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RELATIONSHIP BETWEEN FINANCIAL RESOURCES AND HOME ENVIRONMENT AND STUDENTS' LEARNING RELATED ATTITUDES, BELIEFS AND BEHAVIORS

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Paper written within the frame of the research grant within the project of young scientists and PhD students of the University of Gdańsk in 2012. Title: Konstrukcja kwestionariusza do pomiaru uzależnienia od pracy wśród studentów oraz pomiar związku pracoholizmu studentów z poziomem doświadczanego stresu, zdrowia fizycznego, psychicznego oraz satysfakcji z życia. Number: 538-7400-0890-12.

Abstract: Economic growth depends more and more on the potential of the society and economy to build and use knowledge. Fast and effectively learning people are needed. Two main problems were identified with the optimal usage of human capital as far as education is concerned: students who devote minimum effort and time to learning and acquiring qualifications, and students who learn compulsively, driven by dysfunctional perfectionism. This study tests relationship between financial resources and home environment and students' learning related attitudes, beliefs and behaviors. Results demonstrate that having more financial resources and better home environment is related to positive learning-related attitudes, beliefs and behaviors.

Keywords: learning, knowledge-based economy, financial resources, home environment, students, self-efficacy, perfectionism

1 Introduction

In recent years one can observe growing interest in analyzing social and economic problems from the perspective of knowledge-based economy (Piech, 2003). OECD (1996, p.7) defines knowledge-based economies as «economies which are directly based on the production, distribution and use of knowledge and information». Economic growth depends more and more on the potential of the society and economy to build and use knowledge. This, in turn, means that fast and effectively learning people are needed. From this perspective one of the greatest challenges for the development of the economy based on knowledge is an effective educational system. This requires understanding factors which determine effective and ineffective learning process.

Two main problems were identified with the optimal usage of human capital as far as education is concerned: students who devote minimum effort and time for learning and acquiring qualifications, and students who learn compulsively, driven by dysfunctional perfectionism (Atroszko, 2013). Those from the latter group are not only at high risk of developing full-blown syndrome of work addiction and its detrimental consequences for functioning, such as physical and psychological health problems, and disintegration of familial and social relationships, but also are most probably less productive than non compulsive engaged workers (Atroszko, 2013; for discussion on potential negative consequences of work addiction see: Atroszko, 2011).

Currently, more than ever before, there is need for appropriate understanding of factors conducive to acquiring knowledge and high competence, and those which determine negative attitudes towards learning and refrain development of human capital in the field of education. It is necessary to provide scientific knowledge about methods of encouriging positive learning-related attitudes, beliefs and behaviours, such as high learning self-efficacy and high pleasure derived from learning, and prevent the negative ones, among which following can be identified: high learning compulsion and high learning-related dysfunctional perferctionism. What is more, negative learning-related attitudes, beliefs and behaviours may include neglecting other domains of life, especially social relationships and health, and a tendency to getaway from personal problems into learning.

As far as educational possibilities are concerned, the existing research provides much data on the disadvantaged situation of those representing low socioeconomic status, especially in such countries as the United States of America (e.g. Orr, 2003; National Center for Education Statistics, 2008). These studies mainly concentrate on education of children (e.g. Aikens and Barbarin, 2008; Coley, 2002). They demonstrate that children from low socioeconomic households and communities develop academic skills slower compared to children from higher socioeconomic groups (Morgan, Farkas, Hillemeier, Maczuga, 2009).

However, there is scarce evidence of how adverse financial and home environment relates to particular attitudes, beliefs and behaviors among university students. One reason for the absence of systematic studies in this area might be that in many countries higher education requires paying fee and it limits students to the most motivated ones. Other reason may be that in pre-knowledge economy era there was less emphasis in the society and in the economy on knowledge, information and highly qualified and effectively learning employees. Recently, the widespread need for effective learners becomes increasingly pressing and becomes driving force for studies extending our understanding in this area.

On the basis of previous analyses of students learning related attitudes, beliefs and behaviors and their possible relationships with socioeconomic factors, following hypotheses were formulated:

1. The worse are financial resources and home environment the higher is compulsion to learn, learning-related dysfunctional perfectionism, learning overload, negligence of health and personal relationships, and tendency to get away from personal problems to learning.

2. The better are financial resources and home environment the higher is learning self-efficacy and pleasure derived from learning.

2 Methods

2.1 Participants

The study was a part of a large research project on the behaviours, attitudes and beliefs related to student learning, quality of life, stress levels, and coping with stress.

Thus far, 1,359 students of different fields of study, modes of study and years of study from the public and private universities in the Polish Tri-City area consisting of Gdańsk, Sopot, and Gdynia participated in the study. The data analysed in this article was gathered in the period from May 2012 to January 2013 - outside the examination session and not directly before or after it (over three weeks). Among the subjects were students from first to fifth year of study. The study group included both full-time students and part-time students. Among the respondents were 844 (62.1%) women and 515 men. The average age was 20.06 years (SD = 2,70).

At this point, it is important to note that one of the limitations of the study is slight over representation of women in the sample. This is due to the fact that at this stage - despite the initial assumption of the quota selection and effort to secure the appropriate balance between women and men, students from public and private universities, types of universities, mode of study, courses and years of study - the study sample is a convenience sample.

2.2 Instruments

Multidimensional Inventory - Learning Profile of a Student (MI-LPoS). One of the psychometric tools used in the study was original scale to assess the learning-related behaviors, attitudes, feelings and beliefs. The inventory consists of nine scales measuring learning compulsion, learning-related dysfunctional perfectionism, learning overload, negligence of health, negligence of personal relationships, tendency to getaway from personal problems to learning, learning self-efficacy, and pleasure derived from learning. The scale is intended as a

measure of study addiction components and risk factors. It also includes the scale of the level of energetic arousal as a variable differentiating between hypomanic study addicts and burnout study addicts. Results on this scale were not presented in this article. Respondents provided answers on a five-point Likert scale, from 1 - very rarely to 5 - very often. Thus far, the data obtained showed adequate reliability and validity of this tool. Confirmatory factor analysis confirmed good fit of the measurement model of nine correlated components to data. Cronbach's alpha for particular subscales varied between .70 and .87 (Atroszko, 2013). Convergent and divergent validity of the scales was demonstrated. Compulsion, Perfectionism, Negligence of Social Relationships scales were correlated with Psychastenia scale from MMPI and Doubts about Actions, Concern over Mistakes and Personal Standards from Frost's Multidimensional Perfectionism Scale. MI-LPoS scales did not correlate with Parental Expectations and Parental Criticism scales from Multidimensional Perfectionism Scale, except for low positive correlations with learning-related dysfunctional perfectionism and low negative correlation between learning self-efficacy and Parental Criticism scale.

World Health Organization Quality of Life Scale (WHOQoL-Bref). The WHOQOL – Bref is a generic questionnaire based on a conceptualization of quality of life as an individuals' perception of their situation in life in the context of the culture and value systems in which they live and in relation to their goals, standards, expectations, and concerns (The WHOQOL Group, 1998). It consists of 26 items. WHOQOL – Bref measures quality of life in four domains: physical health, psychological, social relationships and environmental. Each domain consists of three to eight items. What is more, two overall questions yield information on global QoL (Q1), and satisfaction with general health (Q2). Self-report items are scored on a scale from one to five. Higher scores indicate higher QoL with the exception of three items which include pain and discomfort, need for medical treatment and negative feelings (The WHOQOL Group, 1998a). Participants are asked to response in reference to how they assess their life in previous two weeks. WHOQOL – Bref is available in 50 languages. Polish version has adequate reliability and validity. Cronbach's alpha for particular subscales varied between .69 and .84. For the purpose of the analysis presented in this article two items measuring environmental domains were used: one asking about financial resources, that is, having enough money to meet persons needs and second about home environment, that is, satisfaction with the conditions of living place.

Demographic data. Data on gender, age, marital status, place of living, paid employment were gathered. In this article only relationship between gender and age with other study variables is discussed.

2.3 Procedure

Participation in the study was voluntary. Before completing questionnaires, subjects were informed that the survey is anonymous and the results will be used solely for the purposes of the research. Basic information about the study purposes was provided for the participants before completion of the questionnaires and their consent was obtained. Questionnaires were completed in a single session. After filling in the questionnaires participants could ask further questions about the study.

2.4 Statistical analyses

Descriptive statistics were calculated. Point-biserial correlation coefficients were obtained for the relationship between gender and other study variables, except for correlation between gender and financial resources and home environment for which rank-biserial coefficients were calculated. Women were coded as 0 and men coded as 1. Spearman's rank correlation coefficient rho was used as a measure of association between financial resources and home environment measured on the ordinal level and learning related behaviors, attitudes, beliefs and feelings, as well as age measured on the numerical level. For the relationship among other study variables Pearson product-moment correlation coefficients were obtained. Statistical analyses were performed with IBM SPSS 20.PL software.

3 Results

Table 1 presents correlation coefficients between study variables. The results concerning relationship of gender with study variables indicate that being a women is related to higher compulsion to learn, $r = -.10$, $p < 0.01$, higher learning-related dysfunctional perfectionism, $r = -.17$, $p < 0.01$, higher learning overload, $r = -.16$, $p < 0.01$, and higher tendency to getaway from personal problems to learning, $r = -.17$, $p < 0.01$. At the same time being a women is related to lower learning self-efficacy, $r = .12$, $p < 0.01$. There was no relationship between gender and pleasure derived from learning, negligence of health and personal relationships.

Table 1. Mean scores and standard deviations, and percentages, and correlations between the study variables

Variable	Mean (SD)/ %	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Gender[a,b]	62.1% women	-.08*	.04	.05	-.04	.12*	-.17*	-.10*	-.16*	-.04	-.03	-.17*
2. Age	20.06 (2.7)		-.16*	-.02	.12*	.03	-.06*	.00	-.12*	.04	.00	.00
3. Financial resources[c]	3.42 (1.17)			.34*	.11*	.20*	-.12*	.02	-.04	.07*	.02	-.04
4. Home environment[c]	3.93 (0.89)				.04	.10*	-.09*	-.03	-.07	-.01	-.10*	-.09*
5. Learning pleasure	9.06 (3.34)					.43*	.13*	.41*	.06*	.27*	.28*	.37*
6. Learning self-efficacy	16.39 (3.6)						-.19*	.05	-.09*	.20*	-.02	.05
7. Learning related dysfunctional perfectionism	9.99 (3.45)							.53*	.46*	.35*	.42*	.32*
8. Learning compulsion	10.96 (4.11)								.43*	.44*	.53*	.40*
9. Learning overload	12.72 (3.51)									.32*	.43*	.18*
10. Neglecting health	11.32 (3.51)										.36*	.33*
11. Neglecting personal relationships	8.18 (3.18)											.31*
12. Tendency do getaway to learning	5.25 (2.48)											

*$p < .05$,

[a] 0 were women, 1 were men

[b] The correlation coefficients are point–biserial correlation coefficients; for correlation between gender and financial resources and home environment rank-biserial coefficients were obtained.

[c] The correlation coefficients are Spearman's rho correlation coefficients. For other variables Pearson correlation coefficients were calculated.

Age correlated negatively with financial resources, $r = -.16$, $p < 0.01$. The correlation was low and indicated that the older is a student the worse is his or her subjective evaluation of his or her financial resources. Age correlated positively with pleasure derived from learning, $r = .12$, $p < 0.01$, and negatively with learning-related dysfunctional perfectionism $r = .06$, $p < 0.05$, and learning overload, $r = .12$, $p < 0.01$. The correlation coefficients were low and very low, however, they indicated slight tendency to more positive attitudes, beliefs and behaviours in older students in comparison to younger ones. There was no relationship between age and learning self-efficacy, compulsion to learn, negligence of health and personal relationships, tendency to getaway from personal problems to learning.

Pleasure derived from learning correlated positively with learning self-efficacy, $r = .43$, $p < 0.01$, compulsion to learn, $r = .41$, $p < 0.01$ negligence of health, $r = .28$, $p < 0.01$, negligence of personal relationships, $r = .27$, $p < 0.01$ and tendency to getaway

from personal problems to learning r = .37, p < 0.01. Pleasure derived from learning manifested very low positive correlations also with learning-related dysfunctional perfectionism, r = .13, p < 0.01, and learning overload, r = .06, p < 0.05. These results suggest that addiction-related attitudes, beliefs and behaviours have stronger, as in the case of compulsion and negligence of health and relationships, or weaker, as in the case of perfectionism and overload, component of pleasure. This is consistent with addiction development models which assume that in the beginning there is pleasure derived from certain behaviours or substances, which later develops into compulsion.

Learning-related self-efficacy correlated negatively with dysfunctional perfectionism, r = -.19, p < 0.01, and learning overload, r = .09, p < 0.01, and positively with negligence of health, r = .20, p < 0.01. Positive relationship between learning self-efficacy and neglecting health problems requires more studies in order to assess how this relates to psychosocial functioning in short and long term.

All negative learning-related attitudes, beliefs and behaviours were correlated positively, with highest correlation between compulsion and perfectionism, r = .53, p < 0.01 and compulsion and neglecting social relationships r = .53, p < 0.01. The weakest observed relationship was between learning overload and tendency to getaway from personal problems to learning, r = .18, p < 0.01.

The most important results concerned the relationship between financial resources and home environment and learning related attitudes, beliefs and behaviours. There was positive correlation between financial resources and home environment, rs = .34, p < 0.01, which indicate that even though, as expected, these two indicators of material resources, and, as such, indicators of socioeconomic status, were related, the amount of non-shared variance between them was substantial (about 88%). This suggests that different factors may influence the condition of students financial resources and home environment, and/or the way that students subjectively asses them.

Financial resources correlated pisitively with self-efficacy, rs = .20, p < 0.01, pleasure derived from learning, rs = .11, p < 0.01, and slightly lower with negligence of health, rs = .07, p < 0.05. Home environment correlated positively with self-efficacy rs = .10, p < 0.01, and negatively with learning-related dysfunctional perfectionism, rs = -.09, p < 0.01, learning overload, rs = -.07, p < 0.05, negligence of personal relationships, rs = -.10, p < 0.01, and tendency to getaway from personal problems to learning, rs = -.09, p < 0.01.

4 Statistical analyses

First, it has to be emphasized that most of the relationships between financial resources and home environment with learning-related attitudes, beliefs and behaviours were weak or very weak. Most of the correlation coefficients were statistically significant due to very large sample size. According to the interpretation standards for effect size (Cohen, 1988), the effect size for most of the tested relationships was small. However, the effect size has to be estimated and interpreted in the context of the research problem, especially when small effects are observed for phenomena related with very undesirable outcomes for human functioning which relate to great number of people (cf. Atroszko, Kowalczyk, Kowalczyk, 2013). This is because very weak relationships between variables which relate to populations of hundreds of thousands or millions translate to significant differences for thousands and tens of thousands of people. In the case of research concerning education the number of people affected by studied phenomena is huge, and in the context of knowledge-based economy it seems to encompass most of the society. For example, in Poland in 2010 there were almost two million students (GUS, 2011). In the case of such large population and in the context of studied education-related phenomena even small effect may relate to very meaningful outcomes, such as dropout rates, risk of psychological disorders and other health problems, not to mention costs in time and money spend on ineffective learning.

In the view of that, the positive relationships observed between financial resources and home environment and positive learning-related attitudes, beliefs and behaviours and negative relationships between financial resources and home environment and negative learning-related attitudes, beliefs and behaviours are worth great attention. These results mostly confirmed the hypotheses.

The most salient result is that financial resources are related to higher learning self-efficacy. It is especially worth noting because learning self-efficacy is most probably directly related to educational outcomes. There are several plausible explanations of this relationship. One is that having financial resources allows you to spend them on educational materials such as books, software, etc. Having financial resources may allow you to spend more time on learning and less on earning the living. This is also directly related to the possibility that when you have financial resources you may also, on a cognitive level, concentrate more on learning and less on how to earn money for your basic needs. On the emotional level, having financial resources may allow you to derive more pleasure from learning, as you do not have to worry about your household necessities, and pleasure derived from learning is related to learning self-efficacy. On the other hand, having material resources and high learning self-efficacy might be explained, at least partly, by other variable such as general self-efficacy. People who are effective in dealing with different tasks and difficulties in their life may be able to ensure more resources for themselves and be more effective learners.

Both financial resources and home environment were negatively related to learning-related dysfunctional perfectionism. Studies suggest that dysfunctional-perfectionism may be the core determinant of work and study compulsion (Atroszko, 2010) which is the main component of work and study addiction. Detrimental effects of workaholism on all domains of functioning of a person are now recognized and necessity of early interventions is emphasized (cf. Atroszko, 2011). Dysfunctional perfectionism is the tendency to avoid any errors and concern over mistakes because the person beliefs that any fault, blunder and sign of incompetence may cause other people to dislike and/or disrespect them. It seems plausible that this belief may be stronger in persons in worse financial situation and home environment as lack of resources may cause them to be more vulnerable to the threat of social exclusion, and consequently further exclusion from access to resources. This is important not only from the perspective of the development of study or work addiction syndrome, but also because dysfunctional perfectionism is one of the most important psychological factors in the development of variety of behavior disorders and a risk factor for suicide (O'Connor, 2007).

Overall conclusion of this study is that having more financial resources and better home environment is related to positive learning-related attitudes, beliefs and behaviours. From the perspective of the development of knowledge-based economy it is necessary to understand all factors facilitating effective knowledge production, distribution, acquisition, processing and practical usage. Lack of financial resources may be directly related to worse educational possibilities due to inability to gain access to educational resources such as books, software, paid courses, tutors etc. However, growing development of open access educational resources in the internet shifts attention, especially in the developed countries, to psychological factors which may hinder effective learning in students who have access to all needed educational resources. Relatively disadvantaged financial and home environment situation may influence psychological processes which impede effective knowledge attainment in those who otherwise have access to all necessary information. Understanding these processes is crucial for optimizing development of knowledge-based economies. If worse financial situation causes higher learning-related dysfunctional perfectionism and this in turn causes less effective

learning and higher stress, higher risk of depression and other psychological disorders, as well as physical symptoms, then it is crucial to understand what are the conditions preventing this process to occur. In other words what is the optimal resource distribution to optimize knowledge acquisition and knowledge economy development.

The strength of this study lays in a large and heterogenic group of students from different universities, different faculties, courses of study, modes of study and years of study. All instruments used in the study showed adequate reliability and validity.

