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E D I T O R I A L B O A R D

RESEARCH PAPERS
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DIAGRAM OF AUTOMATED GRIPPERS CHANGING IN THE INTELLIGENT MANUFACTURING CELL

Nina DANIŠOVÁ, Jozef MAJERÍK

Abstract

This paper deals with the complex design of sensor equipment which will be used by automated gripper changing systems in a manufacturing and assembly cell that is located at the Institute of Manufacturing Systems and Applied Mechanics. This complex sensor equipment design derives from knowledge about intelligent manufacturing systems. Sequential diagrams are used as a tool for the design of the sensor equipment. In this paper we describe the design of a sequential diagram for automated changing of grippers at the manufacturing and assembly cell.

Key words

manufacturing systems, complex design, sequential diagram, grippers, assembly cell, knowledge

Introduction

Industrial manufacturing is still moving forward. Today we do not talk only about using IT or classical automated instruments. When we are talking about flexible manufacturing systems it is effective to also talk about possible uses of a new generation manufacturing systems. These new-generation manufacturing systems are also called intelligent manufacturing systems (IMS). All IMS subsystems include components of so-called machine intelligence (or sensor equipment). Use of given systems in combination with machine intelligence will lead to the complete removal of the laboratory from the manufacturing system. Monitoring systems use sensors that are located at some proper place in the system, such as a particular tool, machine, or manipulating device. Sensors are identifying parameters which are then used as input data in the control system. Following from this data, some technological process, manipulation, or other helping process is administered.

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Analysis of flexible manufacturing cells

A flexible manufacturing cell can be found at the Department of Technological Devices and Systems (see Figure 1). This flexible manufacturing cell is created by some bearing subsystems such as:

- Industrial robot with Cartesian kinematics,
- Shelf storage system.

Fig. 1. *Flexible manufacturing cell and workplace of the cell*

There are five manufacturing phases integrated in the flexible manufacturing cell:

- storage (semi product storage and storage of final product just before shipping),
- transport and manipulation (transport and manipulation of semi products and products),
- manufacture (manufacturing of a single semi product through the final product),
- assembly (assembly of a single final product into the one final product assembly),
- shipping.

Following previous conclusions and knowledge which come from studies of intelligent systems, specially designed sensor units were added in the flexible manufacturing cell for each device. That means that every device will have its own sensor units which will be used for processing of primary information. Such information ensures communication between single devices and the control system. Before specification of single sensor units, it was necessary to specify the requirements, which will be given to the intelligent manufacturing and assembly cell that will be designed.

The main requirements used for intelligent manufacturing and assembly cell design were the following:

The designed intelligent cell has to be able to react to various situations which occur during the manufacturing process, such as:

- the changing shape of manufactured or assembled parts,
- changes of the part dimensions,
- usage or lack of usage of single subsystems by the manufactured parts,
- changes in the part types,
- change of the technological parameters,
- assurance of collision situations in the cell,
- low manufacturing costs.

Just as in the case of the flexible manufacturing cell, design of the intelligent manufacturing cell is borne of two basic subsystems and also contains five manufacturing phases.

Writing methodology for communication between single devices of IMC

Before design of sensor equipment for single system subsystems, it was necessary to establish writing methodologies for single stays and movements connected with parts. These stays of parts have to be created during running production processes in the intelligent manufacturing cell. Proper writing methodologies were created in order to define the communication methods between single devices during running production processes. Sensor equipment, therefore, can be designed according to the written methodology for communication between single devices. In the beginning, the two kinds of writing methodology were using evolution diagrams and algorithms, and writing that used rules of sequential diagrams.

Sequential diagram

This new writing methodology is most commonly used for the UML programming language. These diagrams are used to demonstrate the description of objects stays. Sequential diagrams are used for showing how single objects are communicating with each other simultaneously. The method of sequential diagrams was chosen as the appropriate means of demonstrating communication between single devices operating in an intelligent manufacturing cell. Only synchronous messages can be found in the designed intelligent manufacturing cell. This means there will not be any other operation created without backward signal in the control unit.

Sensorial equipment design of automated grippers changing

Writing methodology using sequential diagram is a useful way to analyze communication between single devices, which are placed in the working space of the cell.

The sensor of the type **SIEN – M8NB-PO-K-L** is applied to identify the particular storage grippers. Colour- sensing sensors were designed to identify single gripper types for fitting to their shapes. This application uses two such sensors with type **SOEC-RT**. Sensor placement is shown in Figure 3.

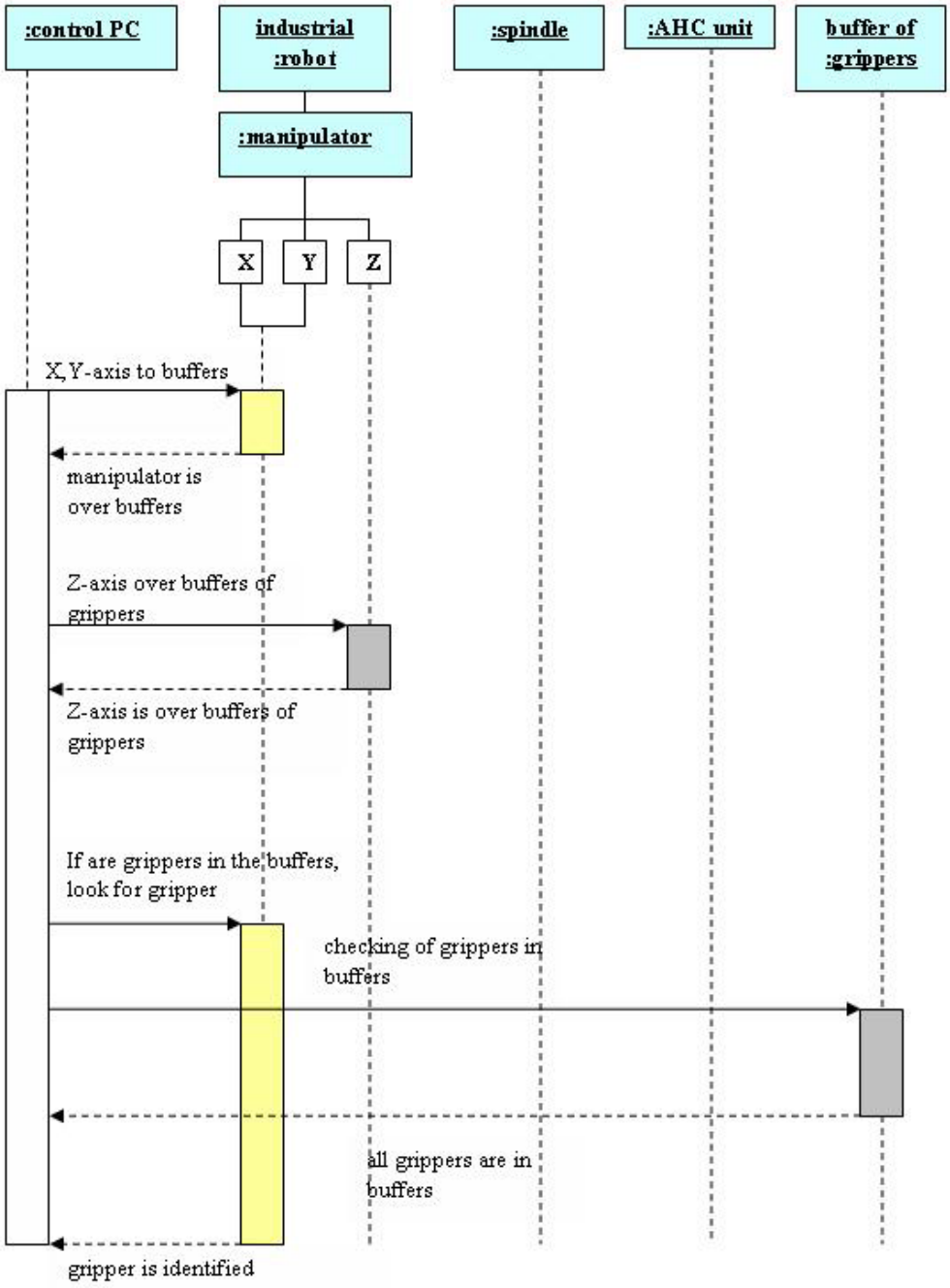

Fig. 2. *Sequential diagram beginning - diagram of automated grippers changing*

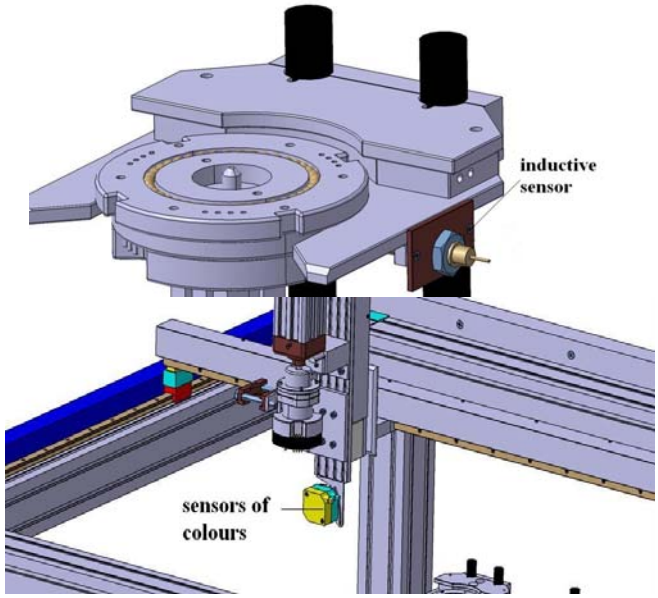

Fig. 3. *Placement of sensors at the manipulator body*

In the moment of manipulation the signal is coming to the control unit. This signal is indicating where there are free positions within the shelf.

Conclusion

During the design process of the intelligent manufacturing cell and automated tool changing system, a sequential diagram methodology was used. This methodology was chosen to describe communication of all devices during the manufacturing and assembly process. Sensor equipment was selected following information regarding communication and signal transmission. The purpose of using the sequential diagram methodology was to upgrade the flexible manufacturing cell towards the intelligent manufacturing cell with the help of sensor equipment. It will then be used for laboratory purposes.

This article was written with help from enormous efforts such as **VEGA 1/0206/09 Intelligent manufacturing assembly cell.**

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FACULTY OF MATERIALS SCIENCE AND TECHNOLOGY IN TRNAVA
SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA

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SUSTAINABLE PARTNERSHIPS – A NECESSITY FOR OUR COMPANIES

Bartolomej HAJNIK, Peter SAKÁL

Abstract

The aim of our companies has to be the production of quality, environmentally suitable and secure products (or services) realized in an adequate way and with adequate technology. It is very important to employ theoretically and practically qualified human resources which must be managed and motivated not only towards fulfillment of sustainable development (SD) but especially of ***sustainable partnership (SP).***

Key words

sustainable development, sustainable partnership, human resources oriented for change, environmental orientation of human resources

Introduction

The Nobel prize winner for economics (2001) J. E. Stiglitz pointed out in his work [4, p. 54] that the current globalization process (characterized by reduction of transport costs and of the barriers to free flow of goods, services and capital while there are still remaining barriers to the free flow of work force) is actually analogous to the previous process of creation of national economies. We have a system which could be called **global governance without global government.** A system in which some institutions, such as The World Bank, the International Monetary Fund, and the World Trade Organization, and some individuals, such as ministers of finance, industry and trade who are deeply connected to financial and business interests, are dominating the scene where many of the persons directly depending on the decisions of the mentioned institutions remain without any possibility to declare themselves. It is time to change some of the rules governing the international economic

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system and to think about how decisions are made on an international level and for whose benefit.

Sustainable partnership – necessity for our companies

The leading representatives and owners of our companies have understood very quickly that if their products (or services) have to compete in the European and world economic environment, they have to consider the issues of quality and protection of the environment, adequate security of all parts of the transformation process, ergonomics, and most urgently **the issues of power and material intensity** in their business strategies. This perspective signals the necessary introduction and compliance with **SP.**

The experiences of well developed Slovak companies confirm that our companies are striving for new structure in management of human resources in order to support *SD as a part of the organizational structure* that collects, processes, evaluates, archives, and publishes in responsibly information about the maintenance and protection of the environment. The phenomenon of change is focused not only on maximal utilization of company resources for producing goods (or offering services) to the client, but also on creating the potential for future development of the company. Change is represented in the fact that our companies ultimately must enter into **SP,** which will result in products created from the mosaic of economic, political, social, cultural and also environmental components for our future generations.

The action plan for SD of the Slovak Republic (SR) for 2005-2010 confirms our ideas [2, attachment, p.11]. Support for innovations:

- *increase of investments in research and development (to a level of 1.8% of GDP by 2010) and their effective utilization,*
- *increase the share of state funds used for financing of research and development (to a level of 0.6% of GDP by 2010),*
- *support of the innovative and scientific-technical activities of universities, and the incorporation of their results in the entrepreneurial environment,*
- *support for creation of entrepreneurial clusters which along with the state will finance the activities of research, technology and innovation centers,*
- *support for creation of innovative clusters and networks mainly within small and middle-sized companies (SMC).*

Reality and intentions

The reality is that we have to respect the abidance of SD rules more than before:

- *rule of saving – to restrict waste of all resources, to prefer durable products over single-use (creating waste), to reduce the loss of heat and all kinds of energies,* ***as the future will be about energy,***
- *recycling of used materials and products – to save all resources and to reduce pollution of the environment (E) and the work environment by waste or waste water,*
- use of renewable energy sources (RES) – sun, water, wind and biomass.

The share of total electricity consumption from RES was 14.4 %. Based on the directive 2001/77/ES on support of electric energy produced from RES on the internal market with electric energy, the Slovak Republic should reach the announced goal of 21 % by 2010. The **energetic burden** of the national economy (NE) (kgoe – kilograms of oil equivalent) means the ratio of gross domestic energy consumption to GDP in a given calendar year. It is the measure of the energetic consumption of the NE and its energetic efficiency (it is 1.5 times higher in SR than in the average OECD country).

As an illustration:

In the EU 25 in 2003, this ratio was 209 kgod/1000 EUR; in the Slovak Republic in 2003 it was 937 kgoe/1000 EUR; and in Austria in 2003 it was 150 kgoe/1000 EUR. The energetic efficiency concept forms the basis of the framework program document, along with expected activities and rules until 2020, produced by the Ministry of Economy of the Slovak Republic in cooperation with the Slovak energy agency and other state bodies. The main intentions of this concept are to achieve a gradual decrease in the energetic demand of the Slovak Republic to the EU level, to create a motivating environment for energetically efficient behavior of inhabitants and market participants, as well as to support sustainable energy solutions and the introduction of new innovations and energetically effective technologies in all segments of the national economy. The main goal of this concept is to reach a **9 % savings** in final energy consumption from 2008 to 2016 [2 p.19], in line with directive 2006/32/ES on energy services.

Support will be granted to projects for building or operating equipment which is expected to use renewable energy sources:

- *building or reconstruction of small water plants with installed performance up to 10 MW,*
- *building or reconstruction of equipment for energetic usage of biomass,*
- *installation of heat pumps,*
- *installation of sun collectors and photovoltaic cells,*
- *building or reconstruction of equipment using geothermal energy,*
- *installation of equipment using wind energy.*

The ideas mentioned above do not degrade the indisputable significance of nuclear energy, which is the most important source of production and consumption of electric energy in the Slovak Republic. It is necessary, however, to look for innovative ways of increasing the share of new and renewable energy sources.

More than ever, it is also necessary, in all segments of the national economy, to use suitable technologies for regeneration and protection of the natural environment, to separate and recycle waste and waste waters, to solve old environmental problems, to prevent not only environmental crashes and crises (a proactive approach), but also especially energetic, fuel, and material crises which will inevitably end up in human resource crises (such as increased unemployment, decreasing of sources for education, social aspects and effects, health care and educational problems, etc.).

Figure 1 shows the aim of companies – a sustainable partnership

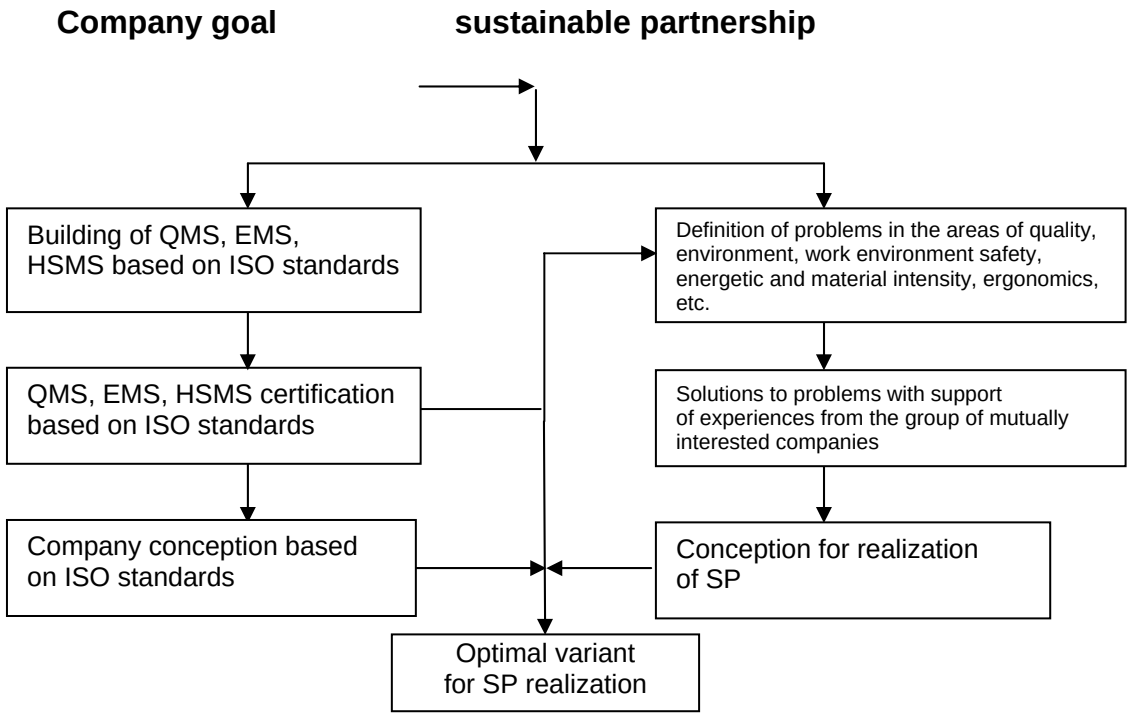

Fig. 1. *Company goals and sustainable partnership (SP)*

The unique contribution

The ideas mentioned above express opinions on the inevitability of change in the theory and praxis of management in our companies by respecting a new approach – **SP**. SP must find a solid space in all phases of management: in planning, in organizing, in leading people, in communication, in decision making, and in control. From this point of view it is necessary to support change in the approaches of company owners and employees, and to introduce new approaches to particular activities and processes **for support of scientific research activities of universities, with the aim of building connections for implementation in entrepreneurial spheres.**

Conclusion

New approaches by management are required in the Slovak Republic, particularly due to changing business dynamics, increasing investment risk, increasing capital demands, the inevitability of decreasing energetic and material intensity in products and services because of the need for sustainable maintenance of superior environmental standards and security, and ergonomic concerns. The ideas of a company's management about the company's current and future purpose are called its mission. The mission has to respect the concept of **Sustainable Partnership** in the new circumstances of the current economic and social climate.

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SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA

2009 Number 26

CREATION AND EFFECTIVENESS OF EDUCATIONAL TEXTS FOR DIRECTED SELF LEARNING AT SECONDARY TECHNICAL SCHOOLS

Marianna KOŇUŠÍKOVÁ, Jan KOSTELNÍK

Abstract

This article deals with planned research which is part of a dissertation in the field of didactics with the title "Creation and effectiveness of instructional texts for directed self-learning at secondary technical schools." It illustrates the importance of directed self-learning by pupils and of the creation of high quality self-instructive learning texts for pupils of secondary vocational schools. It briefly characterizes the objectives and research hypothesis, the sample and subject of the research, the methodology and the organisation of the research.

