Towards Earth Resources:

Challenges of the Automotive Industry

Proceedings of mini-workshop TER2021

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Preface

We live in turbulent times. The events of the past months have shown us a mirror of our society in many ways. They have alerted us to the importance of human life, healthy environment, interconnectedness of the economy and industries... The months of the pandemic have particularly highlighted the importance of scientific research and the links between research and practice. The period of lockdowns and isolation considerably complicated the functioning of the society in this respect as well and deepened the essential need for personal contact. For these reasons, we especially appreciate, dear workshop participants, that we can welcome you at this event in person. As the current restrictions allow us to hold this workshop only in a restricted form of a mini-workshop, we decided to target it in one of the key areas of the Slovak economy - the field of automotive production. Therefore, the current mini-workshop *Towards Earth Resources* (TER2021) is subtitled *Challenges of the Automotive Industry*.

The aim of this mini-workshop is to discuss current topics and issues of this key sector in Slovakia in the presence of participants from both the university and research environment as well as participants from the environment of automotive suppliers. Although the number of participants is limited due to the current pandemic situation, we believe that discussing these important topics in person has its added value.

Mini-workshop TER2021 is organized by the Slovak Society of Applied Cybernetics and Informatics (SSAKI) a member of the Association of Slovak Scientific and Technological Societies, namely, the branch office of SSAKI by the Institute of Control and Informatization of Production Processes (SSAKI URIVP) of the Faculty of Mining, Ecology, Process Control and Geotechnology of the Technical University of Košice, Košice, Slovakia. On the behalf of organizers of the event, let me express the hope that you will enjoy the TER2021 workshop.

Erika Fecková Škrabuľáková - Editor

Programme

9:00 a.m. - 9:15 a.m.	Registration of participants
9:15 a.m. - 9:20 a.m.	Opening of the event
9:20 a.m. - 10:30 a.m.	1st block of lectures
10:30 a.m. - 10:50 a.m.	Coffee break, refreshment
10:50 a.m. - 12:00 p.m.	2nd block of lectures
12:00 p.m. - 1:00 p.m.	First problem section, brainstorming
1:00 p.m. - 2:00 p.m.	Lunch
2:00 p.m. - 3:10 p.m.	3rd block of lectures
3:10 p.m. - 3:30 p.m.	Coffee break, refreshments
3:30 p.m. - 4:15 p.m.	4th block of lectures
4:20 p.m. - 5:20 p.m.	Second problem section, brainstorming
5:20 p.m. - 5:30 p.m.	Closing of the event, summary, conclusions

1st block of lectures	
9:20 a.m. – 9:40 a.m.	***Monika Ivanová et al.:*** On the Preparation of Slovakia for the Massive Usage of Electric Cars
9:45 a.m. – 10:05 a.m.	***Lukáš Vrteľ:*** Technology Pathway on the Road to Zero Tailpipe Emissions
10:10 a.m. – 10:30 a.m.	***Erika Fecková Škrabuľáková and Aman Upadhayay:*** On the Modeling of the Context of Exhaustible Earth Resources Extraction
Chairman:	***Beáta Stehlíková***

2nd block of lectures	
10:50 a.m. – 11:10 a.m.	***Ladislav Drančák:*** On the Use of Machine Learning Methods to Control Production Processes
11:15 a.m. – 11:35 a.m.	***Beáta Stehlíková:*** Statistical Evaluation of Contact Forces on Guide Idlers at Pipe Conveyor's Belt
11:40 a.m. – 12:00 p.m.	***Matúš Kopil:*** The Influence of Different Corrosive Environments on the Static Strength of the Rope Used for Rescue
Chairman:	***Martin Szabó***

First problem section	
Chairman:	***Andreas Volkov***

3rd block of lectures	
2:00 p.m. – 2:20 p.m.	***Gabriela Bogdanovská:*** Human Reliability Assessment at Concluding Tests in Automotive Industry
2:25 p.m. – 2:45 p.m.	***Andreas Volkov:*** On the Ensuring of Technical Purity in the Production of High-tech Systems and Components for the Automotive Sector
2:50 p.m. – 3:10 p.m.	***Mária Ždímalová:*** Image Processing in Industry, Engineering, Civil and Mechanical Engineering
Chairman:	***Monika Ivanová***