A cross-sectional design in the present study was employed and thus conclusions about causes and effects cannot be drawn. All data in the study were based on self-report, therefore the results may have been influenced by the common method bias (Podsakoff, MacKenzie, Lee, Podsakoff, 2003). Future research should determine whether there is causal link between broadly understood socioeconomic status and negative learning-related attitudes, beliefs and behaviours, including learning time commitment, as it seems crucial in the light of the current studies demonstrating gradual decrease in average time that students devote to learning (cf. Babcock and Marks, 2010). Future studies should also take into account possible moderating effects of socioeconomic factors on the relationship between attitudes towards learning and learning time commitment.

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Primary Paper Section: A

Secondary Paper Section: AM, AN

THE TREATY OF STABILITY, COORDINATION AND GOVERNANCE IN THE ECONOMIC AND MONETARY UNION - UNDER THE ASPECT OF ENFORCEMENT AND SANCTIONING ABILITY

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Abstract: The article deals with the regulations of the Fiscal Stability Treaty to control budget deficits within the European Union. It deals critically with the sanction and implementations options, also with regard to non- compliance of the so-called Maastricht criteria, the already existing European Stability and Growth Pact, and the takeover into national law.
The possible sanctions which are part of the Pact at the present time appear vague and unrealistic formulated so that an effective implementation can hardly be assumed.

Keywords: Fiscal Compact, European Union, stability criteria, budget deficits, national debt

1 Introduction

The Treaty on Stability, Coordination and Governance in the Economic and Monetary Union, also referred to as Fiscal Compact, Fiscal Stability Treaty or TSCG was signed on 2 March 2012 by all Member States of the European Union, except the Czech Republic and the United Kingdom. On 1 January 2013 the TSCG entered into force for all states which ratified it until this day. In countries where the ratification process will take longer, the Treaty will enter into force on the first day of the month which follows the the ratification.

2 Stricter rules?

The two most important rules of the EU fiscal pact are intended to be - briefly summarised - stricter rules on the budget discipline:

The national debt must be reduced to less than 60% of the gross domestic product (GDP). This percentage must be achieved through an annual reduction of one-twentieth of the overlying amount. The structural deficit, should not be higher than 0.5% of GDP if the debt level is above 60% GDP or else it shall be less than 1,0%. Another definition is that the “general budget deficit” must be less than 3,0% of the GDP.

It seems, that we have heard these rules already some years ago.

These goals are not really new. A look at the history of the Euro and the European Union shows that there were already a number of requirements for fiscal discipline, which were ignored by almost all Member States, without any consequences, but on the contrary led to a reduction of existing regulations.

In 1996 by the ECOFIN Council (Council of Economic and Finance Ministers) was in Dublin (hereinafter referred to as the Maastricht rules) of the "European Stability and Growth Pact", and also established as Article 104 of the EC Treaty to the European treaty. This includes a commitment to a total debt of not more than 60% of gross domestic product and an annual budget deficit of not more than 3% of the GDP.

The signatory States commit themselves to the rapid implementation of this medium-term objectives. But with the reservation that the respective country-specific sustainable risks in the implementation will be taken into consideration and this assessment lies with the EU Commission. Naturally, these criteria are not clearly defined.

"The Contracting Parties shall ensure rapid convergence towards their respective medium-term objective. The time frame for such convergence will be proposed by the Commission taking into consideration country-specific sustainability risks." (European Council 2012)

The possibility of a deviation from the objectives of the TSCG under extraordinary circumstances ("exceptional circumstances") is sets out the following letter c).

„The Contracting Parties may temporarily deviate from their medium-term objective or the adjustment path towards it only in exceptional circumstances as defined in paragraph 3.“ (European Council 2012)

These extraordinary circumstances are defined as follows in point 3 of article 3:

""Exceptional circumstances" refer to the case of an unusual event outside the control of the Contracting Party concerned which has a major impact on the financial position of the general government or to periods of severe economic downturn as defined in the revised Stability and Growth Pact, provided that the temporary deviation of the Contracting Party concerned does not endanger fiscal sustainability in the medium term." (European Council 2012)

Here, the Treaty allows some room for manoeuvring. The criteria of the TSCG can be overridden in times of economic difficulties or an economic downturn, if the temporary deviations unsustainable endanger the finances of the State concerned. So deficits may rise during hard economic times.

Now, however, especially in times of signing the contract, most participating countries are in a (banking, monetary, economic) crisis.

So these are the "loopholes" that are called for by critics of the pact and, this leads to their opinion to call the treaty an “absurdity”.

2 Possible Sanctions

So what is new? More or less nothing, it seems. Maybe it is, that in the future there should be stronger consequences for deficit violations? Let us have a look. The Euro convergence criteria (also known as the Maastricht criteria) also had harsh penalties for breaches of these criteria: If in three consecutive years the deficit is above these criterias, the country has to make a non-interest bearing deposit at the EU, which, can be up to 0.5 percent of the nominal GDP of the country depending on the level of deficit (in the year 2004 this would have been a total amount of approximately EUR 10 billion for Germany). If the deficit should be continuing also for the next two years, this deposit is transformed into a fine and divided among the States, which have maintained the proposed budgetary discipline. The fine was never applied. This seemed at first to be clear and strict guidelines. But the problem lies with the institutions and people acting. The European Council decides whether and what sanctions will be taken. This, the European Council, is formed by the governments of the EU Member States and would simultaneously have to decide on sanctions against them. Naturally, it is these governments that are responsible for the national debt. This meant that all violations have remained without consequences. Not least also because the largest and strongest economies, Germany and France, were also so-called deficit sinners. Rather than enforce existing regulations, these were suspendet after pressure from France and Germany (2003), and as a result the rules were softened and made dependent on undefined criteria (2005).

Rules and conventions only then make sense if they can be sanctioned also. Otherwise they are not worth the paper they are written on. What sanctions does the fiscal pact have?

Article 8 of the Pact governs the process of sanctions. The jurisdiction of the signatory States submit to is the European Court of Justice. Should the Commission come to the conclusion

that one of the parties has violated the contract, or the anchoring of the "debt brake" in national law, one or more other countries can bring the matter before the European Court and demand the imposition of financial sanctions. The European Commission on the other hand, receives no private right of action.

Article 8 Paragraph 1. „The European Commission is invited to present in due time to the Contracting Parties a report on the provisions adopted by each of them in compliance with Article 3(2). If the European Commission, after having given the Contracting Party concerned the opportunity to submit its observations, concludes in its report that a Contracting Party has failed to comply with Article 3(2), the matter will be brought to the Court of Justice of the European Union by one or more of the Contracting Parties. Where a Contracting Party considers, independently of the Commission's report, that another Contracting Party has failed to comply with Article 3 (2), it may also bring the matter to the Court of Justice. In both cases, the judgment of the Court of Justice shall be binding on the parties in the procedure, which shall take the necessary measures to comply with the judgment within a period to be decided by the Court." (European Council 2012)

The European Court of Justice can impose if it grants the lawsuit, a penalty up to 0.1% of the gross domestic product of the defendant State:

Article 8 Paragraph 2. "If, on the basis of its own assessment or of an assessment by the European Commission, a Contracting Party considers that another Contracting Party has not taken the necessary measures to comply with the judgment of the Court of Justice referred to in paragraph 1, it may bring the case before the Court of Justice and request the imposition of financial sanctions following criteria established by the Commission in the framework of Article 260 of the Treaty on the Functioning of the European Union. If the Court finds that the Contracting Party concerned has not complied with its judgment, it may impose on it a lump sum or a penalty payment appropriate in the circumstances and that shall not exceed 0,1 % of its gross domestic product. The amounts imposed on a Contracting Party whose currency is the Euro shall be payable to the European Stability Mechanism. In other cases, payments shall be made to the general budget of the European Union." (European Council 2012)

This means that only Governments may sue each other. But not the EU Commission may bring - as requested by Angela Merkel - legal proceedings going. Never, in the history of the EU, a Member State has filed a lawsuit against another State. A situation that is inconceivable in the European politics and diplomacy and could lead to serious intergovernmental disagreements.

Furthermore, there is a doubt by lawyers at the possible jurisdiction of the European Court of Justice. Because the sanctions are not EU law, but a pure inter-State Treaty of a part of the EU Member States, and vary from article 126 of the Treaty of Lisbon, the fiscal pact would have to be signed by all 27 EU Member States, so that any sanctions imposed by the European Court of Justice, are really binding and enforceable. Otherwise the fiscal pact would not automatically take precedence over national law, and it would be easy for the defendant and convicted Government, not to implement a judgment of the European Court of Justice.

3 Conclusion and discussion

The TSCG is undoubtedly an ambitious project for the recovery of the budgets of EU Member States. But will it redeem what the policy promises of the new Treaty? Well balanced budgets, less national debt and more stability for the common currency? So far, hardly a state has complied with the Maastricht criteria. Due to the lack of sanction mechanisms it could occur that not many states will be impressed and fear sanctions. We have seen that ruels were not followed.

It is also crucial question whether the Member States due to the economic circumstances have a chance to meet them (eg Cyprus, Greece, Portugal, Spain).

As always with such agreements, this is dependent on the trading parties and their behavior in the situation. The TSCG provides guidelines and goals, but whose fulfillment is dependent on the will and the possibilities of the individual Member States. Of course there are certain mechanisms designed to ensure compliance. However, whether these are ever used is highly questionable because of past experiences with the already long existing Maastricht criteria and associated sanctions, or their abrogation by the most powerful states of the EU. Especially in the current situation, as in many countries of the European Union there are Especially in the current situation, as the support for the Euro drops rapidly in the population and in most countries of the EU have been held heated discussions over a disintegration of the euro-zone up to an exit from the Euro.

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Primary Paper Section: A

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CONTRIBUTION TO THE FREE TIME IN HOSPITALIZED CHILDREN IN CZECH REPUBLIC

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Abstract: The article deals with the problem of free time hospitalized children. Characterizes children's free time and analyzing psychotherapeutic support options pediatric patients. Also draws attention also to this new innovative way psychterapeutické support and leisure activities such as children of cancer patients through their visits to the Zoo. Highlights the effectiveness of this type of leisure time as an effective psychotherapeutic support these children. Describes this possibility, which has become an established tradition in hospital in Brno in the oncology clinic at Black fields. Documented so extremely interesting use of free time, which featured a form of psychotherapy has a very positive meaning for hospitalized pediatric patient. Significantly contributes to mental balance and well-being child patient, which is currently in the oncology area (and obviously not in it) extremely important in the overall treatment process.

Keywords: leisure, hospitalized children, psychotherapy

1 Introduction

A leisure time might be characterized as an opposite of a required work and responsibilities. A time when a man can chose his activities optionally and they bring a feeling of satisfaction and relaxation (Pávková et al., 2005). These activities restore and develop his or her physical and spiritual abilities at the same time. In this time a human is becoming a one's own man, he or she belongs one's own the most. All the activities that are carried on, even a man is undertaking them for himself or for others, based on an inner initiative or on an interest (Němec et al., 2002).

A leisure time of children in a hospital is a time, when children are not expecting any examination, operations or treatment procedures. When they do not need to fulfill any school duties, it is a time when a child can dispose of activities freely, based on a child judgment to a certain extant – based on an environment a child is in and based on an actual patient mood and a psychical state.

If a child in a leisure time in a hospital is left "just so", without any notice, a leisure time becomes an empty time, in which will be a solid space for a boredom state and for bothering. But based on an environment and on a situation the child is in, even for nostalgia, an anxiety, and for inquietude. To not let this happened the children in their leisure time are under a supervision not only of hospital staff, but even under a supervision of professionals from other supporting professions such as social pedagogues, schoolmasters in hospital schools, psychologists, game specialist, and volunteers: high school and university students, hospital jesters etc.

Since 1994 a survey of Endowment Fund Klíček In Czech Republic has been carried out in a children departure in hospitals. All the children departures in the Czech Republic have been questioned. The questionnaires were filled in by responsible employees of a certain department. The text containing their answers and it is therefore their presentation of an achal state of children departments in the Czech Republic. Concrete results of this surfy are available from 29. 10. 2007 on web sites www.detivnemocnici.cz[1].

On a question how is the children leisure time shielded in hospital, doctors and nurses named partly material equipment: televisions in bedrooms and in playrooms, videos, DVDs, etc. An important part of the leisure time was attributing to hospital schools, to a role of playing specialists and volunteers, and to special activities (theater performances, visiting of zoo, etc.).

From parents of sick children point of view is at the very first place a child health state, a quality of medical treatment, and a fast recovery, so that all what is closely connected with their quality of life. A somatic aspect is significantly affected by a good psychical condition that participants on the leisure time usage.

A function and possibilities of the leisure time defines Opaschowski (2001). As a ground functions he sees recreational functions: recovery and relaxation; compensative disappointments and frustration elimination; pedagogical and further educational, contemplation - seeking for a meaning of life and its spiritual development; communicational social contacts; participation – participate in society running process; integration family life stabilization and in growth into society organisms; en cultural – cultural development of one's own, creative expressions trough art, sport, and other technical activities.

From a hospitalized child point of view *a recreational function*, i. e. recovery and relaxation after medical treatments, examinations, procedures, and even after school duties. On the other hand even a fulfillment of school duties and elaboration of home works might have, under certain circumstances, a recovery character. Family visits and a time spend with relatives might be a part of a relaxation; on the other hand it might be exhausting even if a visit is nice and welcome.

Exhaustion state might occurs when an organism is weakened; a child can be easily tired out; during a visit an arguing might occurs, at this case the visit just deepens stress and frustration from a longitudinal stay in a hospital.

A recreational function (passive or active form) might be filling with a movement, e. g. callanetics by teenage girls, computer games or websites searching, mobile phone games, communication between patients etc.

The most frequent controlled activities, in a category of leisure time activities of children in hospitals, are graphic activities that contribution is highly rated among hospitál staffs. For example a head nurse in Masaryk town's hospital in Jilemnice, Janoušková Marie pointed out that pedagogues of a hospital school put a great pressure on working activities; *they create a lot of bright products, children are coloring their t-shirts, so that they have good experiences from a hospital environment even back home. Even during a school age child acceptance process that is staying in a department without parents, from time to time a tear is dropped, during a planning of replacement sometime can be hearted "I do not want to go home yet, I must finish the picture." Sometimes children even do not have a time for parent´s visits*[2].

A play specialist is significantly involved in fulfillment of a leisure time in a hospital with an aim in securing a rest and a recovery of sick children, if a hospital has a play specialist or schoolmistresses available. They are trying to create a homelike environment for children, occupy them, and not let them think about their injuries. The occupation in a public nursery is closely related to a school work, also it is securing a full spiritual activity of a child, and it is developing a spare time activity in graphic, esthetic, musical, and working education.

Situations that are evoking a frustration or a disappointment might occur very easily: a child is informed about unpleasant news. The child is afraid of examinations or of painful operations. Despites of an effort of hospital staff, pedagogues, game specialist, and the others, the child is stressed thanks to: staying in hospital, not improving or upsets of physical condition, the stay in a hospital is extended, leaving of friends back home – roommates or visitors, spoiled visits of parents or relatives, homesickness etc.

To compensate a disappointment and a stress help activities mentioned above.

Its role plays even friends between patients, behavior of hospital staff, and lots of other people and activities. A great joy brings for example a brief or an email from home – from friends, from schoolmates, and from a class teacher.

Pedagogical and educational functions in a leisure time fulfill homework from teachers; if it is on a volunteer base and it is not

[1] Královec, J., Královcová, M. *Nadační fond Klíček.* [online] retrieved 2013. from: www.klicek.org/index2.html

[2] Janoušková, V. *Masarykova městská nemocnice v Jilemnici.* retrieved 2013. from:www.detivnemocnici.cz/seznam/l/l_d03.html

