended with a Q&A session in which the participants asked about the benefits of digitalisation in mining and the importance of data to ensure automated equipment is working the way it should be.

Dr. Yuriy Zhukovskiy

Digital competencies as a basic requirement for modern Mining and energy

Saint Petersburg Mining University, Russia

On 6 May, the fifth unit of the Austrian branch's online lecture series titled "Digital Competencies as a Basic Requirement for Modern Mining and Energy" took place.

The lecture was held by Dr. Yuriy Zhukovskiy, associate professor at the electrotechnical department and director of the Research Center for Digital Technologies at Saint Petersburg Mining University.

His lecture was divided into two main parts.

It started with an overview of the current global energy challenges, concerning not only the energy sources but also the energy consumption:
technologies are continuously improving and getting more efficient, but the number of energy consuming devices is rising rapidly. Another factor that often fails to be included concerning energy consumption and environmental footprints are cryptocurrencies.

Digital transformation will play a vital role in the global challenges that arise with our growing population. This growth comes with an increase of consumption of raw materials and energy, migration to large cities is expected and the living standards are rising globally. Scientific and technological processes will have to progress towards improvement and efficiency, especially focusing on the energy industry and energy consumption.

Dr. Zhukovskiy emphasised that, in order to become efficient and transform an industry, one also has to understand processes and be aware of the progress made outside of that industry, and for mining, energy sources and consumption are key sectors to observe.

He went on to the second part of his lecture by raising one important question: what is digitalisation? Most people, when thinking of digitalisation, have the change of an analogue process to a digital one in mind. However, it is not only a technical transformation, but a transformation of an entire industry. This includes transformations of business processes, in regulation, of the energy structure and in management.

Making these changes will take time, but when the transformation process is completed, a digitalised industry comes with a lot of benefits. The processes will be faster and the production will be a lot more flexible as it will be possible to easily adjust products to changes in the supply demand and the clients' needs.

In addition, the industry will be economically more efficient as the processes will operate together harmoniously.

Concerning the mining industry, Dr. Zhukovskiy was sure that, if the mining industry cannot be made efficient and sustainable, all other industries will not be efficient and sustainable, since almost every other industry is in some way connected to the mining industry.

He underlined the importance of digitalising systems as a whole, because just digitalising parts of them would not achieve big enough effects. It is essential to remember that investing in digital technologies means investing in the work towards the achievement of the sustainable development goals.

The lecture ended with a Q&A session, in which questions about cyber security concerning data used in mining and trends of artificial intelligence and virtual reality in mining were asked.

Dr. Philipp Hartlieb

Measurement and digital analysis of mining processes

Montanuniversität Leoben, Austria

On 10 May, Dr. mont. Philipp Hartlieb gave us an insight into the complex and challenging topic of “Measurement and digital analysis of mining processes.”

Dr. Hartlieb is a senior scientist at Montanuniversität Leoben, Austria. He holds an MSc in Applied Geosciences and did his PhD at the Chair of Mining Engineering of Montanuniversität Leoben on “Investigations on the effects of microwaves on hard rock” in 2013. His research focuses on rock fragmentation and excavation technologies, including drilling & blasting, mechanical excavation and alternative excavation methods, as well as the efficient acquisition, use and analysis of data in the mining process. This leads to a holistic picture of the entire process, quantifying the effects of upstream processes (e.g. blasting) to downstream (run of mine).

The lecture started with an example of a commonly used mining process; Dr. Hartlieb discussed the process steps where data can be generated. After the question where data is generated was answered, he asked the audience their opinion on what types of things could be measured, which happened through an interactive online poll. The wide variety of answers given from the audience mostly overlapped with his examples. This overview allowed a good insight into how huge and versatile the field of data measurement actually is.

He stressed how much digitalisation would actually be possible and how little was actually happening; this statement was backed

up with diagrams concentrating on the grade of digitalisation in different sectors of our daily lives and among others, one especially on the mining sector.

Nowadays, nearly every activity can be expressed through numbers. However, the true challenge is to use those numbers efficiently and transform them into usable information. An important factor for data analysis is the nature of the data. A distinction has to be made between quantitative and qualitative data, structured and unstructured data and last but not least, direct and indirect data.

