New Horizons of Engineering Education from the View of Cybernetics Methods in the Field of Metallurgy and Mining

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Abstract *- The usual methods of engineering study suffer from absence of the general cybernetics view. This way the huge advantages of up to date information technologies could be lost. New application methods and new ways of information acquisition from technologies were developed according to the general cybernetics principles at the Department of Automation and Computer Techniques and the Institute of Economics and Control Systems at VSB-TU of Ostrava. The general cybernetics idea, that is not used very often within the systems of engineering education, comes from the biological systems similarities. We can see the cybernetics approach especially at sceptron analysis of technological processes, that is at biological systems performed through biological sensors and brain (biological control system).*
Within the contribution you will find two examples, that demonstrate the above mentioned principles.

The first example describes the cybernetics view of continuos metallurgy technologies and the second example solves the problem of raw material selection within mining technologies. The meaning of provided examples is to highlight and demonstrate the necessity of cybernetics view and the importance of some information, that is omitted in technological processes, information with high importance in the respect to systems behaviour. We are 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 in the subjects oriented to special data acquisition methods for control of technological processes. 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.

Informationalisation of Education

We do use classical didactic schemes at almost all forms of education on our departments of VSB Technical University of Ostrava. The lecturers use the chalk, blackboard and pre-prepared slides or overheads for teaching of given themes, to explain students the main ideas and problems of studied subjects. We can see, only very rarely (within the teaching process), the full interconnection of all forms and functions of information. The information has been understood as the data, that the professor explains on the lecture. There is very rapid development and advances of information technologies in last years, that leads us to full connection of information forms - data, text, sound, picture - with their functions - processing, generation, storing, transmission. The interconnection of information forms we can see especially in computers (data, text, pictures) or in video-conference 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.
These above mentioned phenomena leads to informationalisation of human community. The main task for modern lecturer on university 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 of future human community. To be able to solve this problem, we have to utilise the modern 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 next development and utilisation of general cybernetic income to analysis and synthesis of engineering problems.

Cybernetic view

We 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 harmonic signals and there is a lot of excellent literature too, for example [1].
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 harmonic 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 software packages, that can very effectively cover the demands of both engineering education and industrial production. For this reason, we would like to give you in next chapters some practical examples from our research and educational practise.

Example from metallurgy

The first example comes from the grant project „Complex project of technological innovation of continuous casting of steel in Czech Republic“, that has been solved on the Faculty of Metallurgy and Material Engineering, VSB Technical University of Ostrava [2] and it's partial stage: „Systems for algorithmization of decision-talking processes at control of continuous casting of steel “ on the department of Automation an Computer Technics in Metallurgy [3].
The technological process of continual steel casting is from the cybernetic view multidimensional system. The state of conticasting and it's thermal-heat parameters are changed upon the influence not only of casting speed, level of steel in crystallizer, but also of the intensity of primary and secondary cooling and chemical composition and temperature of casting steel too. The target function of control system is stabilisation of technological process, the quality control and maximal reduction of the number of break-outs. For this purpose, there was solved a task within the grant project, oriented to utilisation of cybernetics view and focused to application of some special methods of evaluation of sceptron information. There were used the responses of input signals in the form of deterministic, periodic or stochastic stationary ergodic signal for the system analysis. We can obtain, from complex analysis of this process, important information regarding the solidification process, respectively the information about the relation between the liquid and solid phase in crystallizer and about the length of liquid conticasting. We have identified the mentioned metallurgical process as the cybernetic system and prepared laboratory model and simulations. The principle of laboratory simulation is based on the fact, that there is applied special signal from electric-acoustic converter (frequency from 2kHz to 15 kHz) onto the cast-iron mould model, with the volume of $4dm^3$, that is filled by Woods metal. There can be used the hammer beat, as next input signal, that reperesents approximation of Dirac impulse. There is, on the opposite side of cast-iron mould model, a piezo-ceramic sensor, as the source of output signal, at this experiment. The signal is converted in amplifier and then recorded at PC system AT CODAS. The signal from piezo-ceramic sensor is processed by fast Fourier tranformation in the analyser and next stored at hard disk of computer.
The whole configuration of experimental model is equipped by a measuring loop of thermal parameters of melted metal in the mould. This measuring loop is realised by thermocouple (Ni-NiCr) with stabilisation of cold side. The data from thermocouple characterise the state of metal phases (liquid and solid) in crystallizer. From the beginning of isothermal process, where in the mould is only the liquid phase, up to the end of the process, where there is only the solid phase, we are able to evaluate the rate between the liquid and solid phase with sufficient accuracy. The process identification use the analytical method of evaluation of resonance amplitude in different frequency bands.
The experiment starts by electric heating of mould with Woods metal up to the temperature, when the metal is completely melted. Then we stop the heating and due to the heat flow through the mould, the process of solidification of Woods metal passes through. The rate between the liquid and solid phase in different time is estimated as the relation of the solidification time and the whole process time on the cooling characteristics (thermal analysis). The measuring of resonance properties is performed in equidistant time intervals and is registered in PC as a temperature record.
The figure 1 shows amplitude distribution in the whole frequency spectrum in the form of scan diagram. We can see there the resonance amplitudes and their shifting within the interval from 3,5 up to 4,5 kHz according changes of the rate between the liquid and solid phase. The results give the proof of the resonance properties dependency on the rate between the liquid and solid phase in the mould model. There could not be obtained similar results without

utilisation of cybernetic view and sceptron information analysis. *See Figure 1.*

Example from mining technology

Next example of complex cybernetic analysis of technological process is from mining industry and was solved on Institute of economy and control systems, VSB Technical University of Ostrava. The question was the decision of amount and quality of material on belt conveyor lines, used for coal/waste material transportation on open-cast mines in North Bohemia. The excavator works in the area, where is mixed the different sort of coal in the seem and other waste material. Raw material comes to the belt conveyor lines and we have to decide. What is the material, coal or waste? What is the quality of transported material? The answer can be provide by cybernetic view and analysis of process sceptron information.