Key words

self-instructional educational text, creation of learning texts, directed self-learning, independent work

Introduction

Textbooks and instructional texts are among the oldest products of human culture and were used long before the invention of book printing. One of the founders of the theory and creation of modern textbooks was Jan Amos Komenský who was the author of the first illustrated textbook *Orbis Pictus* [1]. Written material is still the most common instructional material in the world. In many countries it represents almost 85% of all teaching materials. New technologies occur but they still do not stop the development of written material and do not replace its place in education.

There are several reasons for this fact. For example, printed study material is transferable and relatively long lasting, it can be recorded, archived, and repeatedly used in case of necessity, it is flexible (a book can be used in several ways), and the reader can decide

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the rhythm and speed of reading and can stop at specific texts if desired. Books are used frequently at the present and they have become a natural and indispensible part of education [2].

Progress in informational technology has also brought about changes in the educational system. New forms of e-learning, including distance learning, as well as open education, flexible education, and blended learning have entered our educational system and opened new study possibilities for many students. The core of modern forms of learning is based principally on the use of electronic information and communication technologies (internet, e-mail, fax, mobile phones, video-conferenc es, etc.), however an indispensable role is still played by instructional texts which have been specifically adjusted for these forms of learning.

New interesting possibilities for self-learning by students have been created with the use of a great amount of learning materials instructing the learner as if he/she were present in a traditional lesson. Such educational materials have to be self-instructing and structured in order to enable continuous and systematic study. The instructional texts respond to the variety of educational styles which students prefer and which suit them best. Such texts are used as a basis for directed self-learning, and they are usually accessible either in electronical form, on CD, or on the internet.

Educational texts play a decisive role in the process of education. They are a significant working instrument for students and help for the teacher's work. Several research studies show that it is not the syllabus but the textbook that determines the quality of the educational process [3].

Directed individual work

Directed education is not only aimed at storing information, data, and processes into a child's memory, but it also develops brain skills – cognitive competence. It is a demanding way of learning in which the instructing subject (teacher) has to perfectly master the way of presenting the cognitive competencies; he needs to think over thoroughly the approach to instructing a student and be able to carry it out. It is inevitable that he will come to perfectly know the pupil and his ability to learn. This kind of teaching can be done in various ways – by humans or by computer, but most often through a symbiosis of the two [4].

According to Kulič (1992), the purpose of each test is to make it gradually unnecessary. That means to adapt the learning person into a system of full auto-regulation. At the beginning the student is lead by the teacher who directs the educational activity, but later on the directed learning can have the form of controlled self-education and self-learning [5].

The humanistic approach to education recommends the teacher not do anything that the pupil is able to do alone, because otherwise the pupil's activity is suppressed. During teaching it is more effective to give preference to self-direction and self-assessment as compared to outer control and outer assessment, as the independence and freedom of the pupil is more likely to be fostered [6].

Individual work by pupils is one of the most important manifestations of learning. On one hand it has the character of a teaching method, and on the other hand it has the character of an organisational form because it can be situated in various teaching environments (e.g.

workshops, laboratories, etc.). It can basically fulfill all didactic functions through specialisation. Its centre lies however in the fixative and applicatory phase of teaching. A common feature of all kinds of individual work is that they lead to self-instruction and self-education. The assumption is still however the long-term and systematic guidance of the pupil by the teacher [7].

"The decisive period for the development of independence and for the forming of relevant working and studying habits and techniques is the period of secondary education" [8, p. 9]. That is why it is so important that pupils start soon enough to develop their ability for individual learning, to look for new information, to solve problems, etc. In this period great attention is also paid to self-instruction and self-learning.

The importance of self-instruction and self-learning through individual work by pupils can be summarized into the following points:

- Individual work should help pupils to develop their skills in such a way that they are able to solve tasks with the help of basic theoretical principles (individually with initiative and self-confidence),
- The pupils should form the ability and a life long need for self-education by means of individual work,
- Through the control of results and the course of individual work, deep and long lasting knowledge can be acquired through the control of results and of the individual work. The managing of controlled individual work by pupils stimulates continuous learning,
- Control of individual work enables the deepening and acceleration of feed-back between the pupil and the teacher.

Self-organisation of individual pupils' work and its control is a significant problem for the realisation of self-education and self-instruction. It is necessary to elaborate detailed plans of individual work for pupils in the specific professional subjects, and to coordinate them mutually from time to time [7].

A teaching system will show its effectiveness as long as one of its elements is individual work. The basic objective of individual work is the discovery, re-creation, and creative application of knowledge. This requires inner activity by the student in relation to selection, transformation, and hierarchical aligment of information. The student requires knowledge individually and he also individually reproduces knowledge and applies it mainly when solving problem tasks [9].

Creation of self-instructional teaching texts

From the pedagogical point of view self-instructional teaching texts are means of teaching and self-learning which have to fulfill two main functions: informing and regulating. Texts are a source of knowledge and information and concurrently a guideline for how to actively work with the presented information/knowledge, i.e. how to organize and control the learning process of the students with a tendency to gradually increase the level of students' auto-regulation, with the aim of achieving the defined objectives. A consequence of high quality instructional texts for distance learning is the fact that even in developed systems of distance education, which typically apply multimedia, up to 94 % of learners use printed instructional texts. Therefore only by their high quality and ability to better guide self-learning can self-instructional texts for distance education compete with traditional instructional texts [10].

Instructional texts for directed self-learning must first of all be [11]:

- **Self-instructional –** i.e. study materials must provide everything (predominantly motivation) without the help of a teacher, enabling students to achieve defined goals of the educational programme (teaching unit). Self-instruction materials must attract the interest of the learner and "draw" him/her into the topic. It is therefore important that authors are aware of students' approach to learning and that they know their "style" of learning, motivation, and interests.
- **Structured** so that they initiate and enable continuous and permanent study, and they must be comprehensive, well-arranged, attractive, etc.

Instructional texts for directed self-learning are different from simple textbooks and scripts. Especially notable is the text division (doses), its graphical lay out, and relief through pictures, schemes, graphs, different symbols, and illustrations [12]. The self-instructional text has to direct the individual steps of the learner in his/her education. It therefore must provide the learner with everything necessary for effective teaching/learning.

According to Gazdíková these are [13]:

- clearly defined long term and specific goals and their consequent correlation with the content,
- utilization and connection to students' previous knowledge,
- respect for the learners' different needs,
- a sufficient number of practical tasks for practice and fixing of acquired knowledge,
- a sufficient number of explanatory examples,
- questions and exercises for self assessment,
- interesting and attractive material from the content and formal point of view.

Since self-instructional teaching and learning materials are used for self-study they must be written on a high qualitative level, they must respect all previously listed requirements, and more attention must be paid to the dimensions of comprehensibility [14].

Research focused on the creation of self-instructive texts

Currently, pupils are under the stress of a great amount of information from different subjects and sources. Therefore it is necessary to be flexible in the utilization of different methods. It is also necessary to provide pupils with appropriate didactic means which should simplify their process of learning, be it visualisation or practical experience which would foster the acquisition of new knowledge.

A textbook often does not express the topical importance of a given issue. It is often extensive and not interesting and it often happens that there is no textbook to the subject. It is then replaced by books which do not deal with the topic enough or too extensively and the pupil is lost in the web of interlinked knowledge which is then demotivating, and the student does not want to continue reading.

The creation of "tailored" teaching texts should help the pupils to learn easily, to shorten the total time needed for preparation at home, and to create more space during a teaching unit for practical examples and illustrations and a more detailed explanation of new topics. In studying the self-instructional texts that have been created, the pupils should start studying

from the beginning of the reading. The text will become interesting to them because it will be written in such a way that they learn the consequences, it will be completed with pictures, control questions, and many elements that will facilitate learning.

It is very important that secondary school pupils are prepared for their further education. This occurs when they are capable of reading with comprehension and acquiring various reading strategies which they can use not only at school but also in their everyday life.

It often happens that secondary school graduates continue their studies at a higher level and they are not prepared for the system of studying which requires their independence and individuality. Such practical preparation should start from the first moment they begin studying at a secondary school when the teacher first leads and directs the students and continuously strengthens their ability to manage their self-instruction and self-education.

With the creation and use of self-instructive texts something new is introduced into the teaching process of pupils. It is something new, something interesting and practical. At the same time the students' reading skills will be supported as well as their comprehension from the start of reading, and this is a basis for their further education.

Planned research on the creation and effectiveness of teaching texts aimed at directed self-instruction at secondary vocational schools

The main objective of the research is to verify, through experiments, the effectiveness of teaching the subject Ecology Basics at the secondary vocational school in Kysucké Nové Mesto with use of the created texts which enable effective self-instruction.

In order to achieve the set objective, the following partial objectives have been defined:

- to create self-instruction teaching texts for a selected part of the subject Ecology Basics,
- to verify by experiment the effectiveness of teaching the selected part of the subject Ecology Basics through use of self-instructional teaching texts by pupils attending the first year of Secondary vocational school in Kysucké Nové Mesto, and to compare traditional teaching with teaching when self-instructional teaching texts are used,
- to determine the approach of pupils towards the evaluated way of teaching the subject Ecology Basics,
- to evaluate the subject matter and issue recommendations for the introduction of self-instructional teaching texts in the subject Ecology basics.

The subjects of research are:

- effectiveness of teaching the subject Ecology Basics with use of the created self-instructional teaching texts,
- knowledge and intellectual skills of pupils from Year 1 of the Secondary Vocational School in Kysucké Nové Mesto,
- time for individual preparation at home (preparation of pupils for the lesson of Ecology Basics) during the period of experimental way of teaching
- approach of first year pupils to the subject Ecology basics with the usage of created self-instructional text books.

Main hypotheses of the research:
Teaching of the subject Ecology Basics with use of the created self-instructional teaching texts is more effective than traditional methods of teaching.

The term *effectiveness* (more effective teaching) stands for:
- better knowledge and intellectual performance by pupils belonging to the experimental group,
- less time needed for preparation at home
- prevalence of a positive approach from pupils towards the verified methodical teaching system

In order to verify the main hypothesis, we will observe and evaluate the following hypotheses:

H1: Pupils from the experimental group (EG) will achieve better results in their final didactic test, which will be aimed at knowledge and intellectual skills and will be taken at the end of experimental teaching, than pupils from the control group (CG).

H2: EG pupils will, at the end of the experiment, state in a questionnaire that they needed less time for preparation for the lesson on Ecology Basics than CG pupils.

H3.1: The comprehension of self-instructional teaching texts will be assessed positively from the pupils.

H3.2: The level of comprehension of the created self-instructional teaching text assessed by a Cloze test will be higher than 65%.

H4: The attractiveness of the created self-instruction teaching text will be assessed by pupils predominantly in a positive way.

H5: In questionnaires of EG pupils, a positive evaluation of teaching through the use of the created self-instructional teaching texts will prevail over the negative ones.

The basic unit of the selected samples for research is formed by pupils of first year classes at the Secondary Vocational School in Kysucké Nové Mesto (on average 270 pupils in the relevant school year 2008/2009). The pupils are divided into classes according to specialisation. There are approximately 30 pupils in one class.

The selected group (research sample) will consist of pupils from six classes with an average of 30 pupils in a class. The assumed number of respondents is 180. The experimental group will be formed by three classes and the control group by three classes as well.

The following research methods will be used for verifying the research hypotheses aimed at the effectiveness of created self-instructional texts for the subject Ecology Basics in comparison to traditional methods of teaching:
- *Natural pedagogical experiment* – main research method *Didactic tests* – verification of H1,
- *Questionnaire* – verification of hypotheses H2, H3.1, H4, H5
- *Cloze test* – verification of hypothesis H3.2,
- *Expert method* – additional method used for verification of H3.2
- *Statistical methods of processing the research results.*

Conclusion

At present the research is in the phase of preparation and the execution is planned with the start of the academic year 2009/2010. With the preservation of the stated research conditions the achievements will be accomplished which can help with verifying the validity of the stated hypothesis. We assume that the quantitative and qualitative analysis of the research results will enable us to propose recommendations which will improve the quality of teaching the subject Ecology Basics in Secondary Vocational Schools.

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IMPORTANT ASPECTS OF CONTINUOUS QUALITY IMPROVEMENT IN SLOVAK ENTERPRISES

Marta KUČEROVÁ, Jaromíra VAŇOVÁ, Helena FIDLEROVÁ

Abstract

This paper discusses quality improvement in praxis and its important aspects within applying a principle of continuous improvement in Slovak enterprises. As the first part of conducting a research project, VEGA No. 1/0229/08 Perspectives of quality management development in coherence with requirements of Slovak republic market, research on the use of principles of quality management in some chosen Slovak enterprises, has been completed. The data obtained can serve as a basis for improving the actual situation at hand. Gained information can be utilized for analysis of the situation and comparison of fulfillment of several requirements in various industry sectors. This paper considers methods for quality improvement and aspects of continuous quality improvement in praxis.

Key words

principles of quality management, methods, procedures and tools for improvement, continuous quality improvement, proactive improvement

Introduction

Project VEGA *Perspectives of quality management development in coherence with requirements of Slovak republic market* considers research and analysis of actual situations in theoretical knowledge about quality management and assumed trends of theory development, according with demands and needs of the market.

A proposal of system solutions for efficiently applying quality management principles while considering praxis requirements will be worked out. Analysis and gained information from research for each industry sector will serve as the basis for the proposals. Actual

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situations of quality management processes in several sectors of industry are currently being compared with demands of some quality management system models.

One of the most important areas of quality management is continuous improvement. It is the continuous process that shows whether an organization improves its performance of manufacturing and non-manufacturing procedures. This is an important element in order for an organization to achieve its goal of remaining competitive.

Implementation of Continuous Improvement in Some Chosen Slovak Enterprises

In research project VEGA No. 1/0229/08 *Perspectives of quality management development in coherence with requirements of Slovak republic market* we deal with eight quality management principles in praxis.

In the first phase of the project it has been realized through a questionnaire concerning the application and comparison of principles of quality management in actual situations within enterprises, just how some requirements are fulfilled in several industry sectors in Slovakia.

The questionnaire had been completed by 124 Slovak enterprises, which can be organized into 3 main industry groups:

- 35 % - automotive industry
- 35 % - machine industry
- 30 % - other industry.

The first part of the questionnaire identifies which activities in enterprises are focused on continuous quality improvement, how enterprises understand continuous quality improvement in praxis, and some differences between enterprises.

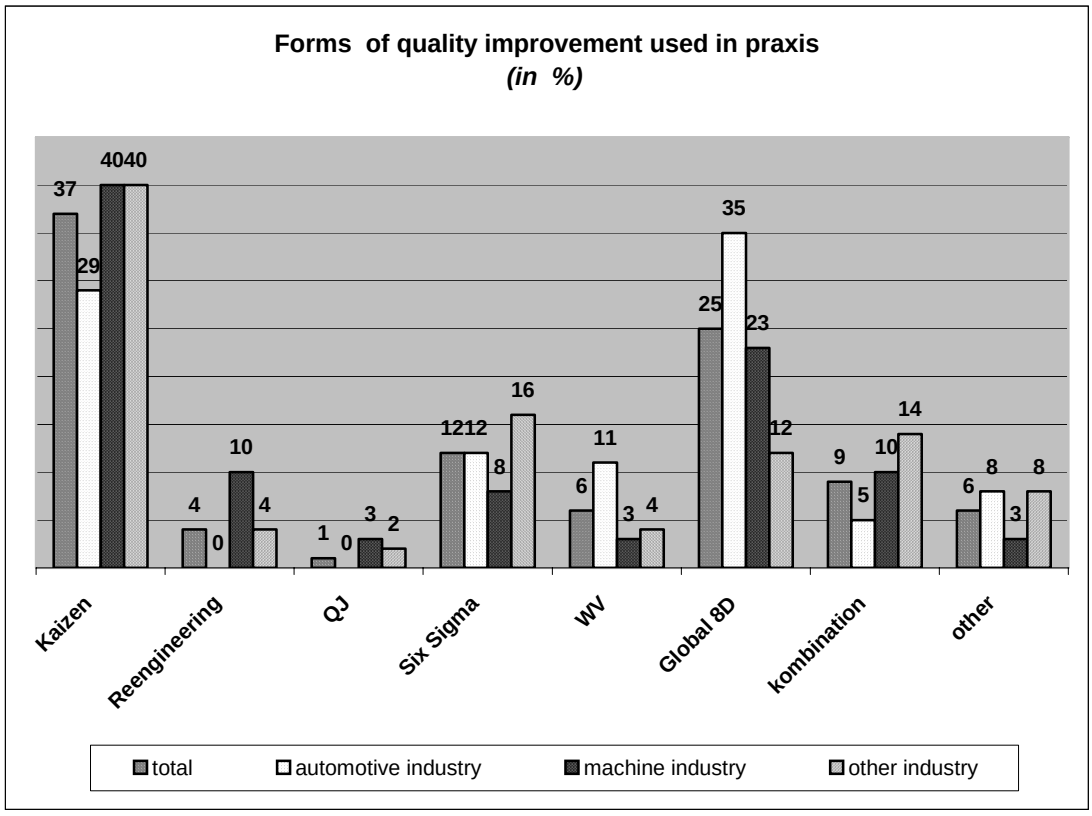
Graph 1. *Results of research about the quality improvement in praxis*

A sample question from the questionnaire is: *How do you understand continuous quality improvement in your enterprise?* (see Graph 1).

- 52 % of the organizations answered that continuous quality improvement means improvement of competitiveness and better position on market for the organization
- Only 15 % of respondents answered that continuous quality improvement means better effectiveness of quality management system
- Only 10 % of respondents answered that continuous quality improvement means cost reduction for variance in production

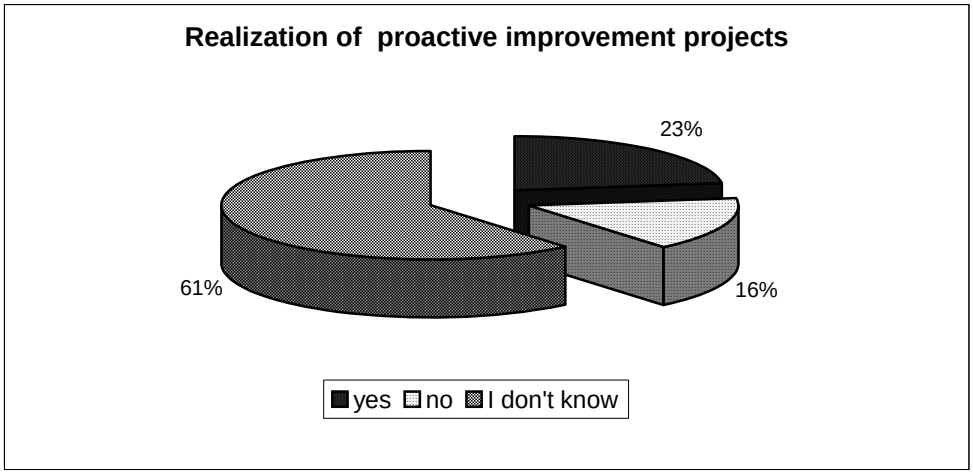
We did not find any significant differences in results between the automotive industry, machine industry, or other industries.

Another important question in our questionnaire regarded methods of improvement used in enterprises. From the research results it is evident that there are some differences in the application of methods for quality improvement in praxis. Results are represented in Graphs 2 and 3.



Graph 2. *Results for forms of quality improvement used in praxis*

We can see that 40 % of the firms in the machine industry and in the *other industry* category use Kaizen compared to only 29 % in the automotive industry. In the automotive industry Global 8D is the most widely used by 35 % of respondents and less used Six Sigma.