4th block of lectures	
3:30 p.m. – 3:50 p.m.	***Martin Szabó:*** Advanced Solutions of U. S. Steel Košice for the Automotive Industry
3:55 p.m. – 4:15 p.m.	***Jana Šoltész Matulová et al.:*** Reducing the Environmental Burden of Soils via Treating the By-products of Steelmaking Process as Secondary Raw Materials
Chairman:	***Mária Ždímalová***

Second problem section	
Chairman:	***Erika Fecková Škrabuľáková***

Contents

Human Reliability Assessment at Concluding Tests in Automotive Industry

Gabriela Bogdanovská[1]

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This contribution is focused on the analysis and reliability assessment of the human factor in conducting serial sample tests from automotive industry. When tests are realized, it is very important that these are objective and reliable [1]. Human factor failures and errors can have fatal consequences for society [2]. The assessment of the reliability of the human factor is performed in the individual activities of the operator, which he performs during the testing [3][4]. The form was designed and created, based on the TESEO (Tecnica Empirica Stima Errori Operatori) method for the reliability evaluation of the human factor [5]. The TESEO technique describes the probability of a system operator's failure as a multiplicative function of 5 main factors, which are: The type of task to be executed; Time available to the operator to complete the task; The operator's level of experience/characteristics; The operator's state of mind; The environmental and ergonomic conditions prevalent. The result of the assessment determines the most critical human activities at tests execution. The critical activities are subject to analysis and evaluation. Afterwards the preventive and corrective steps are proposed. These measures can reduce human factor failure probabilities and improve the reliability of the activities performed.

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On the Use of Machine Learning Methods to Control Production Processes

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Using the data collected in the manufacturing industry, we will seek to integrate machine learning methods aimed at optimizing production and manufacturing processes as such. Through our data analysis, we will be able to identify where more accurately in the process it is possible to improve the process, predict the error rate of equipment. Defining a shortage leads to savings in resources and time. In this case, we will use artificial neural networks (ANN). The main advantage of this ANN is that it is possible to use a large amount of data that does not assume a predetermined model. The created models include the use of measured data for their eventual optimization, which are used for their performance analysis. We will be able to determine the resulting data: predict machine error rate, machine performance and process production improvement.

On the Modeling of the Context of Exhaustible Earth Resources Extraction

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[2]Rajiv Gandhi Proudyogiki Vishwavidyalaya (Technological University of the State of Madhya Pradesh), Bhopal, Madhya Pradesh, India

The growing demand for minerals related to the development of industry, transport and the growth of the global population and amount of vehicles used is reflected in increased extraction of raw materials such as oil, coal and natural gas. As these key raw materials belong to the exhaustible earth resources, it makes sense to perceive their extraction in a global context. This point of view is necessary, despite the fact that the data relevant to a given raw material are ordinary given in different units of measure: oil production is typically expressed in thousands of toe per year or thousands of barrels per day, annual coal production is usually given in exajoules and coal mining is routinely given in billions of cubic meters per year. The question is how to compare the individual levels of parameters and express their interrelationships. In this contribution, we discuss the possibilities of such expressions through the use of unusual three-dimensional graphic design techniques with computer support or acoustically modulated data perception techniques, i.e. not only by visualizing them in tabular or graphical form, but also by involving other sensory perception, namely, hearing.

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On the Preparation of Slovakia for the Massive Usage of Electric Cars

Monika Ivanová[1], Erika Fecková Škrabuľáková[2], Andrea Rosová[2], Elena Grešová[2], Marian Šofranko[2] and Vojtech Ferencz[2]

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In the connection with saving mineral resources and the reduction of greenhouse gas emissions the question of electromobility is widely discussed theme nowadays. In order to fulfill decarbonization targets, incentives of many countries lead to the support of electromobility. In this contribution we discuss the question to which extend is Slovakia prepared for the wide-spread utilization of electric cars. We compare the data related to car-electromobility in Slovakia with those related to other Visegrád Group countries, selected European countries and the European Union average. For this purpose we define and utilize the infrastructural country electromobility coefficient. Its computing is covered by the appropriate analysis and calculations done previously. Several indices that keep particular information about the state of preparation for electromobility are discussed here, as well. Based on the data obtained, we show that the stage of preparation of Slovakia for electromobility among Visegrád Group countries is rather good, although it is far behind the European Union leaders. We also show that the rapid growth of electromobility infrastructure in Slovakia in the last 5 years influenced the stage of its preparation for the massive usage of electric cars in a very positive manner.