After an explanation of the above-mentioned data types, he introduced the key performance indicators (KPI), a tool for working with data. Through data, we gain insight into the mining process; the KPIs act as a set of measures focusing on those sides of organisational performance that are critical for the success of the organisation. Which KPIs are important for an operation vary from mine site to mine site. They have to be chosen individually for every application. In the minutes that followed, Dr. Hartlieb explained several different types of KPIs. Using a case study, he went into more detail about technical, temporal and spiral KPIs and showed their operational value for a conveying process with trucks in a mine.

To close his lecture, Dr. Hartlieb emphasised the importance of choosing data to be processed carefully. What kind of data fits together? Is this kind of data meaningful? Is it better to elevate a small amount of data which is usable and expressive than to have a lot of non-significant data?

In the Q&A session, the attendees showed a keen interest, especially in methods for choosing the right KPIs for a process evaluation. Other topics of importance were the relevance of technical competencies of future engineers in the field of using evaluation programmes and programming in general.

Professor Nikolaus Sifferlinger

Emerging role of robots in mining

Montanuniversität Leoben, Austria

On 19 May, Professor Nikolaus Sifferlinger from Montanuniverstät Leoben shared his knowledge and broad work experience on the emerging role of robots in mining.

Dr. Sifferlinger has built his university career at Montanuniversität Leoben: in 2006, he earned his PhD on “Product Safety of automated Mining and Tunnelling Machinery;” in 2014, he became a senior researcher, lecturer and project manager and since 2016, he has been a professor of excavation engineering at the Chair of Mining Engineering and Mining Economics.

Professor Sifferlinger started his lecture with an overview of underground mining conditions. The harsh environment of an underground mine, like high temperatures at great depths, toxic gases, the danger of rock fall or rock burst, just to name a few, are demanding conditions for human operators. Occupational health and safety aspects add to this.

The desire to replace human operators with robots is a long-standing one. Besides the above-mentioned reasons, raising the efficiency of operations and the sustainable usage of resources are additional main drivers to establish fully automated mines.

Nowadays, the tasks of mining robots are exploration, roadway development, the installation of infrastructure production and transport.

Dr. Sifferlinger especially stressed the importance of the develop-

ment of robots in the area of maintenance and repair work, because without covering this working area, a take-over from human operators will not be possible.

In this context, it was also pointed out that budgets for R&D in the mining industry are limited; as a result, robots made for mining only are beyond reach.

Fortunately, an engineer would not be an engineer if he could not find a solution to this problem: removing human operators from dangerous areas is particularly a demand of the space and military industry. Those are sectors with an immense budget for development, which brought robots like the humanoid ATLAS and the four-legged SPOT (both from Boston Dynamics) to life. SPOT, for example, is already used at a mine in Sweden as a pilot project to monitor dangerous areas after rock bursts.

While Professor Sifferlinger mentioned that those high-tech robots are still ambitions for future mining engineers, he emphasised that there are robots already working in mines, for example the CAT Longwall Automation. This system operates in good coal seam conditions and is 98% automatic. Another example he showed the audience was autonomous trucks, which are used in underground mines just like they are in open-pit mines.

A point worth mentioning for him was the topic of cyber security. The threat of cyber attacks is a real one and has to be brought into consideration while planning an autonomous mine. He could not stress the importance of this topic enough.

To conclude his presentation, he introduced the use of mining robots in the interstellar sector as one of the future challenges mining engineers will face.

The subsequent Q&A mirrored the great interest of the audience. Many questions were asked, especially on the topic of autonomous mining, as it is not greatly present in the daily mining business, and how the realisation could be driven forward.

Dr. Michael Tost

Sustainability issues in mining

Montanuniversität Leoben, Austria

On 26 May, the eighth unit of the Austrian branch's online lecture series titled "Sustainability Issues in Mining – What Needs to Be Made Sustainable?" took place.

The lecture was held by Dr. Michael Tost, senior researcher at Montanuniversität Leoben and owner of Mango Impact e. U., a sustainability consultancy in Austria.

Before starting his own business, he worked for Vale, at the World Economic Forum, and for over 12 years internationally in sustainable development-related roles for Rio Tinto.