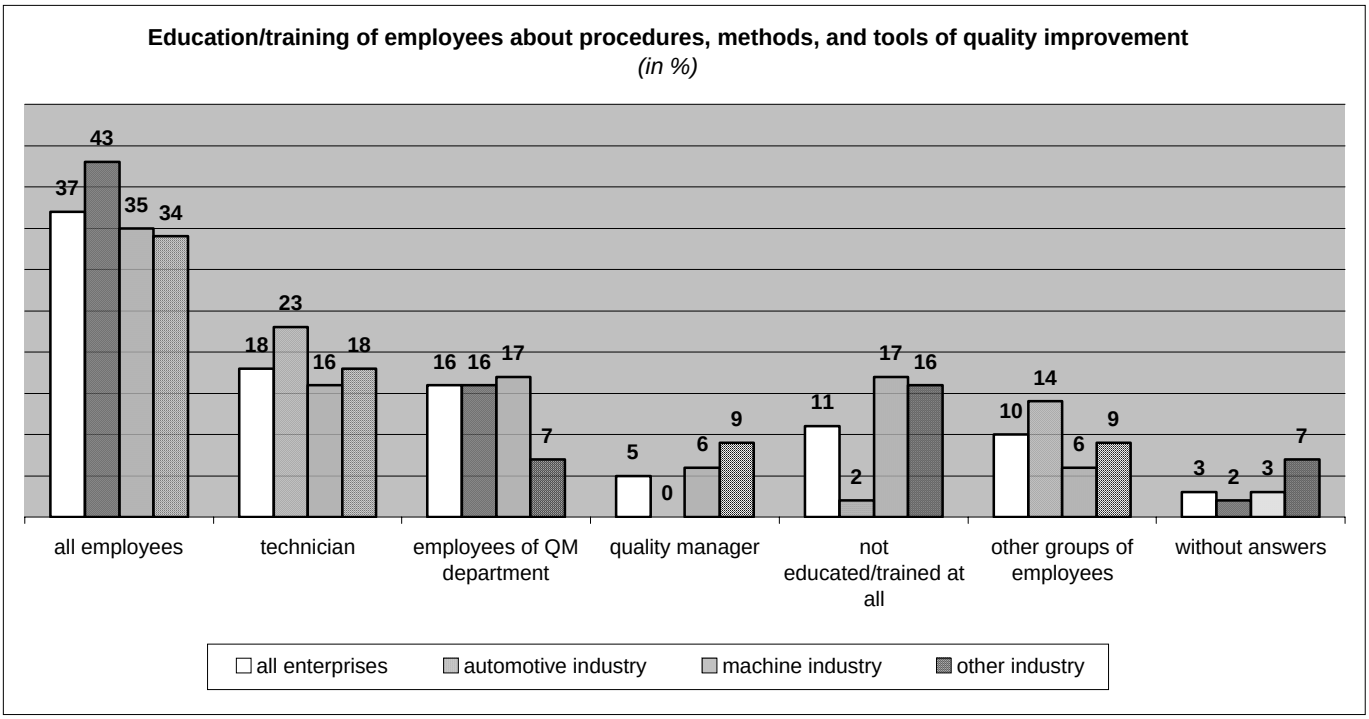


Graph 3. *Realization of proactive improvement projects*

For Graph 3, the survey question asked was: *Are you aware of certain projects focused on proactive improvement in enterprise?*

Based on the responses we suppose that this approach is not applied much in Slovak industry enterprises because 77 % of respondents answered that these projects are not yet realized or they simply were not aware.

Most activities for improvement have the reputation of corrective or preventive actions. One of the reasons for such results could be that the term *proactive improvement* is not well known in Slovak enterprises.



Graph 4. *Results for training of employees about procedures, methods and tools of quality improvement*

Other reasons for this situation are insufficient knowledge and proficiency of employees in the area of progressive methods for improvement. Most respondents answered that employees are educated/trained about methods, procedures, and tools for quality improvement, however, many organizations claim only certain chosen employees are educated in this area (See Graph 4).

Another survey question asked was: *Are employees systematically educated/trained about procedures, methods, and tools for quality improvement?*

In the automotive industry 43% of respondents answered that all employees are systematically educated/trained. We supposed the reasons could be due to strict requirements from technical specification ISO/TS16949 Quality management systems - Particular requirements for the application of ISO 9001:2000 for automotive production and relevant service part organizations, which is valid also in the area of continuous improvement for enterprises of the automotive industry. This specification for the automotive industry is enhanced within the sphere of activities such as permanent improvement of processes, improvement of production process, problem solving, emphasis on failure prevention, influence of corrective activities, etc.

Research Contribution

The principle of continuous improvement is one of the core quality management principles. Following our research we investigated some differences in its use in various industry sectors in Slovakia. The first part of our research project detected some important aspects that will be the objectives of our research issues in the future.

Continuous improvement is an important factor by which competitiveness is influenced in whole enterprises. Therefore it is necessary to find possibilities for quality improvement of processes as prevention and use more proactive approaches, as opposed to only problem solving.

In our further research we will be concerned with trends and perspectives of quality management in enterprises on present turbulent and the global market.

Conclusion

Each enterprise with a quality management system is responsible for application of continuous quality improvement through enhancement of processes and activities in the whole production cycle.

As quality improvement is better understood, all activities will lead to a new level of performance regarding employees, processes, products, and management.

Positive effects of quality improvement are reflected especially in profit of the enterprise. Techniques of quality improvement should be implemented in all organisation structures of enterprise.

This paper is part of research project **VEGA No. 1/0229/08, Perspectives of quality management development in coherence with requirements of Slovak republic market.**

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CUTTING FLUIDS MANAGEMENT

Eva KUCHÁRIKOVÁ, Jozef PETERKA

Abstract

This article is a summary of basic cutting fluid characteristics and discusses how to prevent pollution from them. It includes information about cutting fluids management that can be readily adopted to prevent the onset of fluid degradation, maintain fluid quality, extend fluid service life, and reduce waste. In conclusion the proposal and targets of continual measuring fluid parameters are presented.

Key words

cutting fluids, environment, management, continual measuring.

Introduction

Machining can be defined as the process of removing material from a workpiece in the form of chips. This process is performed in the system MTWJ (M - machine, T- tool, W- workpiece, J – jig). The cutting fluids are integral parts of this system. In general, the cutting medium can be divided into these categories [2]:

- gaseous,
- liquid,
- solid.

Besides the usual tribological requirements, new cutting fluids have to meet the requirements of the environment protection set either by in-house regulations, or regulations imposed by the state or international ISO 14000 standards [9].

In most cases environmental parameters of the cutting fluids are setting new constraints on machinability parameters. Therefore, manufacturers as well as end users should end it in their common interest to develop new kinds of cutting fluids whose quality is identifiable in terms of machinability parameters as well as environmental parameters [8].

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Cutting fluid characteristics

The prime functions of cutting fluid are effective cooling and lubrication. With supply of cutting fluids the friction is also reduced. This functions and effects require the cutting fluids to be in a fluid form [1].

There are also consistent media such as fats or powder lubricants. Though the friction can be reduced, they are not able to sink the heat in the cutting area and that is the reason why they are not used so frequently. The main application fields for these lubricates are thread cutting or special forming operations [4].

Only the gas media have not been employed in manufacturing so far because their application is difficult. If particular gases are applied properly, they can remove the heat and also reduce the friction if their chemical properties are suitable [10].

Nowadays the air-mist cooling is also expanding but the cutting fluids are still the most applicable cooling medium by metal machining. Besides cooling and lubrication effects they also have other functions [4].

Main functions of cutting fluid are [1, 7]:

- cooling,
- lubrication,
- removing chips and metal fines from the tool/workpiece interface,
- flushing,
- prevention of corrosion.

Cutting fluids are used in machine shops to improve the life and function of cutting tools. They are also a key factor in the machine shop productivity and the production of quality machined parts.

Currently new requirements can be identified in the metal cutting application field. The attention is mainly concentrated on improving of working conditions, reducing the health danger for machine operators, and application of new manufacturing procedures, materials and technologies. That concludes the necessity for reduction of fat consumption, processes fluids, and their negative influence on the environment [6].

In practice trends of employing new non-ferrous materials and ceramic compositions can be observed. They progressively substitute some metal parts of machines. Working properties of cutting fluids improve. They are able to cover a wide area of requirements for heavy machining operations, which result from production and application of modern metal cutting machines.

There are now several types of cutting fluids on the market, the most common of which can be broadly categorized as cutting oils or water-miscible fluids. Water-miscible fluids, including soluble oils, synthetics, and semi-synthetics, are now used in approximately 80 to 90 per cent of all applications [12].

Although straight cutting oils are less popular than they were in the past, they are still the fluid of choice for certain metal-working applications.

Cutting fluids can be divided into two categories [3, 9]:

- **water-based fluids** -including straight oils and soluble oils,
- **oil-based fluids** -including synthetics and semi-synthetics.

Cutting fluid management for pollution prevention

In the past, it was common for the machine shops to dispose of their metalworking fluids as soon as they showed signs of degradation and decreased performance. This practice resulted from fewer environmental regulations in place at the time [10].

Effective programs can keep metal-working fluid as clean as the initial raw product, significantly prolonging its service life. Facilities may represent a savings of 15 to 50 per cent by implementing a thorough fluid management program. The payback for establishing a management program is often achieved within one or two years.

Castrol company offers manufacturers an easy-to-use and reliable way of achieving consistent system stability and operational performance on their very own premises. This company developed a system for real-time monitoring for water -miscible fluids [11].

The effect of improved concentration control reduced annual concentration additions on one central system by 4,000 liters, amounting to a 15% reduction and a significant overall cost saving (see Figure 1).

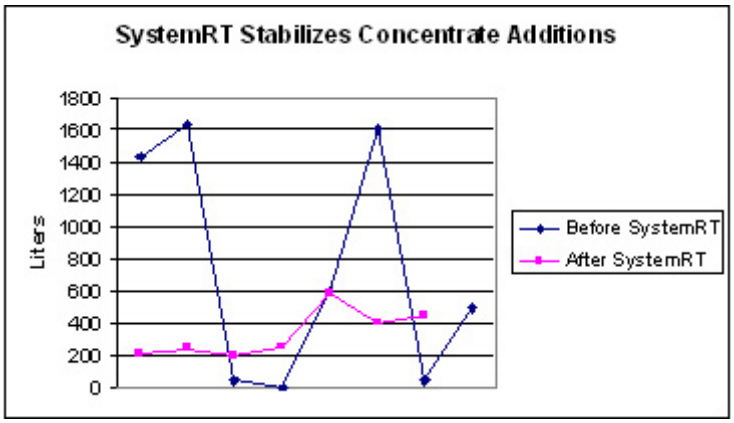

Fig. 1. *The real-time fluid monitoring and analysis capabilities of Castrol [11]*

In general there are three components of a successful fluid management program [10]:

- administration,
- fluid monitoring and maintenance,
- fluid recycling.

This section reviews the role each component plays in an effective fluid management program, but our attention is directly on fluid monitoring and maintenance.

Fluid Monitoring and Maintenance

Monitoring and maintaining fluid quality are crucial elements of a successful fluid management program [10]. A fluid must be monitored to anticipate problems. Important

aspects of fluid monitoring include system inspections and periodic measurements of fluid parameters such as concentration, biological growth, and pH. Changes from optimal fluid quality must be corrected with appropriate adjustments (such as fluid concentration adjustments, biocide addition, tramp oil and metal cuttings removal, and pH adjustment). It is important to know what changes may take place in your system and why they occur. This allows fluid management personnel to take the appropriate steps needed to bring fluid quality back on-line and prevent fluid quality problems from recurring. Despite high market requirements on the quality and environment management (e.g. standards ISO 9000, ISO 14001, QS 9000) in pratice customers show lower interest in preventive inspection of cutting fluids [5].

Over time, cutting fluids can become contaminated by chips and fines, tramp oil, bacteria, and dissolved salts. Therefore, monitoring the pH, water hardness, specific component concentration (i.e. additives, tramp oil, biocide, etc) allows fluid management personnel to take the appropriate steps needed in time to prevent failure of the fluid [12].

The proposal of methodology for in-line obtaining electrochemical parameters of cutting fluids

The proposal of methodology for the obtaining of cutting fluid parameters is based on the measuring of:

- temperature,
- concentration,
- pH.

by sensors placed in a cutting fluid container. The scheme of procedure or methodology of measuring is shown in Figure 2.

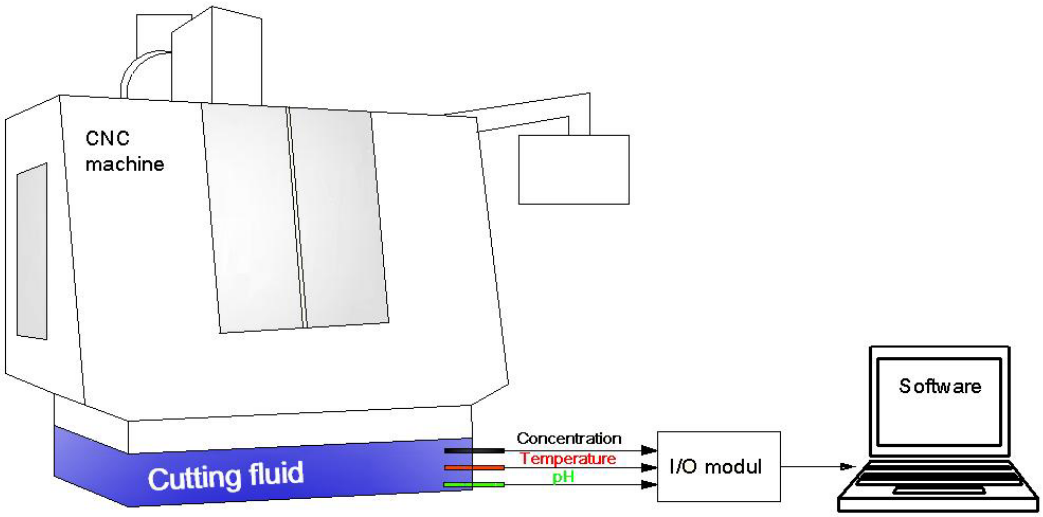

Fig. 2. *Engineering design of methodology for the in-line measuring of electrochemical parameters*

Sensors for measuring pH, concentration, and temperature will be placed on cutting fluid container. I/O module has three inputs for contact or voltage. It communicates with the computer network (Ethernet, Internet). A/D converter or I/O module transforms analog signal into digital signal.

Measuring data will be processed by software. Purposes of the in-line obtaining of physical and chemical parameters of cutting fluids are:

- provide effective consumption of cutting fluids,
- alleviate environmental impact,
- alleviate economic costs.

Scientific asset

The asset of this paper is pointing out the importance of cutting fluids in machining. The contribution is a summary of basic cutting fluid characteristics and forms how to prevent the pollution from them. Development of our own methodology for the in-line monitoring of cutting fluid parameters is the scientific contribution.

Conclusion

Cutting fluids play an important role in machining operations and impact the shop productivity, tool life, and quality of work. With time and use, fluids degrade in quality and eventually require disposal once their efficiency is lost. Fortunately, cutting fluid life may be extended significantly by implementing an effective fluid management programme. The primary objective of fluid management is to maintain fluid quality and performance through administration, monitoring, maintenance, and recycling practices. This allows machine shops to make the most cost-effective use of their fluid.

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BUILDING PHASES OF THE PROCESS-ORIENTED SYSTEM

Renata NOVÁKOVÁ

Abstract

In some conditions we often find a formal method towards the application of the process approach in quality management systems. This lecture shows a procedure of phase building the process-oriented quality management systems as a reaction to this formal approach.

Key words

application of the process approach, the process-oriented quality management system, phases of building the process-oriented quality management system

Introduction

If the company attempts to create the process-oriented quality management system with the customer's best interests in mind, while forming a value-creating chain, then it is necessary to build this system at the very beginning on the basis of clearly defined objectives derived from the company strategy. Any process and its operations not meeting these essential preconditions may not ultimately lead to the customer's satisfaction and thereby to the effective management of the company itself.

Phases of building in the process-oriented system

Creating of the process-oriented quality management system consists of the following phases:

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1. In the first phase of the process-oriented quality management system it is necessary to review or develop a company strategy that will serve as the basis for designing future processes. Another important aspect in compliance with the requirements of a respective ISO standard, is that all parties involved are aware of the company objectives. In addition, it is pertinent for all involved (although not mentioned in the ISO standard) to know the key qualifications and strategic risks of the company.

   Key qualifications of the company include abilities and possibilities of a respective company in individual areas of activities that are necessary and at the same time limiting for a successful implementation of the company strategy. Goals, requirements, and desires of the company may be great and ambitious, but they must be based on real capabilities and opportunities of the company. If not, the strategy and its particular aims become unattainable. It is important not only to know key qualifications of the company, but to also have abilities to develop them and thereby acquire competitive advantages. Critical success factor (CSF) is a criterion of particular qualification for a respective company.

   Strategic risks of the company are threats to the successful company business. The highest risk is an unknown risk (the feeling that there is nothing that would endanger a respective company). In order to judge particular risks, a risk priority number must be expressed taking into account the probability of the risk occurrence, seriousness of the risk impact on internal or external customers, and probability of revealing the risk (modification of the FMEA method).

   Examples of key qualifications of the company (CSF) may include:
   - advanced technology in a certain field
   - individual qualifications and personal quality of the company employees
   - uniqueness of implemented designs in the field
   - uniqueness and inimitability on the market
   - ability of effective utilization of financial sources
   - knowledge of the market, customers, and competition
   - special knowledge and expertise of the company and its employees
   - ability to implement internal changes early and effectively
   - ability to learn from own mistakes, etc.

   Strategic risks of the company (risk priority number) may include:
   - business risks of a respective field of business
   - credit risks of the company
   - risks resulting from acting and politics of the country
   - international risks relating to the field of business
   - competition in the respective field of business, etc.

   The scheme of creating the company strategy is expressed in Figure 1:

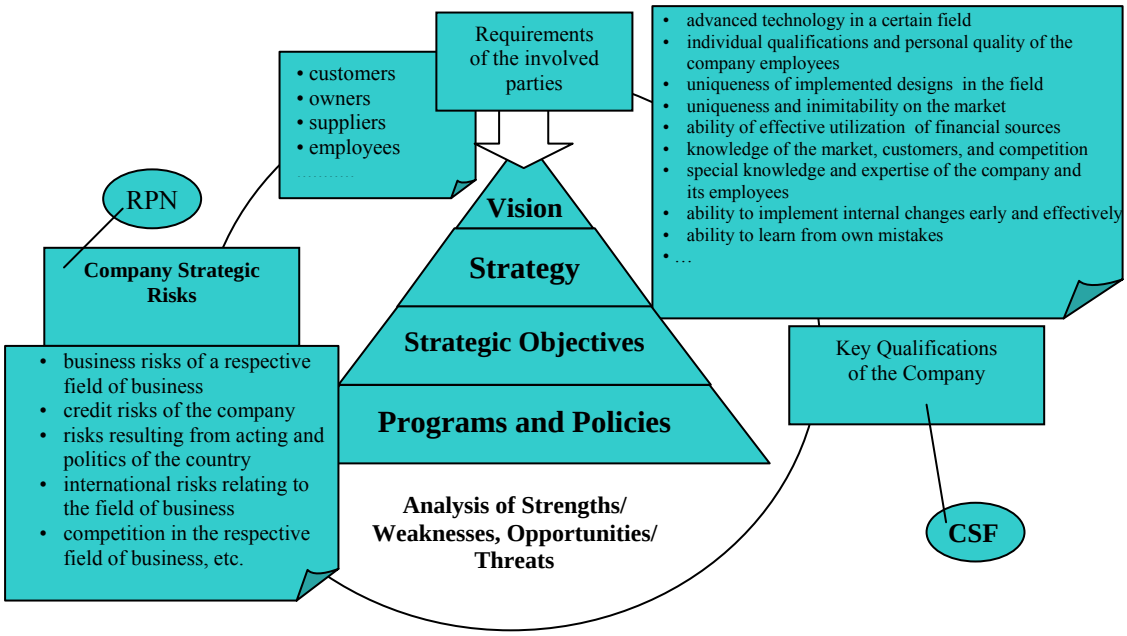

Fig. 1. *Determination of the Company Strategy*

2. The second phase of building the process-oriented quality management system consists of determination of the requirements of processes. Processes of the company are an instrument and means for achieving set-up objectives resulting from the strategy. In this phase of building the process-oriented quality management system it is therefore important to determine basic requirements on the present and future processes. When determining these requirements the following key questions should be applied:
   - Are particular categories of processes in the company defined correctly?
   - Do the present and future processes correspond to a determined strategy of the company?
   - Are any basic partial processes known relating to a value-creating chain of the operations creating a value added for customers of the company processes?
   - Are the processes able to meet requirements of the involved parties?
   - Are any links known between individual processes and lower order processes of the company?
   - Do the processes have active feedback and control mechanisms for their effective management?
   - Are the owners of processes who are competent and qualified to control the company processes defined correctly?
   - Is there any negative impact of local interests inside the company that would result from a respective organizational structure?
   - With respect to processes of the company, are competences and responsibilities of the employees responsible for the implementation of partial company processes determined correctly?