forced – it might be supported with a teacher's personality and sympathy of a student to a teacher, form of homework, help to younger friends etc.
By *contemplation* an age of children is the most important. By believing children it is dealt about e. g.: a prayer – alone, with a friend, brothers and sisters, parents. An issue might occur in a specific stressful situation by hard sick patients e. g.: oncology diseases. In such cases a psychologist is significantly involved.
For a *communication function* of the leisure time it is essential to keep in touch with a family and with peers. This fact is support with a trend of losing visiting hours of hospital departments, a possibility for parents to stay with their children during hospitalization.
Regarding *the participation* – children are participating on running process of a hospital, e. g. decoration of departments' walls with own drawn pictures.
The pupils also assist at preparing of various actions in a hospital or in a hospital school – trips, competitions, projects etc.
An integrative function, form a hospitalization point of view, is to a certain extent lowered, but thanks to segregation it is possible to partly eliminate this issue based on shortening of hospitalization length and based on a presence of family. In some departments e. g. psychiatry, a music therapy is held. This therapy, besides a therapeutic effect, allows a cultural development of children patients – *creative realization trough arts.*
Children creativity is also developed trough listing of quality music, active singing or playing some instrument, e. g. while walking in a hospital park.
Children patients are mainly allowed to leave a hospital area, especially those with a hard sickness that have to stay in beds under a continual supervision of hospitál staff. That is not encouraging them at all in their moods and psychical condition that are (Dlouhý, 2011).
So essential for a faster recovery and returning back home. That is the reason why some "good souls" are trying to bring some pieces of the outside world in - trough a nice visit that will bring in an entertaining program, presents, sweets etc.
A trip outside a hospital is highly welcome if there is permission from doctors.
This fact has already realized several employees from Brno's zoo and prepared an innovative activity as a trip for small patients of Faculty hospital Children hematology in Černá Pole on the 1st of June, 1997 – Day of children, along with their parents accompanied by hospitál staff. As Linhartová (2007) pointed out, the action had a remarkable response. It brought lost of joy and relaxation to all the participants. It helped to relax children, ease theirs stress, and involve them more in a treatment process. After the first success form a one-time action became a tradition. Children became regularly – every first Tuesday in a month – visiting animals in the zoo situated on Monks Mountain in Brno. A leaflet with "a tiger's invitation" gets children regularly for more than ten years.
Children are tolerating much better a hospitalization thanks to the trips to the animals. Thanks to the effect of stay in fresh air the children have a better appetite that is very significant by oncology patients. By drawings pictures next day after trips, children can recall experiences from the zoo visits and pleasant moments spent outside a hospitál are again recalled. A children good mood is infectious; it is transmitted to parents and medical staff (Dlouhá, 2006).
An idea to give a piece of leisure time to several volunteers and Professional even of different specializations (oncologists, university pedagogues, zoologists, nature lovers), had an external employee of Brno's zoo prof. MVDr. Dagmar Ježková, CSc. She argued a director of the zoo MVDr. Martina Hovorku, Ph.D., a head of Children oncology clinic prof. MUDr. Jaroslav Štěrba, Ph.D., and several others into the realization of this project participating up till today (Linhartová, 2007).
In to the drawing of pictures, children parents are also often involved, especially mothers. They are recalling animals that they met a day before. They are trying to capture details of a favorite animal and afterwards they are comparing their work. Students' visits are also a pleasant relaxation even for family members that have as well as thein children a chance to relax, change thoughts, and least for a little while forget hardships connected with a hospital of their kin (Dlouhá, 2006).
During these meetings in Brno's zoo, there are not offered only a zoo attraction, but *"an extraordinary kindness was handed out, a leisure time of some volunteers, even some sweets from a zoo budget for enjoyment, a joy for oncologist children patiens were offered"* (Linhartová, 2007, p. 74). And it is offered not only to the children, but even to their parents and medical staff. A trip to the zoo meets definitely a relaxation function (meeting the animals, meeting their way of living and behavior), pedagogic educational function (listing to a soft splashing of water by seals' poll, watching exotic fishes bustling in aquarium in the tropical kingdom) is an ideal scene for contemplation.
If sick children are accompanied by their family or health brothers and sisters, the visit has a communicational and an integration contribution. As Linhartová (2007) pointed out, satisfied parents and grandparents of sick children that are involved in these activities are often confirming these facts in interviews with the hospital staff.
Thanks to graphic activities with pedagogic faculty students the children are also involved in the running process of departments – the pictures partly decorate children rooms and hospital halls, but what is significant, they are sending towards Mrs. Jensen in Norway within in a frame of Stonožka project. The pictures are distributed in to the whole world form Norway and gains from the project are used for buying all sorts of equipment for sick children (Bendíková, 2010).
Thanks to graphic activities children also develop their creativity and an ability to capture details of an observed phenomena or a memory on it trough drawings, batiks, linocuts, and other graphic techniques. It also contributes to their en-cultivation – a culture development of their own trough ATS (Bendíková, 2008).
On simulative meaning of animals behavior in zoo for sick children, drew attention colluviums - About not dying (may 2005) and About tiger's invitation (may 2007) held in a lecture hall of Brno's zoo. Their psychotherapeutics benefits for all that are involved in zoo visits appreciated prof. MUDr. Jiří Vorlíček, CSc., prof. MUDr. Jan Žaloudík, CSc. and others.
In today's sick patients medical care theories, especially in children age, there is a main principle in a complex treatment involving all complicated processes going along with a child from a beginning of medical process to the end of treatment (in an ideal state to the complete recovery). In this conception of the medical care not only a doctor is involved, but even other professionals from assisting professions and ordinary persons that are trying to keep a child in an adequate psychic condition and that are trying to ensure a child a quality utilization of leisure time. Do not expose a child to homesickness and dark thoughts on own pain and diseases and throughout this effort contribute to a faster return into a common life. All the leisure activities for sick children prepared and realized with an agrément and supervision of attending doctor and nurses, characterize a solid amount of devoted work motivated by compassion on the pain and suffering (Dlouhá, 2012).
It is necessary to highly appreciate and support them in their work, because thanks to them children are getting an opportunity to variegate the medical treatment.
They bring joy and relaxation, so that a psychical condition is improved, a quality of life is affected, and in such consequences, even a health condition.

2 Conclusion

The leisure time of children in hospital is a time when there is no medical examinations, medical procedures or treatments are not head of a child. It is a time hen a child eedn´t to fulfill school duties and it is a time that a child can, to a certain extant (based on an environment a child is in, physical a psychical condition of a child), spent freely based on an own discretion. To not let a child be alone in unhappy thoughts about a stay in hospital and about a separation from family and friends, hospital staff and other specialists (special pedagogues, schoolmasters, psychologists, game specialists, volunteers students form high schools and universities, hospital jesters etc.) are taking care about the leisure time of children in hospital.

Hospital staff, in a way of complex approach to the sick children treatment and seeing the treatment as bio-psycho-socio-spiritual wellbeing, welcomes these activities.
Whereas it is a matter of fact that nothing should be affecting the process of treatment and all that are involved in improving tendency of the time when is a child in a hospitál have to respect a treatment mode and all instructions of the attending hospital staff.
A good example of an extraordinary initiative of decoying a child form a diseases and from unpleasant experiences that is highly welcome from hospital staff and where is the staff even taking apart, are trips of oncology diseased children from Faculty hospital Brno in Černá pole. These activities are being held for more than ten years. In this period more than 280 children together with their parents and hospital staff participated in. The trips in to the zoo contribute to a higher quality of leisure time of sick children and they have a significant psychotherapist meaning for them.

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Primary Paper Section: A

Secondary Paper Section: AK, AM

AN EYE TRACKING SYSTEM: TOWARDS APPLICATIONS IN MARKETING?

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Abstract: Exploring the emotions that can be induced by properly designed marketing communication messages is a modern and very interesting area of research in marketing. For measurements of the induced emotions various medical devices are used (eg, EEG, MRI, etc.) that can influence the natural behavior of the respondent in the course of the experiment. The following text aims to introduce the possibility of identifying other emotions that may be hidden in pupil size and its changes. An eye camera allows measurement of changes in pupil size depending on the projected visual stimulus. This paper presents the possibility of using eye cameras to identify the emotions that are demonstrated in an experiment carried out with known and unknown logos respectively.

Keywords: emotions, pupillometry, marketing, eye tracking

1 Introduction

1.1 Motivation

A new laboratory for studies of pupillary response was built at the Czech Technical University in Prague. This article presents the experimental setup that is based on an eye-tracking camera. Results obtained during first tests, focused on identifying potential applications in marketing, are included.

In addition to the common measurement of eye movements, the use of an eye-tracking camera allows us to monitor also the size of the pupil and its response to visual stimuli. One potential application for eye tracking is to investigate the effectiveness of marketing communication. With respect to the marketing communication, it is mandatory to monitor and evaluate not only the interests of the individual under test but also his/her emotion and cognition. State of the art methods for determining emotional and cognitive load are based on measurement of physiological variables (e.g. measurement of skin-galvanic potentials, EEG) or sensing activity of various parts of the brain using magnetic resonance[13].

The above-mentioned medical devices limit, to a large extent, the natural behaviour of the respondent in the course of the experiment. It would be very beneficial to replace them with a device that would not affect user comfort. Such a device would likely become a dominant tool for the benchmarking of marketing communication. The eye-tracking camera is a natural candidate for doing so, however, the ability to recognize emotions from the variations in pupil area needs to be proven first.

This article is organized as follows. First, the eye movement laboratory is introduced. Next, an initial experiment is described. Assumptions made, as well as hypotheses to be verified are presented. Finally, the obtained results are given and discussed in detail.

1.2 Description of the experimental setup

The laboratory of eye movements' research is made of a PC station and an eye camera. The laboratory is located in a room without windows so as to ensure constant lighting conditions. The eye camera is composed of hardware components (Headset - Sensor part with accessories) and software components (an application for visual stimulation, including the synchronized recording of measured data). The device measures the pupil area and provides an indication where the person being tested is looking at the moment (x, y coordinates within the monitor frame), including selected statistical parameters and visualization of the measured data. The hardware part consists of a head beam, on which an infrared eye camera and a semipermeable mirror are mounted (Figure 1). This arrangement ensures minimal disturbance of the visual field of the tested person. The camera captures the eye reflection in the near infrared region through the mirror placed before the eye of the tested person. Infrared LEDs illuminate the measured scene with a power that complies with EN 62471 standard[6]. The semipermeable mirror performs its function in the range of 700 to 1000 nm.

Figure 1 - Headset with a digital camera.

The camera is a black and white digital with a 752 x 480 pixel resolution and a data reading frequency up to 87 Hz. The recorded image is directly transmitted via USB interface to a personal computer, in which the accompanying application is installed. Its task is to visually stimulate the tested person and synchronously record the measured data, which are then evaluated. The application is also a means to create actual experiments (pictures, static or dynamic images, videos). It is possible to assign different timing to each stimulus, adapt system calibration according to the requirements of tested tasks, play audio tracks or perform partial graphic processing of measured data (for example: time sequence tracking of image, temperature maps, maps of interest, the zone of interest or graphical comparison of eye movements for different tested persons).

Visual stimuli are projected on a 24-inch monitor with a resolution of 1920x1080 pixels. The accuracy of the eye movements detector, at a 600 mm distance from the monitor, is approx. 0.5°, which corresponds to inaccuracies of about 5 mm. The detection algorithm for finding the pupil center has a reliability of 98% with an accuracy for its area determination of ± 1 mm2. A student with eye tracking in the experiment is shown in Figure 3 and a recorded image of the eye is shown in Figure 2.

Figure 2 - Recorded image of the eye.

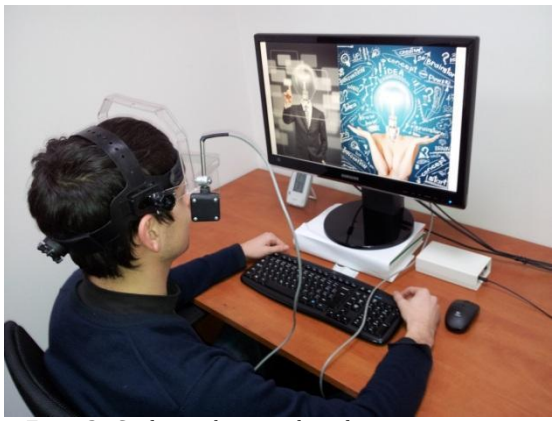

Figure 3 - Student with eye tracking during an experiment.

For measuring the light intensity the system is supplemented by a light meter TECPEL DLM-536, which is connected via USB interface directly to a personal computer and records the level of overall lighting (Monitor and Lighting of the laboratory).

1.3 Default assumptions

Eyesight is the sense that allows us to perceive light as well as the colour and shape of objects. It is certainly the most important sense; we perceive up to 80% of all information through vision. The sensory organ of sight is the eye, the function of which is to receive and process respectively, the light stimuli coming from outside into the eye, on the retina. In determining the emotional response to a particular stimulus, in our case, a logotype, we started from the previously presented knowledge about the behaviour of the pupil[8]. We assumed dilatation of pupils for positive emotion and respectively, narrowing for negative emotion. The breadth of the pupil is controlled by smooth muscles contained in the iris, i.e., the circular sphincter innervated by the parasympathetic fibres coming from the oculomotor nerve (III nerve oculomotorius) controlling pupil contraction and dilation innervated by the sympathetic system controlling its expansion. The parasympathetic is part of the autonomic nervous system used to manage internal organs, blood vessels and some other organs, while the sympathetic system is involved in the function of internal organs and blood vessels[12].

It is therefore an involuntary reaction, which is a carrier of objective information, unfortunately, also dependent on other parameters[9]. Among other influences, such as the use of certain drugs, certain neurological disorders, the age of the respondent, the physiological possibilities of the pupil, the respondent's interest – i.e. the observed object, etc., of paramount importance is undoubtedly the light incident into the eyes of the tested person. Higher intensity of the incident light causes a more "defensive" response of the eye, which is a narrowing of the pupil. In the dark, on the contrary, the pupil is maximally dilated. The diameter that the pupil of the human eye can, in point of fact, vary in the range is measured from 1.5 to 9 mm and on the subject it responds with a delay of about 0.2 seconds, with a maximum response between 0.5 and 1 sec[2].

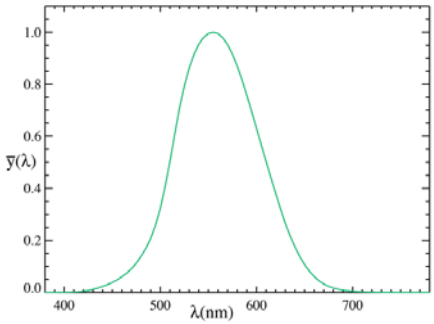

Figure 4 - The photopic vision curve.

From this perspective, it is therefore necessary to create an experiment respecting the above parameters and in particular to the maximum extent possible to suppress the influence of light, so that only the emotional response of the tested person to a given stimulus is actually measured. Measurement of the influence of light on the human eye is the concern of photometry, which compared to radiometry, is based on the knowledge of the sensitivity of the human eye to different wavelengths of the visible spectrum[3]. In Figure 4 the photopic vision curve (in daylight) is shown[5]. This characteristic is used by filters in luxmeters, which measure the intensity of light.

Before identifying the emotional response to a given visual stimulus it is appropriate to project to the tested person a control image, which will have the same value of the luminous flux or light intensity, of the overall brightness, and also similar values of brightness contrast[5]. This follows from the principle of the receiving and interpreting of visual information by the human eye, on which, besides having the effect of sharp foveal vision (about 1-2 degrees), it also causes peripheral vision[11].

2 Design of experiment

2.1 Initial experiment and its objectives

The objective of the experiment was to project to the tested persons selected logotypes and, with the help of the eye camera, to measure changes in their pupil area. The measured data were then compared with information about the familiarity/unfamiliarity with the logotype, which was indicated by the respondent in a questionnaire filled in after the experiment.

The experiment had several objectives:

1. Verify that the technology used is able to detect measurable changes in pupil size when logotypes are displayed on a screen.

2. Evaluate whether the measured pupillary response is related to the respondent's familiarity with the displayed logo.

3. Verify the technical parameters of the experiment, and propose any adjustments needed for further research.

2.1 Design of the experiment

The experiment was made up of seven black and white graphic logos of institutions (KFC, World Wide Fund for Nature, Nike, Playboy, DC shoes, United States Institute of Peace, Yamaha).The logos were chosen so as to maintain a balance between the familiarity and unfamiliarity of students with the logos. In order to minimize the effects of colour on pupillary response, only black and white logos were selected.

In order to distinguish between the influence of image brightness and the influence of the information content (see assumptions above), each logo was preceded by a control image from which any information content was removed. Two operations were considered for the information removal: either smoothing the image by a low-pass filter or replacing the image with a mosaic of squares filled with an appropriate colour. The representative colour was chosen so as to preserve typical hue and saturation in the corresponding image area[1]. Preserving the luminous flux value was approximated by using the average value[10] of the local image area.

Both approaches required the selection of a spatial scale of the modifications. The scale would be a trade-off between sufficient information removal and preserved image granularity. The low-pass filtering usually resulted in an excessive image blur. The mosaic approach allowed for higher local variations in brightness, as can be seen in Figure 5.

Figure 5 –Comparison of low-pass filtering (center) and the mosaic approach (below) applied to a test image (above).

The information removal achieved by the mosaic was further increased by local permutations of the squares. The mosaic squares were grouped into (disjointed) quadruples of neighbours. In each quadruple, one of the following permutations was performed: clockwise rotation, counter-clockwise rotation, or mutual exchange of the opposite squares. The resulting control image is shown in Figure 6.

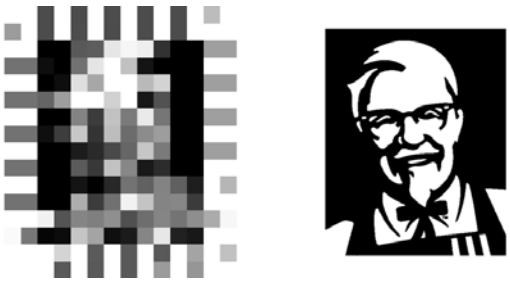

Figure 6 – The KFC logo (right) and the associated control image (left).

The whole experiment was composed of 15 images (see Figure 7) that were displayed on the monitor with the following timing:

1. Black (initial stabilization): 10 seconds,
2. Control image: 3 seconds,
3. Measured stimulus of logotypes: 8 seconds.

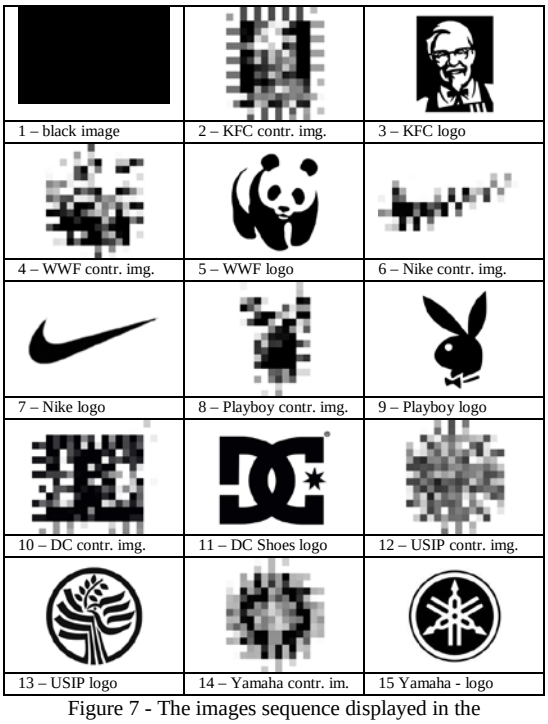

Figure 7 - The images sequence displayed in the experiment.

2.3 Execution of the experiment

The experiment was tested on student volunteers. Only the 23 students who (stated that they) did not use any drugs and did not suffer from any neurological disease were selected for evaluation. Before starting the experiment, it was explained to the students that several logos would be projected on a screen while an eye-tracking camera would record their pupillary response. Then the students were asked to fill in a survey, where they indicated which logos they recognized, which they did not, and which logos they were not sure about.

The measured pupillary responses were quantified using common performance indicators: mean value of pupil area (the initial drop omitted from calculation), difference between maximum and mean pupil area and time to reach maximum area[4]. A typical response along with the performance indicators is shown in Figure 8.

3 Results and discussion

The following observations can be made with respect to the above defined objectives of the experiment. The pupillary response to displayed logos is well captured by the eye tracking camera and image processing software components, as can be seen in Figure 8.

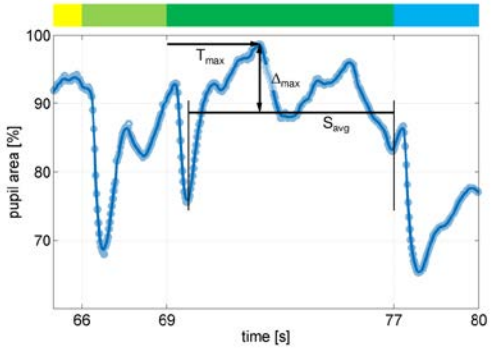

Figure 8 - A typical pupillary response (bottom) to visual stimuli (top, each stimulus represented by a colour). The performance indicators: mean area Savg, maximum dilation Δmax and time to maximum Tmax.