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The Influence of Different Corrosive Environments on the Static Strength of the Rope Used for Rescue

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There are many chemicals used during the production process in industry. This is not only the case considering heavy industry but also in the chemical and other industries, automotive industry inclusive. In the situation of an endangerment of the health of employees in the case of an unexpected event, rescuers must have precisely defined procedures for rescue in such an environment. A rope is a part of the material used by the rescue. The corrosive environment affects its properties a lot. The contribution deals with the change of the properties of such a rope due to the corrosive environment. The commonly used chemicals and chemical reactions in the rope material, as well as the parameters of the rope before and after its exposure to the corrosive environment are presented and discussed here. The knowledge of the change in the parameters of the rope can be taken into account during the implementation of the rescue operation, what allows the rescue services directly to implement it without further threat to rescuers or rescued.

Statistical Evaluation of Contact Forces on Guide Idlers at Pipe Conveyor's Belt

Beáta Stehlíková[1]

[1]Technical University of Košice, Košice, Slovakia

In this contribution the computed effect of changes of tension force of conveyor belt to the value of contact forces is presented. Measurements were realized at a model of the hexagonal idler housing of pipe conveyor. The concept of the test equipment at the Technical University of Košice is designed so that it represents the section of pipe conveyor in which the conveyor belt is transformed to the pipe form. The measured data are presented by descriptive statistics. For this purpose results are compared by nonparametric statistical methods. We discuss cause and effect diagram, which presents the variability of measured data as the effect. Causes presented potential sources of variability during the process of measuring contact forces.

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Advanced Solutions of U. S. Steel Košice for the Automotive Industry

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The ability to transport us to almost any place is what makes a car irreplaceable. The most widely used material in vehicles is steel due to its mechanical properties, efficiency and affordability. Steel is a universal, fully recyclable and sustainable material. In cooperation with customers from the automotive sector, the goal of U. S. Steel Košice is to make every effort in order to develop innovative solutions. Meeting the increasing demands on lighter and stronger steels is a good way for the company to help make transport more environmentally friendly. Lightweight steel with exceptional strength is designed for the production of car units with low CO_2 consumption. While in 2015 the permitted value of emissions production in the automotive industry was at the level of 130g CO_2/km, the standard for 2021 reduced it to 95g CO_2/km. As the average value of CO_2 from exhaust gas production in Europe is currently 123.4g CO_2/km, it makes sense to consider possibilities for reducing it. One such possibility is the reduction in vehicle weight, because every weight reduction of approx. 12 kg is reflected in a saving of 1g CO_2/km. U. S. Steel Košice provides a wide range of steels for variable applications in the automotive industry. As raising road safety standards is key in the development of solutions for the automotive industry, it is important that steel produced by this company is also suitable for the production of safety parts, reinforcements, beams, discs and brakes. High-strength steel is an universal material for the production of light vehicle components, which is characterized by high mechanical resistance, better energy absorption in the event of crush and increased fatigue resistance. Lightweight steel construction reduces vehicle weight while maintaining strict safety standards. U. S. Steel Košice produces steel in accordance with the quality standard EN ISO 9001 and ISO/TS 169 49 for the automotive industry. In this contribution, we present the advanced solutions of US Steel Košice for the automotive industry, which were created thanks to the active cooperation with car manufacturers. This above-standard cooperation aims to meet the growing demand for safer, lighter and greener vehicles with a gradual reduction in emissions and energy consumption throughout the vehicle's life cycle.