   In this phase it is particularly important to determine requirements on individual processes of the company completely and clearly, as well as to determine interconnection among these processes with regard to objectives and tasks resulting from the company strategy.

This phase also includes determination of basic partial processes of a value-creating chain creating a value added for the customer.

3. The third phase of building the process-oriented quality management system deals with determining criteria for individual processes. Based on set up requirements on individual processes of the company, criteria of individual processes are determined here. The effort should be made to determine such criteria that will clearly show performance and efficiency of the management of individual processes.
   Individual criteria of processes are based on the nature of a monitored process. It is very important how a respective criterion expresses the quality of management of a respective process, its inputs and outputs. The principle shall apply that criteria of processes must be evaluable and can be easily monitored for a long time.
   Key efficiency indicator of the process (KEI) is a criterion of a particular quantitative and qualitative feature of the process and when it is not met, it may, in general, influence outputs and the fact whether expectations of internal or external customers are satisfied.
   A critical point of the process is the operation or a set of operations that in a decisive way influence outputs from the respective process and whose low efficiency may essentially influence the processes in a negative way or worsen obtained values of the key efficiency indicators of the process, thereby not satisfying expectations of internal or external customers. Besides determining the respective criteria (efficiency process indicators) it is also necessary to determine their required or target values. The scheme of determining process criteria is shown in Figure 2.

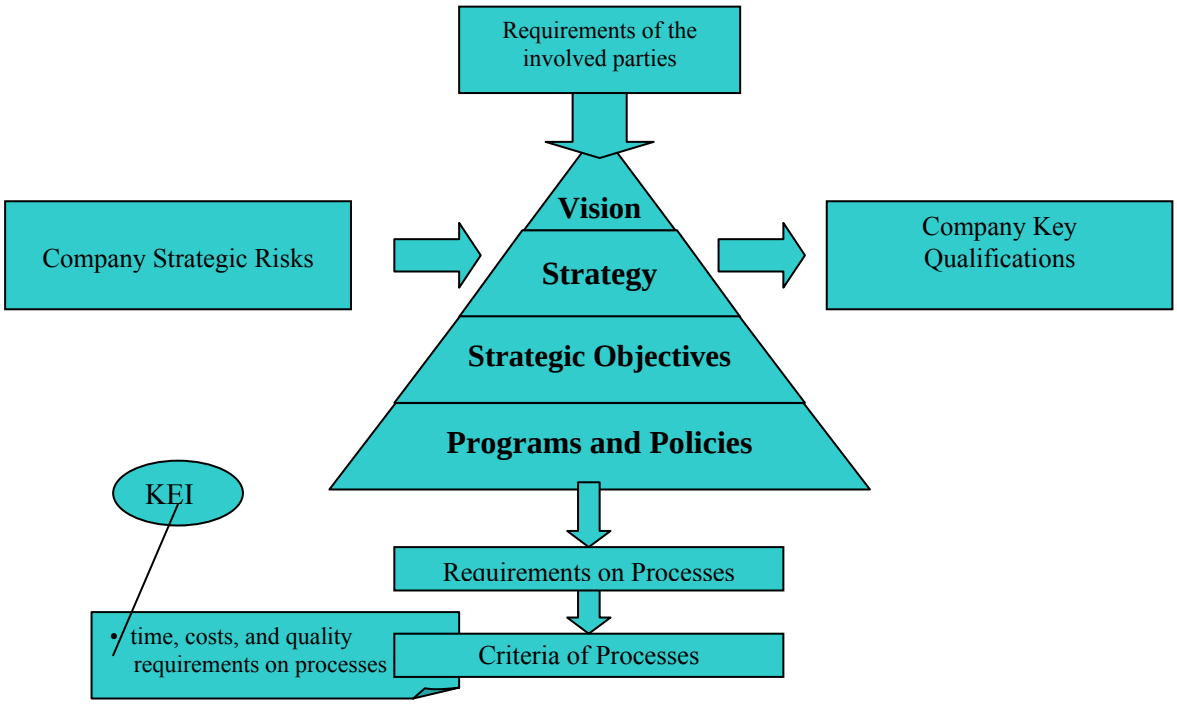

Fig. 2. *Determination of the Process Criteria*

4. Making a process pattern is the phase of building the process-oriented quality management system in which a process pattern is made as well as the structure of individual mutually interconnected processes of the company. It is done in such a manner that a value-creating chain is made which will create a value added for the customer. Intentions and ideas of the company transformed to objectives through clearly defined and formulated requirements on individual processes are projected together with determined criteria and their target values in a respective process pattern of the company.
   It is very important to define individual inputs and outputs of processes of the company regardless of whether the processes are implementation or supportive ones or whether they are processes satisfying an external or internal customer. It shall apply that the amount of satisfied internal customers is a precondition for satisfying external customers. The same shall apply for the case that if internal customers are not satisfied, then most likely external customers will not be satisfied as well.
   As far as we know the requirements on individual processes, individual criteria and their target values (that should be reached), it is foremost important to know any input requirements and sources of individual processes. It would be very difficult to reach the expected outputs without defining the input requirements.

   It is also required to know inputs and necessary sources of the individual processes of the company as well as the individual outputs and the expected effects of these processes. Any aspects must be in compliance with the aforementioned targets and criteria of individual processes that resulted from the company strategy.

   When creating a particular process, the company has to deal with so-called operational risks with the same extent as when dealing with strategic risks while determining the company strategy.

   Operational risk (process disorder) may considerably influence the stability of a respective process and result in expected outputs from this process (FMEA process) not being met. Operational risks shall include, for example:
   - technological disorders of processes
   - failure of used methods and procedures
   - real status of qualifications and abilities of the personnel
   - failure to cope with mutual links among processes (handover of outputs among individual divisions)
   - indirect influence of strategic risks on operations of processes and decisions during their management
   - failure of control mechanisms
   - incompetent decisions and their impacts on the efficiency of processes

   The scheme of formation of a process pattern is shown in Figure 3:

   The figure shows requirements on inputs to processes and outputs from processes.
   The examples of inputs to processes may be as follows:
   - requirements of internal and external customers on inputs to processes
   - expectations of internal and external customers from processes
   - sources of processes (requirements on facilities, material, employees, and information system
   - methods, procedures, and regulations relating to respective processes, etc.

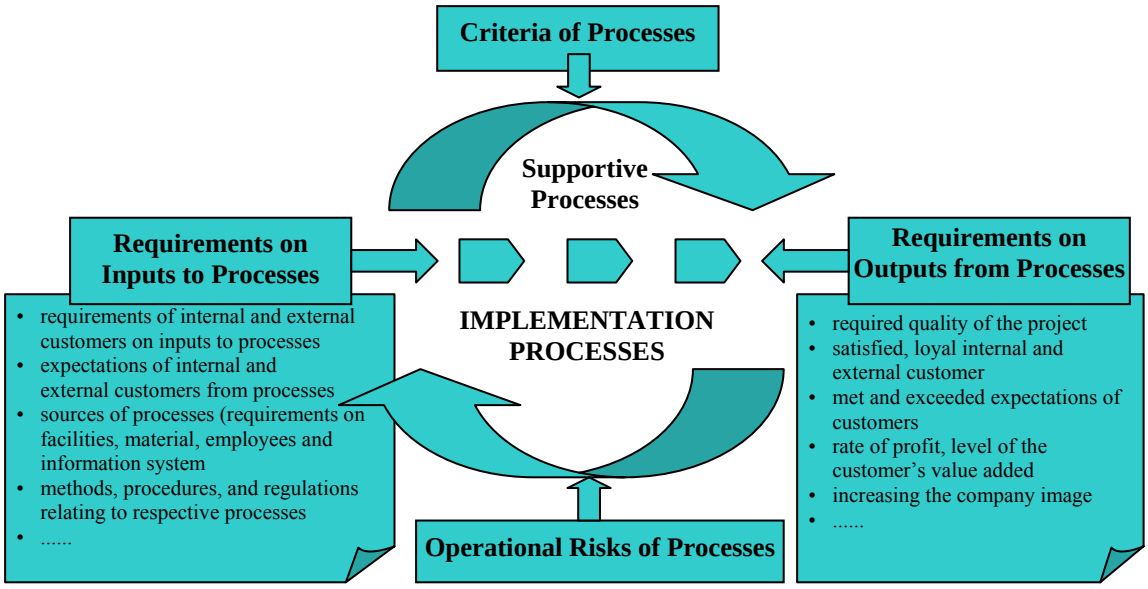

Fig. 3. *Formation of a Process Pattern*

Requirements on outputs from processes may be as follows:

- required quality of the project,
- satisfied, loyal internal and external customer,
- met and exceeded expectations of customers,
- rate of profit, level of the customer's value added,
- increasing the company image, etc.

Contribution

The contribution of an author of this article lies in the fact that he reacts to shortcomings of a formal approach in the process perception of the quality management. A proposed stage method of the process approach application fully respects principles of the process orientation of management and also refers to the sequence of steps in building the process-oriented quality management.

Conclusion

Formal application of the process approach represents only one form of Q-business and it rather decreases than increases the efficiency of the quality management system. The process-oriented quality management systems on the other side represent a reserve in increasing the efficiency of the quality management system.

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RESEARCH PAPERS
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CONSIDERATION OF SUSTAINABLE DEVELOPMENT

Miroslav RUSKO, Karol BALOG, Michal VEREŠ

Abstract

The fundamental principle of the Transport Policy of the Slovak Republic is sustainable development, which is based on promoting sector balance, supporting transport users, promoting equal opportunities, using land and resources efficiently, and providing open access and a gradual shift of costs to those who cause them. Stemming from the White Paper, this approach is reflected in the basic principles leading to proportional and structurally balanced sustainable transport development and to establishment of new, mutual relations directed internally as well as abroad. Further growth of mobility cannot continue in the same manner as in the past, i.e. without gradual introduction of new environmentally-friendly transport policies. The growth may soon become of unsustainable dimensions. Technological innovation may contribute to reorganisation of the transport system in order to make it able to fulfil growing demand for mobility and, at the same time, ensure energy savings and greater respect for the environment.

Key words

environment, mobility, technological innovation

Introduction

Slovakia currently sees a tendency towards increased road transport, in particular freight and individual car transport, whilst rail transport, suburban bus and urban public transport face a decline. This unfavourable situation in transport contributes to an increasing burden on the environment, including residential areas, by emission of harmful substances and noise from traffic [2].

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Significant changes in the last years were manifested in Slovakia by substantial growth of the number of motor vehicles. Related changes in the transport situation are visible mainly in cities and residential areas, where the environment is increasingly burdened and the health of citizens is affected.

Reducing negative impacts of transport on the environment

The transport sector as a whole has negative effects on all elements of the environment (air, water, soil, fauna and flora). However, the most affected is air due to impacts of combustion of hydrocarbon fuels used by motor vehicles. During the combustion process toxic or carcinogenic substances are created (VOC, CO, NOx, SO2, solid pollutants, heavy metals) as well as substances which contribute to warming of the Earth's atmosphere (CO2, N2O, CH4). Development in emissions produced by transport in Slovakia in the last years regarding impacts on the environment is influenced by two significant factors, i.e. the negative impact of fast growth in road transport, particularly the most unfavourable individual car transport along with its increasing volumes and fuel consumption. This impact is positively inhibited by the more intensive application of a new generation of vehicles with environmentally and energetically more suitable parameters, equipped with a three-valve catalyst, thereby enabling significant reduction of the produced harmful substances (CO, NOx, VOC). 2005 saw a decline in the levels of monitored harmful substances as compared to the previous year, except for a slight increase in production of NOx pollutants and solid substances [2].

As regards to the share of transport in the overall emissions of monitored harmful substances in 2005, transport contributed 38 % of CO emissions, 43 % of NOx emissions, and 24 % of NM VOC. Transport accounted for 18 % of solid pollutants and 0,3 % of SO2 emissions overall in 2005. The share of transport in heavy metal emissions is ca 3,2 %, while the major proportion of heavy metal emissions produced by transport in 2005 was accounted for by copper – 8,7 %, lead – 3 % and zinc – 3,1 %. Similarly, other heavy metals showed a slight increase in measured emissions as compared to the previous year. The main contribution to the overall emission production by transport is accounted for by road transport. The share of other transport modes is very small when considering individual pollutants [2].

In 2006, the transport sector produced 2,407,595.21 tonnes of waste, out of which 64,193.80 tonnes were of dangerous waste and 2,343,401.41 tonnes were of other waste.

Reduction of the negative impacts of transport on the environment is one of the main preconditions for achieving sustainable mobility, while taking into account the objectives of EU documents as well as national goals. By ratifying the Kyoto Protocol – an international agreement stipulating the aim of reducing emissions causing climate changes to the level before 1990, the Slovak Republic committed to an emission reduction of 8 %. This commitment has to be met in all sectors, not excluding the transport sector which contributed around 10 % to the overall CO2 produced by the national economy.

At the same time, reduction of negative impacts on the environment also has to be ensured by an optimal balance of using the potential of individual transport modes via shifting transport volumes to environmentally-friendly transport modes, including rail transport.

Development of suburban rail transport may be considered an efficient way of greening big suburban centres in accordance with experience from abroad.

Promotion of sustainable development of population mobility

Slovakia may achieve the goal of sustainable mobility only under conditions that would accept natural urban and transport connections in the context of transport regionalisation of the Slovak Republic. Rail and intermodal transport are an alternative to less environmentally acceptable road transport.

Efficient and environmentally acceptable nationwide transport services are defined so as to provide trans-regional and regional public and private economic and transport services in urban centres. Localisation of transport infrastructure maintains and develops natural cohesion of the region.

The Priority 4.1 (Specific aim 4 of the Transport Policy of the Slovak Republic) – Development of Public Transport focuses on promoting sustainable development of population mobility. Increasing the share of individual car transport at the expense of the public passenger transport due to increasing living standards of the citizens has a negative impact on the environment. Therefore, public passenger transport plays an important role in the context of sustainable mobility and its development, and thus its promotion is one of significant priorities of transport policy of the Slovak Republic, similarly to the developed countries.

Strategic environmental assessment of the Operational Programme Transport for 2007-2013

The Operational Programme Transport (OPT) is a strategic programme document of the Slovak Republic for drawing financial aid from the EU funds in the transport sector in the period of 2007-2013 [3].

In the National Strategic Reference Framework for 2007-2013 (NSRF), the Slovak Republic has defined a vision for the overall convergence of the Slovak economy to the EU-15 average via sustainable development. Individual priorities of the OP Transport promote the global objective, whereby the OP Transport shall increase performance and competitiveness of the economy and substantially speed up the process of overall convergence. Realisation of this objective shall contribute to enhanced accessibility for Slovakia, its regions and their interconnections, and in synergy with goals of other operational programmes also to reduce regional disparities and support development of economic activities and an increase of Slovak competitiveness [6].

The strategic document Operational Programme Transport is a tool for gradual elimination of unsuitable parameters of transport infrastructure in the regions and solving pressing issues regarding safety, reliability and quality of transport.

Project of Renewal of ZSSK rolling stock fleet

Železničná spoločnosť Slovensko, a.s. (ZSSK) is a rail operator providing for services in the public interest concerning passenger rail transport on the network of ŽSR (Railways of the

Slovak Republic) in the territory of the Slovak Republic, based on the Contract for services in the public interest concluded with the Slovak Republic, represented by the Ministry of Transport, Post and Telecommunications of the Slovak Republic. Železničná spoločnosť Slovensko, a.s. carries out these services under the conditions stipulated by the above-mentioned contract and pursuant to the terms provided by the Decree of the Railway Regulatory Authority no. 654/2005 Coll., i.e. under the conditions of price regulation with a defined maximum fare. ZSSK carries out commercial services only to a minimal extent.

Železničná spoločnosť Slovensko, a.s. was established on 1 January 2005 by a split-up of Železničná spoločnosť, a.s. as one of the two newly founded successor joint-stock companies. The project of the split-up of the former company was based on the principles of the State Transport Policy stipulating performance of transport and business activities concerning rail passenger and freight transport. As regards ownership relationships, the founder and one hundred-percent shareholder of Železničná spoločnosť Slovensko, a.s. is the Slovak Republic. The rights of the State as the sole shareholder are exercised by the Ministry of Transport, Post and Telecommunications of the Slovak Republic.

The Project of Renewal of the ZSSK rolling stock fleet concerning inter-regional public passenger transport consists of three parts or technical solutions:

- purchase of 10 suburban double-deck electric train sets for passenger rail transport,
- purchase of 10 suburban double-deck PUSH/PULL units, modification of 10 electric motive power units of 263 series, purchase of 2 electric multi-system motive power units,
- purchase of 12 inter-regional multiple-unit sets for passenger rail transport.

The project aims at fulfilling the strategic objective of the Operational Programme Transport in the programming period 2007-2013, in particular:

- Specific aim no. 4 – Development of public passenger transport (establishment of conditions for increasing volumes in passenger inter-regional transport),
- Priority aim no. 6 – public railway passenger transport.

The Project shall ensure renewal of a part of the rolling stock fleet, which will be purchased or financed via a non-repayable financial contribution from the European Regional Development Fund, the State budget of the Slovak Republic (funds allocated to the Ministry of Transport, Post and Telecommunications), and via a financial contribution of ZSSK.

Consideration of the sustainable development principles in the Project

The project of "Renewal of the ZSSK rolling stock fleet" takes into consideration sustainable development principles, especially by contributing to the renewal of obsolete and technically unsuitable rolling stock. The extent and scope of technical, transport, economic and environmental out-datedness of the rolling stock at the moment is so large that it would be necessary to refurbish almost the whole fleet. Rolling stock renewal is a large-scope, time-demanding and financially-challenging process.

On the sector level, the project leads to promotion of sustainable mobility through development of public passenger transport, making use of the Contract on provision of services in public interest.

From an investment point of view, the project will be realised as a purchase of new rolling stock. The new rolling stock (produced on the basis of a special order by ZSSK) will be subject to standard environmental requirements in terms of tender documents.

The new rolling stock will meet the current, most strict environmental criteria and norms in terms of EN, STN, valid TSI and UIC Leaflets (e.g. TSI- NOISE 01/16-ST05, part 2 for passenger coaches, UIC 563, EU Directive 1997/68EC and its amendment 2004/26/EC related to the number of produced emissions …), observance of which shall guarantee substantial reduction of noise, products of combustion, reduced risk to ground and surface water by leaking oil products, energy savings, etc.

Preventive activity

The project of "Renewal of the ZSSK rolling stock fleet" takes into account the basic environmental principles:

- efficient use of resources,
- reduced pollution of the environment.

The project partially renews the obsolete rolling stock fleet and thus facilitates preventive activities in the scope of elimination of potential negative impacts by the obsolete rolling stock on the environment.

New units shall significantly affect ZSSK business results by their performances. Besides the possibility of increased revenues from fares, it concerns mainly reduction of operation costs related to:

- fuel consumption,
- electric energy,
- repairs,
- personnel cost,

which will significantly contribute to an enhanced travelling culture as well as reduction of emissions and other impacts on the environment.

Harmonisation of technical conditions

The level of performance, safety, service quality as well as costs of European rail transport depend in particular on compatibility and interconnection of systems in individual Member States, especially as regards inter-operability of the Trans-European conventional rail system. Train operation on the Trans-European railway network requires in particular compatibility of infrastructure characteristics, rolling stock characteristics and interconnection of information and communication systems of the various infrastructure managers.