The set of displayed logos was carefully selected to include widely recognized logos, unknown logos and partially known logos, too. The respective statistics are given in Table 1. On the other hand, no correlation between the logotype familiarity and the pupillary response indicators used was found. A sample outcome of the analysis is visualized in Table 1 as well. Performance indicators for the respective groups and images – mean pupil area Savg and time to maximum Tmax. Normalized values represented by a jet colormap (largest in red, smallest in blue). Elements corresponding to empty groups are white.

Logo	Unknown logo	Known logo, but cannot assign it	Known logo
KFC	0%	4%	96%
WWF	43%	52%	5%
Nike	0%	0%	100%
Playboy	0%	0%	100%
DC shoes	13%	35%	52%
USIP	87%	9%	4%
Yamaha	83%	4%	13%

Table 1 – Relative frequencies of known and unknown logos and performance indicators for the respective groups and images - mean pupil area Savg (left) and time to maximum Tmax (right).

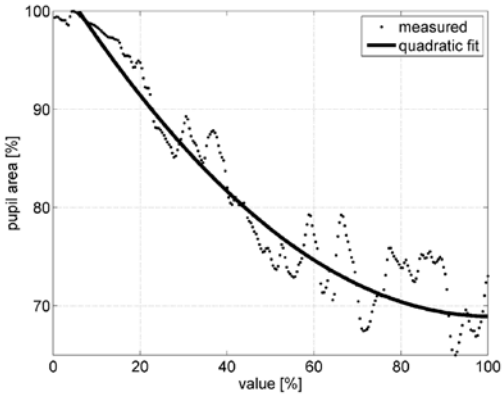

Figure 9 – Measured relationship between hsv value and pupil area. The variations in pupil area are due to the natural oscillations – data measured in one shot.

Timing of the visual stimuli was selected to be long enough to capture the key part of pupillary response. At the same time, the excitation was not overly long (from a marketing perspective). An issue related to the control images was detected, though. Luminous flux generated by the control images was systematically lower than flux induced by the logotypes. Detailed investigation revealed the issue was caused by nonlinear mapping between luminous flux and the hsv value used to approximate it. A similar effect was measured for the relation between the hsv value and pupil area, as shown in Figure 9.

4 Conclusion

A new laboratory for studies of pupillary response was built at the Czech Technical University in Prague. The first experiments confirmed that, from the technical point of view, the experimental setup can be used for evaluation of pupillary response to stimuli displayed on a computer screen. The measured data is virtually free of noise allowing for robust evaluation of almost arbitrary response indicators. The laboratory environment was well accepted by the volunteers. The selection procedure for displayed logotypes provided a rich enough cognitive load of tested subjects.

The relationship between familiarity with the displayed stimuli and the pupillary response has not been explained yet and would be a natural topic for future research. The results obtained are in contradiction with the former conclusions of[8]. However, validation of these hypotheses was not the main objective of the introductory experiments. In fact, the authors would welcome collaboration with peer researchers active in psychology and medicine on such topics in the near future.

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Primary Paper Section: A

Secondary Paper Section: AH, AN, ED, JA

MAIN ASPECTS OF THE COST OF CAPITAL

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The article is an output of scientific project VEGA 1/0357/11 Klieštik, T. and col.: Research on the possibility of applying fuzzy-stochastic approach and Corporate Matrics as tools of quantification and diversification of business risk.

The paper deals with the problem of creating an optimal capital structure of company. One of the most important criteria, when deciding between equity and debt, is cost of capital. This article describes equity, debt and ways of calculation the cost of particular capital components. Cost of equity is generally given by expectations of investors and can be therefore higher than cost of debt which is contractually agreed before investment.

Keywords: Cost of capital, Capital structure, Equity, Debt.

1 Introduction

Capital refers to the financial resources of funds that businesses, individuals, or governments need in order to pursue a business enterprise or implement an investment project. The process of gaining capital necessary for doing business activities is business financing. A real problem is to create an optimal capital structure, which means to choose an optimal ratio of debt and equity capital. Generally speaking, the optimal capital structure is considered to be that which minimizes the value of the weighted average cost of capital, WACC and, consequently, maximizes the value of the firm. One of the most important criteria, when deciding between equity and debt, is cost of capital. We generally know two basic forms of capital: debt and equity [3, p. 6].

Debt – it is capital draw down by bank loans or issuing the bonds. The firm must therefore promise to make payments over the period that the loan is outstanding (interest payments in the case of bank loan or coupon payments in the case of bonds) until the debt matures, at which point the original sum borrowed will need to be repaid.
Equity – firms issue shares, representing a claim on the value of the firm after debt has been repaid. Shareholders receive dividend payments from the firm and can also benefit from any increase in the value of shares.

The structure and quantity of capital should be adjusted according to company's needs and other specific factors. Corporate capital structure reflects firm's history of exogenous shocks to profits and asset values as well as its financing and distribution policies. This dynamic perspective on capital structure originates from Donaldson's field studies (1969) [4] and Myers' theory (1984) [10]. Other economists who characterized optimal dynamic investment were Fisher, Heinkel and Zechner (1989) [5], Leland (1984) [8] and Leland and Toft (1996) [9]. Financial decisions are usually made with the sole aim of maximizing shareholder wealth. But Donaldson's study emphasized goals such as organizational survival and growth, objectives which can conflict directly with the maximization of shareholder wealth [6, p. 4].

According standard textbooks we estimate firm's cost of capital as weighted average of the expected returns on its securities. This approach is straightforward for individual firms since the mix of securities in a firm's capital structure and the rates it pays on various forms of debt are known.
According to investors, cost of capital is considered as expected yield resulting from particular investment. It is the minimum return that company has to achieve when investing. If it doesn't, the investment is ineffective and value of the firm declines. From the debtor's point of view, cost of debt is the cost that he has to pay for gaining and using the capital. In financial decision making the cost of capital is used for [12, p. 157]:

- to determine the discount rate when calculating the effectiveness of an investment project,
- as criterion for creating an optimal capital structure of company,
- as average marginal cost of capital when calculating an optimal amount of capital expenditures,
- in the selection process of appropriate source of financing the investment for estimating the present value of cash flows,
- yield methods of valuation.

2 Risk and Cost of Capital

Investment risk is a part of the investment value by discount rate which reflects the cost of capital. Cost of capital has to correspond to risk taking by investor. Subject investing in a country has to take a risk of particular country, risk of specific sector and risk of company.
Generally we know two basic kinds of risk [3, p. 321]:

a) ***Systematic risk (market risk)*** – it is same for all subjects and given by macroeconomic situation of country. We cannot diversify it (only if we'd invest in more than one country). It is the risk of the loss of the portfolio value caused by price changes of assets in financial markets. Whereas specific risk results from concrete situation in particular company, market risk is influenced by macroeconomic events (for example Growth in gross domestic product – GDP is faster than expected, interest rates rise, the local currency appreciates, the rate of inflation falls etc.).
b) ***Unsystematic risk (specific risk)*** – is the risk of particular investment project, company or sector. We can diversify it by creating a portfolio. The specific risk consists of four parts: managerial, operational, financial and advance risk.

- *Managerial risk* – means the possibility that managers of company won't be competent and will lead the firm to insolvency. Such a risk often occurs in the new companies that may have a problem to succeed in financial markets.
- *Operational risk* – risk that firm won't be able to produce enough revenue to cover the fixed costs of its activities. It relates to active side of the firm's balance sheet.
- *Financial risk* – relates to passive side of the firm's balance sheet and it is the risk that firm won't be able to cover the fixed costs such as fixed interest payments.
- *Advance risk* – depends on investor's requirements for assets of the company in bankruptcy. Generally it means the order in which the investors' requirements will be satisfied.

However there exist many other classifications of risk (for example operational and financial risk).

3 Cost of Debt Quantification

Cost of debt occurs most often as an interest rate paid by company to it's investors (creditors). When company uses debt for financing its activities, there is also necessary to pay interests. Interests of debt can decrease the tax base. This effect of decreasing tax obligation of company is called the debt shield. When specifying the discount rate there is a rule that the longer is the time until maturity of capital, the higher discount rate investor requires. Company uses various forms of capital from various sources of financing and therefore the ways of calculating the costs of particular kind of capital are different [7, p. 54].

Cost of debt can be calculated as:

$$K_d = \text{Interest payments / debt} \quad (1)$$

Where debt is represented by bank loans, short-term borrowings, bonds, overdrafts and other loans and debts for which firm pays interests. In case of debt, the business in receipt of finance is contractually committed to repayment of the original finance at some later date, together with additional payments in the meantime. Payments by a company to honor its contractual

obligations to the providers of such finance have a priority call on the company's resources over shareholder dividends. And also investors who provide debt have no right to any other payments over and above these contractually committed payments. Providers of debt, unlike equity investors, do not benefit in the event that a business performs well [11, p. 99]. It is necessary to keep in mind that in cost of debt are reflected also taxes. Interest payments are part of costs and therefore decrease the tax base.

$$K_d = i \cdot (1 - T) \tag{2}$$

Where:
K_d – cost of debt
I – interest rate
T – tax rate

Cost of bonds – is given by such an interest rate when sum of present value of the bond interest income and present value of bond nominal price is equal to it's market price [12, p. 161]:

$$C = \sum_{t=1}^{n} \frac{i_t}{(1+i)^t} + \frac{N}{(1+i)^n} \tag{3}$$

Where:
C – market price of bond
i_t – interest on bond in each year
N – nominal price of bond
T – years of bond maturity
i – required rate of return to maturity (cost of debt before taxes)

4 Cost of Equity Quantification

There is no clearly defined contractual cost of raising capital through issuing equity, the most common source of capital for companies. The payments that companies must make to shareholders are not contractually defined, but it doesn't mean that equity finance is free. Because the payments that equity investors receive are not determined on a contractual basis, and because equity investors receive payments only after debt payments have been made, equity finance is more expensive than debt finance – companies need to reward equity investors for bearing a higher level of risk than debt investors [11, p. 6].

The opportunity cost of equity investment – opportunity cost means that investor can choose among a range of opportunities when deciding whether to invest his money as equity in a company (he could for example lend it to a bank, company or invest in an enterprise himself). An investor behaving rationally will therefore choose to invest in the equity of an enterprise only if he believes that this is actually the best option in the market [2, p. 318]. It means, that in order to gain equity capital form an individual, a firm must convince him, that the return on such an equity investment will be at least as great as the return on the best alternative opportunity foregone. Cost of equity is therefore given by investors' expectations.

The choice of method to determine the cost of equity depends on the specific conditions of company (size of enterprise, legal form, in the case of joint-stock company is important whether it is traded on the capital market, etc). We know some models that can be used to quantify the cost of equity:

- Capital Asset Pricing Model (CAPM)
- Dividend discount model
- Arbitrage Pricing Theory
- The Fama-French Three Factor Model
- Modular models
- Analysis of risk
- Expert method of determining the cost of capital

The most commonly used model for calculating the cost of equity is ***CAPM*** (Capital Asset Pricing Model) and it assumes that the cost of equity for any investment will increase only with the extent of systematic risk to which the investment exposes the equity investor. CAPM is formulated on the basis of a number of assumptions [3, p. 504]:

- investors are risk-averse individuals seeking to maximize their wealth,
- investors have homogeneous expectations,
- investors can borrow or lend at the risk-free rate,
- all assets are liquid,
- asset markets are frictionless and all investors have access to perfect information,
- there are no taxes, transaction costs, or other market imperfections.

Most of these assumptions are not real but still, this is the most used way by businesses, investors, and share analysts, to calculate the cost of equity. CAPM gives the formula as:

$$K_e = R_f + \beta_e * EMRP \tag{4}$$

Where:
Ke – Cost of equity
Rf – Risk-free rate
Be – Equity beta of investment
EMRP – Equity market risk premium

5 Weighted Average Cost of Capital

Weighted average cost of capital is the weighted average calculated from individual costs of particular parts of capital. Weights are the ratios of these parts. The calculation of average cost of capital is derived from the formula:

$$WACC = w_1.k_1 + w_2.k_2 + ... + w_n.k_n = \sum_{i=1}^{n} w_i.k_i \tag{5}$$

Where:
WACC – weighted average cost of capital
w_i – percentage ratio of i-kind of capital
k_i – cost of i-kind of capital
n – number of kinds of capital

We can substitute optional number of capitals into this formula and calculate their weighted average. The condition is that we have to know the ratios of individual kinds of capital on the total amount of capital. Most finance textbooks (Benninga and Sarig, 1997; Brealey; Myers and Marcus, 1996; Copeland; Koller and Murrin, 1994; Damodaran, 1996; Gallagher and Andrew, 2000; Van Horne, 1998; Weston and Copeland, 1992) present the Weighted Average Cost of Capital WACC calculation as **[**11, p. 2**]**:

$$WACC = K_e \cdot \frac{E}{V} + K_d \cdot (1 - T) \cdot \frac{D}{V} \tag{6}$$

Where:
K_e – Cost of equity
K_d – Cost of debt
E – market value of equity
D – market value of debt
T – corporate tax rate
V – market value of equity plus market value of debt

With rising amount of debt rises also the cost of debt because debt providers require higher yield for taking the risk. They face a significantly different risk profile by comparison with equity investors. The fact that interest costs are paid out of corporate incomes before taxation, and take priority over payments to equity investors, reduces the risk to which debt providers are exposed. Interest costs are determined at the outset of the borrowing and are more likely to be paid than dividend payments. However, cost of equity is generally higher than cost of debt. It also rises with rising debt. Investors in equity of enterprise take higher risk and therefore require higher rate of return.

6 Conclusion

Companies obtain capital from shareholders (equity) and lenders (debt). Both types of capital come at a cost because investors require a return to reflect the opportunity cost associated with committing their money over a period of time. For debt this cost is the rate of interest that the lender charges – this varies with the amount of risk to which the lender is exposed. In the case of equity, it is more complicated to calculate the cost. Companies do not have a contractual obligation to reward shareholders at a specified rate. The cost of equity is the return on investment that

shareholders expect to receive. There are some methods how to quantify the cost of equity. The most commonly used is model CAPM. If we can estimate ratios of particular kinds of capital we can calculate the cost of capital. For this purpose we generally use the formula of weighted average cost of capital (WACC).

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PUBLIC VENTURE CAPITAL FUND IN LITHUANIA: MISSION IMPOSSIBLE?

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Abstract: The goal of the research is to establish whether (and how) public venture capital fund could reveal any strategic opportunities of new and innovative companies and of the whole national economy. Imperfect market situations in which public venture capital fund would possibly operate better than private ones are analyzed and compared with practical experience in different countries.

Keywords: venture capital, public venture capital fund, innovation.

1. Introduction

The importance of venture capital in economy is related to its role in financing new innovative enterprises, as the bank-specific financing for the latter ones is mostly inaccessible due to the insufficiency or the absence of the pledges (Stiglitz, Weiss, 1981); the capital markets are, in turn, accessible only to the major public limited liability companies.

Moreover, while assessing the risk, banks have become even more careful after the financial crisis of 2009. The same reason – financial crisis of 2009 – is at the origin of private investors' reluctance to finance innovative companies (Lerner, 2010); therefore, the question is what could become a new catalyst of venture capital market, and we think that public venture capital fund could act that role.

The goal of the research is to establish whether (and how) public venture capital fund could reveal any strategic opportunities of new and innovative companies and of the whole national economy. The methods of the research cover a comparative analysis of scientific literature and practical experience. The article starts from the imperfect market situations in which public venture capital fund would possibly operate better than private ones. Then we continue with practical experience in different countries and conclude with some proposals for public venture capital development.

2. Venture capital: selection between private and public

In the entrepreneurial society, venture capitalists make venture decisions by using collective experience and knowledge (Cyert, March, 1963; Nelson, Winter, 1982), whereas in the society where traditionally no entrepreneurial spirit exists (e. g. in Lithuania like in many other Eastern European countries) investors' knowledge is based only on their previous experience. In case of venture capital it means that venture capital investments are based on the longevity of venture capital firm (Dimov, Murray, 2007) and the number of ventures in which the firm have invested previously (Gompers et al., 2006). Therefore, in such society small and newly established funds can finance less beginning and high-technology enterprises, selecting larger or longer operating instead – it is especially relevant to the countries where venture capital market is still in the stage of creation and no large or longer operating private venture capital funds exist. On the other hand, public venture capital fund, being able to accept higher risk, would not experience above-mentioned problems of selection.

Another main reason why it can be worth selecting public venture capital is the fact that development of private venture capital market in itself not always takes place smoothly. Its development is affected by different factors, one of which is culture (culture is defined as a set of values, behavioral models, beliefs and underlying assumptions which are followed by individuals in a certain society). Two cultural dimensions are important to the development of venture capital (Li, Zahra, 2012): avoidance of uncertainty and collectivism. Avoidance of uncertainty indicates low toleration of activities considered being risky, such as venture capital investments, and it raises alternative costs of risky activities. Collectivism shows the tendency to count on informal relationships of the groups in solving problems of transactions (Fukuyama, 1995). In collectivistic society, conformism and harmony are considered being a norm, and the behavior which can be understood as opportunistic can bring shame (Steensma et al, 2000). Collectivistic orientation can restrict venture capitalists' transactions by their "circle of acquaintance" (Zacharakis et al., 2007) and prevent potential external investors (venture capitalists) from joining already mentioned circle, by thus restricting their investment opportunities.

Lithuania is characteristic of both the avoidance of risk (according to the EU-wide research, Lithuanians have the lead across the EU countries in the terms of the fear of bankruptcy when starting business (European Commission, 2010)) and the collectivism (as well as the other Eastern European countries); therefore, the development of venture capital in itself takes place (and will take place) heavily. Moreover, as risk premium required from venture capital investments in risk-avoiding society is higher than in non risk-avoiding societies, it should be thought that venture capitalists will also more heavily react to indirect efforts of the Government intended to encourage the development of venture capital. One of the ways to solve it is to establish a public venture capital fund.

Public venture capital fund would be also important in the way that, without sufficient private venture capital in a country, it could play the role of a catalyst by attracting foreign venture capital, as the investments of venture capital funds are limited by geographical distance: with the increase in distance, the spread of information about possible investment targets decreases (Green, 1991); moreover, investors wish to physically take part in the management of a target company (Petersen, Rajan, 2002). Therefore, without local venture capital it is also practically impossible to attract further existing foreign venture capital: investors of the Silicon Valley (venture capitalists) limit themselves to the 1-hour trip by car (Zook, 2002), whereas the limit of 150-250 miles is reached to the extent of all USA (Florida, Kenney, 1998). Other authors (Sapienza et al., 1996) have established aforementioned distance in the UK being equal to 1,5-hour trip by car, and more than 2 hours in the USA. This distance is equal to 232 km in Germany (Fritsch, Schilder, 2011).

