Automation and Control in the Study Program of Mining Engineering Education

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Abstract: There was a creative discussion, in the frame of ICEE 1999 international conference, regarding the united study program for the world study of Mining Engineering. The number of mining engineers who are educated all over the world is not very high, but their importance for the human life is significant. The work and knowledge of our mining engineers are closely connected to the income of people to the nature, to the utilisation of natural and energy sources, to construction of transportation systems, etc.

From this point of view you can see the importance of united educational program of mining engineers. This way we can publish valuable textbooks for mining engineers from almost all countries of the world. The unitisation will provide the real possibility of short term exchanges of pedagogues among world mining universities, exchange of experiences, exchange of students, cooperation with processing of diploma thesis, etc. We are almost sure; it will initiate the foundation of international university mining society (union) based on the cooperation of world mining universities.

This particular contribution deals with the international mining curricula from the side of cybernetics, control and automation. For this education area there was advised the space of 225 hours of lessons of the whole five years engineering study program (5%). The main emphasis is placed on the properties and basic description of dynamic system, general utilisation of control principles and mining process instrumentation. Next part is oriented to the utilisation of special SW packages for design and evaluation of different mining activities up to utilisation of virtual reality.

Keywords: cybernetics, engineer curricula, mining, education

1. Introduction

In the first part of this contribution I would like to deal with the role of cybernetics in the engineering education in generally. The human society is governed by information, informatics forms all human activities and each industrial activity effectively depends on the level of cybernetics principles utilisation.

The usual engineering study has to provide students the general cybernetics education in their curricula. This way the huge advantages of up to date information technologies can be provided. The general cybernetics idea, which is not used very often within the systems of engineering education, comes from the biological systems similarities. You can see the cybernetics approach especially at sceptron analysis of technological processes, which is at biological systems performed through biological sensors and brain (biological control system), [2].

The meaning of presented paper is to highlight the necessity of cybernetics in engineering curricula and to highlight the importance of some subjects that could not be omitted in engineering education, subjects with high importance with the respect to technical systems analysis, control and optimisation. I am sure that the above-mentioned cybernetics principles have touched and will form the engineering education in next millenary. We do use the principles of cybernetics approach of technical systems within the education at our university. The right understanding of these principles creates the base for the next successful operation, management and control of technologies in all branches of human activities.

We can see only very rarely the full interconnection of all information forms and functions within the teaching process. The information has been understood as the data that the professor explains on the lecture. There were very rapid development and advances of information technologies in last years, which leads us to full connection of information forms - data, text, sound, picture - with their functions - processing, generation, storing, transmission. You can see the interconnection of information forms especially in computers (data, text, pictures) or in videoconference systems (sound, pictures, text). Combination of information functions are used within telecommunication systems and especially in computer networks, where the information is generated, processed, transmitted and stored, [3].

Phenomena mentioned above leads to informationalisation of human community. The main task for modern university lecturer has been and will be the effective utilisation of all advantages of multimedia technology within the teaching process and next utilisation of computer technology with the aim of cybernetisation of all production activities in future human community. To be able to solve this problem, we have to utilise modern cybernetic methods of analysis and synthesis of technical tasks with creative application of cybernetic view of studied problems. The classical education methods that have been used in engineering education so far, cannot support the next development and utilisation of general cybernetic income to analysis and synthesis of engineering tasks.

2. Cybernetics in the engineering education

I can characterise the usual educational process by relatively high level of basic theoretical subjects that provides tools for analysing and generalisation of important relations within technological processes of studied specialisation. The cybernetic view of some technical systems is focused especially to optimisation of control activities, with respect to aspects of economy, energy, ecology, etc. that forms important parts of synthesis and application of this system. The cybernetic view of technical problems is based on detailed system analysis of studied task, with the aim of utilisation of supervised information within the feedback control loops, to control the interactions between the technical system and surrounding environment. In such a systems, the classical information technologies are focused to obtaining and processing of the information from state variables and binary states.