Directives on the inter-operability of high-speed and conventional rail systems and the Safety Directive and Regulation establishing a European railway agency were adopted in order to remove technical and operational barriers of the European railway system.

As regards to inter-operability, the European railway system is divided into sub-systems which are defined by technical specifications of interoperability (TSI) and are a tool to achieve harmonisation of the technical means and processes of control and command sub-systems of railway operation. Each sub-system and its components, if newly launched into

operation or on the market, or substantially modernised, have to meet the requirements and parameters stipulated by European legislation and TSIs. Existing sub-systems have to be fully compliant with European legislation and TSIs within the periods stipulated in the national implementation plan [1].

On 1 January 2005 TSIs were adopted for the following sub-systems:

- Control, command and signalling,
- Rolling stock in freight transport,
- Telematic applications for freight, and
- Noise [5].

TSIs for further sub-systems of the conventional rail system are in the process of elaboration. Gradual harmonisation of technical equipment and processes by infrastructure managers and railway undertakings in Slovakia is a priority in order to maintain their business activities in the railway sector (Specific aim 5, Priority 5.2).

Enhancing internal safety

Enhancing the internal safety of transport pertains to transport operation, establishment of conditions allowing the reduction of accidents in all transport sectors, and improvement of rules for transport of dangerous goods.

These tasks may be achieved by measures related to the construction of transport vehicles, infrastructure and installations, measures related to traffic rules and enforcement of their application, as well as measures related to education and training of traffic participants.

Rail transport, compared to other transport modes, is a substantially safer manner of transporting passengers; in the last 15 years no fatal injury involving passengers occurred in Slovakia [4].

Introduction of centralised traffic management, automatic safety installations, rolling stock with higher resistance to impacts, and modern safety management have all contributed to significant reduction in the number of fatal injuries in the case of rail accidents.

Random safety rules need to be gradually replaced by rules based on common standards stipulated via technical specifications of inter-operability. New national rules will thus comply with EU legislation and will facilitate migration to a common approach to railway safety.

Project Proposal pursuant to Act no. 24/2006 Coll. on the environment

The Project of “Renewal of the ZSSK rolling stock fleet”, funded from ERDF within the Operational Programme Transport for 2007-2013, is accompanied by a Project Proposal pursuant to Act no. 24/2006 Coll. on the environment.

ZSSK is regularly facing a decline in the number of transported passengers by public rail transport and increased competition from bus, air as well as individual car transport. As compared to other carriers, ZSSK as a railway undertaking is bearing an investment burden of a substantial extent – the rolling stock fleet presents an investment of several million, or even

billion SKK. Together with high track access charges and the so-called tariff commitment imposed by the Regulatory Authority of the Slovak Republic (which limits revenues from fare), ZSSK is in a situation which does not create conditions for solving the key problem – decline or loss of interest by passengers in public rail transport. The current effort of rail transport is to compete with other modes, in particular road transport. One of the main conditions for establishing greater competitiveness is purchase of rolling stock for passenger transport. Nowadays, the rolling stock fleet of the company is significantly physically and morally obsolete and its modernisation or renewal is indeed necessary, in order to limit the faultiness of the rolling stock and increase the overall reliability, safety and operational economy. The majority of the rolling stock fleet does not meet the criteria for modern passenger coaches stipulated by current requirements on the quality of transport, comfort, travelling culture and fault-free operation. Failure to meet these requirements will lead to further lagging behind other railway undertakings, to loss of competitiveness on the transport market and subsequently to further deepening of the loss.

Purchase of the new rolling stock will not increase the current capacity of all vehicles operated by ZSSK, because the obsolete rolling stock (used in other activities of ZSSK, i.e. outside the Project scope) will be gradually put out of operation and discarded.

The projected activity, de facto, has no alternative solution from an investment point of view. ZSSK might resort to two solutions concerning renewal of its rolling stock fleet:

- modernisation of the rolling stock fleet,
- purchase of new rolling stock.

These variants have to exist in a mutually balanced proportion, however, none can present an absolute solution in the approach to the investment asset, which is rather financially demanding and which will be exposed to substantial loss of its original useful value immediately after being launched into operation – to moral and physical wear.
The proposed project is not subject to an obligatory environmental impact assessment (EIA) in terms of Act no. 24/2006; the projected activity is thus not listed in Annex no. 8 of the Act, the so-called List of proposed activities subject to environmental impacts assessment.

Positive impact of the Project on the environment

The Project shall result in renewal of the rolling stock fleet with a minimal negative impact on the environment. As regards to emissions of the main pollutants caused by traffic, the main share of their overall production is caused by road transport. Rail transport accounts for less than 1% of the total emissions. As the project concerns rolling stock, it will present a mobile source of air pollution, and emissions will thus be dispersed and not concentrated in one location. Thanks to the construction arrangement of brakes in the new train sets, the burdening of citizens with noise will also be minimal. Waste produced during the projected activity will be related exclusively to cleaning of the new trains sets (it will present communal waste), to their maintenance (accumulators, filters, etc.) and to liquidation of the obsolete vehicles to be replaced (waste consisting of ferrous metals). The destruction/discarding of the given types of waste will be carried out in the form of recycling, burning or storing at a disposal site.

Conclusion

Compared to other transport modes (road, water, and air transport), rail has demonstrably fewer negative impacts on the environment. The standing of rail transport on the Slovak transport and economic market is strengthened not only by favourable characteristics related to ecology, but also related to costs and social and economic effects, which are the subject of general interest in all developed countries. The project is assumed to have positive effect due to the replacement of obsolete rolling stock by modern-construction vehicles, which will lead to reduction in noise, emissions, vibrations and tremors affecting people and surroundings, in reduction of risks related to possible danger to surface and ground water and soil, as well as in decreased energy consumption and waste production.

As the Project shall substantially contribute to reduce the burden on the environment, at the moment no measures were proposed to minimize its possible negative impacts on the environment.

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ENVIRONMENTAL SUSTAINABILITY OF TRANSPORT

Miroslav RUSKO, Jana KOTOVICOVÁ

Abstract

Further growth of mobility cannot continue in the same manner as in the past, i.e. without gradual introduction of new environmentally-friendly transport policies, growth may soon become of unsustainable dimensions. Technological innovation may contribute to reorganisation of the transport system in order to make it able to fulfil a growing demand for mobility and, at the same time, ensure energy savings and greater respect for the environment.

Key words

environment, mobility, technological innovation

Introduction

In respect of the age and historical position of rail transport, the newest data on the European level show that railways can offer major social and environmental advantages in terms of energy consumption, atmospheric emissions, transport burdening, and accident rate, etc.

Concept of a sustainable development

A recent notion of human development that identified only with the economic growth has now been corrected so that it would lead also to fulfilment of social goals, in particular to reduction of poverty, enhancement of the quality of life, improved opportunities for better education and health. This change of orientation requires a comprehensive approach to the development of management of mutual relations between nature and humans, branches and structural aspects of development on all levels [10]. As a result of this changed orientation,

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the concept of sustainable development was created, which is further developed and internationally applied. Since the 1960s the knowledge that unlimited or uncontrolled growth, whether of human population, consumption, or pollution etc., is not sustainable under the circumstances of real, existing and limited resources is becoming more wide-spread.

It is, therefore, necessary to replace the model of industrial civilisation by a more sustainable and just concept. The sustainable development concept is nowadays considered as a possible solution for the adverse consequences of global trends in societal development and their negative impacts on the environment. The emphasis is put on the need to base this concept on healthy ecosystems, strong economy and well-functioning social issues.

In its draft on Sustainable Development (SD) Principles, the EU has declared that SD is the key factor of all EC policies stipulated by the Treaty. This document determines the crucial objectives such as environmental protection, social equity and cohesion, economic prosperity and the meeting of international responsibilities. In fulfilling these objectives the EU is guided by the following political principles: promotion and protection of fundamental human rights, solidarity within and between generations, open and democratic society, involvement of citizens, involvement of social and business partners, policy coherence and governance, policy integration, use of best available knowledge, use of the precautionary principle, and the "polluters pays" principle [1].

Transport as one of the major climatic threats

The topic of climatic changes is becoming increasingly urgent. It is implied that the cause behind environmental degradation is mainly *energy production*, while little or no attention is paid to its *use*. In this respect it is important to pay more attention to transport and mobility.

Economic and technological progress keeps contributing to an increase in the volumes of transported goods and passengers all throughout the planet.

Different transport modes are responsible for approximately 30 % of global warming, which is a share larger than that of energy production or industry. In Europe, even despite increasingly cleaner engines, the carbon dioxide emissions have not decreased, but keep growing (+ 25 % since 1990).

According to the European Environment Agency, it is necessary to re-think the whole mobility concept. The Agency also claims that the two main factors which have historically dominated decision-making regarding transport issues (time and costs) now have to be considered alongside a third, equally significant factor, which is environmental sustainability. This new factor has to be taken into consideration at the beginning of infrastructure planning [7].

Transport policy of the EU

Transport is one of the key factors of development in every modern society, while in itself it is not a goal but a means of economic progress and a precondition for achieving social and regional solidarity. The aim of transport policy is to establish transport conditions and minimize the risks related to access to the transport market and transport infrastructure, and ensure continuously growing demand for transport in the society (transport of goods and

passengers) in the required time and quality, while at the same time reducing negative effects of transport on the environment. The framework for achieving these objectives has to be sustainable development, which includes economic growth, social solidarity and ecological acceptability.

The objective of the Common EU Transport Policy is to remove obstacles at the borders between the Member States so as to facilitate free movement of persons and goods between the Member States of the European Union [4]. Its prime objectives are to complete the internal market for transport, ensure sustainable development, make innovations in the transport sector, and increase safety standards. In an ideal case, all European regions should be mutually interconnected by Trans-European railway and road corridors, the construction of which, however, lags behind due to insufficient funding [3].

The EU Transport Policy should ensure the meeting of two contradictory goals: transport development and protection of the environment. It is necessary to propose a European strategy for a reasonable regulation of transport flows, connections of various carriers, and a strategy of transport limits. Railway transport shall play an important role in the future [8].

Interoperability of the Trans-European conventional railway system

The existence of differences in national regulations and technical conditions of railway administrations in Member States of the European Union, which are the result of separate development of railway industries, prevent the international railway transport from unlimited operation of trains on the whole Trans-European railway network. Due to forced stops of trains at borders when they are taken over between individual railway managers and carriers, the transport periods are prolonged and thus the competitiveness of rail transport as compared to road transport is reduced. In the last decades these differences caused reduction of the share of railway transport on the European transport market down to 28 %, with an anticipated further reduction down to 11,2 % by 2030 in case the problem with railway heterogeneity is not solved.

Smooth, obstacle-free train operation on the Trans-European railway network requires comprehensive compatibility of infrastructure characteristics, rolling stock characteristics and efficient interconnection of information and communication systems of various infrastructure managers, carriers and business partners. In order to enhance competitiveness of the Community railways in comparison to other transport modes, which are operated without obstacles thanks to technical compatibility of infrastructure and vehicles; in order to reduce ecological impacts of transport on the environment, to reduce overloaded traffic on European roads, and in order to establish a pan-European transport system, the characteristics of which would ensure fast and safe fulfilment of transport needs of the Community, on 23 July 1996 the European Parliament adopted Directive 96/48/EC on inter-operability of Trans-European high-speed railway system. As Directive 96/48/EC deals with interoperability only within the high-speed railway system, and as the results of the study on integration of national railway systems showed the need for integration in the rail sector as a whole, on 19 March 2001 the European Parliament adopted Directive 2001/16/EC on interoperability of the Trans-European conventional railway system, including further directives and regulations stated below with a direct effect on the overall interoperability of the Community railways:

- Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certificates,
- Directive of the Council 2004/49/EC of 29 April 2004 on safety on the Community's railways and amended Council Directive 95/18/EC on the licensing of railway undertakings and Directive 2001/14/EC,
- Directive 2004/50/EC of 29 April 2004 amending Directive 96/48/EC and Directive 2001/16/EC,
- Regulation no. 881/2004 of the European Parliament and the Council of 29 April 2004 establishing the European railway agency,
- Communication from the Commission to the European Parliament and the Council of 4 July 2005 COM (2005) 298 on the deployment of the European rail signalling system ERMTS/ETCS.

Inter-operability is the main precondition for a well functioning Trans-European conventional railway system. It means the ability of the transport system to ensure safe and smooth movement of transport vehicles on the infrastructure and to reach specific performance levels determined for the system. This ability lies in implementation of managing, technical and operational conditions while meeting the basic requirements.

The European Association for Railway Interoperability (AEIF), acting as a common representative body for infrastructure managers, railway undertakings and industry, was granted a mandate to elaborate technical specifications for inter-operability (TSI) separately for each of the mentioned subsystems with regard to:

- safety, whereby all components used have to meet strict criteria ensuring safe movement of vehicles on transport infrastructure, including safety for servicing personnel at points of operation management,
- reliability and availability, whereby monitoring and maintenance of fixed and movable components, being part of train movement, have to be organised, performed and quantified so as to keep their operability under conditions stipulated in advance,
- health, whereby individual materials and components made of them cannot impose risks to the health of the personnel,
- protection of the environment, whereby individual materials and components made of them cannot impose risks to the environment,
- technical compatibility, whereby the technical characteristics of components of infrastructure and fixed installations have to be mutually compatible with the components built into trains operated on the Trans-European railway network [2].

In 2002 the Commission adopted the following TSI for the Trans-European high-speed railway system:

- rolling stock,
- energy,
- control and command,
- operation and maintenance.

Technical specifications of inter-operability for the Trans-European conventional rail system were divided into three categories, the first TSI category dealing with rolling stock,

telematic applications for freight, noise, control and command, operation and maintenance adopted by the Commission on the turn of 2005 and 2006. TSI of the second and the third category shall be adopted gradually in the following years. TSI define the basic parameters for components and parameters of interfaces connecting subsystems into a whole, and other specific cases which are necessary in order to ensure correct functioning of the whole system, including the technical and geographical scope of application of the given TSI providing for inter-operability of the Trans-European railway system. The adopted TSI apply to new or renovated lines and rolling stock, i.e. TSI:

- Noise subsystem – deals with noise parameters caused by freight wagons, passenger coaches, locomotives and multiple-unit sets when starting, passing through, and standing still and parameters of inner noise in the driver's cabin.
- Rolling stock subsystem – deals with parameters of construction and mechanical components, track interaction and rolling stock measurements, braking, communication, environment conditions, system protection and maintenance in order to ensure technical compatibility not only within the subsystem, but also within the whole system. The focus is on ensuring inter-operability in the rolling stock fleet management subsystem with respect to ensuring required performance when delivering transport services.
- Traffic operation and management subsystem – governs the rules for notices exchanged between infrastructure managers and railway undertakings, the scope of documentation, which the service personnel should have at disposal in order to ensure train operation, as well as physical and professional capabilities.
- Control-command and signalling subsystem – aimed at ensuring safe movement of trains of the Trans-European railway network.
- Telematic applications for freight – commercial operation of trains, wagons and intermodal transport units within the Trans-European railway network requires efficient exchange of information between different infrastructure managers, railway undertakings, service providers, forwarders, authorities and other parties to the transport process [5].

Transport of passengers and goods in the Slovak Republic

The transport sector includes entities providing for public and commercial transport. Public transport includes entities providing transport services by rail, road, water, air or pipe and other auxiliary transport services. Commercial transport is carried out for its own needs or the needs of other parties which belong to different industries of the Slovak economy. The transport sector contributed 6,0 % to the creation of GDP in 2006 [6].

SHARE OF TRANSPORT IN GDP CREATION (%). SOURCE: STATISTICS OFFICE OF THE SLOVAK REPUBLIC - NOTE: ANALYTICAL FRAMEWORK OF THE PUBLISHED DATA ON NATIONAL ACCOUNTS IS BASED ON THE METHODOLOGY OF THE "EUROPEAN SYSTEM OF NATIONAL AND REGIONAL ACCOUNTS ESA 1995"

Table

1993	1996	1999	2000	2001	2002	2003	2004	2005	2006
6,1	8,3	7,8	7,5	7,6	7,6	7,1	6,8	7,2	6,0

Public passenger transport by road and rail has continued to indicate a long-term trend of declining number of transported passengers and overall performance. Transport volumes in passenger road transport reduced by more than 30 % as compared to 1993; in the case

of rail transport the decrease amounted to even more than 50 %. Volumes of waterborne passenger transport were reduced by more than 40 %. In the monitored period (1993-2006) the volumes of air passenger transport rose substantially (from 37 million passenger-km in 1993 to 2,829 million passenger-km in 2006).

Transport of goods and transport volumes of road freight keep growing. Road transport has the major share in freight transport volumes – ca. 67 %. Performance of rail freight transport decreased in 2006 by more than 30 % as compared to 1993, and volumes transported by water grew in 2006 by ca 11 % as compared to 1993.

Transport Policy of the Slovak Republic by 2015

The fundamental principle of the Transport Policy of the Slovak Republic is sustainable development, which is based on promoting sector balance, oriented on transport users, promotion of equal opportunities, efficient use of land and resources, open access and gradual shift of costs to those who cause them. Stemming from the White Paper, this approach is reflected in the basic principles leading to proportional and structurally balanced sustainable transport development and to the establishment of new, mutual relations directed internally as well as abroad. Sustainable mobility development was defined as a global objective for transport policy of the Slovak Republic, i.e. establishment of conditions to satisfy constantly growing transport needs of the society (transport of goods and persons) in required time and quality, while simultaneously reducing negative impacts of transport on the environment. The global objective contains eight specific goals, which are: (1) ensuring competition within the transport sector, (2) modernisation and development of transport infrastructure, (3) ensuring sufficient resources to fund transport, (4) reduction of negative impacts on the environment, (5) increasing the quality and development of transport services, (6) increasing safety and protection, (7) promotion of research and development in transport and (8) coping with transport globalisation.

Modernisation and development of transport infrastructure

The Priority 2.1 (Specific aim 2 of the Transport Policy of the Slovak Republic) – Modernisation and Development of Railway Infrastructure, states that the technical basis of railway transport in Slovakia is not sufficiently ready for changing conditions and the structure of the transport market due to a low technical level and quality of the technical basis of railway transport, and due to neglected maintenance and insufficient upgrading. The risk posed by low-quality transport infrastructure lies in a decrease of transit volumes and a decline in domestic transport and passenger volumes transported by regional and long-distance services, whilst the existing situation has the advantage of sufficient density of lines, stations and stops (high transport coverage of the territory), high capacities, good qualitative and structural basis of infrastructure and good connectivity of the rail network of ŽSR to the neighbouring networks [9].

Funding of transport sector

The Slovak Republic adopted the concept of modernisation of its rolling stock with the aim to renew the obsolete RS fleet (Priority 3.3, Specific aim 3 of the Transport Policy of the

Slovak Republic – Renewal of Rolling Stock Fleet). In relation to passenger rolling stock renewal, the financial-need formulation takes into consideration investment incentives that would remove the lag of the Slovak Republic behind neighbouring railway administrations. As the state budget and financial possibilities of ZSSK would not allow for modernisation of the rolling stock fleet for passenger transport, it was concluded that it is necessary to make use of a contribution from the state, self-governing authorities and villages to the funding in the following period. The following measures were proposed:

- on the level of central state administration bodies/higher territorial units/municipalities – to support renewal of rolling stock for public transport providing long-distance services (under the condition that RS is used to fulfil public service obligations); taking into account transport needs of given stakeholders on the level of state and regional bodies/higher territorial units and municipalities.
- on the level of private entities:
  - provide for rolling stock renewal for delivery of services in the public interest on the basis of public order and ensuring basic transport services covering the territory so as to meet ecological requirements,
  - provide for renewal of rolling stock delivery transport services by integrated transport systems within passenger transport.

Greening of transport and technical condition of the vehicles

The Transport Policy of the Slovak Republic (Priority 4.3 Greening of transport, Specific aim 4) comes to the conclusion that, in regards to greening of transport, it is necessary among others to introduce stricter assessment of technical condition of vehicles and gradually discard vehicles not meeting the defined limits for noise and emissions.