Reducing the Environmental Burden of Soils via Treating the By-products of Steelmaking Process as Secondary Raw Materials

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One of the basic prerequisities of automobile production is the supply of high quality steel. During the last decades of years the world's annual steel production has been steadily increasing except of two small fluctuations. This resulted in a huge amount of by-products of steel industry such as dusts, sludges and slags. Average production of one tonne of steel results in formation of various volumes of by-products, which vary from 200 kg up to 400 kg. These can be treated either as wastes that burden the environment or as secondary raw materials that can be reused. Here we discuss recycling perspectives of these items based on series of experiments in which the amount of quartz, as well as the percentage Fe and Fe oxides, calcium and zinc oxides have been determined. The work is important from the environmental point of view as it brings a complex view on the characteristic properties of steelmaking dusts and sludges in the shape of physico-chemical and morfological properties, granulometric composition, mineralogical and thermal analysis.

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On the Ensuring of Technical Purity in the Production of High-tech Systems and Components for the Automotive Sector

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Every modern company tries to meet the prescribed requirements and expectations of its customers because the high quality is what differentiates it from the competition. The need to quantify the extent to which all requirements and expectations can be met is therefore more than current. An important element of the entire quality management in the complete life cycle products of the automotive industry is the knowledge and proper use of the so-called core tools. These include advanced quality planning product, which means analysis of errors and their consequences, analysis of measurement system, production parts approval, and statistical process control. Nowadays, especially in automotive industry, there is an increasing emphasis both on the quality of the final product and the quality from the stage of its development and the very course of production. It is true that the product, which is to be fully functional and suitable for use, should be manufactured in a stable manner process. In practice, this means that the process should be capable of producing with acceptable variability of all predetermined quality indicators, influenced only by random ones causes. Each process can be characterized by one or more variables - quality indicators, which are at the same time regulated quantities. In our case the controlled variable in the case of purity tests is the number of particles of different sizes present on the components. This contribution deals with the implementation of statistical process control into a specific production process of the Magneti Marelli in order to monitor the cleanliness of components on a selected production line.

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Technology Pathway on the Road to Zero Tailpipe Emissions

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As the auto industry moves towards a low emissions era, tightening and converging fuel efficiency and emissions standards leads to broad adoption of engine boosting systems. Over the half of all gasoline powertrains are expected to be turbocharged by 2022. Garrett is the market leader in turbo technologies in every region of the world and across all vehicle classes and engine types. This is due to its world-first gas variable geometry turbo, which works in tandem with combustion phasing to improve engine thermal efficiency, enhance fuel economy, reduce CO_2 emissions and deliver best-in-class performance as well as thanks to its pioneer variable nozzle turbine and two-stage systems for diesel cars and trucks, what leads to opening up of the engine downsizing options for automakers through impressive power density, while improving fuel efficiency and reducing NO_x and CO_2 in real world driving conditions. But as the needs to reduce dependency on fossil fuels are quickly creating demand for alternative sources of energy, the growing trends towards hybridization open up possibilities to transfer electric boosting technology from racetrack to road, as well. Therefore, Garrett is pioneering E-Turbo technology to deliver superior performance, fuel economy and emissions, by integrating state-of-the-art, ultra-high-speed electric motors and power electronics into its turbocharger product families. In this contribution our boosting technologies, including turbochargers and compressors, are discussed, which enable to meet stricter fuel economy standards without compromising driveability. This is creating new benchmarks in environmental performance and unlocking a technology pathway on the road to zero tailpipe emissions.

Image Processing in Industry, Engineering, Civil and Mechanical Engineering

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Mechanical and geotechnical engineers use image processing as a tool of analyses for different industry materials. In this contribution we discuss the use of the computed tomography to explore the microstructure of materials in industry, civil engineering and other industry topics. Consequently we use and apply different techniques for segmentation of give data. Our data are provided as images. Our aim is to detect concrete microstructure of materilas and serach for elements, minerals (cruis, vids, etc.). Presented segmentation methods are graph cuts, pixel aggregation methods, segmentation by weighted aggregationand tresholds techniques. The main objective of this contribution is to present new applications of the image processing, segmentations, computed tomography, different from convetional ones. Our aim is to study microstructure and defects of materials using segmentation mathematical techniques and theirs optimization.

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