The analytical study of biological systems gives us the patterns for cybernetic principles application in technical systems. The information processes of sceptron character are used, without any exception, in all high-level biological systems that were developed by the nature through billions of years. The base is the utilisation of acoustical information, vibrations and resonance properties within the biological and consequently in technical systems. Next important part of such information is analysis of heat or photons flows or the production scene processing (perceptron information). We have got very effective mathematical tools in the form of software packages and hardware equipment for the analysis of such a signals.

Different situation is in the field of utilisation of sceptron information in synthetic phase of systems design; it means the utilisation for the control systems design and implementation of computer technique. With respect to the fact, that the information, obtained by the analysis of technological signals, has very complex characteristics and multidimensional relations, it seems to be very useful to apply here the advantages of fuzzy logic, neurone networks and genetics algorithms, for the technical cybernetics systems optimisation. Even in this field we can find very wide range of excellent literature and hardware and software tools that can satisfy very effectively the demands of both engineering education and industrial production. For this reason, I would like to give you in next chapters some ideas connected to role of cybernetics in the engineering curricula.

3. Cybernetics in the engineers curricula

Basic idea regarding the curricula of mining engineer of 3-rd millennium provided Professor Strakos on the board of the last ICEE International Conference in Ostrava, Czech Republic [4]. The engineering study program is there divided into 4 thematic areas:

1. *Engineering foundation of study*
2. *Specialised disciplines*
3. *Economics*
4. *Social sciences*

Cybernetics forms a part of specialised disciplines, it means about 5% of the whole lessons, see figure 1. But I am sure, that cybernetics has to be a very important part of each of mentioned thematic ranges, except of social sciences. For example the first thematic area, *Engineering foundation of study*, should cover basic subjects as *Informatics, Systems Theory and Computer Technique*. The thematic range of *Economics* should cover *Logistics* and utilisation of up to date *SW tools and packages* like *ERP or MRP systems* This subjects should be generally in the curricula of engineering study program.

The thematic area of specialised disciplines contains five parts:

- *Geological disciplines*
- *Mining disciplines*
- *Electrical engineering*
- *Mining mechanization*

- *Cybernetics*

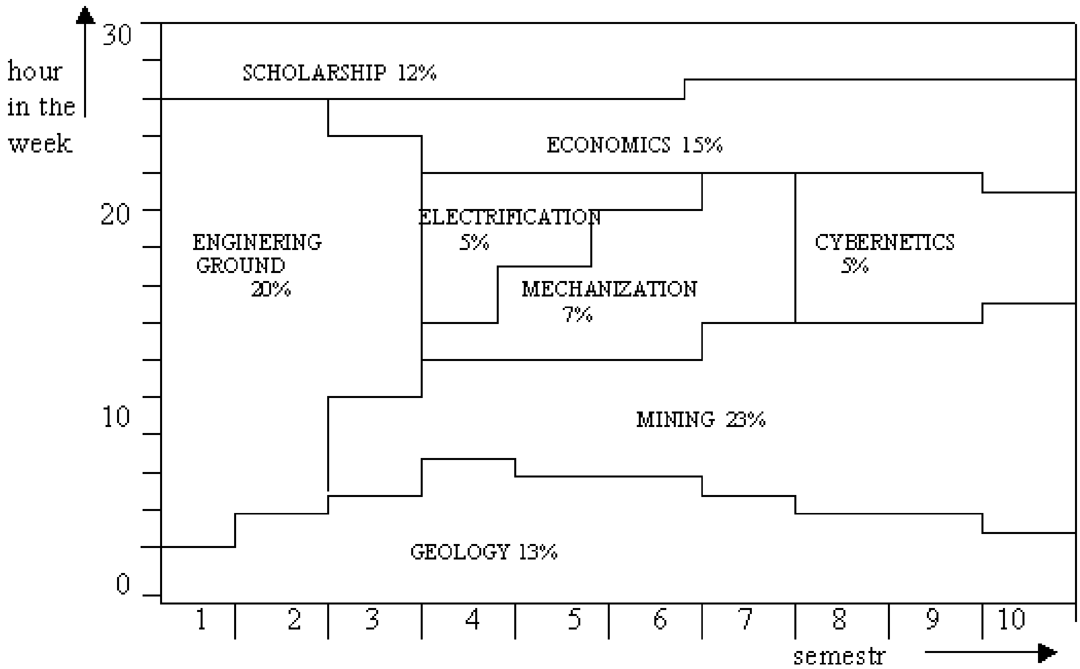

Figure 1: Time schedule of specialized study areas, [4].