Reduction of negative effects causing increased adverse climatic changes

It was calculated that shift of transport volumes from public road transport and individual transport to rail could reduce negative effects causing a growth of adverse climatic changes in the amount of EUR 496,422 per year. The total present value is EUR 4,574,147.

Increasing qualitative parameters of transport infrastructure

In respect to enhancing the quality of transport infrastructure, it is necessary to carry out its modernisation and development (Specific aim 5, Priority 5.1). From a technological point of view, the emphasis is put on enhancing transport quality especially by traffic organisation, ensuring a transport process that would be economical, safe and environmentally-friendly.

Conclusion

Slovakia currently sees a tendency towards increased road transport, in particular freight and individual car transport, whilst rail transport, suburban, bus and urban public transport face a decline. This unfavourable situation in transport contributes to an increasing burden on the environment, including residential areas, by emission of harmful substances and noise from traffic.

At the same time reduction of negative impacts on the environment has to be ensured also by optimal balance of using the potential of individual transport modes, via shifting transport volumes to environmentally-friendly transport modes, including rail transport. Development

of suburban rail transport may be considered an efficient way of greening big suburban centres in accordance with the experience from abroad.

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LIFE CYCLE ASSESSMENT OF FLOORS FOR THE FOOD INDUSTRY

Miroslav RUSKO, Jana KOTOVICOVÁ

Abstract

For the purposes of this research, floors on the basis of concrete, asphalt and dry-shakes have been selected from a whole range of different aspects. This constricted selection of three types of industrial floors has been chosen from the aspect of a more detailed analysis of these three kinds. The reason is that if we compared a greater number of industrial floors, we would not achieve such a great and detailed analysis as in this case. Three types of industrial floors have been chosen which are generally considered by manufacturing firms to be the most used and the most sold. In the past and at present, concrete and asphalt floors have been much used, especially in agricultural premises due to their undemanding character and relatively low purchase price. The dry-shakes have been chosen in view of the fact that they are much used and that they rank among the types of industrial floors with a long service life with respect to the rate of input costs, which is the top priority for the food industry.

In view of the fact that the concept of "industrial floors" can be understood from many points of view, it is necessary to specify and define certain research criteria to be applied in the life cycle analysis (LCA).

Key words

LCA, industrial floors, food industry

Introduction

Thanks to the growing public awareness of the quality of the environment and gradual application of the instruments of environmental policy, we can observe an ever-growing interest by both industrial firms and the general public in the impacts of production and services on the living environment and in the effort to minimize them. The reaction to the

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actual situation gave rise to the development of various methods and approaches to the assessment of the environmental impacts of production and services, which dates back to the beginning of the 60s of the last century. The goal of these efforts is to select, promote and produce a product or a working process that would be the most favourable from the ecological aspect. Nevertheless, the developed methods required a great amount of information and often rendered variant and incomparable results. To bring into effect complete characteristics of the environmental impacts of behaviour of human society, it was necessary to consolidate the hitherto used methodology and to create a more or less uniform apparatus known at present under the term of Life Cycle Assessment (LCA). This method studies the environmental aspects of production and their possible impacts on the living environment in the course of the whole life of the product, starting from the obtainment of raw materials, through the production, utilization, the disposal and waste management, which is “from cradle to grave”

Material and methods

An ecological product should be able to declare its origin and the energy demand in its production. To compare the energy demand of various products, the method of “Life Cycle Assessment of Products" (LCA) is applied. Using this method, we can define the amount of energy necessary for the production and, at the end of the life cycle, also for recycling the definite product (a car, a kilogram of detergent or for example thermal insulation) and also the amount of emissions released into the environment.

The manufacturing of concrete mixtures should not disturb its neighbourhood; it is therefore of prime importance to locate properly the production plant and to use advanced manufacturing technology which eliminates the negative impacts on the living environment.

Dustless and completely waste-free operation of concrete mixing plants should be environmentally-friendly and also give regard to the working environment of the employees. The recycling equipment cleans the residues of concrete mixtures from the washing of agitator trucks and concrete pumps. Clean material and recycled water are returned back to the production process.

The environmentally-friendly behaviour is given by the possibilities offered by up-to-date technologies and not least by a responsible and systematic approach of the manufacturer. It is of prime importance to select correctly the site of the concrete mixing plant and to apply advanced technology to eliminate the negative impact of the manufacturing process on the living environment, to green the surroundings of the producing plants so that the natural landscape pattern is not harmed. The present-day aesthetically designed production plants thus become an important salient feature of their surroundings; they are built up as waste-free production plants fitted with efficient filtering equipment and they are very environmentally-friendly.

As in every industrial activity, the mining of gravel sand also affects the natural landscape pattern. Many companies strive to minimize these impacts, to seek new positive factors for the mining process and to take advantage of them. In the framework of reclaiming industrial land, newly accessed water is incorporated into the landscape. In the exhausted areas, plantings are made, grown trees are planted, shores are reinforced with newly-planted bushes, and this all relates to the regional bio-corridors in the given region. In many cases, the locality

is, after the exploitation, environmentally more valuable than before the beginning of the exploitation.

To dispose of concrete in an ecologically accepted manner, there are specialized firms equipped with special facilities. In most cases, the waste originator finances both the recycling and transportation of unneeded concrete to the site of the recycling line. A specialized firm sorts the concrete (and/or debris) and tries to arrange it for further use. For example, it may be used as a component part of compost, to reinforce forest-roads and cart-roads, or to reinforce building sites for various purposes. It is also possible to reuse the broken concrete to prepare concrete.

After a definite period of time, concrete may lose the properties it had when it was placed. It may crack and "spall" due to external actions and it may be generally harmed by frequent use. In this case, the users have several possibilities. They can either remove the given concrete or they can improve it with a new layer of concrete which will cover the shortcomings of the old one. The disadvantage of this method is its profitability in dependence on the total service life of the structure.

As we have already mentioned, this study is limited mainly to poultry breeding and/or to its application in farms specialized primarily in poultry breeding. This example can be used to demonstrate the service life of concrete. The standard service life of concrete when used in a traditional manner is approximately 30-50 years depending on the quality of material, installation, etc. The poultry's excrement contains acid elements which deteriorate the concrete and thus the standard service life is essentially reduced. Installed concrete thus has to be repaired at regular intervals (reconstructed) or it has to be replaced. There exist many technical solutions to prevent or to reduce these problems. It is primarily a case of regular coatings and preventive repairing of local deterioration.

The term recycling in its general meaning means that the existing ripped-up (or milled-out) asphalt can be melted and placed back to the original place or to a new place. The material to be recycled is processed mechanically and thermally. Asphalts are recycled directly on site.

Dry-shakes essentially mean further treatment of concrete, so we can say that recycling is in this aspect practically identical to the recycling of concrete. It is thus a case of overlaying (reconstruction) of the existing concrete layer, where the old surface is used as a base for the placing of a new top layer. Another possibility is to remove the existing concrete, and in this case the recycling would consist of an expert firm crushing the material to obtain the required fraction, sizing it and using it as reinforcement, or it will be added to the new concrete by the dry-shake treatment.

Concrete dry-shakes, as a surface treatment of concrete, are very advantageous; however, they are at the same time essentially more expensive than traditional concrete. Nevertheless, the concrete with dry-shake technology improves its structure and its properties in general. It also considerably extends its service life. This is the reason why at present a lot of firms select exactly the concrete variant with dry-shake technology. The acquisition costs are considerably higher, nevertheless, thanks to a longer service life and higher resistance of the floor, the costs related to the acquisition will return in the form of a longer use of the floor and in the form of lower costs related to its possible repairs.

Definition of the subject matter of analysis 115

The aim will therefore be to compare which of the three industrial floors has the best properties, and especially which of them has the least environmental impact.

ADVANTAGES AND DRAWBACKS OF THE COMPARED INDUSTRIAL FLOORS Table 1

	Concrete	Dry-shakes	Asphalt
Advantages	price	long service life	wear resistance
	strength	resistance to abrasion	noise damping
	stiffness	dustless	watertight
	smooth surfacing		resistant to heat-frost alternation
Drawbacks	dusting	technological exigency	deformation
	low resistance to abrasion	price	follow-up reconstruction with asphalt
	absorptiveness		thermal instability

Results and discussion

The data presented on the individual flows in the evaluated systems were obtained from the records of the companies, technological descriptions and/or verbal consultations with appointed workers of the technological department, and from the records kept by the company environmentalist.

INPUT/OUTPUT MATRIX FOR THE PRODUCTION OF CONCRETE AND DRY-SHAKES Table 2

Technological operations	**INPUTS**			**OUTPUTS**		
Unit [per 1000 m^2 of products]	**Petrol [litres]**	**Diesel oil [litres]**	**Electric power [kWh]**	**Emissions of CO_2 [g]**	**Noise [dB]**	**Waste [kg]**
Collection of soil	-	32	-	2321	107	-
Soil haulage	-	194.25	-	14089	85	4000 [1)]
Aggregate haulage	-	166.5	-	12076	85	-
Aggregate cartage	-	13	-	943	107	-
Aggregate compaction	-	5	-	363	63	-
Mixing of concrete	-	-	131.35	-	-	76
Concrete cartage	-	177.6	-	12881	85	120
Placing concrete	-	-	87.5	-	73	150
Vibration of concrete	-	-	1.5	-	30	2
Application of dry-shakes						
Pulverisation of emulsions	5	-	-	340		-
Scouring	60	-	-	4075		2
Cutting of expansion joints	24.2	-	-	1643	108	-
Disposal	-	52	-	-	110	375000 [2)]

INPUT/OUTPUT MATRIX FOR THE PRODUCTION OF ASPHALT Table 3

Technological operations	INPUTS			OUTPUTS		
Unit [per 1000 m^2 of products]	Ground gas [litres]	Diesel oil [litres]	Electric power [kWh]	Emissions [g]	Noise [dB]	Waste [kg]
Collection of soil	-	32	-	2321	107	-
Soil haulage	-	194.25	-	14089	85	4000 [1)]
Aggregate haulage	-	166.5	-	12076	85	-
Aggregate cartage	-	13	-	943	107	-
Aggregate compaction	-	5	-	363	63	-
Mixing of asphalt	1250	-	126	69375		
Haulage of asphalt	-	83.25	-	6038	85	-
Placing of asphalt	-	44	-	3191	86	
Rolling of asphalt	-	16	-	1160	74	
Disposal	-	58	-	4207	102	250000 [2)]

Notes:

1) in this case the soil was considered as waste in view of the fact that it was not further employed in the production of concrete floor, nevertheless, it can be used as back-fill or fill in further building activities and/or it may be deposited in a dumping place
2) material produced in the disposal of an old asphalt floor may be regarded as waste and deposited in a dumping site, nevertheless, in practice, this "waste" is considered to be valuable raw material for consequent utilization in placing asphalt surfaces

Evaluation of assessed technologies

"*Evaluation of energy demand*", i.e. the consumption of energy obtained by transformation of primary non-renewable resources. Data on the electric power consumption in the individual stages of both assessed technological processes necessary to produce 1 m^2 of products are presented in the following table.

EVALUATION OF ENERGY DEMAND Table 4

Operation	Unit	Concrete, Dry-shakes	Asphalt
Mixing	[kWh/m^2]	0.131	0.126
Placing	[kWh/m^2]	0.088	-
Vibration (compaction)	[kWh/m^2]	0.002	-
TOTAL	**[kWh/m^2]**	**0.221**	**0.126**

The first classification part also includes the consumption of primary energetic raw materials. Table No. 5 represents the amount of gasoline, diesel oil and natural gas necessary to assure all technological processes of the assessed technologies related to the production of 1 m^2 of products.

CONSUMPTION OF PRIMARY ENERGETIC RAW MATERIALS TO ASSURE THE TECHNOLOGICAL PROCESSES Table 5

Raw materials	Unit	Concrete	Dry-shakes	Asphalt
Gasoline	[l/m^2]	0.084	0.089	-
Crude oil	[l/m^2]	0.640	0.640	0.612
Natural-gas	[l/m^2]	-	-	1.250
TOTAL	**[l/m^2]**	**0.724**	**0.729**	**1.862**

GENERAL REVIEW OF PRODUCTION OUTPUTS Table 6

PRODUCTION OUTPUTS	Concrete	Dry-shakes	Asphalt
CO_2 [g/m^2]	48.391	48.731	113.763
Waste [kg/m^2]	379.350	379.350	254
Mean noise value [dB] *	93.43	93.43	86.59

*Mean noise level was defined as a weighted mean in which the weights constituted mean operating time of the individual machines

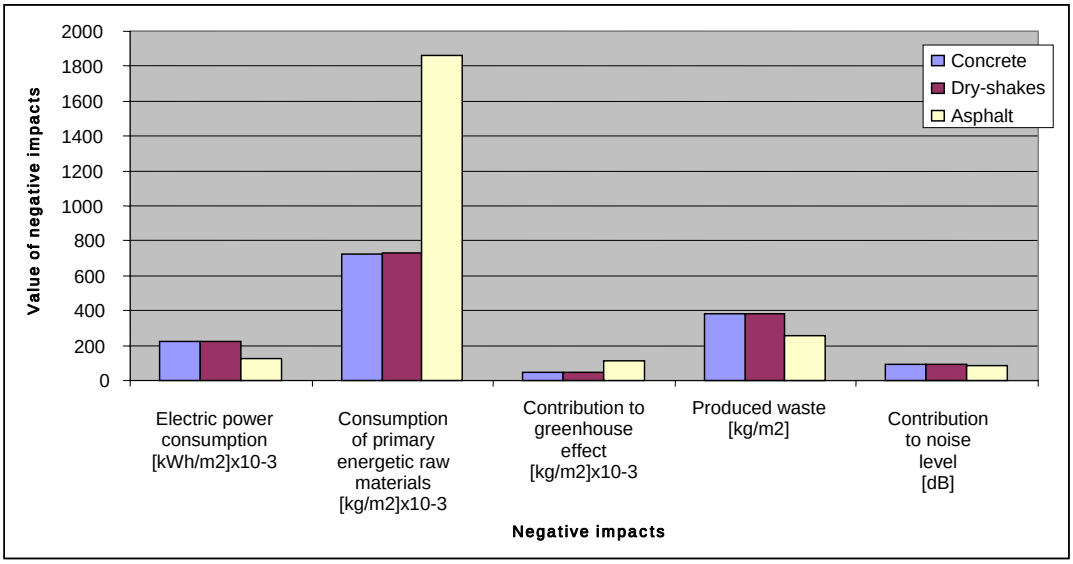
The contribution to the greenhouse effect forms part of the third classified group. From the perspective of its consequences, the greenhouse effect has a global character and it ranks therefore among the most important environmental impacts. It contributes to the increase in global temperature without respect to the site of origin of the emissions.

The amount of waste produced has been included into the fourth classified group, because the amount of waste plays an important role in the ecological and subsequently also in the economic aspects of production.

The measure of noise was included in the last classified group. It was defined as the weighted mean from the aspect of the operating time of the individual working machines. The noise level has a disastrous influence on the standard of living of the population and the workers.

TOTAL NEGATIVE IMPACTS AFFECTING THE LIVING ENVIRONMENT Table 7

Classification group	Units	Concrete	Dry-shakes	Asphalt
Power consumption in examined processes	[kWh/m^2]	0.221	0.221	0.126
Consumption of primary energy raw materials	[kg/m^2]	0.724	0.729	1.862
Contribution to greenhouse effect	[kg/m^2]	48.391×10^{-3}	48.731×10^{-3}	113.763×10^{-3}
Produced waste	[kg/m^2]	379.350	379.350	254.000
Contribution to noise level	[dB]	93.43	93.43	86.59
Total negative impact	**-**	**473.773**	**473.778**	**342.692**



Graph 1. *Total negative impacts on the living environment in the production of surfaces*

The assessed technologies, variants marked as X_1, X_2 and X_3, may be evaluated based on the determined negative environmental impacts, according to the criteria marked A_1 through A5, applying mathematical operational analysis. For this purpose, one of the methods of multi-criterion evaluation was selected. Specifically, in the question is the weighted sum method, the essential part of which is the determination of the weights of the selected criteria. To determine the weights, the so-called scoring method was selected. For each criterion, all the interested persons determined a point scoring evaluation using a 0 to 5 scale. The more important is the criterion for the given person, the higher the score. The review of point scoring by the individual persons is represented in Table 8.

REVIEW OF POINT SCORING OF THE CRITERIA

Table 8

Designation of criterion*	**Person 1**	**Person 2**	**Person 3**
A_1	2	3	3
A_2	5	4	5
A_3	4	3	4
A_4	3	3	2
A_5	1	1	2
Total:	**15**	**14**	**16**

Explanatory notes:

A_1 represents the electric power consumption;
A_2 represents the consumption of primary energetic raw materials, i.e. crude oil and ground gas;
A_3 designates the contribution to the greenhouse effect;
A_4 designates the contribution of the produced waste;
A_5 designates the contribution to the noise level.

On the basis of the above data, the weights of the criteria were determined according to the individual participating persons. The described calculation is represented in Table 9.

CALCULATION OF WEIGHTS FOR THE DEFINED CRITERIA Table 9

Criterion (v_{ij})	**Person 1**	**Person 2**	**Person 3**	**$\sum v_{ij}$**	**Total weight (v_i)**
A_1	0.133	0.214	0.188	0.535	**0.178**
A_2	0.333	0.286	0.313	0.932	**0.311**
A_3	0.267	0.214	0.250	0.731	**0.244**
A_4	0.200	0.214	0.125	0.539	**0.180**
A_5	0.067	0.071	0.125	0.263	**0.088**

The established vector of weights for the needs of this study is therefore as follows:
V = (0.208; 0.291; 0.185; 0.213; 0.102).

Each VHV task is characterized by the so-called criteria matrix, in which the columns correspond to the criteria, in this case A_1 through A_6, and the lines correspond to the evaluated variants (X_1 and X_2). The elements of matrix a_{ij} express the evaluation of i-variant according to j-criterion. The criteria matrix has the following form:

$$Y = \begin{pmatrix} A_1 & A_2 & A_3 & A_4 & A_5 & \\ 0.221 & 0.724 & 48.391\times10^{-3} & 379.350 & 93.43 & X_1 \\ 0.221 & 0.729 & 48.731\times10^{-3} & 379.350 & 93.43 & X_2 \\ 0.126 & 1.862 & 113.763\times10^{-3} & 254.0 & 86.59 & X_3 \end{pmatrix}$$

It is also necessary to determine the ideal and basal variants. The ideal variant is the hypothetic or real variant that attains the best possible values in all the criteria. The ideal variant in the set task is vector H = (0.221; 1.862; 113.763×10^{-3}; 379.350; 93.43). In an analogous manner, a basal variant is the variant that has all the values of the criteria at the lowest level. Also in an analogous manner, the basal variant is vector D = (0.126; 0.724; 48.391×10^{-3}; 254.0; 86.59).

The next step was the unification of the set criteria. Nevertheless, all the criteria of this study are considered to be minimizing criteria and the above-mentioned step was therefore omitted.

The values of the criteria matrix are expressed in various units and it is therefore necessary to normalize all these values according to the relation $r_{ij} = (y'_{ij} - D_j)/(H_j - D_j)$, where D_j represents the lowest value of the j-criterion and H represents the highest value of j-criterion.

The resulting matrix is the so-called normalized matrix in the following form:

$$Y^* = \begin{pmatrix} 1 & 0 & 0 & 1 & 1 \\ 1 & 4.39\times10^{-3} & 5.2\times10^{-3} & 1 & 1 \\ 0 & 1 & 1 & 0 & 0 \end{pmatrix}$$

In the weighted sum method, the optimum variant is the variant that minimizes the sum of the products of weights and the respective criteria values in the event that all the set criteria are minimizing criteria. The resulting evaluation of variants is summed up in Table No.10.