Dr. Tost's lecture revolved around the question as to whether or not mining can be sustainable. He focused on the three spheres that are impacted by the mining industry, namely the environment, society and the economy.

He took a short detour to the past and the beginnings of the mining industry, where mining used to have a relatively small impact on the environment and the public viewed mining as an important and respected branch of industry, as mining led many countries to increasing their wealth.

Dr. Tost went on to compare those perceptions of the past to where the mining industry stands today:

Water use, land use, and CO2 emissions not only impact the environment, but are also very present in the public eye, giving the

mining industry a bad reputation and public unacceptance.

Furthermore, many deposits of resources are located in areas with rich biodiversity, which is a cause for conflict.

In addition to that, automation plays a part in social and economic issues, reducing the number of jobs, especially in poorer regions.

Another aspect is the impact of the extraction of non-renewable materials on renewable materials, and if that impact is not more important to focus on than the finite nature of non-renewables itself.

The most important question of this lecture was a very basic one: What does sustainability even mean?

The answer to this question is that sustainability is dependent on the definition of the term “sustainability.”

Dr. Tost talked about the difference between weak and strong sustainability. The concept of weak sustainability assumes that sustainability can be achieved if well-being is increased. In other words, if a negative impact creates a positive outcome that outweighs the negative impact, the process is still sustainable, even if it is minimising natural capital.

Strong sustainability, on the other hand, says that wealth and well-being are limited by natural capital, and if natural capital is decreased, the process can never be sustainable.

He concluded that, depending on the definition, mining can be sustainable in terms of weak sustainability, but will never be sustainable in terms of strong sustainability.

In the following Q&A session, questions were asked about the time frame for sustainability in mining and how sustainability can be made a valuable asset for companies.

Dr. Sami Virolainen

Circularity of critical metals

LUT University, Finland

On 1 June, the ninth instalment of the Austrian branch's online lecture series with the title "Circularity of Critical Metals" took place.

The lecture was held by Dr. Sami Virolainen, leader of a research team in Industrial Hydrometallurgy at LUT University, focusing on solvent extraction and ion exchange.
Additionally, he is the director of a multidisciplinary research platform "Sustainable Circularity of Inorganic Materials."

Most raw materials used in modern technology, high-tech applications and energy applications are metals. The balance between the supply and demand of metals, above all critical metals, is a huge challenge, especially because primary resources in Europe are scarce, as stated by the speaker.

Although recycling processes for key materials are already increasing and advancing, the industrialised countries are exporting the majority of these highly valued materials in waste and scrap.

Dr. Virolainen drew attention to the challenge that comes with the concept of metal circularity. Even though in theory, you can separate anything from anything using solvent extraction, it is not possible in real-life industry since there are many other factors that need to be considered.
This includes process reliability, the availability of reagents, water balance, and impurities that might cause problems during the

separation. Besides, the cost of the process itself usually causes waste.

He put emphasis on the fact that one cannot focus solely on the technical aspect, but needs to consider economic, political, environmental and social aspects.

Dr. Virolainen continued his presentation by showing facts and figures about raw materials and their residues remaining in solid and liquid wastes of the mining and metallurgical industry.

One big sector with recycling potential he mentioned is anthropogenic waste, in other words electrical and electronic equipment. In Europe, out of the millions of tonnes of electrical and electronic products generated, less than 40% are reused or recycled. Advances need to be made concerning the recycling processes, but money is still a big factor. In order to get companies to recycle products, the recycling processes would need to be economically profitable.

He also touched on the topic of possible movable recycling plants. The idea is that a moving container with specific equipment needed for the separation would be cheaper than the transport of waste electronics.

He closed his presentation with an explanation of the functionality of solvent extraction and ion exchange. These procedures make it possible to recover critical metals, such as cobalt or lithium, with a very high purity.

The lecture ended with a Q&A session, in which questions about the likelihood and feasibility of a truly circular society and the flaws of circular processes were asked.

Industry Professor
Jutta Nuortila-Jokinen

Sustainable Development & Circular Economy

LUT University, Finland

On 11 June, the tenth unit of the Austrian branch's online lecture series with the title "Sustainable Development and Circular Economy" took place.