It will be very useful to include some cybernetic subjects into the five above-mentioned parts. For example *Geological disciplines* provides students *Geoinformatics* and *3D deposit modelling*, *Mining disciplines* provides *special SW tools* for mine design, modelling and optimisation *(VULCAN, SURPAC)*, *Electrical engineering* provides *Electronics* and *Actuators* and *Mechanisation* part provides special robotics. All above-mentioned subjects will support subjects of *Cybernetics*, as the base for mining automation.

4. Cybernetics in mining engineering

For this part of mining engineer education the space of 225 hours of lessons of the whole 5 years engineering study program (5%) was advised. The main emphasis is placed on the properties and description of dynamic system, basic control principles and mining process instrumentation. Next part is oriented to the utilisation of special SW packages for design and evaluation of different mining activities up to utilisation of virtual reality.

I have recommended the increasing of the space of education up to 7% of the whole engineering study program, to be able to learn five special cybernetics subjects:

a) Automated control theory
b) Instrumentation and technical means
c) Mining automation and distributed systems
d) Modelling and SW support
e) Intelligent systems

The cybernetics subjects have to start in the third year of study, in 7-th semester and each should cover 60 lessons (2+2). I suppose for 7-th semester the first two subjects, 8-th semester the c) and d) subjects and for the 9-th semester the e) subject. I advice to increase the lessons amount per semester up to 32 or 33. This will create the space in the 10-th semester for thesis processing and compiling.

a) Automated control theory

This subject provides to the students information from linear control systems theory, basic knowledge of linear dynamic systems behaviour description, knowledge of control systems structure and controller synthesis.

b) Instrumentation and technical means

This subject provides the information from technological process instrumentation, principles of measuring of technological signals and its processing, basic description of sensors and actuators.

c) Mining automation and distributed systems

This subject provides basic information about both underground and opencast mining automation; automation of preparation plants and gives the students basic description of distributed control systems

d) Modelling and SW support

This subject provides basic information about modelling and simulation of mining systems and technologies and about SW support of automation – SCADA systems and special mining SW packages.

e) Intelligent systems

This subject provides basic information regarding artificial intelligence and artificial life application, utilisation of neural networks, fuzzy logics, expert systems and virtual reality for mining control and automation. It is a platform for the future of mining automation.

5. Conclusion

We can find some perspectives of future mining activities within the project Intelligent mine, which was announced by Helsinki University of Technology. All mining activities should be controlled from special control rooms on the surface, with utilisation of full-automated machines and technologies. The future engineers will not be able to control and evaluate the complex technological processes behaviour without the utilisation of general cybernetic view on the processes. Modern complex analysis of technical systems needs detailed description of their structure and behaviour - static and dynamic properties, with respect to essential connections to the environment and with respect to internal complexity.

I am sure, that modern cybernetic methods are not utilised and presented enough in engineering curricula. You can see the advances of cybernetisation and informationalisation of all aspects of human life. The next step, to take profit from the huge potential of computer technique, is the effective utilisation of information processed by information systems and next application of this information in feedback control loops in industry and services. The success of mentioned feedback control is determined by the quality of analyse of controlled system and must come from very serious cybernetic view of the systems and their environments. I do believe, that cybernetic sensing of engineering problems and technologies will be the most important base for effectiveness of all human activities, from the very beginning of next millennium.

The cybernetic view of human activities has to create basic part not even of engineering education, but necessary educational base of all specialists, that will influence future development of human society.

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