APPLICATION OF THE WEIGHTED SUM METHOD Table 10

Variant	Sum of products of values of criteria matrix a_{ij} and the corresponding weights of the criteria (v_i)	Total	**Order of variants**
X_1	$1 \times 0.178 + 0 + 0 + 1 \times 0.180 + 1\times 0.088$	0.446	**1.**
X_2	$1 \times 0.178 + 4.39\times10^{-3} \times 0.311 + 5.2\times10^{-3} \times 0.244 + 1 \times 0.180 + 1 \times 0.088$	0.448	**2.**
X_3	$0 + 1 \times 0.311 + 1 \times 0.244 + 0 + 0$	0.555	**3.**

Conclusion

The aim of this study was to show the possibilities for application of the life-cycle methodology using a concrete example from the technological practice for the purpose of ecological production and reduction of its environmental impact. This goal has been essentially attained. It has been proven that the LCA methodology may be used for the comparison of environmental impacts of three technological processes. The solution of the study was, however, complicated by several facts, namely the non-existence of analogous

materials in available literature and the unavailability of some data from the partnership firm that are subject to trade secrets. A great obstacle we faced was also the fact that it was difficult to obtain concrete information from the manufacturers of construction machinery and mechanization. The precondition for reaching the primary goal was the attainment of secondary goals. Among them, the most difficult goal was the attainment of necessary data and their subsequent conversion to the set functional unit, and in certain cases it was necessary to make use of expert assessment by specialist workers.

At present, a unified methodological procedure to regulate the assessment of the impacts has not yet been defined. The relevant part of the considerations was therefore based on the subjective approach of the compiler, who discussed it with experts in the defined fields both at theoretical and practical levels.

The assessment was based on the electric power consumption and the consumption of primary energetic raw materials (crude oil and ground gas), the contribution to the greenhouse effect, the production of waste and the contribution to the noise level. From the aspect of the total negative environmental impact, only a negligible difference between the technology of concrete floor production and the production of dry-shake floors has been ascertained by means of mutual comparison. A major negative environmental impact of the technology of asphalt floor production against the technology of concrete floor and dry-shake floor production is due to a higher consumption of primary energetic raw materials, in particular of natural gas. The total consumption of primary energetic raw materials is in the case of asphalt floor technology approx. 155% higher than in the technology of concrete and dry-shake floors technology. This consumption is due to the technological parameters of the production of asphalts. Due to this increased energy demand, in particular in the case of the consumption of natural gas, this technology renders a higher contribution to the greenhouse effect, namely by approximately 133% against the consumption of concrete and dry-shake technologies. The positive feature of the production technology of asphalt floors is lower consumption of electric power and lower production of waste compared to the technology of concrete and dry-shake floor production. Electric power consumption is, in the case of asphalt floors, approximately 57 % lower compared to concrete and dry-shake floors; from the aspect of waste production, the asphalt technology is approximately 33 % more economical compared to the remaining technologies. From the aspect of their contribution to the noise level, there are only minimum differences between the assessed technologies; only the contribution of the asphalt technology to the noise level is approximately 7.8% less. From the aspect of the total environmental impact, only minimum difference has been found between concrete and dry-shake technology. The difference between the two technologies and the technology of asphalt production is approximately 27.7% in favour of the asphalt technology.

To attain higher objectivity in the obtained results, the assessed technologies were evaluated using mathematical operations analysis. To this effect, one of the methods of multi-criterion evaluation of variants was applied, namely the weighted sum method. The results proved that the optimum variant is the technology of concrete floor production. The second optimum variant is the technology of dry-shake floor production, and the third one the technology of the asphalt floors. It has to be also emphasized that the differences between the evaluated production technologies were of minimum extent.

Consequently, operations producing the greatest negative impact on the environment were identified. These are in the first place the transportation of raw materials by trucks, waste produced by the disposal of the floor at the end of its life cycle, and also the consumption of electric power, in particular by auxiliary construction mechanization.

Nevertheless, the decision-making process in which mainly investors participate is comprised also of other necessary aspects, particularly the economic information related to the investment and operating costs and/or the market size, and also to the possible social impacts and safety precautions. A very important criterion to be taken into consideration in the decision-making process is the total service life of the product, in this case of the floors in agricultural premises. The expected service life of concrete floors is approximately 30 years. The dry-shake treatment of concrete floors increases the cost of realization of the floor (by approx. 60 – 100 Czech Crowns/m^2); nevertheless, it highly improves the technical properties of the resulting product, primarily its resistance to external influences, its durability and its load-bearing capacity. Thanks to this treatment the dry-shake floor can attain much longer service life than standard concrete floors. The expected service life of asphalt floors is approximately 25 years.

The expected application of the results obtained by the solutions from this study offers to the management of the respective firm further improvement of the ecological - economic characteristics of the technology of floor production in agricultural premises. At the same time, the results of the study also offer a primary instruction for the application of LCA methodology to the technologies of production of various types of industrial floors.

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OPEN SOCIETY PROGRESS PROVISION AND CONFIDENTIALITY OF KNOWLEDGE IN A SMALL WORLD

Jaroslav ŠMÍD, Peter SAKÁL

Abstract

This paper defines and explains the concept of open innovation and the difference between open and closed approaches of companies to innovation. It also explains the model of the small world and its use in simulation of knowledge diffusion as well. The generally used model of the small world is supplemented by the parameter of knowledge confidentiality. By using this model, it is confirmed that a society which freely shares knowledge has a higher aggregate level of knowledge than a society in which some members keep the knowledge confidential. Knowledge diffusion is also verified on the model of society in which knowledge is shared mutually by each member of the society.

Key words

open innovation, cluster, small world, knowledge diffusion

Introduction

The phenomenon of the small world can be simply explained by the fact that everyone knows each other, thanks to people who are acquainted. Two mutually unknown persons living anywhere in the world have a connection through a relatively small number of people. As shown in [1] the phenomenon of the small world appears in the real world in some cases, for example in networks arising in nature and technology. Collaborating networks of innovative and research companies, knowledge exchange within the model of open innovation, and the World Wide Web development and its similarity with the small world are also the subjects of further studies. A survey of studies dealing with similarities of processes occurring in the real world and in the model of the small world is presented in many other papers [2], [3].

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Open Innovation

According to Henry Chesbrough [4], open innovation is the purposive inflows and outflows of knowledge to accelerate internal innovation and expand markets. It means that companies can/should use both external and internal sources of knowledge and innovation, as well as internal and external paths to expand markets.

In the open innovation management model, the company uses internal R&D as well as external sources, buys results and patents from other companies, and cooperates with universities and R&D institutions. Moreover, results which the company does not plan to use directly in the future are offered for sale to other companies. The company gets additional financial resources and releases its own human resources. The company may establish a new company which will develop the knowledge of the parent company further. The open model of innovation processes offers more options too, for example the free release of knowledge, organizing into clusters, associations, and chambers.

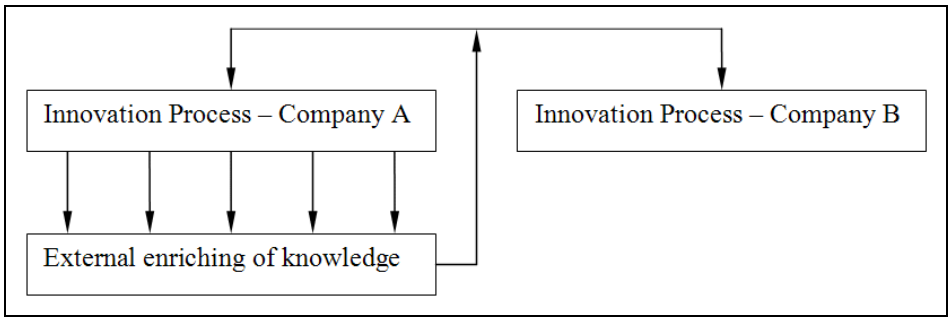

Fig. 1. *Supply / Confidentiality of knowledge*
Source: Open Innovation – Rethinking [7]

Other principles and opportunities of open innovation are introduced in [4] and [5]. A more detailed consideration of the company A in [6], which freely shares its knowledge with the company B, which on the other hand only takes and keeps knowledge confidential as shown in Fig.1.

Small World

In various papers, for example [3] and [7], the model of the small world is described and defined as a graph in which every vertex/member has a direct connection with some other members and is endowed with certain knowledge. A random member that broadcasts its own knowledge to any other member is chosen in time. This happens via the direct connection and the same area of knowledge.

Let us consider the graph in Fig. 2, which consists of N members. Each member is connected to n nearest members. When modeling the situation, each member connection is changed with the probability p and is connected with the member which is chosen randomly without having any prior connection. Two extreme cases come to existence in this way. The first occurs when the probability $p = 0$, in which no connection is changed (Regular world) and the other extreme occurs when the probability $p = 1$, in which all connections are

randomly changed (Random world). If the probability is in the range of $0 < p < 1$, the so-called small world comes into existence, gaining interesting features.

The definition and the exact formal description and establishment of the small world model is given in [4]. Formally, let

$$V_i(t) = (V_{i,k}(t); k = 1, ..., K) \tag{1}$$

be a vector of knowledge of the member i at time t for every category of knowledge k.

$$V_{j,k}(t+1) = V_{j,k}(t) + \max\{0, \alpha[V_{i,k}(t) - V_{j,k}(t)]\}; \; k = 1, ..., K \tag{2}$$

is the vector of knowledge of the member j, after receiving the knowledge from the member i. Here, the parameter α reflects the increase of the aggregate knowledge of the member j by receiving new knowledge, which together with the existing knowledge generates the new knowledge creation.

The average level of knowledge of the member i at time t is then:

$$\overline{\mu_i}(t) = \sum_k V_{i,k}(t)/K \tag{3}$$

The aggregate average level of knowledge of society is:

$$\overline{\mu}(t) = \frac{1}{N} \sum_{i \in I} \overline{\mu_i}(t) \tag{4}$$

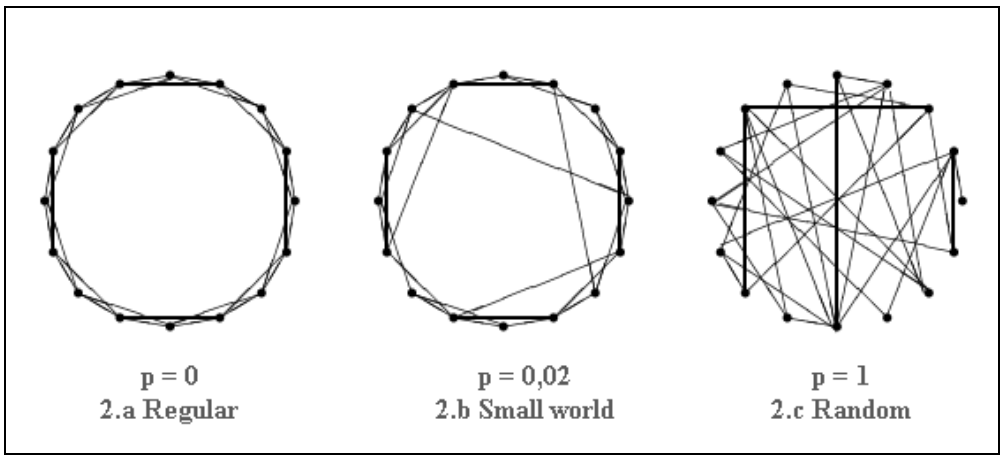

Fig. 2. *Transition of the regular world to the random one and the small world phenomenon*
Source: The Dynamics of Collective Invention [3]

When creating the small world it is interesting to research two variables that characterize it: the average shortest path length λ and the average cliquishness C. The path length is the number of friendships in the shortest chain connecting two members. The cliquishness reflects how many friends (members that have a direct connection) of one member are also friends of each other. The regular world is characterized by a high value of λ and C, as shown

in Fig. 2.a. In the random world the values of λ and C are low. The phenomenon of the small world arises when the value of λ is significantly reduced and the value of C remains high as the consequence of the influence of a few random connections.

Results

The impact of the knowledge confidentiality of some members on the aggregate average knowledge level of the cluster and its evolution was examined in the small world model. Knowledge confidentiality is characterized as the behavior of a member who receives knowledge from other members but does not share this knowledge. In our model this is represented by a situation when some members receive knowledge according to (1), the knowledge is assessed according to (2), and when the time comes to broadcast their own knowledge, they broadcast it with the null value.

The computation and creation of the small world model was made with the following parameters:

The number of members N=100, the number of connections of each member n=16, the probability of change of each connection with another randomly selected member p=0,1 and the parameter α=1,2 that reflects the increase of aggregate knowledge of a member by receiving the new knowledge, that together with the existing knowledge generates new ideas. T=100 broadcastings for a different number of randomly selected members that broadcast knowledge with the null value – non-sender members were done in the following model of the small world. The number of non-senders was divided into three categories: Non-Senders=0, Non-Senders=30 and Non-Senders=90. The average knowledge level of each member is computed according to (3) and (4) covering five different areas of knowledge Vi. These were randomly generated with a value from 0 to 100 in time t=0 (the initial level of knowledge). The aggregate average knowledge level as a function of time for a different value of the number of Non-Senders in our society is shown in Fig. 3.

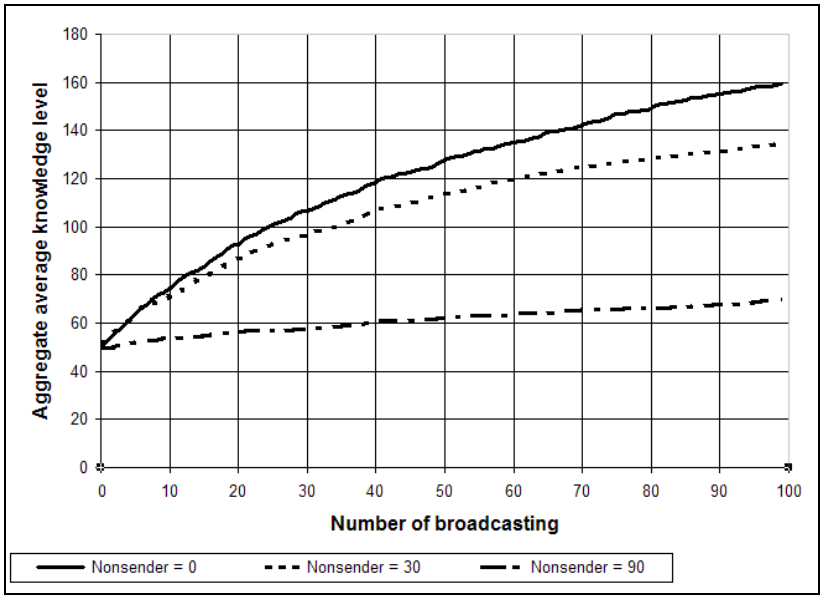

Fig. 3. *The aggregate average knowledge level as a function of time for different values of number of Non-Senders*

The obtained results were verified and confirmed by the model under the same conditions with the exception that the knowledge is shared mutually. The small world model arises when the number of connections of each member is close to the total number of members. The results obtained from this model are similar in nature. The difference is that the aggregate average level of knowledge with different values of number of members who do not broadcast their knowledge in time converges more quickly to the same value. However, the difference of the aggregated average level of knowledge in the early stages of the society development is significant.

Contribution

The contribution to the problematic is in the new supplemental parameter dealing with the knowledge diffusion in the small world. The number of members who receive knowledge from other members, but who on the other hand keep their knowledge confidential, represents the new parameter. Monitoring the knowledge diffusion was supplemented with the extreme case – the average number of connections between members is close to the total number of members. This means that the knowledge is shared mutually. This model also confirms that the society which freely disseminates knowledge has a higher overall knowledge level and evolves rapidly in the early stages.

It should be stressed that a society, for example a cluster of entrepreneurs, which shares knowledge, can form such a society. It may be any society that consists of multiple clusters and individual members. One of the basic tasks of knowledge exchange in the cluster and outside the cluster is confirmed this way.

In the real world, various open discussion groups on the Internet, conferences, journals, proceedings, etc. give everyone the possibility to present their findings to the entire society, clusters, or cooperating groups. These are considered to be societies in which knowledge is mutually exchanged.

Conclusion

There are a number of additional parameters which are neglected and which could be taken into consideration. Different thoughts on knowledge diffusion were presented, for example [1], [2], [3] comparing the phenomena occurring in the real world with the results obtained by the model of the small world.

Since this is a closed system, the knowledge converges to a certain level which does not represent the real status. To keep the progress of the society, it is necessary to support "progressive" knowledge. This entails a new paradigm – a change in the current way of thinking. This is represented by the irregular incidence of high α values in our model.

The knowledge diffusion research on models of the small world can continue by monitoring and comparing the level of knowledge of individual members that keep knowledge confidential and members that broadcast knowledge. Because of the fact that companies, institutions, and independent researchers are not interested in releasing strategically significant knowledge and solutions before the end of the development, or represent an innovative higher order leap, the model can be enriched with the parameter reflecting the rate of knowledge release, or with the parameter which attributes a certain

strategic importance to the knowledge. The situation of desired and unwanted release of knowledge can be simulated in this model. The results can be further verified in real associations or groups by questionnaires surveys and personal interviews.

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A COMPARISON OF DIE GEOMETRY IN THE DRAWING PROCESS

Viktor TITTEL, Miroslav ZELENAY

Abstract

Experiments were conducted on the drawing of high tensile strength wires ($S_u \leq 3\,000$ MPa) ϕ 0.30 mm. An influence of relative die pressure on their consumption was found. The drawing angles of dies were sought which had a size of $2\alpha = 11°$ and 13° from producers A (current) and B (new). Approximately 650 tons of wires with very good quality were produced during the experiment. The total die consumption from company B was lower by more than half as compared to company A. The lower die consumption of B13 was probably influenced by the quality of the die treatment and the keeping of geometric accuracy. For the dies B11, a more favourable Δ-parameter, and therefore the relative die pressure, played a significant role, which was lower than dies with a drawing angle of 13°. The mathematical dependencies between the relative pressure and die consumption were also found.

Key words

die, reduction, die geometry, wire, drawing process, die consumption

Introduction

A die is a basic tool which is used for the drawing process of steel wire. The process of plastic deformation of drawn wire is performed in the die. The plastic deformation is impacted by the influence of a common pressure in the die and the drawing force which is affected on the wire. The die is constructed so that it ensures the required accuracy of size and surface quality. Die geometry is an indispensible component of die construction and mainly approaches the angle size 2α [4, 5].

Both the wire and the die warm during the drawing process due to the transformation of deformation work with heat. The next source of heating is friction between the wire surface

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and the die. The heating of surface layer wire is also influenced by the drawing speed, which is dependent on the contact time of the wire surface and the die. The greatest efficiency of deformation work on the wire is drawn through die ranges in a relatively narrow band of the chosen die angle 2α. The work will increase if we use a small approach die angle, which is because it is needed for overcoming the friction between the wire and die. The work will increase if we use a big approach die angle because it is needed for additional internal material movement. The size of the drawing angle also influences lubrication efficiency. Decreasing the drawing angle can decrease the friction factor μ from 0.05 to 0.005. One reason is that the lubrication gains more hydrodynamic character [2, 4].

The experiment

A target of the experiment was to verify a change of the die geometry directly in conditions of steel cord wire production. The die geometry change consisted of a drawing angle change of 2α from the original 13º to a verified 11º. Other goals were to make a comparison of dies in the same operational drawing conditions, an evaluation of drawn wire quality, and also an evaluation of complex die consumption.

Description

Our experiment proceeded in a wet wire drawing shop. Steel cord wire with a diameter of 0.30mm was produced in the wet wire drawing shop over a long term. This type of wire was used as a semi-product for a bunching (double twisted cabling) of steel cord 2 x 0.30.

Wire with diameter of 0.30 mm was produced from a patented semi-product and the surface of the semi-product was coated with brass. The experiment was executed by using a die series with 20 dies.

The dies from company A were preferentially used in wet wire drawing. The dies were delivered as semi-products. It was necessary to prepare and polish these at required dimensions and a specified geometry in a local die shop. The dies from “company A” were delivered with a standard die geometry with approach angle 2α = 13º (A13). The dies from the “supplier A” were compared to dies from company B which prepared dies with approach angle 2α = 13º and 2α = 11º (B13, B11).