The lecture was held by Jutta Nuortila-Jokinen, who holds an industry professorship in separation technology in circular economy at Lappeenranta-Lahti University of Technology. She has over 30 years of experience in both academia and industry. Her special fields of expertise lie in a holistic approach and a deep understanding of separation technology when developing value added and environmentally benign processes and services for the process industry.

She started her presentation pointing out that consumption worldwide is rapidly growing and that a material-hungry world cannot be sustainable. Yet she stressed that a sustainable world has to include social and economic aspects, not just environmental ones.

Professor Nuortila-Jokinen stated that the core element of circular economy is the way of thinking. The mindset on the consumers' side has already begun to change. People tend to utilise their products longer and many are starting to buy second-hand. They are also opening up to question whether or not it is necessary to own a product, or if it is sufficient to rent it whenever they need it, carsharing being one example.

The way products are being built has noticeably changed in the past decades. Devices used to be designed for as big a lifespan as possible, and if parts of the device failed, the defective pieces were repaired or exchanged and the product could be used even longer. Nowadays, the service sector for repairs has almost disappeared, as new products are too cheap for repairs to pay off. This development leaves huge potential for young entrepreneurs to rebuild the service sector, focusing not only on repairs, but also take back programmes and reselling.

On the company's side, attitude is one of the first challenges that the sustainable development of a product has to overcome. The trend has been that when choosing a company to work for, more and more employees are taking the values into account that the company represents.

In the next part of her lecture, Professor Nuortila-Jokinen spoke about eco-design, which is the most applicable tool to design a sustainable circular economy.

It builds on the principle of continuously thinking about the product and on ways to improve it to have a lesser environmental or social impact. Making a product more sustainable can be economical if waste can be eliminated; less energy or materials are needed for production, which leads to lower costs.

In this context, considering the afterlife possibilities of a product is crucial during the design process, as the worst thing to happen would be for a product to end as toxic waste, because of one material that could have been substituted with something else.

She emphasised that listening to the consumer offers big advantages to a company. Knowing the needs of customers and using that knowledge to adapt the design of the product and improve ecoefficiency is key.

She finished her presentation with various examples of companies and products, and the lecture ended with the Q&A session.

Priv.-Doz. Dr. Katharina Gugerell

Montanuniversität Leoben /Boku Wien, Austria

The role of minerals safeguarding and possible land-use planning instruments

On 16 June, the eleventh unit of the Austrian branch's online lecture series with the title "The Role of Minerals Safeguarding and Possible Land-Use Planning Instruments" took place.

The lecture was held by Dr. Katharina Gugerell, senior research associate at Montanuniversität Leoben and tenure track professor at the University of Natural Resources and Life Sciences Vienna, who teaches internationally in several countries and has managed various international research projects.

As commonly known, minerals play an important role for the European economy. Even though the consumption of minerals per person is expected to go down, the overall consumption is estimated to almost double within the next 40 years, as many minerals are required for future technologies. Therefore, a strong interest on both the policy and industry levels exists to guarantee a secure and continuous supply of the said resources.

The extraction of resources is fundamentally shaping landscapes and transforming natural capital irreversibly. In addition, the extractive sector finds itself in conflicts with biodiversity conservation, urban development, water, animal herding and tourism.

Dr. Gugerell explained the difficulty of implementing safeguarding policies in Europe, as the European Union (EU) does not have the power to launch framework directives. The EU can only give recommendations; the responsibility of accepting and implemen-

ting those recommendations lies with each member state.

She highlighted this aspect with the presentation of policy networks and valorisation schemes for resources from several countries such as Sweden, Portugal and Austria. It showed the differences in the national interests and that the concepts themselves can be composed very differently.

Dr. Gugerell mentioned that safeguarding is still not embedded broadly. One challenge is that there is still little knowledge of how to translate sustainable development goals into feasible and appropriate instruments; another is the amount of information that is needed to actually declare a deposit as worthy of safeguarding.

She went on to describe the role of land-use planning in the resources industry. The aims are to plan and manage spatial resources ahead, while integrating and balancing the many different interests of the public and private sectors.

These competing demands are accelerated by the scarcity of land and the location dependency of resources, and may, in some cases, lead to conflicting directives.