The acoustic noise comes from the joints of conveyors. The material flow is there directed from one belt to next belt by special steel shield, to prevent the damage of the belt, figure 2. There are two noise sources, the falling material and shield vibrations. We have got two sources of signal/information, each of them have its different character and each of them comes from the same material movement. The falling material gives special noise, that depends on the characteristics of material, especially on it's plasticity. Even by the ears we can hear the difference in the noise of coal or waste material. The question is to find and measure the information from the acoustic record. The finding of suitable frequency or frequency band was task of research project.

The second source of noise/information is the acoustic signal from the steel shield and we can measure this information by vibration sensors. The shield has got it's own resonance frequency, that is independent on the quality of falling material. But the amplitude of the shield own resonance depends on the amount of the material. The accuracy of such information was not excellent, but for the reasons of operational control was very useful. The second task was to find the information regarding material quality. It was find through modulation of shield own resonance frequency. This modulation depends on the plasticity of falling material and gives very good information for decision of material quality. The frequency analysis was performed by fast Fourier transformation and according the results was developed special electronics equipment for material amount and quality evaluation. The explored information was perceptible by biological sensor - human ear. But the problem was to process this sceptron information by technical equipment, with the aim to close the control loop for the evaluation of material amount and material quality decision. The cybernetic view of presented problem and detailed analysis of sceptron information was the fundamental base for this problem solving.

Steel shield with vibration sensor

Belt conveyors line

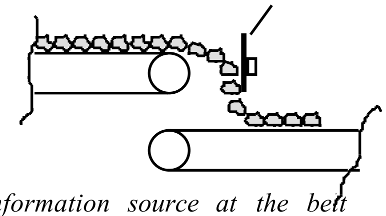

Figure 2 : Noise/information source at the belt conveyors line.

Conclusion

The two above mentioned examples illustrate the possibilities of sceptron information analysis, that are important for design of accurate and valid model of studied technical system. Analyse of sceptron information gives to the engineers very effective tool for control of very complicated technological processes. The future engineers will not be able to evaluate the complex processes behaviour without the utilisation of general cybernetic view on technological 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.

Authors of this paper are sure, that modern cybernetic methods are not utilise and presented in engineering education yet. We do some research projects, to join the engineering education with cybernetic analysis and principles.

For example, within the project of Czech Ministry of Education, #F1 528, „Bilateral interconnection of step, to take profit from the huge potential of computer technique, is 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. We 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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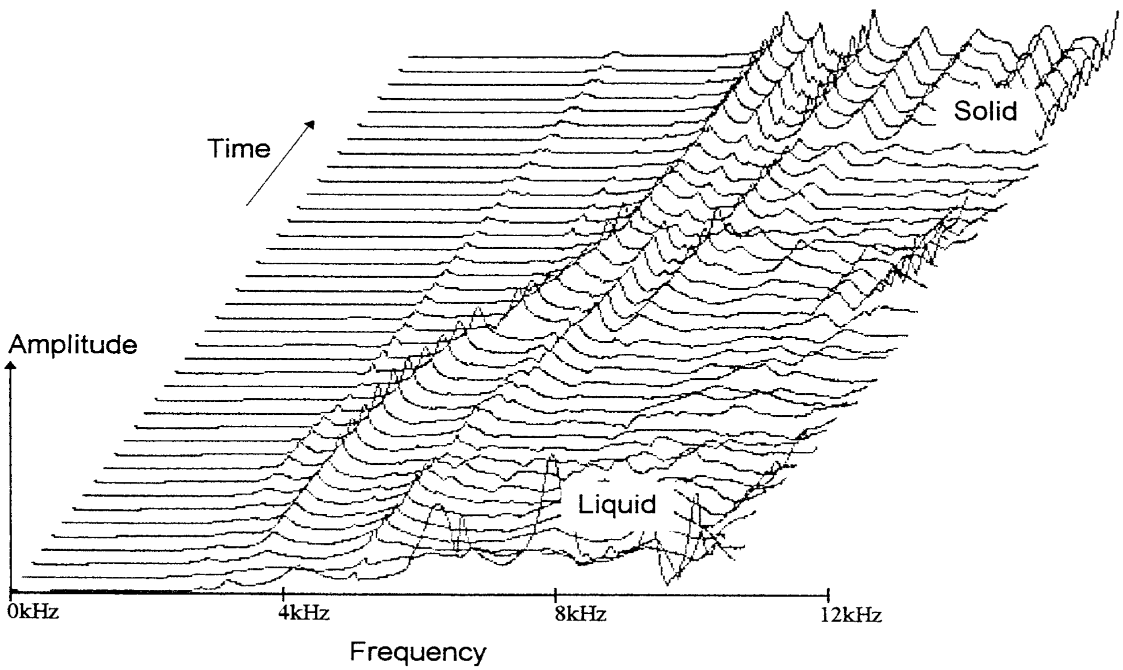

Fig. 1 Scan diagram describing responses on input Dirac impulse and characterizing frequency changes in dependence on solid and liquid phase ratio