At the beginning of the experiment three machine groups were dedicated for the location of die series from “company B” with approach angles 2α = 13º and 2α =11º (B13, B11) in a wet wire drawing shop. All other machines were used for the installation of standard die series with an approach angle of 2α = 13º (A13). The standard wire production for a comparison purposes was just produced on these machines. During the experiment the evidence form was located directly on the machines, and the operators which operated those machines registered the required data. The drawing speed was 18 $m.s^{-1}$.

The experiment took 41 days. During this time more than 650 tons of wire with very high quality was produced. During the experiment some heats of wire rod were produced. The chemical composition, mechanical properties, as well as metallographic parameters of the wire rod heat that was used were very similar, without expressive differences. The lubricant emulsion used was the same on all machines and the same conditions were kept according to the valid technological procedure. During the experiment we also evaluated die consumption,

mechanical properties, wire fractures, and the following wire processing – those detailed results will be published later. Die consumption was evaluated in dependency on a Δ – parameter size and relative die pressure. In 1958 Δ – parameter was defined by J. G. Wistreich [3] as "the ratio of the arc, spanning the midpoints of the die face "d_m" to the length of contact between wire and die "l" (fig. 1).

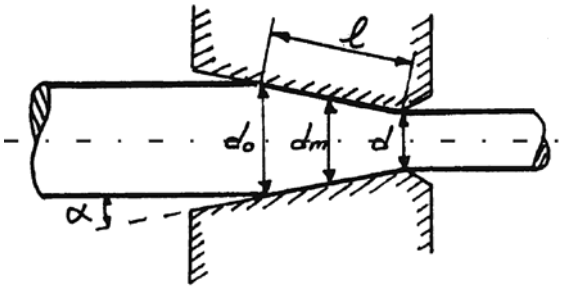

Fig. 1. *The wire in the die. Schematic [2,3]*

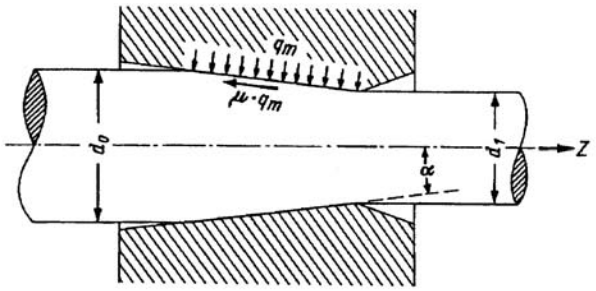

Fig. 2 *Pressure between wire and die [2,3]*

$$\Delta = \frac{d_m}{l} = \frac{d_0 + d}{d_0 - d}.\sin\alpha \ , \tag{1}$$

where α – ½ drawing angle [°], d_0 - diameter of wire before drawing [mm], d - diameter of wire after drawing [mm].

$$\Delta = \frac{1}{\varepsilon_d}(1+\sqrt{1-\varepsilon_d})^2.\sin\alpha \qquad \text{where } \varepsilon_d \text{ – calculated reduction [-] .} \tag{2}$$

Relative die pressure

$$\frac{q_m}{\sigma_m} = \left[-\ln(1-\varepsilon_d).(1+\frac{\mu}{\alpha}) + \frac{2\alpha}{3}\right].\frac{1-\varepsilon_d}{\varepsilon_d.(1+\frac{\mu}{tg\alpha})} \ , \tag{3}$$

where q_m – pressure between wire and die [MPa],

σ_m – flow stress, which is approximately equal to the mean value of the yield strength $S_{0.2}$ [MPa].

Results and discussion

All values of the drawn wires kept in the tolerance zone 180 ÷ 230 N. Exchanges of individual dies were continuously registered and the exchanges can be seen in Fig. 3.

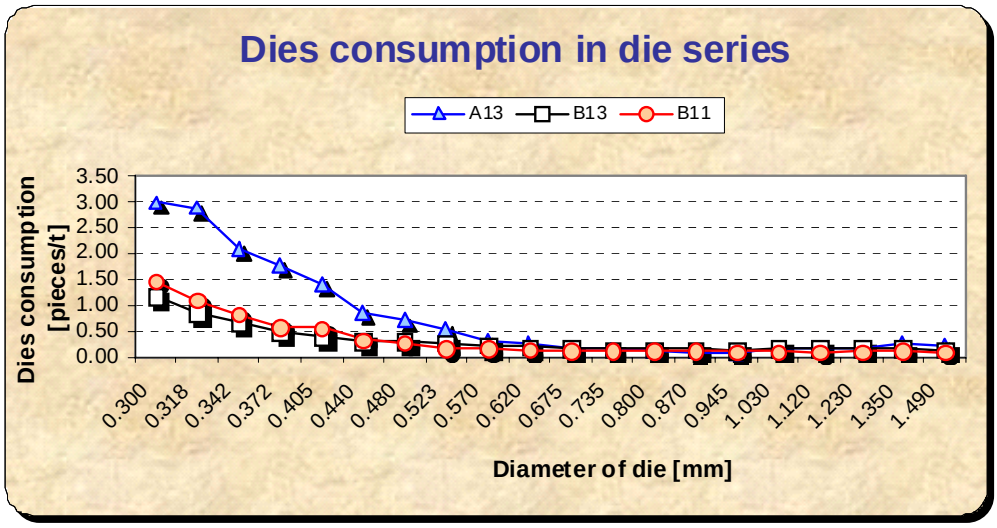

Fig. 3. *Dies consumption*

In general the consumption of B11 dies was lower compared to both other die groups. A backset occurs in the finished dies when the value of the Δ-parameter begins to increase and there is also pressure in the die. The value is more favourable (lower) for B11 dies (for the last die Δ = 3.29) against dies with the approach angle 13° (B13 for the last die Δ = 3.89). In general, dies with a lower Δ-value require better lubricant properties with a lower friction coefficient and good resistance against dissociation. The properties of our lubricant did not probably satisfy to a full extent these criteria and therefore the hardening of wires which were drawn with the die B11 were slightly more compared to wires processed with die B13. A confirmation of this idea is the slightly higher breaking force and also tensile strength compared to dies of group B13. A comparison of relative die pressure and diameters are listed in Table 1.

COMPARISON OF RELATIVE DIE PRESSURE AND Δ-PARAMETER FOR EACH DIAMETER IN THE DIE SERIES Table 1

∅ [mm]	A13	B13	B11	A13	B13	B11	Ø [mm]	A13	B13	B11	A13	B13	B11
	q_m/σ_m [-]			Δ – parameter [-]				q_m/σ_m [-]			Δ – parameter [-]		
1.49	1.45	1.45	1.35	2.23	2.23	1.89	0.62	1.59	1.59	1.47	2.68	2.68	2,26
1.35	1.48	1.48	1.37	2.31	2.31	1.95	0.57	1.60	1,60	1.48	2.70	2.70	2.29
1.23	1.46	1.46	1.36	2.25	2.25	1.90	0.52	1.58	1.58	1.46	2.64	2.64	2,24
1.12	1.59	1.59	1.48	2.66	2.66	2.25	0.48	1.58	1.58	1.46	2.65	2.65	2,24
1.03	1.60	1.60	1.46	2.71	2.71	2.30	0.44	1.57	1.57	1.45	2.61	2.61	2.21
0.95	1.58	1.58	1.49	2.64	2.64	2.23	0.41	1.61	1.61	1.49	2.74	2.74	2.32
0.87	1.61	1.61	1.48	2.75	2.75	2.33	0.37	1.59	1.59	1.47	2.68	2.68	2.26
0.8	1.60	1.60	1.47	2.71	2.71	2.29	0.34	1.60	1.60	1.48	2.70	2.70	2.29
0.74	1.59	1.59	1.47	2.68	2.68	2.27	0.32	1.73	1.73	1.58	3.12	3.12	2.64
0.68	1.59	1.59	1.47	2.67	2.67	2.26	0.30	1.95	1.95	1.77	3.90	3.89	3.29

Within the frame of the experiment the total die consumption from company B was more than twice lower than dies from company A. The lower consumption of B13 dies was probably influenced by the quality of the die treatment and the keeping of geometric accuracy. For the B11 dies the Δ-parameter, and therefore more favourable relative die pressure, played a significant role which was lower than dies with the drawing angle 13º. The comparison of total die consumption is in Table 2.

COMPARISON OF TOTAL DIE CONSUMPTION Table 2

Die group	A13	B13	B11
Die consumption [pieces/tonnage of production]	15.29	6.26	6.56

When we analyzed and found the dependencies between die consumption and relative die pressure, Wistreich´s theory was confirmed that die consumption would increase if the relative pressure between wire and die increased. Table 1 and Fig. 3 show that the lower relative die pressure affects the lower die consumption and also a longer lifetime. The relative die pressure shows that the higher it is the higher the non-homogenous deformations are [2, 3]. The lowest die consumption was reached at the die dimensions which were calculated with the lowest relative pressure (Fig. 4).

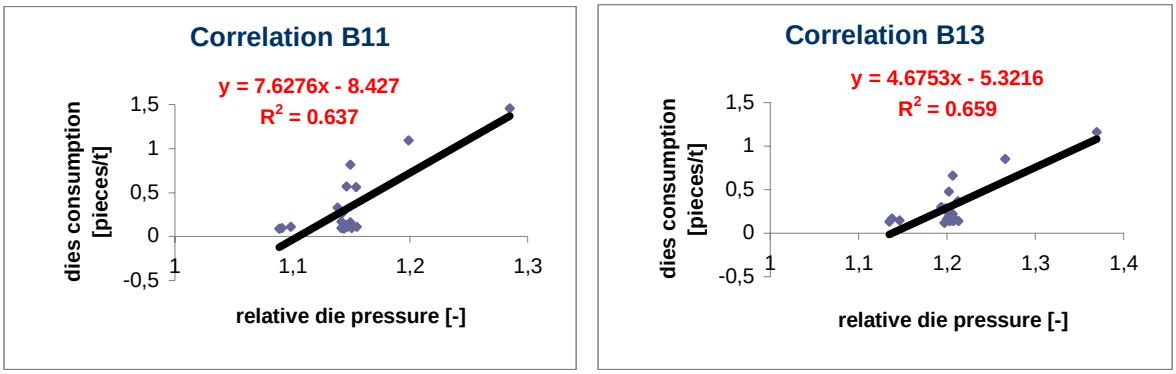

Fig. 4. *Dependency of die consumption on relative die pressure*
Note: a value of R^2 = 0.4995 and correlation equation y = 13.813x – 15.884 are valid for A13 dies

Based on the results it can be supposed that it would be suitable to use different calculated reductions for dies with a drawing angle of 11° such that we decreased the relative die pressure and so positively influence the die consumption. In the future we can also suppose a trend for the next decrease of the drawing angle 2α for the wires drawn at the allowance of Δ-parameter size and relative pressure.

Contribution to this problem

We see a contribution that we used the Δ-parameter and relative die pressure for evaluation of die consumption. The mathematical dependencies between die consumption and relative die pressure were confirmed. Wistreich´s theory was confirmed by the lengthy experiment and the direction of the drawing angle decrease with an allowance for the relative pressure and Δ-parameter size.

Conclusion

As demonstrated and confirmed by the experiment the influence of die geometry on mechanical properties and die consumption is enormous. Under the same drawing conditions if we change the die geometry we can reach a reduction of more than twice lower die consumption, as we can see in Table 2. From the experiment it follows that die consumption can also be influenced by the quality and accuracy of die geometry composing what is seen in Table 2 from the comparison of both die groups with drawing angle of 13°.

Based on the results, this experiment can be globally evaluated as an experiment with enormous benefit because it demonstrated a way for the next route in steel-cord wire production. The main direction should be focused on the drawing angle decrease, accuracy of die geometry make-up, and correction of calculated reductions for new die geometry.

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MOTIVATION – A WAY TO RETAIN KEY EMPLOYEES

Jana URDZIKOVÁ, Jozef KISS

Abstract

The subject of this study is employee motivation. In the introduction it describes the importance and essence of motivation and points out the human factor as the most valuable resource of organisations. The second part contains knowledge about the application of motivation in Slovak organisations.

Key words

motivation, employees, motivational factors

Introduction

The need to point out the application of employee motivation at the time of economic crisis may appear to be negligible. However, the opposite is true. It is precisely the period of transformation and reorganisation in organisations when it is essential to retain key people and especially those who are critically important from the point of view of the organisation, but also many others who ensure its functioning and the satisfaction of its customers. Employee motivation is not easy, especially if there is very strong competition in the field of the organisation's business activities, concerning not only products but employees too.

Motivated workforce – the most valuable resource of organisations

People are a common and essential element of any organisation and constitute its human resources, who, using their creative powers and work skills, create new values reflected in the prosperity and competitiveness of the organisation.

At the same time, however, they constitute a force that - due to improper management - may cause an adverse economic situation in the organisation, thus contributing to its possible demise. Therefore, the area of human resource management in organisations is a vital point. One personnel action is motivation of employees, which plays an important and irreplaceable

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role, as it directly influences the conduct of people in the organisation. It is an incentive to encourage employees to work, and thus to achieve their individual goals. The aim of any organisation is to have motivated employees, because such employees work hard, and their diligence is focused on important goals.

Motivation means a certain state of internal activation in the individual which gives rise to a chain reaction based on their needs and satisfaction. Individual motives appear as internal motives and activities pursuing the achievement of the desired objective. They can be seen as possible causes of behaviour. People of various professions, occupations and ages might have a large number of different motives. These are interrelated and create some form of hierarchy. Figure 1 below shows the basic scheme of motivation.

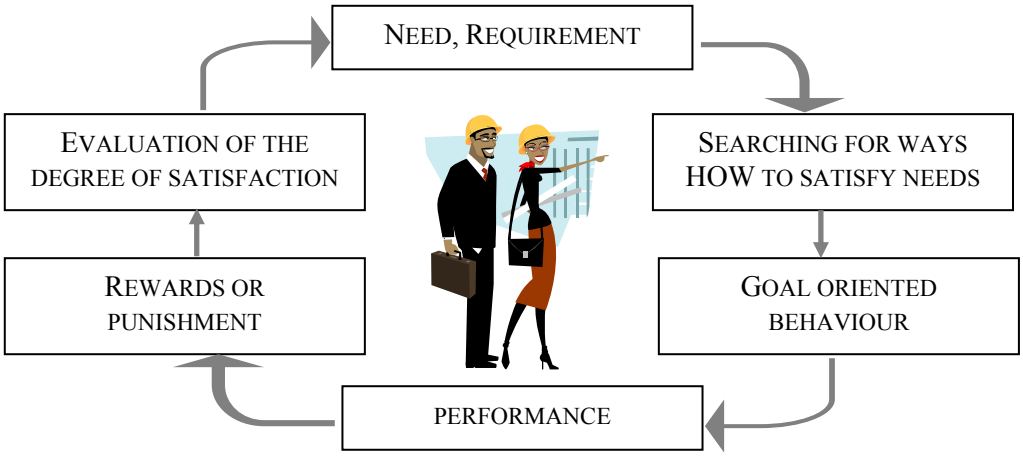

Fig. 1. *The basic scheme of motivation [1]*

Work motivation can be achieved in two ways:

1. *by self-motivation* – people motivate themselves by seeking and carrying out work, which is satisfying for them, or they think it will be satisfying for them,
2. *by management's efforts and stimulation* – through various financial and non-financial forms, they purposefully encourage employees to improve working performance.

Motivation strategy is based on the overall strategy of the organisation and is a part of personnel strategy. An elaborate strategy should clearly support the achievement of the organisation's objectives while enabling employees to achieve their personal goals. Decisions on the selection of motivational factors and means of motivation are an essential stage in the process of creating a motivation strategy.

Motivation at work is immediately reflected in the performance of the employee. Using appropriate incentives, employees doing the same tasks work harder and are higher performing compared to those who are not motivated properly.

According to Hekelová [2], "to encourage high quality work means to purposefully influence people so that it evokes desirable work behaviour". The right motivation is a means of improving employees' relationships to their work activities, organization, and collaborators, and it is also a way of increasing responsibility for the quality of their work.

The current state of the application of motivation in Slovak organisations

A picture of how motivation is applied in Slovak organizations is given by the results of a survey carried out at MTF STU (Faculty of Material Sciences and Technology of Slovak University of Technology), Institute of Industrial Engineering, Management and Quality.

It was based on Herzberg's two factor theory characterised by two main groups of factors affecting work motivation (motivators and hygiene or maintenance factors) that created the basis for the acquisition of empirical data for the thesis.

Motivators (success, recognition, the work itself, responsibility, advancement, personal growth, etc.) represent a long-term need following psychological growth and have a high level of motivation leading to satisfaction. They are usually connected to the content of the work carried out. They enable psychological stimulation and allow the individual's self-realisation. They are necessary for his/her growth. On the other hand, hygiene factors are mostly related to work environment, which is an indispensable part of the process of motivation.

The survey was conducted in Slovak organisations having a developed quality management system certified according to international ISO standards and, as to their size (the number of their employees), they rank among the categories of small and medium organisations. Summarising the results of a questionnaire survey completed with the knowledge gained through conversations and expert talks, we can draw conclusions which are references for improving employee motivation for business subjects:

- create a separate motivational programme for selected groups or selected individuals in accordance with their career plans;
- focus not only on material or financial incentives, but put much more emphasis on the intangible, psychological motivation as acknowledgment for the work done, the possibility of career advancement and the like;
- put emphasis on the proper arrangement of the work environment and micro-climatic conditions in the workplace;
- use an appropriate personnel management style for each task;
- use an appropriate form of compensation for employees, as it is very important what form of remuneration the organization applies when rewarding their employees;
- provide employee benefits as motivational stimuli.

The survey results prove the importance of applying motivation since - when taking a comprehensive look at its results - we can state that most organisations prefer hygiene factors (salary, management style, work environment) to real motivators (recognition, career development, responsibility, etc.) in order to reduce dissatisfaction of employees. Improvement in the understanding of the principles of motivation – especially as to the provision of employee benefits and in the use of public praise – can be observed in all organisations.

Many organisations, however, believe that the greatest motivator to improve the employee's performance is financial motivation. It can be concluded that organisations do not use real motivators adequately, but prefer to use hygiene factors. Hygiene factors alone do not motivate employees as sufficiently as organisations think. They only reduce dissatisfaction, which may sooner or later arise again. The key is to find a suitable level of using real motivators combined with hygiene factors. Organisations must therefore concentrate

on understanding the needs of employees and their motivation, focusing on the aims and objectives of the organization as well as paying attention to their participation in continuing improvement. In this way the most effective process of motivation will occur.

Scientific contribution

This article's contribution is the demonstration of the current application of motivational factors in Slovak organisations and suggestions for improvement of employee motivation in business practices. Improvement of motivation increases the efficiency of organisational goal fulfilment. Therefore, it is very important to consider the choice of suitable motivators and not only hygiene factors, which are a necessary part of the motivation process. If the organisations choose suitable hygiene factors and join internal factor motivators with them they will create optimal premises for real working satisfaction and continuous output improvement.

People are critical factors of success, therefore we must support the initiative to give a chance for creativity and, of course, reward their results. Everyone in the organisation must have a sense of their personal importance, be sure that their share in the results of the organisation is essential, and thus become a part of it. Taking this fact into account, motivation of employees must become an integral part of the tasks imposed by top management of organisations as far as personnel management is concerned.

Conclusion

The subject of work motivation is serious, rather complex, and highly relevant nowadays. For a long time, theoreticians have been trying to understand its essence and create an adequate theory of it. On the other hand managers require a methodology and procedures for motivating employees as the success of organisations lies in the workforce and its satisfaction. In any case, great attention has been paid to motivation for decades, whereas a broad, but still open knowledge base has come to the surface.

The need to point out the application of motivation is given mainly by the fact that the success of an organisation depends primarily on the satisfaction of its employees. Increasing the productivity of human resources is a challenging task and its solution lies in modern ways of people management. Purposeful formation, development and implementation of human resources require a systemically outlined human resource management on the basis of the goals and objectives of the organisation. Motivation to improve work performance is to a large extent a part of satisfaction itself.

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