It is essential to make systematic assessments of potential land-use options that fulfil the demands and needs of communities while safeguarding natural resources such as forests, agriculture, watersheds, ecosystems and mineral resources.

Dr. Gugerell closed her lecture emphasising once again the need for land-use policies due to the rising demand for raw materials. These instruments would need to be adjusted and translated into local implementation, as a one-size-fits-all instrument does not exist.

In the Q&A session, the participants were interested in the challenges that arise with conflicting directives.

Manuel Labrador Ortega, MSc

Mixed reality handbooks for mining education

MiReBooks

On 17 June, the twelfth part of the Austrian branch's online lecture series titled "Mixed Reality Handbooks for Mining Education" took place.

The lecture was held by Manuel Labrador Ortega, now project manager of "MiReBooks" at Montanuniversität Leoben.

Before, he worked in the oil and gas industry for four years, gaining insights into the digitalisation of the industry.

The project "MiRe-Books" is set to deliver new digital standards for higher education across Europe using virtual and augmented reality based (VR/AR) interactive mining handbooks for a new digital learning experience.

Nowadays, digital technologies are introduced into our lives from a very young age, changing the way we assimilate information. Yet, throughout the years of education, the methods of learning are still mainly paper-based and technologies are just slowly starting to be implemented in everyday school life.

For engineering students, the topics become increasingly complex and, in some cases, are abstract and difficult to understand. In this scenario, visiting real operations helps to understand and assimilate these concepts.

Nevertheless, operating sites are often hardly accessible because they are remote and hazardous for students.

MiReBooks is creating a series of mixed reality (MR) mining books that bring the mine into the classroom and enhance the comprehension of complex topics with 3D models that are visualised in AR and VR.

For this purpose, 3D models of mining machinery are created and 360° videos of mining sites across Europe are filmed.

In addition, suitable texts are written to create a complete learning experience.

MR lectures can be created using the MiReBooks software. This enables the lecturer to add and edit 360° videos and 3D models to the slides in a very user-friendly manner. During the lecture, the software allows the professor to control the lecture from a device, such as a tablet, and interact with the students as they visualise content in VR.

It should be pointed out that this method is not solely limited to the mining sector, since the software for creating the presentations is completely independent of mining.

Other fields, such as medicine, can also make use of it as long as the digital content is available.

In the following Q&A session, questions were asked about the chance of making mining more appealing to younger students with this software.

MiReBooks in action in a classroom

Dr. Christoph Ponak

The role of engineering in tackling climate change

Engineers for a Sustainable Future, Austria

On 23 June, the thirteenth unit of the Austrian branch's online lecture series with the title "The Role of Engineering in Tackling Climate Change" was held by Dr. Christoph Ponak.

Dr. Ponak is a senior scientist at the Chair of Thermal Processing Technology at Montanuniversität Leoben. His research concentrated on high temperature recycling processes for communal and industrial residues. He also co-initiated and co-leads the environmental protection association's "Engineers for a Sustainable Future" and "shiftTanks."

This session began with an introduction to sustainable development. He outlined that in order to be able to start thinking about sustainable development, basic needs of the people have to be met. Bluntly said, it has to be easily achievable for people "not to die." If this is possible, people get quality of life and well-being. Having this state of comfort then puts them in the position to concern about sustainable development.

The definition builds on the well-being of the people and is defined in the Brundtland Report as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

It is not a coincidence that many of the Sustainable Development Goals concern social issues, such as no poverty, zero hunger and good health.

Dr. Ponak continued to talk about the basics of climate change. He explained the greenhouse effect and went into detail about the history of atmospheric CO2 concentration and the functionality of proxies, which are measurable indicators for past atmospheric compositions.

Lastly, he also touched on current threats to natural, managed or human systems, such as corals, flooding, crop yields, tourism or heat-related morbidity and mortality.

The lecture then switched into a workshop that encouraged all the participants to actively engage in the topic. They were put into several groups and discussed the two questions that Dr. Ponak had posed.

The first question was “What can we do and what is the single most important climate solution?”, followed by the second one, “Who is responsible to act and who is the single most important actor?” Each group put their answers collectively into a poll, after which all of the answers were discussed with Dr. Ponak.