One of the ways to solve the above-mentioned problems is the syndication of venture capital funds (Sorensen, Stuart, 2001). After interviewing German venture capital providers, it became clear that investors often use syndicates to find themselves closer to their investment targets (Fritsch, Schilder, 2008). One of the members of a syndicate has always been established not far from the investment target and exactly he performed its supervision. The other members of a syndicate play the role of passive co-investors (Wright, Lockett, 2003). Thus, syndicated investments can be located at a larger distance from venture capital funds than the non-syndicated, provided that at least one member of a syndicate will have been established relatively close to the investment target. This is exactly the reason why it can be expected that investors being far from investments will look for a partner of a syndicate, who is closer. Therefore, it is important for a region (or a country) to have a sufficient number of venture capital providers who could act as catalysts, when connecting regional economy to further global supply chains by way of syndication. Thus, public venture capital fund established in a country, could, even not being of high volume, act as a catalyst and, by attracting foreign venture capital, invest in high technology companies. This could also happen in a syndicated manner. Moreover, while being public, it would provide foreign investors with the "guarantee of reliability" (Lerner, 1999).

The level of activity of venture capital in a country also depends on the development of its financial system (Black, Gilson, 1998; Jeng, Wells, 2000). Financial system, in turn, can be oriented to

banks (e. g., Germany, Japan), capital markets (US, UK) and financial markets (Israel) (Mayer et al., 2005). Respectively, key sources of venture capital are banks; pension funds and insurance companies; and the individual investors with large private corporations.

Lithuanian financial system, as for the other countries of the Continental Europe, is attributed to the first type; therefore, banks should mostly invest in venture capital. Nevertheless, without the existence of the other above-mentioned conditions, banks do not rush to invest in venture capital, and with the bank-specific financial system, abilities of other financial market participants to invest in venture capital remain highly limited. Thus, the development of venture capital remains exceptionally within the liability of the Government. It can, in turn, behave in two ways: to promote private investors to invest to venture capital or to invest itself, by establishing a public venture capital fund. If the second option is selected, all advantages of the first method would be retained; however, additional advantages would emerge: firstly, public venture capital could accept higher investment risk than private venture capital could afford, especially in early stages of business financing; and secondly, public venture capital could promote the development of private venture capital, as it occurred in Singapore, Israel and other countries.

In general, importance of public venture capital to a country (or a region) could be shown by a stochastic dependence, which could be a function of respective parameters discussed above. Design of such dependence is the object of our further research.

3. Practical experience in using public venture capital

First venture capital funds were established in 1940s in US and UK[1] (Fritsch, Schilder, 2011); however, venture capital markets became institutionalized only in 1980s (Bruton et al., 2005). Venture capital is best developed in US, and that was determined by few causes: the Small Business Investment Act was adopted in 1958 which permitted newly established small business investment companies to finance and control small entrepreneurial businesses in US. Another not less important factor of the development of venture capital in US was the amendment of the laws on the pension funds in 1970s, which permitted pension funds to invest in the independent investment funds, including venture capital ones (Kenney, 2000).

Venture capital sector in Europe started developing quickly only in 1970s (UK), after liberalizing legal acts in respect of the banks, pension funds and other venture capital funds. Improved legal environment had also influence, i.e. reformation of the tax system, related to the reduction of the profit and capital gain taxes, also the tax exemption for the investors of private capital. In the Continental Europe, venture capital took significance only in 1990s; and in Asia, as in the larger part of remaining world, only in the second half or even at the end of 1990s (Li, Zahra, 2012).

Europe lags behind US by volume of venture capital investments for several reasons: the unfavorable regulation of labor market and tax environment not promoting venture capitalists to invest, the lack of enterprising and proactive people wishing and not being afraid to implement new ideas, the absence of experienced venture specialists, and the absence of the liquid market for the exit of venture capital (Gompers, Lerner, 1998).

This is why the European Commission recognized in the Communication on the renewed Lisbon strategy that there is a gap of venture capital in Europe. This gap is mostly felt by hi-tech companies which are recently established and having a high growth potential. In the opinion of the Commission, key source of the market insufficiency is insufficient or asymmetric information increasing the transaction and agency costs (i. e., the costs of collecting the information and assessing the investments), as well as the fear of the risk; therefore, the promotion of venture capital investments is one of the goals of the Community, and the gap of equity capital in certain circumstances can justify the measures of the state aid. Thus, the state aid promoting the supply of venture capital can be an effective measure to reduce market insufficiencies. On the basis of this fact, the European Commission adopted the Guidelines on state aid to promote venture capital investments into SMEs where the terms and conditions of the provision of state aid in the form of venture capital are established. The logic of the support is based on the fact that there are no alternative financing measures in financial markets (i. e., market insufficiency exists). It shows that the EU countries can be and are promoted to support the development of venture capital at the national level. The selection of the form of the aid measures belongs to the Member States.

In the opinion of the Commission, the discussed effect can be exercised by the following measures:

1. Constitution of investment funds (venture capital funds) in which the State is a partner, investor or participant, even if on less advantageous terms than other investors.
2. Guarantees to venture capital investors or to venture capital funds against investment losses, or guarantees given in respect of loans to investors/funds for investment in venture capital, provided the public cover for the potential underlying losses does not exceed 50 % of the nominal amount of the investment guaranteed.
3. Other financial instruments in favor of venture capital investors or venture capital funds to provide extra capital for investment.
4. Fiscal incentives to investment funds and/or their managers or to investors to undertake venture capital investments.

In 2010, the Commission stated that "market data suggest that venture capital markets have still not recovered to pre-crisis levels. The number of equity investors has decreased compared to 2008." It also maintained that "the likely explanation is that risk aversion has augmented." Therefore, in 2010, the Commission amended the Community guidelines by doubling the amount of the aid to one entity (up to EUR 2.5 million).

The European Commission also took other initiatives, such as *Joint European Resources for Micro to Medium Enterprises* (JEREMIE) which is the joint initiative of the European Commission and the European Investment Fund (EIF) to solve the problem of the lack of venture capital for micro to medium enterprises in certain regions.

Besides the JEREMIE initiative, the aid is also provided according to the following programs: EU Competitiveness and Innovation Framework Program (CIP); G2G intended for the innovative entrepreneurs of the EU; and venture capital measures of the European Investment Fund (European Commission, 2009). Thus, the European Union speaks for the usage of public venture capital, especially in those sectors and regions where private venture capital is not enough (i. e., where market insufficiency exists).

Beyond the limits of the EU, public venture capital funds (or respective program) have been established in Canada (Labor Sponsored Venture Capital Corporation) (Cumming, Macintosh, 2006), Australia (Innovation Investment Fund) (Cumming, 2007), Singapore, Israel, etc.

In the very EU, such funds operate in the United Kingdom (Enterprise Investment scheme; Venture Capital Trust) (Cowling et al., 2008), also in Finland (SITRA) and even in Estonia (Estonian Development Fund).

The idea to set up the Estonian Development Fund dates back to 2000 when the President of Estonia Lennart Meri called to look for Estonia's own Nokia. In the memorable speech given on the occasion of the 82nd anniversary of the declaration of

[1] Apart from the historical examples, such as Genoa in 14th century.

independence of Estonia, L. Meri reminded that "Finland built itself up at a rapid pace through a union between money and mind, and the Finns call that union SITRA (Finnish Innovation Fund)". By completing the speech, L. Meri invited the Estonians to create their own SITRA, the goal of which would be to accelerate the restructuring of the production and the development of the technological enterprises. The Estonian Development Fund was launched in April 2007. The mission of the fund is to contribute to creating a future for Estonia by developing its venture capital market. For that purpose, the Fund performs venture capital investments in the development-oriented technical enterprises together with the private sector. The Fund is accountable to the Parliament; its Supervisory Board consists of the representatives from the Parliament, the Bank of Estonia, the Ministers of Economy and Finance, the Rectors of technological universities of Tartu and Tallinn.

Few days before the speech of L. Meri, the President of Lithuania gave even three speeches (in 2000, in Lithuania, as in Estonia, the 82nd anniversary of the declaration of independence was celebrated), and in only one of them, intended to the heads of the diplomatic missions accredited in Lithuania, he mentioned that "in the new age, we will further work, so that the name of Lithuania would be related to the openness, dynamic development, ability to accept the challenges of globalization," however, he did not told how we will reach these goals, i. e., he did not call, did not mobilize the nation to any particular goal.

The way how such speeches of the heads of the states can be stimulating, inspirational and mobilizing, is well shown by the speech of the President of the US John F. Kennedy, given on 25 May 1961 at the Congress, when the US tried to recover after the double shock: the launch of the satellite Sputnik and the flight of the Soviet cosmonaut Yuri Gagarin to the space less than two months before the President's speech. "I believe we possess all the resources and talents necessary; but we have never made the national decisions or arranged the national resources required for such leadership. We have never specified long-range goals on an urgent time schedule, or managed our resources and our time so as to insure their fulfillment. <…> let it be clear that I am asking the Congress and the country to accept a firm commitment to a new course of action, a course which will last for many years and carry very heavy costs…" Then, he set out the program how to send the US astronaut to the Moon within 10 years. Actually, there was no need for such a long time – a decade – to reach the goal – it was implemented in just 8 years.

Estonians might not succeed to create their own Nokia but three years after their President's speech, they created Skype, and after another 8 years (in May 2011), Microsoft bought Skype for 8.5 billion US dollars. Market capitalization of Nokia at the same time was less than 4 times higher (and it was before the crisis of Nokia).

Thus, it is evident that the mobilization of the society to reach the important goals is the prerequisite of success, would it be an inspiring speech of the head, or a well prepared national development strategy. Another important aspect is a set of the measures to implement the strategy, such as the Estonian Development Fund. It is true to say that Estonians had both things: the strategy and the measures to implement it; whereas the Lithuanians had none, as there is still practically no venture capital promotion system in Lithuania at the national level even today.

Meanwhile, a research conducted in Lithuania in 2004 (Miliute, 2004) revealed that 25% of surveyed companies emphasized the importance of venture capital in the activities of scientific valleys, so that the usage of venture capital would allow the valleys to achieve better results in their activities. However, no measures were taken to attract venture capitalists to the valleys in Lithuania.

4. Venture capital in Lithuania: prospects for development

There are many agencies, willingly giving advices, but not money necessary for venture capital investments, in Lithuania. The Lithuanian Development Agency was founded in 1997 by merging together Lithuanian Investment Agency and Lithuanian Export Development Agency, and in 2010 it was again divided into public agencies Invest Lithuania and Enterprise Lithuania. Besides those ones, we also have Lithuanian Innovation Centre, 7 business incubators, as well 3 science, studies and business valleys. These are impressive numbers; however, none of these agencies deals with the initial financing of business ideas.

Thus, it is hardly surprising that venture capital is not an important source of financing of innovations in Lithuania: new projects are financed either by own means of companies (67%) or by the aid of the EU (28%) (Adekola et al., 2008). In 2009, according to the investments of private and venture capital, Lithuania, together with the other Baltic States, lagged at the end of all European countries (Fig. 1):

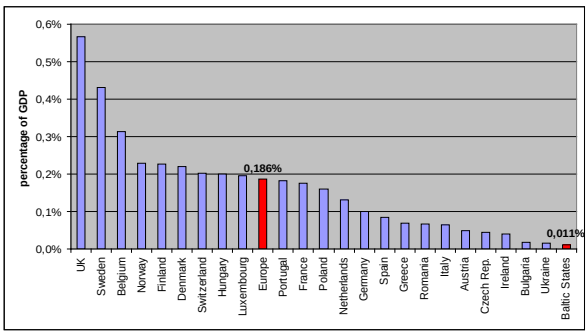

Fig. 1. Private equity and venture capital investments in European countries in 2009 as a percentage of GDP (Source: EVCA and own calculations)

According to the data of the Statistics Lithuania, there are few reasons why venture capital is used insignificantly in Lithuania: Lithuanian entrepreneurs find the availability of bank loans more important than venture capital; Lithuanian entrepreneurs are conservative and do not wish the interference of the third party in their business (venture capitalists receive part of the rights of control of a company in exchange for the invested money); also the lack of information about venture capital exists[2]; finally, bank loans are better assessed for their lower interest rates (Venckuviene, Snieska, 2010).

The EU initiatives currently play the most important role in promoting the development of venture capital in Lithuania: according to one of them – the already mentioned JEREMIE – 5 venture capital funds have been established: 3 of them in 2010 and 2 in 2011. We believe that further development of venture capital market could be accelerated by a more active role of the state and establishing of public venture capital fund.

5. Conclusions

1. The importance of venture capital in economy is related to its role in financing new innovative enterprises.

2. Public venture capital could be an alternative to private one in societies where private venture capital market is weak due to its financial system or cultural aspects (no entrepreneurial spirit, avoidance of uncertainty and collectivism).

[2] A survey on venture capital in Lithuania, conducted at the end of 2010, showed that even 93% of the managers who took part in the survey did not know any venture capital fund operating in Lithuania, and 91,5% of the respondents could not name any Lithuanian company, in which such funds had or have invested. Thus, it is hardly surprising that, on the basis of the data of that research, 78% of the surveyed managers did not include venture capital funds in the list of opportunities for the development of their company.

3. As different researches show, investments of venture capital are limited by distance. Thus, public venture capital fund could, even not being of high volume, act as a catalyst and, by attracting foreign venture capital, invest in local high technology companies. This could also happen in a syndicated manner.

4. European Commission speaks for the public aid for venture capital markets when market insufficiency (equity gaps) exists. State aid consists of different forms of public support to venture capitalists, venture capital funds and/or their managers; one of these forms could be a public venture capital fund.

5. As venture capital market in Lithuania is undeveloped and its development is going slowly, public venture capital fund would probably help to activate national venture capital market. The justification of the existence of such a fund and positive aspects of its activities is the object of our further research.

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Primary Paper Section: A

Secondary Paper Section: AH

INFLUENCE OF SUPERVISION AND PREVENTIVE MEASURES ON SOCIAL WORK WITH AGGRESSIVE CLIENTS: A RETROSPECTIVE VIEW OF THE INCIDENCE OF CLIENT VIOLENCE

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The paper is a part of grant project VEGA No. 1/0332/12 titled Analysis of Selected Client Violence Risk Facts within the Social Work Emphasizing the Client Violence Prevention and Development of Social Workers – National Survey on the Occurrence of the Client Violence against Social Workers in Slovakia.

Abstract: The paper deals with the incidence of client violence in the Slovak Republic. The author presents a definition of client violence. It offers an overview of research on the issue of client violence in the helping professions with an emphasis on research undertaken in the field of social work in different countries. The author presents a retrospective view of client violence research - comparison of results obtained in 2007 and 2013. The findings confirm the increased incidence of all forms of client violence. It also offers a comparison of client violence with researches from different countries. At the end of this paper the author is checking the relationship between client violence and supervision and preventive measures for victims of workplace violence, which she verified by the correlation analysis.

Key words: violence at work, client violence, forms of client violence, client violence research in social work.

1 INTRODUCTION

During the last thirty years incidence of client violence in the helping professions has been gradually increasing. It is caused by various factors, overall development of the society, increase in criminality, and world-wide crisis, which resulted in global growth of social issues.
In terms of typology, according to OSHA (Occupational Safety and Health Administration, USA) the client violence is the second type of workplace violence:

I. The first type is the most common workplace violence. It is the workplace violence committed by a stranger in risky occupations, such as 24/7 stores, liquor stores, 24/7 gambling clubs, jewellery stores etc.
II. The second type of violence includes incidents when an employee providing the service becomes a victim. In this type of workplace violence the perpetrator is a recipient of these services. It can be for example a client of social worker or a patient in health care establishments.
III. The third type of violence in this categorisation consists of incidents, in which the perpetrator is a person working in the same organisation as a victim. It can be a co-worker, former employee or superior of a victim.

The client violence in social work is understood as any (verbal or physical, intentional and unintentional) threat, assault or attack by a client (a former client, family relative of a client) against a social worker.

2 CLIENT VIOLENCE IN SOCIAL WORK AND OTHER HELPING PROFESSIONS – OVERVIEW OF RESEARCH

The first studies undertaken in the issue of client violence were focused on the helping professions in general. The most often these studies involved physicians, psychiatrists, health professionals, psychologists, and social workers. They were usually aimed at identification of a threat by a client – a patient, a feeling of threat, and assault.

Whitman[1] noted that 43% of the survey participants – psychologists, psychiatrists, and social workers had felt threatened by their patients, and 24% had been assaulted. Bernstein[1] reported that in his sample of marriage and family counsellors, psychologists, psychiatrists, and social workers, 36% had been threatened with assault and 14% had been assaulted by client. Another threatened group consists of people working in the field of mental health and those working with mentally ill, in particular after deinstitutionalisation treatment of mentally ill patients in USA.

The workers providing social assistance, services or care, nurses and health professionals constitute the group that is at the highest risk, which is also indicated by results of several studies. In Poland Merecz, Drabek and Mosciska[2] conducted a survey of 1,163 nurses, which revealed that 90% of them had reported incidents of verbal abuse from clients, and 2% had been targets of physical aggression. Alexander et al.[3] in the study undertaken with a sample of 1,522 nurses, health professionals, and physicians in Australia found out that almost 70% of them had experienced violence from patient. The particularly threatened group consists of physicians and health professionals in the field of psychiatry, which was also proven by the study of Privitera et al.[4] who found out at one university Department of Psychiatry that 53% of psychiatrists had been threatened and 25% had been assaulted by a patient. Finnish study[5] identified incidence of occupational accidents caused by a person other than the co-worker in various occupations, and showed that the most accidents happened in the health care professions, i.e. 34% of all occupational accidents, and the second highest number of accidents happened to social workers, i.e. 19%.