For the first question, answers varied from social responsibilities, reducing emissions, renewables, to change of consumption patterns. As for the second question, over half of the participants put the government as the most important actor, followed by the individual.

At the end of his lecture, he suggested that our society tends to see a problem as solved as soon as people agree on a solution, even though it has not been executed yet. Many climate solutions are very material-intense and producing all the materials needed will take time, effort and money. This makes the availability of climate solution technologies an issue. It will also be hard to achieve sustainability if it comes with personal sacrifices for the individuals.

The participants really enjoyed this different style of lecture.

Oliver Gulas-Wöhri, MSc

Sustainable Development in former mining regions across Europe

UNESCO Geopark Styrian Eisenwurzen, Austria

Organisation der Vereinten Nationen für Bildung, Wissenschaft und Kultur

Steirische Eisenwurzen UNESCO Global Geopark

On 24 June, the fourteenth and final unit of the Austrian branch's online lecture series with the title "UNESCO Global Geoparks – Sustainable Development in Former Mining Regions Across Europe" took place.

The lecture was given by Oliver Gulas, who holds a master's degree in Mountain and Climate Geography and is the CEO of the UNESCO Global Geopark Styrian Eisenwurzen.

UNESCO Global Geoparks are single, unified geographical areas where sites and landscapes of international significance are managed with a holistic concept of protection, education and sustainable development. These Geoparks contribute to eight of the seventeen Sustainable Development Goals, such as quality education, climate action, or responsible consumption and production. Today, about 170 UNESCO Global Geoparks exist in over 40 countries, many of them in Europe and Asia.

Mr. Gulas went into detail about the Geopark Styrian Eisenwurzen, located in the heart of Austria around the Styrian Erzberg, which is the largest open-pit iron ore mine in central Europe and the largest siderite deposit worldwide.

Over 80% of the Geopark's area is covered with forests, and the landscape is shaped by 2 rivers. The Geopark contains gorges and caves, castles and waterfalls, museums for forestry or fossils.

The projects within this area are dedicated to preserving nature and protecting habitats, flora and fauna. They are designed to teach people about the geology and nature around them in a playful, interactive way, for example GeoRafting, which is a rafting tour that also teaches about the geological phenomena in the area. The Geopark is also a popular destination for school classes.

The lecture continued with the presentation of various UNESCO Global Geoparks across Europe:

- Ore of the Alps, located near the city of Salzburg, where the mining of copper, iron and gold has determined life for over 5500 years.

- Karavanke, a cross-border Geopark of Austria and Slovenia. The area has a rich iron and coal mining tradition, and is known worldwide among mineralogists for its lead and zinc ore deposits. They are currently working on a long-distance hiking trail around the Park with a length of 260 km and 12 daily stages of the trails to raise awareness of the rich geodiversity.

- Idrija Geopark in Slovenia, situated at the junction of two mountain ranges, creating an exceptional geoheritage with deep gorges, tectonic phenomena and deposits.

- Geopark Harz in Germany, the largest Geopark in Europe, that is filled with former mining geosites and where former quarries are now home to protected animals and plants.

- Troodos Geopark in Cyprus, that includes the biggest historic asbestos mine in Europe. The rehabilitation of the mine is now a big development project of the region, and already half of the area has already been reforested.

The lecture ended with a detailed Q&A session, giving insights into the management of such Geoparks and ongoing projects at Styrian Eisenwurzen.

OUTLOOK: ONLINE LECTURE SERIES - PLANETARY BOUNDARIES

Have you heard about planetary boundaries? And would you ever connect mining engineering and ocean acidification? What about engineering processes affecting the atmospheric aerosol loading?

Announced in 2009, the **planetary boundaries** framework became a foundation for the United Nations Sustainability Developments Goals.

The Austrian branch of the International Competence Centre for Mining-Engineering Education under the auspices of UNESCO has given priority to the topics of sustainability, the global supply of raw materials and raw materials policy.

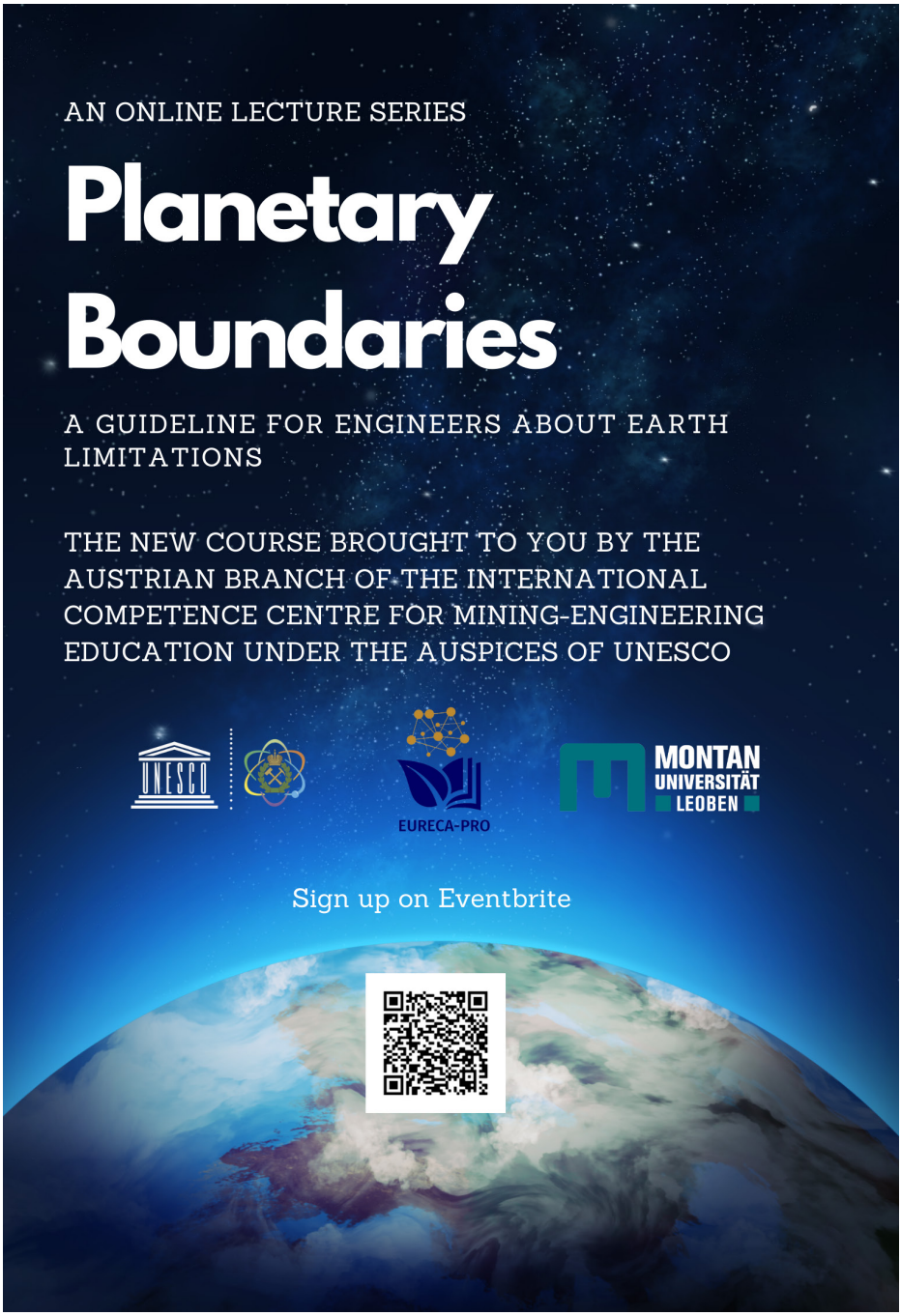
It is aligned with the strategy of the Centre to implement knowledge about sustainable development in our study programmes and research activities.

With great acknowledgment of the importance of the planetary boundaries' framework, the Austrian branch is offering a special course on this subject **to raise awareness** of planetary boundaries to a **new generation of engineering students and professionals.**

The live lectures will be held online. Participation is free of and open to everyone upon registration on Eventbrite.

During this series, the concept of planetary boundaries will be introduced by **international experts**.

The lecture series starts in the second week of October 2021.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