One of the most significant authors dealing with the issue of client violence in social work is Christina E. Newhill[6]. Her study of prevalence and risk factors for client violence toward social workers is a milestone in this field. She conducted the survey in 1993 in USA in Pennsylvania and California. In the survey 1,600 respondents were addressed and 1,129 filled questionnaires were returned. Respondents – social workers were randomly selected by computer from membership directory of the NASW (National Association of Social Workers in USA). In the questionnaire Newhill distinguished three types of client violence: property damage, threat in the form of verbal threatening or threat in the form of physical gesture and assault, which she further divided into two sub-categories: actual assault, in case of which the client laid hands on social worker, and attempted assault, which did not involve physical contact. 57% of the respondents had experienced one or more types of client violence during their career, 83% of them had been threatened by a client and 40% had experienced attempted assault or physical assault by a client. In the study the author also determined to what extent social workers perceive client violence as an issue. The results showed that 78% of the respondents consider this issue to be significant for social work, although only 31% of them stated that they had experienced this issue during their practice. 52% of the respondents stated that they had felt fear at some moment while working with clients. Another aim was to determine whether the

[1] JAYARATNE, S. - CROXTON, T. - MATTISON, D. A national survey of violence in the practice of social work. In *Families in Society*. ISSN 1044-3894, 2004, vol. 85, No. 4, pp. 445-452.
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respondents achieved specialised education or training for work with an aggressive client. 59% of the respondents had been trained for work with aggressive or potentially aggressive client, and 79% of them would like to receive further education in this issue.

The study undertaken in 1996 in USA by Lucy D. Rey[7] shows that 23% of social workers from research sample of 300 respondents had been physically assaulted by one or more clients during their practice and 63% of them had been aware of violent situations which had happened at their workplace.

Macdonald and Sirotich[8] by their research in reporting of incidence of client violence in random sample of social workers in Canada, Ontario, found out that 87.8% of the respondents reported verbal harassment by a client at least once during their practice, 63.5% had been threatened by physical violence, 28.6 % had been at least once assaulted by a client, 7.8% had been injured, i.e. 13 respondents, and injury of six respondents had to be medically treated.

In 2002 Shields and Kiser[9] conducted a survey in USA to find out the extent and type of client violence toward social workers. 171 respondents, child social workers and workers in the sector of providing various types of financial assistance, participated in the study. In the questionnaire the authors defined psychological violence as non-physical violence, including threats, offensive language, and shouting at a worker during his conversation with a client. Physical attack was defined as hitting, throwing objects or "grabbing" a social worker, i.e., situations of physical contact between a client and a social worker. Conversation was defined as behaviour of a worker, by which he tries to de-escalate the client violence. 56% of the respondents stated that they had experienced a threat of violence while working with clients. Almost 10% of the respondents had been physically attacked by a client. A majority of the respondents experienced during their work with the client that the client shouted at them or verbally insulted them. 28% of them stated that they had been verbally sexually assaulted by a client and 67% felt the danger when visiting a client at home.

In 2004 Jayaratne, Croxton and Mattison[1] conducted a national survey of violence in USA, using a sample of 941 respondents randomly selected from the membership directory of the NASW. The sample of respondents included social workers from different fields of social work – health care, mental health, education system, family care, and family services etc. They were interested in incidence of individual forms of client violence and found out that 22.8% of their respondents had been physically threatened, 3.3% physically assaulted, 15.1% threatened with a lawsuit, 1.4% sued, 49.3 % verbally abused, and 8.4% sexually harassed by a client during their practice.

Ringstad[10] implemented a survey in USA of 1,029 respondents – social workers, in which he dealt with incidence of client violence in the past year, but also with incidence of violence against clients during the same period. He determined various kinds of psychological and physical aggression. The results showed that 62.3% of the respondents had been assaulted in certain way by psychological aggression and 14.7% by some form of physical aggression. 11.9% of the respondents assaulted their client by psychological aggression and 4% by physical aggression.

Koritsas, Coles and Boyle[11] carried out the research in client violence in Australia on a sample of 1,000 respondents questioned on the basis of the membership directory of the Australian Association of Social Workers. In the questionnaire, the authors identified incidence of six forms of violence during the last twelve months of the respondents' practice. In particular, they focused on verbal assault, understood as use of vulgar language, shouting, and the same situations during telephone conversation with a client, property damage or theft – damage or theft of property of the social worker, his family or workplace. Intimidation in form of intentionally used threatening words and gestures. Physical violence, when a social worker is physically assaulted by a client or there is an attempt of such physical attack. Sexual harassment as any form of sexual allusions, unwelcome sexual advances from a client, profane and offensive jokes and comments with sexual connotations. Sexual assault in form of sexual attack. The identified forms of violence were observed from clients, friends of clients, their family relatives, but also colleagues and other professionals. Results showed that 67% of the respondents had experienced at least one of these forms of violence during the last year. 57% of the respondents had been verbally assaulted, 18% had their property damaged or had been robbed, 47% of the respondents had been intimidated, 9% physically assaulted, 15% had experienced sexual harassment, and 1% of the respondents had been sexually assaulted.

From the above summary of the most significant studies on this issue it is clear that the most common form of violence the social workers have to face in their practice is verbal aggression of their clients.

Incidence of aggression on the part of the clients may be influenced by various factors. Some of these factors are likely to be on the part of these clients. We can try to use them to distinguish risky clients. The study undertaken by the author in 2007 confirmed experience from abroad, where the respondents identified reduction of state benefits for the client, taking the child from the family, and client under influence of narcotic drugs as the most frequent aggressive situations. Within the present grant we would like to focus on more specific identification of risky clients in terms of their gender, race, age, or background.

From all other factors mentioned in this paper we would like to focus especially on supervision, which has become the part of further education of employees of social services providers since 2008. Supervision should represent a significant part of performance of the profession of social worker. For people working with clients in serious and crisis life situations it is one of the most important preventive measures in case of burn-out syndrome and generally in long-term performance of this demanding profession.

3 RESEARCH 2007

The study we conducted in 2007 was focused on identification of incidence of selected forms of client violence toward social workers. It confirmed results of the above mentioned studies from abroad. In comparison with the foreign studies there is a lower incidence rate of physical violence in the Slovak Republic, but it is conditioned by overall trend in the society (e.g. according to Eurostat the number of murders per million inhabitants in the Slovak Republic during 2007-2009 was 16.5, in UK it was only 12.5, and in USA it was about 40 murders per million inhabitants per year).
The study was undertaken with a sample of 177 respondents, 21 men, 156 women – employees of the Labour, Social Affairs and Family and SSE (social services establishments) in the Košice Self-governing Region. For the purpose of comparing with above mentioned studies we found out that almost 32% of

[7] REY, L. D. What social workers need to know about client violence. In *Families in Society*. ISSN 1044-3894, 1996, vol. 77, No. 1, pp. 33-39.
8 MACDONALD, G. – SIROTICH, F. Reporting client violence. In Social Work. ISSN 1468-0173, 2001, vol. 46, No. 2, pp. 107-114.

[9] SHIELDS, G. – KISER, J. Violence and aggression directed toward human service workers. In *Families in Society*. ISSN 1044-3894, 2003, vol. 84, No. 1, pp. 13-20.
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the respondents had experienced at least one physical threat by a client at some point of their career, 10% physical assault, 75% verbal abuse, which makes these results similar and comparable to other results mentioned above.

Within this research we verified several factors, which could have an influence on incidence of client violence or would be related to the same. We tried to determine whether the strategy of coping with aggressive situations of social workers influences incidence of client violence. We used CAS questionnaire, which distinguishes four types of coping with experienced aggression. We wanted to know whether there is any relation between incidence of verbal abuse and a strategy of coping with aggression. This was also confirmed in the factor of appeasement which indicates that the social workers who have a tendency to settle a conflict situation by appeasement, report higher incidence of verbal violence from the clients.

Tab 1 Coping with experienced violence

Correlation coefficient	Contra-aggression	Helplessness	Non chalance	Appeasement
	- 0.10	0.10	0.05	0.17*

Surprisingly, relation between the factor of contra-aggression and increased incidence of verbal violence, which we had expected, was not confirmed. However, it can be caused by the fact that person who uses the strategy of contra-aggression is less sensitive to verbal violence. In other words, what the person with appeasement strategy considers violence does not have to be considered violent situation by a person using the strategy of contra-aggression.

We also measured the aggression rate by means of AQ questionnaire, which distinguishes four subscales of aggression, i.e. physical aggression, verbal aggression, anger, and hostility. However, relation between individual subscales or overall aggression and incidence of verbal violence was not confirmed.

Tab 2 Aggression rate

Correlation coefficient	Physical aggression	Verbal aggression	Anger	Hostility	OS aggression
	- 0.08	- 0.00	0.01	- 0.03	- 0.03

4 RESEARCH 2013

The study was conducted in 2013 with the sample of 100 respondents, 77 women and 23 men – employees of the Office of Labour, Social Affairs, and Family and Institution of Social Services from the Košice Self-governing Region working with the clients. Its aim was to determine incidence of client violence and verification of impact of selected factors on client violence.
Age of respondents (two respondents did not provide the data) ranged from 23 to 60 years, the mean age was 39.76.

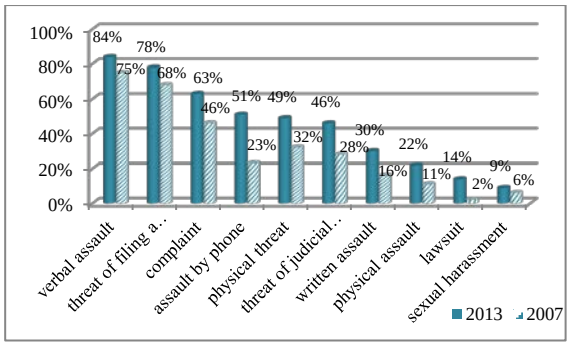
Tab 3 Age of respondents

	min	max	mean	st. dev.
N = 98	23	60	39.76	9.47

The following chart shows a comparison of results of 2007 and 2013. The results present at least one experience of a respondent with the respective situation during his practice, so they do not show frequency of incidence. The growth of client violence incidence in each item is obvious. The most significant growth refers to increase in assault by phone, i.e. by 28%, physical threat by 17%, and threatening with a lawsuit by 18%.

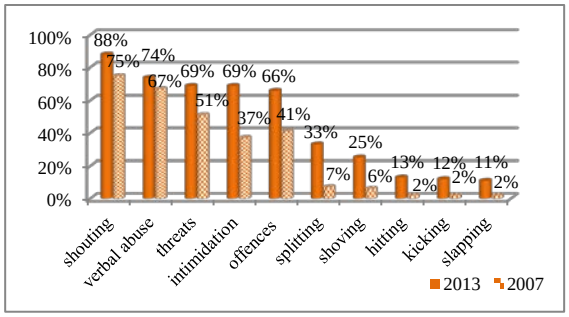
Chart 2 shows a comparison of individual forms of verbal and physical violence of clients toward social workers.

Chart 1 Comparison of client violence incidence



We observed the highest increase in physical aggression; however, it may be caused by the research sample. The most frequent forms of aggression were slightly increased, but confirmed the previous results that verbal aggression occurs to a great extent. The highest increase was shown in spitting by a client, which had been experienced by 33% of the respondents.

Chart 2 Comparison of individual forms of violence



Within this research we examined relation of overall score of threat by a client and supervision. We proceeded from amendment of the Act in 2008 (Act No. 448/2008 Coll. on Social Services and on change and amendment of Act No. 455/1991 Coll. on Trade Licensing as amended). Despite the fact that the experience of institutions indicates that this regulation is not followed in practise, we can assume that the workplaces with higher incidence of client violence have regular supervision to protect their workers. The study repeatedly confirmed that supervision is not a matter of course, some social workers even do not know what exactly supervision means. This is the reason why we also asked respondents whether there is any supervision at their workplace or not. It is also surprising that the respondents from the same workplace provided different answers, which can mean for example that supervision is carried out within the competences on the level of individual departments or it is provided only to certain employees.

We assume that the supervised workers are more sensitive to violence, and they would identify the respective situations as violent (they are able to identify such situations). The overall score of supervision consisted of two items: frequency of supervision at workplace (we consider answers 3 and more in 6-degree scale regular supervision at workplace) and assistance of supervision in performing of profession (answers 3 and more in 6-degree scale mean that a worker considers supervision helpful for performance of his profession). In this regard we tested also preventive measures (formal and informal advices from colleagues, prevention at workplace), and due to the same reasons we expected confirmation of the relation.

Relation between threat by a client and supervision as well as a relation between a threat and preventive measures were confirmed. It can mean that the preventive measures are taken at the workplaces with higher frequency of client violence.

Tab 4 OS threat (Cronbach´s alfa 0,818)

	OS supervision	OS preventive measures
OS threat		
Pearson Correlation	,286**	,293**
Sig. (2-tailed)	,005	,003

**0.01

We also tested a relation between the factor of verbal violence and the factor of supervision, and a relation between the factor of verbal violence and the factor of prevention at workplace. The relation was confirmed in both cases.

Tab 5 OS verbal violence (Cronbach´s alfa 0,936)

	OS supervision	OS preventive measures
OS VV		
Pearson Correlation	,269**	,369**
Sig. (2-tailed)	,008	,000

**0.01

Finally we tested a relation between the factor of physical violence and supervision, which was not confirmed, yet a relation between physical violence and preventive measures was confirmed.

Tab. 6 OS physical violence (Cronbach´s alfa 0,796)

	OS supervision	OS preventive measures
OS PV		
Pearson Correlation	,189	,205*
Sig. (2-tailed)	,067	,042

*0.05

5 DISCUSSION AND CONCLUSION

Only the results directly comparable with our survey are presented below, as the similar studies have been already mentioned above.
Macdonald and Sirotich[8] in Canada noted that 87.8% of the respondents reported having been verbally harassed by a client at least once at some point of their career, which is similar to our results – 84% of the respondents reported having been verbally assaulted by a client. In 2002 Shields and Kiser[9] made a survey with 171 respondents in USA. Apart from other results they also observed that almost 10% of the respondents had been physically assaulted by a client and this situation was reported by as many as 22% of the respondents in our research, however, a question arises as to what respondents consider physical assault and how serious such physical assault was – this issue was not questioned neither by us nor the authors of the above study.

Koritsas, Coles and Boyle[11] carried out a study on client violence in Australia on the sample of 1,000 respondents, in which they determined incidence of various forms of violence during the past year and found out that 57% of the respondents had been verbally assaulted and 9% physically assaulted. We found out that 4% of the respondents reported having been physically assaulted several times a year, and 2% of them at least once a month, which makes comparable 6% during the past year. 23% of the respondents declared that they had been exposed to verbal assault several times a year, 19% at least once a month, 8% at least once a week, and 2% almost every day. After assessment of the results it can be said that during the past year 52% of our respondents experienced verbal assault. It is also a very similar result.

In general we can summarise that incidence of client violence in the Slovak Republic is similar with respect to the number and frequency with findings from other countries. Therefore in the following national survey we would like to focus on mapping of the greatest possible scope of individual forms of client violence, factors that might influence client violence, preventive measures, and determination of risk factors in this issue.

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Primary Paper Section: A

Secondary Paper Section: AO

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APPLICATION OF MONTE CARLO SIMULATION IN THE FIELD OF MECHANICAL ENGINEERING

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The article is an output of scientific project VEGA 1/0357/11 Klieštik, T. and col.: Research on the possibility of applying fuzzy-stochastic approach and Corporate Metrics as tools of quantification and diversification of business risk.

Abstract: The paper deals with one of the often used computer simulation, mathematical-statistical method of individual variants and risk quantification - Monte Carlo. It is divided into two main parts. The first one is focused on the essence and characteristic features of this simulation, such as the sensitivity analysis, steps of simulation performance and its basic principles. The second part represents a Monte Carlo simulation example and its practical application in the field of industry engineering. According to mathematical formulas or statistical methods, there are Monte Carlo characteristics described, calculated and simulated in this part. The conclusion includes interpretation of success potential of a particular project.

Keywords: risk, Monte Carlo, variables, costs, standard deviation..

1 Features of Monte Carlo Simulation

The fundamental characteristic of simulations is the information usage from the complete distribution of the input variables. The indicators of project effectiveness are calculated according to this distribution. In this case, the values of input variables are derived from the defined distribution.

Monte Carlo method is used to quantify the likely and deterministic tasks based on multiple repeated random experiments. We construct probabilistic task with identical solution to the original task. The final solution has a probabilistic character.

Monte Carlo simulation was employed for forward propagation of the aleatory type input uncertainties

- Gela,
- R. Garga,
- C. Tongd,
- M. Shahnama,
- C. Guenther [5]

The Monte Carlo method can be used to address any mathematical problem or model that is too complex, time consuming, or resource intensive to solve analytically. Instead of tackling the numerical problem directly, Monte Carlo allows the researcher to obtain an approximation of the solution through setting up an experiment of statistical sampling. As the name indicates, the method borrows from games of chance such as those played at the famous casinos of Monte Carlo in Monaco. The Monte Carlo method relies on realizations (draws) from a probability density function. Ideally, to correctly apply the Monte Carlo method and obtain valid results, the sampling method employed should be completely random. The number of realizations has to be sufficiently large to accurately represent the distribution of the input variables. [9]

The computer simulation Monte Carlo is a mathematical-statistical method of risk measurement of individual variants. It is used when there are multiple risk factors that affect the performance of investment projects.

To facilitate the MCMC analysis, a statistical model was generated in order to implement a Bayesian approach. Bayesian modeling draws from two types of knowledge to derive model parameter estimates: prior knowledge, as described in initial parameter distributions, and information that can be deduced from measured data, if appropriately analysed. [2, 5]

Markov chain Monte Carlo (MCMC) methods have been an important algorithm in various scientific fields [8, 10]. MCMC methods can generate samples that follow a target distribution by using a simple proposal distribution. However, in sampling from a complex distribution such as a multimodal one, the standard MCMC methods produce samples that theoretically converge to the target distribution but practically do not. The produced samples can be trapped in a local mode for an extremely long period. [1]

The essence of Monte Carlo simulation is to generate a large number of scenarios and criteria values conversions for each scenario. Simulation outputs can be displayed in numeric or graphical form.

We apply Monte Carlo simulation to company profit in this paper. Profit is an important characteristic determining the success, respectively failure of the business and is mainly used in the methods of profitability determining and business performance. Profit represents trading income, i.e. the difference between revenues and costs, and a strong emphasis is placed on it from the view of all interested groups, stakeholders, both owners and investors, but also creditors whose key interests are free resources on debt settlement. Profit as a target performance indicator is interacted with the market. [7]

One of the Monte Carlo simulation´ s parts is the sensitivity analysis, which allows calculate the sensitivity of the selected project financial criteria to possible changes in the values of risk factors that affect this criterion. With this analysis we can determine how is the profit, as an evaluation criterion, influenced by the sensitivity of quantity, selling price or cost. Risk factors, where changes in the selected criteria are small are less important, and vice versa. The advantages of sensitivity analysis are simplicity and graphical clearness. On the other hand, the main disadvantage is ignoring the different rates of uncertainty of the individual factors.

Monte Carlo can by divided into several steps, according to Souček. First four steps represent the simulation preparation and the last one simulation performance:

1. Investment project model design and processing in a computer program
2. Identification of key risk factors
3. Determination of likelihood distribution of factors
4. Determination of statistical dependence of risk factors
5. Simulation performance and interpretation of simulation results [11]

By creating the project model it is important to consider the level of detail of the model, which is intended to represent a compromise between simplicity and credence of the project. It is important to recognize the complexity of relationships between profit, as an evaluating criterion, and various risk factors. Souček highlights to keep the principle that all input variables of the model (risk factors) should form a separate, distinct part of the model. [11]

Risk factors represent the input variables of the financial model, which significantly affect the simulation output uncertainty in the form of evaluation criteria. Key risks are those that are sensitive to even the smallest changes in inputs of a simulation and are uncertain. To determine this sensitivity we use the already mentioned sensitivity analysis. It is recommended to start with a larger number of factors and according to simulation results try to minimize them.

2 Practical application of Monte Carlo Simulation

The first step in profit simulation is to define the basic variables affecting the profit. Monte Carlo simulation is applied to an enterprise which operates in the field of mechanical engineering

and industrial engineering and plans to invest in new production hall.

Estimated investment costs are:
€ 1.9 million with probability 0.28
€ 2.5 million with probability 0.50
€ 2.025 million with probability 0.22

The amount of fixed costs is € 400 000 and the lifetime is twenty years. Estimated sold quantity is:
1 770 units with likelihood 0.30
1 950 units with likelihood 0.50
2 250 units with likelihood 0.20

***Retail price** is set on:*
€ 367.5 with likelihood 0.25
€ 275.0 with likelihood 0.45
€ 280.0 with likelihood 0.30

***Manufacturing overhead costs**:*
€ 1.5 with likelihood 0.30
€ 3.0 with likelihood 0.40
€ 4.5 with likelihood 0.30

***Material costs** are:*
€ 3.0 with likelihood 0.35
€ 6.0 with likelihood 0.45
€ 7.5 with likelihood 0.20

***Unit labor costs** are set on:*
€ 30.0 with likelihood 0.28
€ 33.0 with likelihood 0.42
€ 40.5 with likelihood 0.30

We used MS Excel to simulate individual fundaments that influence the result. Each characteristics is simulated on 1 000 repetitions.

Table 1 Investment costs simulation examination, part 1

	A	B	C
1	**Investment costs**	**Likelihood**	**Cumulative likelihood**
2	1 900 000	0.28	0.28
3	2 500 000	0.50	0.78
4	2 025 000	0.22	1.00

Table 2 Investment costs simulation examination, part 2

	D	E
1	**Random number**	**Simulated investment costs**
2	=RAND()	
3	=RAND()	
4	=RAND()	

Simulated investment costs are calculated via the function:

=IF($D2<=$C$2;$A$2;IF($D2<=$C$3;$A$3;$A$4)) (1)

Sales volume, unit selling price, unit variable costs consisting of material costs, production overheads and unit wage are simulated in a similar way. Fixed costs are not subjected to the simulation.

The operating result is simulated as the last one. We use following formulas to simulate it:

$$P = I - C \quad (2)$$

$$I = S = q.c \quad (3)$$

$$C = q\sum_{i=1}^{n} v_i + \sum_{j=1}^{m} f_j + \frac{I}{S} \quad (4)$$

$$P = q.c - \left[q\sum_{i=1}^{n} v_i + \sum_{j=1}^{m} f_j + \frac{I}{S}\right] \quad (5)$$

$$P = q.[c - \sum_{i=1}^{n} v_i] - \sum_{j=1}^{m} f_j - \frac{I}{S} \quad (6)$$

Where:
P – profit
I – incomes
C – costs
S - sales
q – sold quantity
c – retail price
vi – variable costs
fj – fixed costs
I – investment costs
T – lifetime

Table 3 Simulated input values – costs, quantity, price

Simulated invest. Costs	Simulated quantity	Simulated retail price	Simulated material costs
1 900 000	1 770	367.5	3
2 500 000	1 950	275	6
2 025 000	2 250	280	7.5

Table 4 Simulated input values – overhead, wages, profit

Simulated manufact. Overhead	Simulated wages	Simulated profit
1.5	30	94 410
3	33	-70 650
4,5	40.5	10 625

Then we determined the most appropriate statistical distribution - Normal Gaussian distribution, which allows us to statistically process the results for the simulated profit. Values of simulated profits are divided into intervals from - ∞ to ∞, the interval range is 15 000.

Table 5 Normal distribution of simulated profit

	A	B	C
1	**Lower interval limit**	**Upper interval limit**	**Occurrence frequency**
2	-∞	- 25 000	1
3	-25 000	0	0
4	0	25 000	0
5	25 000	50 000	0
6	50 000	75 000	15
7	75 000	100 000	92
8	100 000	125 000	139
9	125 000	150 000	202
10	150 000	175 000	154
11	175 000	200 000	40
12	200 000	∞	357

Because we used the Normal distribution we determine the parameters of this distribution, which are subsequently converted. In this case, we chose the following:

- Modus
- Median
- The standard deviation
- The arithmetic mean
- Lower and upper quartile

The arithmetic mean is calculated as follows:

$$\bar{X} = \sum_{i=1}^{k} x_i . f_i \quad (7)$$

Where:

xi – interval mean value

fi – relative occurrence frequency

The mode is the value of symbol X, which occurs in particular empirical set most frequently. In the frequency distribution lines it is that value xi, which comes with the highest absolute or relative frequency. This value does not have to be represented by the distribution exactly, because multiple values can occur with the same highest frequency. [3]

$$\hat{x} = a + h.\frac{d_0}{d_0+d_1} \quad (8)$$

Where:
a – lower limit of modal interval
h – interval range
d_0 – the difference between modal and previous interval frequency
d_1 – the difference between modal and next interval frequency

Median is the fair value $\tilde{x}$, which divides an identified set of values $x_1, x_2, ..., x_n$ arranged in ascending order of size into two equal-sized parts. Median basic advantage is that it is not affected by the extreme values. [4]

$$\tilde{x} = a + h\,.\frac{0.5-F_{\tilde{x}-1}}{f_{\tilde{x}}} \quad (9)$$

Where:
a – lower limit of median interval
h – interval range
$F_{\tilde{x}-1}$ – relative cumulative frequency of previous interval
$f_{\tilde{x}}$ – absolute frequency of median interval

The standard deviation is the square root of the variance and expresses the dispersion of the values around the mean. It represents how these values differ from the mean value. Because the dispersion is calculated in the square units of measure, it cannot be logically interpreted. That is why we try to get a degree of variability, which is expressed in the original units of measurement. [3]

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2 . p_i} \quad (10)$$

Where:
n – total number of units,
x_i – individual selection units,
p_i – occurrence likelihood of i - event
$\bar{x}$ – arithmetic mean

Lower quartile divides the unit set so that the value of variable x of quarters of units is lower or equal to the first quartile and the value of the variable x of three-quarters of units is higher or equal to the first quartile.

$$\tilde{x} = a + h\,.\frac{0.25-F_{\tilde{x}-1}}{f_{\tilde{x}}} \quad (11)$$

$$\tilde{x} = a + h\,.\frac{0.75-F_{\tilde{x}-1}}{f_{\tilde{x}}} \quad (12)$$

Where:
a – lower limit of median interval
h – interval range
$F_{\tilde{x}-1}$ – relative cumulative frequency of previous interval
$f_{\tilde{x}}$ – absolute frequency of median interval

The following tables show the calculation of statistical characteristics of Monte Carlo simulation. In addition to absolute frequency detected by a computer simulation, we calculate the relative, absolute cumulative and relative cumulative frequency. The indicator mean was calculated as the conjunction of relative frequency and mean value. The resulting average profit is quantified as the sum of all partial averages. In our case, the average profit is € 120 910.

The probability that the company will generate the loss in particular period is 0.1.

Table 6 Simulation result – arithmetic mean, part 1

	C	D	E	F
Class	**Absolute frequency**	**Relative frequency**	**Cumulative absolute frequency**	**Cumulative relative frequency**
1	1	0,0010	1	0,0010
2	0	0,0000	1	0,0010
3	0	0,0000	1	0,0010
4	0	0,0000	1	0,0010
5	15	0,0150	16	0,0160
6	92	0,0920	108	0,1080
7	139	0,1390	247	0,2470
8	202	0,2020	449	0,4490
9	154	0,1540	603	0,6030
10	40	0,0400	643	0,6430
11	357	0,3570	1000	1,0000
Total	1000	1,0000	x	x

Table 7 Simulation result – arithmetic mean, part 2

	G	H
Class	**Mean value**	**Arithmetic mean**
1	-37500,00	-37,50
2	-12500,00	0,00
3	12500,00	0,00
4	37500,00	0,00
5	62500,00	937,50
6	42500,00	3910,00
7	112500,00	15637,50
8	137500,00	27775,00
9	162500,00	25025,00
10	187500,00	7500,00
11	112500,00	40162,50
Total	x	120910,00

Modal interval was defined in Class 11, in interval from 200 000 to ∞. It was calculated via the formula 4.

$$\hat{x} = 200000 + 25000.\frac{(0.357 - 0.04)}{(0.357 - 0.04) + 0{,}357}$$

The calculation shows that the most frequent value of the simulated profit is **€ 211 758.16**.

Building on the characteristics of the median as the middle value of the character of a statistical set, median interval is in Class 9.

$$\tilde{x} = 150000 + 25000\,.\frac{0.5 - 0.449}{0.154}$$

The mean value of simulated profit was determined on the level of **€ 158 279.22**.

Lower quartile distributes the statistical set in the ratio of 0.25 to 0.75. Based on this definition, the lower quartile interval is represented by the Class 8.

$$\tilde{x} = 125000 + 25000\,.\frac{0.25 - 0.247}{0.2020}$$

With the likelihood of 0.25, the simulated profit will by lower than € 125 371.29 and with 0.75 the simulated profit will be higher than € 125 371.29.

A similar procedure is applied to determine the upper quartile; its interval will be the Class 11.

$$\tilde{x} = 200000 + 25000\,.\frac{0.75 - 0.643}{0.357}$$

With the likelihood of 0.75, the simulated profit will by lower than € 207 493.00 and with 0.25 the simulated profit will be higher than € 207 493.00.

Table 8 Simulation result – standard deviation

	I	J
Class	**Dispersion**	**Standard deviation**
1	3 909 375,63	1 977,21
2	0,00	0,00
3	0,00	0,00
4	0,00	0,00
5	21 065 634,38	4 589,73
6	28 094 557,50	5 300,43
7	1 063 610 711,88	32 613,05
8	2 555 426 376,25	50 551,23
9	2 910 503 846,25	53 949,09
10	1 055 925 025,00	32 495,00
11	2 731 719 598,13	52 265,85
Total	10 370 255 125,00	101 834,45

To determine the extent of variability of simulated profit we used standard deviation and we built on the formula No. 10 The actual profit value may differ from the average value of **± € 101 834.45**.

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Primary Paper Section: A

Secondary Paper Section: AH, BB

THE USE OF ANALYTIC INDICATORS FOR PERFORMANCE MEASUREMENT

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Abstract: The article is dedicated to the use of analytic indicators for performance measurement. If a company wants to build and maintain competitive advantage it needs to evaluate its performance and also applies strategic management system. In the article are described differences between synthetic and analytic indicators and the main part is description of the analytic indicators used in practice, such as pyramidal decomposition and Balanced Scorecard.

Keywords: analytic indicators, company, performance, balanced scorecard, pyramidal decomposition

1 Introduction

While studying the issue of performance measurement we try to find the answer on a question which indicator is the best for measuring and evaluating business performance. The right answer is that the ideal indicator which can combine all requirements asked to obtain this information doesn´t exist. It is not important to find and use general indicator, but to determine for each activity or company specific and suitable indicator. The biggest mistake in finding the right performance indicator is that people go after data that is easy to get rather than what is really needed.

Selection of appropriate performance indicator is a very difficult and responsible task for each company. Indicators and criteria for measuring business performance have passed through progressive development and there are lots of views how we can divide them. Basic division of indicators is based on the level of detail so we meet with synthetic and analytic indicators. Synthetic indicators focus on each side of business performance while analytic indicators always focus on specific side or activity of business performance. Otherwise during evaluation we have to take into consideration both indicators.

The main goal of this article is to define analytic indicators for performance measurement, reasons why it is not enough to use only synthetic indicators and also their use in practice.

2 Analytic indicators

Analytic approach to performance measurement is used not just to define factors influencing business performance. The main task is to critically review performance of the company and generate activities for increasing it. It´s necessary to realize that company departments or activities are not separate parts or isolated factors. They are connected all together and also with its surroundings. Analyzed company activities must be researched in their natural environments not in a man-made one.[1]

Requirements on the information needed from analytic indicators for performance measurement must respect demand of the company management. Hierarchical levels and characteristic of analytic indicators always come out from a user's necessity. Objects of the analytic approach could be company organizational structure, products, processes, customers and so on.

When choosing objectives and indicators, decisions should be guided by the desired impact. There is no fixed method of converting the desired impact into objectives, indicators or targets. The arbitrary element always present in such decisions reflects the policy choices of the company being made. Nevertheless, solid reasoning will enable the links between company goals and desired impacts to become clear.[2]

Analytic indicators for performance measurement should emphasize the reasons which are relevant on results. Sometimes reasons are applied incorrectly or replaced which leads to misunderstandings.

3 Why is not enough to use synthetic indicators for measuring business performance?

Indicators for performance measurement can be divided on synthetic and analytic. When writing about analytic indicators it should be remembered why it is not enough to use only synthetic indicators. There are lots of restrictions connected with the use of synthetic indicators without support of the analytic indicators. These restrictions are for example limited information function of the system for performance measurement, limited possibilities for interpretation of information about business performance, limited predictive potential or limited function for managing company departments.[3]

Use of synthetic indicators limits information function, because of consequences of the wide range of factors influencing business performance. With this comes close limited possibilities for interpretation of information. Synthetic indicators give us answers about actual company performance, but not about reasons of these results. Also limited predictive potential is connected with them. Prediction of the business performance is based only on trend analysis of the future development values of the indicators. If we have only the values from synthetic indicators about the whole company performance it is impossible to identify performance of departments or company activities separately. That is the reason why managing company departments is limited.

4 Analytic indicators in practice

Analytic approach contents many methods and processes for the performance measurement. The most used ones are pyramidal decomposition of profitable indicators and Balanced Scorecard. These methods are further specified in the next sections.

Another widespread analytic approach for the performance measurement is a component analysis of profit which combines structure analysis and factors of profit. Profit analysis is also part of the systematic indicators for performance measurement but deeper analysis contains other points of view.

4.1 Pyramidal decomposition

Pyramidal decomposition of profitable indicators is a traditional and widespread analytic approach for performance measurement. It is the typical approach based on a decomposition of factors influencing business performance. It helps to answer how each factor affect the final value of indicator.[4]

The top performance indicator in the pyramidal decomposition is directly and clearly expressed by an indicator return on asset or return on equity. Users can very well understand connection between them. All analytic indicators included in the pyramidal decomposition are expressed in the same type of metrics.

Pyramidal decomposition combines multiplicative and additive type of analysis, while on the first level of decomposition the multiplicative decomposition is used, the additive decomposition follows on next levels. There are many options for creating

[1] Pavelková D. – Knapková A.:Výkonnost podniku z pohledu finančního manažéra. Praha: LINDE, 2005. 302 p. ISBN 80-86131-63-7

[2] Wagner, J.: Měření výkonnosti – Jak měřit, vyhodnocovat a využívat informace o podnikové výkonnosti. Praha: GRADA, 2009. 256 p. ISBN 978-80-247-2924-4

[3] Wagnerová, I.: Hodnocení a řízení výkonnosti. 1. Vyd. Praha: Grada, 2008. 128 s. ISBN 978-80-247-2361-7

[4] Petřík T.: Ekonomické a finanční řízení firmy – Manažérske účetnictvi v praxi. Praha: GRADA, 2009. 736 p. ISBN 978-80-247-3024-0

pyramidal decomposition of profit indicators on the first level and the most named is Du Pont´s decomposition. Decomposition of indicator return on equity is shown in figure 1 and another type of decomposition is shown in figure 2.

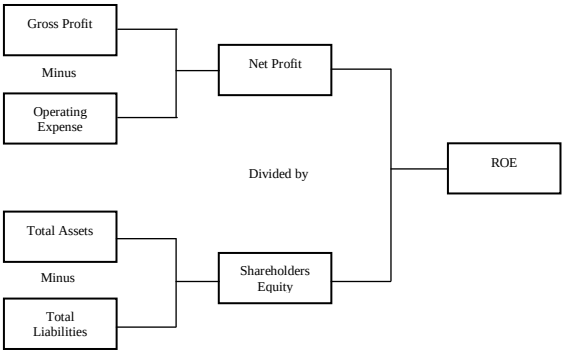

Fig.1 – Decomposition of return on equity. Source: Nickols Fred, Intervention Logic: Linking Action to the Bottom Line, 2012 from: http://www.nickols.us/se_intervention_logic.htm

Return on equity is the indicator of profitability. It is determined by dividing net income for the past 12 months by common shareholders' equity (adjusted for stock splits) and the result is shown as a percentage. Investors use ROE as a measure of how a company is using its money. ROE may be decomposed into return on assets (ROA) multiplied by financial leverage (total assets/total equity).

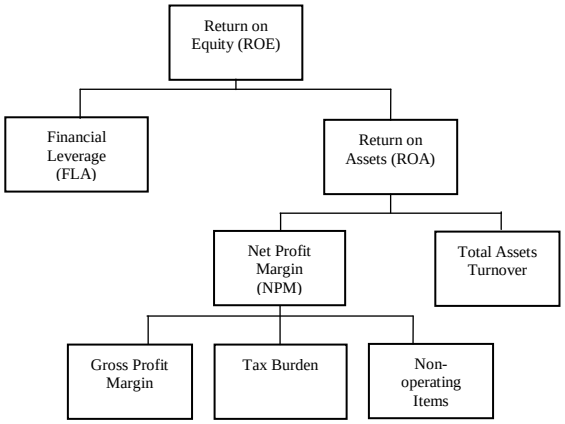

Fig. 2 – Decomposition of return on equity. Source: Wong Joshua, DuPont Analysis, 2009, from: http://amgstr.blogspot.sk/2009/04/dupont-analysis.html

Many analysts consider ROE the single most important financial ratio applying to shareholders and the best indicator for performance measurement by company´s management. Return on equity is calculated by dividing net income after taxes by owners' equity. This is a measure of how well the company is investing the money invested in it. A high return on equity indicates that the company is spending wisely and is likely profitable; a low return on equity indicates the opposite. As a result, high returns on equity lead to higher stock prices. Some analysts believe that return on equity is the single most important indicator for performance measurement.

Pyramidal decomposition gives users deeper information about performance but doesn´t wider. Better value of one factor used in decomposition leads to increased value of the whole company performance. Results of the pyramidal decomposition help managing company departments, because management can determine performance of each department.[5]

[5] Fibírová, J., Šoljaková, L.: Reporting. 3. Vyd. Praha: GRADA, 2010. 221 p. ISBN 978-80-247-2759-2

4.2 Balanced Scorecard

Balanced Scorecard is a multidimensional system allowing definition and realization of organizational strategy on each company´s level to maximize the company value. Application of the system in the company leads to efficient use of company sources in order to permanent increase of shareholders´ value.

BSC was originally developed by Kaplan and Norton in 1992 as a performance measurement tool, the scorecard is now associated increasingly with strategy implementation. It acts as a management framework with the potential to identify and exploit organization's key value drivers to their best strategic advantage. Goals and indicators of BSC are based on company´s vision and strategy, while following performance of the company from four perspectives:[6]

- customer perspective,
- internal perspective,
- learning and growth perspective,
- financial perspective.

Four Perspectives of Balanced Scorecard allow company to achieve a balance between short-term and long-term objectives, between desired outcomes and the drivers of those outcomes and between hard and softer indicators, more subjective indicators. Despite the large number of indicators used in the BSC which can lead to guessing, correctly assembled BSC contains only meaningful data because all indicators are directed towards achieving an integrated strategy.[7]

This system points to a complex economic activity of the company with quantifiable, financial as well as non-quantifiable indicators of quality and supplies the need for the company to be consistently competitive.

Balanced Scorecard expands the set of objectives for the company beyond normal aggregate financial measures. The company management can be measured as company creates value for current and future customers as well as to change the quality of the systems, procedures and human resources that are necessary to improve future performance. Although BSC captures short-term performance through a financial perspective, it also reveals the value-drivers, leading to higher long-term financial performance. Schematic representation of the four perspectives is shown in figure 3.

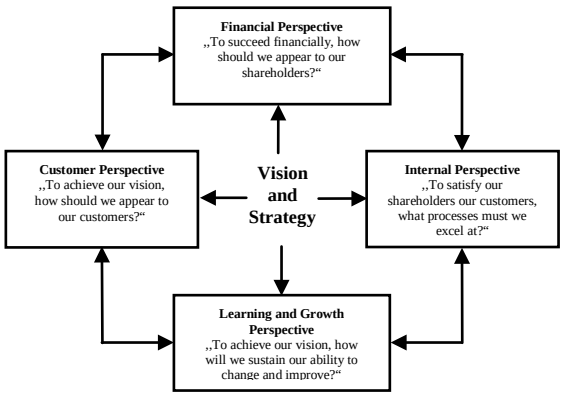

Fig. 3 – Balanced Scorecard – four perspectives Source: Wagner, J.: Měření výkonnosti Praha: GRADA, 2009. s. 232. ISBN 978-80-247-2924-4

The measurement is generally seen as a tool of control and performance evaluation in the past, while the indicators used in the BSC are used to formulate company strategy with adaptation

[6] Marinič, P.: Plánovaní a tvorba hodnoty firmy. Praha: GRADA, 2008. 240 p. ISBN 978-80-247-2432-4
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on individual and business needs and on needs of individual departments to achieve a common goal. BSC should be used not as a controlling system, but as a system of communication and information.[8]

5 Conclusion

Performance is a recurrent theme in the majority of management branches, including strategic management. For a company it is important to find the right indicator or sometimes a group of indicators to use. Measuring performance is very important task and must connect each company´s department.

The purpose of the article was to define analytic indicators for performance measurement, their connection with synthetic indicator and their use in practice.

For performance measurement companies can use synthetic and analytic indicators. Each of these indicators has its advantages and disadvantages and they should be used together while evaluating business performance. Synthetic indicators for performance measurement are not full value solution. Analytic indicators show also reasons not only values of performance. They can include pyramidal decomposition and Balanced Scorecard. Pyramidal decomposition gives deeper information about performance while Balanced Scorecard converts vision and strategy across balanced file of perspectives.

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Primary Paper Section: A

Secondary Paper Section: AH, BA

[8] Vysušil, J.: Metoda Balanced Scorecard v souvislostech. Praha: Profess Consulting, 2004. 120 p. ISBN 978-80-7259-005-6

SUSTAINABLE DEVELOPMENT & DIVERSITY: REFLECTIONS ON KNOWLEDGE, CULTURAL DIVERSITY AND ENVIRONMENTAL SUSTAINABILITY FROM A *TRANS*DISCIPLINARY PERSPECTIVE

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Abstract: In our rapidly globalizing world, continuous readjustment of the scientific basis of sustainable developmennt (SD) is a prerequisite for sustainability. We shed light on the shift in international discourse concerning culural diversity and SD. We analyse worldviews as a constitutive element of SD, proposing to re-interpret SD as a joint worldview-construct in progress, embracing a multiplicity of visions and knowledges. Through critical literature review, we identified *trans*disciplinarity, co-creation of knowledge and inra-/inter-cultural dialogue as a necessity for SD to retain its ‚universal' appeal. *Transversal* thinking, biocultural diversity and trends within SD research act as a guide throughout our reflection on knowledge-creation for and interpretation of SD, starting from a worldviews perspective and interdisciplinarity.

Keywords: sustainable development, sustainability, diversity, worldviews, knowledge, interdisciplinarity, transdisciplinarity, science for sustainable development

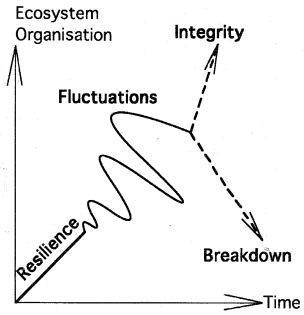
1 Introduction

Sustainable development (SD) is a hard to define concept. Attempts towards *exact* definitions of SD fail repeatedly because of invocation of normativity, contextual values and priorities. The enormous complexity of interwoven socio-ecological (sub)systems does not ease the job. Attempts to interpret SD and to translate it into decisions and actions are hampered by these complexities. *'plus c'est la même chose, plus ça change'* This converse of the French aphorism (Bateson 1972: 440) seems to be the more exact definition of biological, ecological and social *cybernetic* and *homeostatic* systems.[1] We interpret this phenomenon of *spread of change* as a learning process and a guide throughout our argumentation. A static interpretation of SD and purely mono-disciplinary attempts to address sustainability related issues are not compatible anymore with the growing complexity of the socio-cultural dynamics through which SD is being shaped and the resilience of transforming ecosystems that has to be optimalised. Transitions towards sustainability aim at the same kind of dynamics, a world that is constantly transforming and evolving.[2]

The growing knowledge of socio-ecological systems, their mutual interactions and interconnections, *feedback loops* and circuits demands as well a continous readjustment of the scientific basis of SD. In interpreting SD we can not opt for a purely scientific study of 'matter' any longer. We have to integrate other forms of knowledge (e.g. local knowledge) and keep in mind the discursive political-ecology that eventually interprets data and that constructs solutions, priorities and perceived risks in the scope of SD. (Dove & Carpenter 2008: 321-422) In a world confronted with growing uncertainty and complexity - fed by rising globalisation and (super-) diversification – stakes are high and decisions become more then urgent. (Ravetz 1999) (See also Figure 1 on ecosystem unpredictability[3]) Synergies have to take place and multiple legitimate viewpoints – from a wide variety of disciplines – have to collaborate in order to make accurate decisions and action possible to address the problems of our world today. The inherent normative character does not ease the future of SD in a context of complexity and uncertainty. Further on in this paper, this *normativity* will lead us to scrutinize the 'pretentious' ambition of SD as a *universally* desirable goal or pursued ‚state-of-being'. Interdisciplinarity – or as we argue later on in this paper *trans*disciplinarity – might give an interesting outcome and important component for the scientific challenge of *coupling* the cybernetic systems of the individual human organism, the human society and the larger ecosystem. As Bateson (1972) argues, also *consciousness* will play a major part in enabling us to do so. Guattari (1989) – in his theory of *three ecologies* (societal, natural and psychological) - points out the need to bridge disciplines and systems to address the environmental and sustainability related crises (confronting us in an ever more urgent way today) by learning to think *transversally* (see § 2.3).

In this paper – based on critical literature review - we shed light on three major topics related to SD, its diversities and its knowledge needs. First, we reflect on sustainability and diversity from a cultural perspective by addressing three focal points: cultural diversity (CD), worldviews and the eco-sophical concept of *transversality.* (Guattari 1989) Second, we elaborate on both cultural and biological diversity (BD) as constitutive elements of SD, linked by the concept of *knowledge*. This *biocultural diversity* (Haverkort & Rist 2007) will serve as a shifting point towards the core of this paper, being interdisciplinarity, knowledge and SD. Third, we continue our argumentation on SD as a knowledge-based concept by having a look at recent trends and evolutions within sustainability research - as *science for SD* - and what insights have been gained in these academic fields regarding interdisciplinarity. By interpreting SD through these perspectives, we identify challenges for and recommendations on interdisciplinary sustainability research and SD as a knowledge-based concept.

Figure 1. Ecosystem unpredictability



Source: After Weyns 1998 and Prigogine and Stengers 1984

2 Sustainable Development and its Diversity of Visions

During the 1980's there was a shift in thinking about the economics of development. The earlier centrality of economic growth (increases in real GDP per head) was replaced by broader notions. Development was approached more as a human-centered rather than a commodity-centered process. Important contributors to this paradigm shift are the UNDP's *Human Development Reports* – starting in 1991 – and the writings of economist Amartya Sen, characterizing development as 'human capability expansion', including access to cultural resources and

[1] A constancy of some variable is maintained by changing other variables. (Bateson 1972: 441)
[2] We refer to the *dynamism principle* of SD: the idea of SD as process of directed change or an ongoing evolutionary process, and not as a defined end-state. (Lafferty & Meadowcroft 2000)
[3] The non-linearity of complex dissipative systems, which occurs when they are far from equilibrium, makes the potential fluctuations unpredictable. (Prigogine and Stengers 1984 in Weyns 1998)

cultural participation. The importance of culture in the development scenario was brought forward by the World Commission on Culture and Development ('the Perez de Cuellar Commission'), resulting in the report *Our Creative diversity* in 1995. (WCCD 1995) The Commission suggested taking culture out of the periphery of development studies, by pointing out the substantial cultural dimensions of a human-centered development paradigm. UNESCO elaborated these ideas in its *World Culture Report* (2000).

On September 3rd 2002 the UNESCO and UNEP organized a round-table conference in Johannesburg, during the WSSD. This debate put forward the problem of CD and BD on a higher level. Before, the 'official' concept of SD particularly embraced economic, ecological and social parameters, but largely ignored important cultural bottlenecks. According to UNESCO a change of strategy was an absolute need. CD had to gain a central role within all SD negotiations. Therefore UNESCO created its 'Universal Declaration on Cultural Diversity'. (UNESCO 2002)[4] It clarified the importance of CD: *'As a source of exchange, innovation and creativity, cultural diversity is as necessary for humankind as biodiversity is for nature. In this sense, it is the common heritage of humanity and should be recognized and affirmed for the benefit of present and future generations. (art. 1)'* Putting CD forward as a crucial factor for development because it widens the range of options open to everyone: *'it is one of the roots of development, understood not simply in terms of economic growth, but also as a means to achieve a more satisfactory intellectual, emotional, moral and spiritual existence. (art. 3)'* It raised the defense of CD as an *'ethical imperative, inseparable from respect for human dignity (art. 4)'*. UNESCO looks at CD as the key to sustainable human development, emphasizing that *'Market forces alone cannot guarantee the preservation and promotion of cultural diversity, … (art. 11)'*. The Declaration does not put CD above human rights guaranteed by international law, for not ending up in a situation of 'absolute relativism'. But it sees CD as an adaptive, survival-related process, as a *'living, and thus renewable treasure'* and therefore it should not be perceived as unchanging heritage but as *'a process guaranteeing the survival of humanity'*. (UNESCO 2002: preface) By seeing diversity as a living process, it tackles static, essentialist and reductionist approaches of the cultural concept. The 2002 declaration views 'indigenous knowledge' also as such an adaptive and survival-related process, involving intra-community examination of knowledge. (McKee 2008) TheUNESCO reports on CD expressed the need to promote awareness among policy- and decision-makers about the benefits of intercultural and interfaith dialogue, while bearing in mind its potential instrumentalization.[5]

Arjun Appadurai stated that CD guarantees sustainability, because it connects universal development goals with attainable and specific moral perceptions. (UNESCO – UNEP 2002) Long-term biodiversity always depends on maximum diversity of this kind of moral visions. If 'human diversity' decreases, as a consequence also the archive of visions – that connects moral management of nature with 'material' well-being – declines. Both these diversities constitute the best available resistance to ideological and technological uniformity. CD means more than pure differences in culture. It is a value that recognizes differences in people as a part of systems and relations. It unites values like creativity, dignity and community. Without these 'cultural' values no single sustainable perspective on development is possible, because it will not be based on the moral dedication of the executers. (Appadurai 2003)

One of the main concerns and criticisms on SD today is the dominance of economic conceptions, identifying them as particularly problematic for sustainability. (Gottlieb 1996, Bell & Morse 2010) The dimension of culture and its definition is often narrowed down (e.g. heritage, arts, …) and by doing so made irrelevant for the wider development discourse. Nurse (2006) calls to reflect on the impact on sustainability by the mode of development thinking that puts emphasis on 'growth-oriented industrialization' or 'profit-driven production' and he points at the growing diffusion of consumerism.[6] These critiques call for an alternative framework for SD, of particular importance for developing countries. By giving culture a more central role in the SD paradigm, as an alternative framework, it allows for much greater diversity in policy choices. *'… what is proposed is a non-deterministic approach that breaks out of progressivist, universalistic and dependency-creating development thinking and promotes self-reliance, social justice and ecological balance. (Nurse 2006: 38)'* (See chapter 3 and Haverkort & Rist 2007, Haverkort & Reijntjes 2007 on biocultural diversity and endogenous development)
In the next subchapter we will elaborate on one particular aspect of CD in the scope of SD, being *worldviews*. We propose a re-interpretation of SD as a joint *worldview-construction* in progress, embracing a plurality of visions (and knowledges). Interdisciplinarity will play a significant role for SD's potential as a worldviews-construct through inter- and intra-cultural collaboration and identification of shared goals, focusing on inherent heterogeneity (see §2.3).

2.1 Worldviews and SD

Worldviews – as one particular aspect of CD - are defined as a combination of a person's value orientation and his or her view on how to understand the world and the capabilities it offers. They are the *lens* through which the world is seen. (van Egmond & de Vries 2011: 855) The kind of (often unconscious) mental habits, frames and assumptions of which worldviews are composed, might not immediately seem to be relevant to contributors of the SD debate, but exactly these kind of cultural mechanisms or 'filters' are the basis on which humans decide how to act, according to their perception of the environment and reality. (Weyns 1998) It shapes their beliefs in nature and in the world-as-a-whole. (Schlitz, Vieten and Miller 2010) Worldviews are perceived as cognitive, perceptual, and affective maps that people continuously use to orient and explain the world, and from which they evaluate, act and put forward prognosis and visions on the future – and as a consequence on sustainability related issues.[7] (van Egmond & de Vries 2011) Our answers on 'ethical' questions concerning humanity as a whole (e.g. sustainability) depend on our worldview. Indeed our personal worldviews truly matter and influence our suggested political solutions. (Apostel 2002) Worldviews are complex, heterogeneous and unequally developed, as people are unequally informed. The possibility of completely describing perfectly balanced worldviews is excluded by this diversity in their construction. Scientists should be utterly aware of the underlying heterogeneity of worldviews. Following worldviews theories, SD will not be interpreted everywhere in the same way or might even not be workable in some places at all. Therefore the actual interest for the sustainability researcher lies in what people working towards SD *think* SD is – what *they call* SD. (Lafferty & Meadowcroft 2000)

As worldviews are *unfinished*, this dynamic incorporates the possibility of change and amelioration of our personal view on the world. (van Egmond and de Vries 2011: 862) Therefore we suggest the re-interpretation of SD as a joint worldview-construction in progress. (Van Opstal & Hugé 2013) Worldview construction is collective work that is not identifiable with only one individual person, but tries to connect shared goals - or in the scope of SD a sustainable worldview - with acceptable and

[4] elaborated in the 2005 *Convention on the Protection and Promotion of the Diversity of Cultural Expressions* and 2009 *UNESCO World Report. Investing in Cultural Diversity and Intercultural Dialogue.*
[5] The insight that culture can never be reduced to the inferior position of an instrument for economic growth was one of the key issues of the 1998 conference *The Power of Culture* organized in Amsterdam, The Netherlands.
[6] See also Igoe & Brockington 2007 and Igoe, Sullivan & Brockington 2009 on green capitalism, market environmentalism and neoliberal conservation.
[7] Haverkort and Reijntjes (2007: 431) apply worldviews to environmental issues: *'Worldview: (or cosmovision) the way a certain population perceives the world (or cosmos). It includes assumed relationships between the human world, the natural world and the spiritual world. It describes the perceived role of supernatural powers, the relationship between humans and nature, and the way natural processes take place. It embodies the premises on which people organise themselves, and determines the moral and scientific basis for intervention in nature.'*

specific views of these individuals or the social groups they are living in. The definition of SD proposed by the Brundlandt Commission (WCED 1987) as *'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'* is the most widely excepted and frequently cited one. As such, it will continue to serve as the guide toward future 'sustainability'. Jepson Jr. (2004) raises the potentially problematic character of this definition, because of the use of many 'underdefined' terms (neither interpretation of these terms is inherently inconsistent with the definition itself). *'This definition raises as many questions as it answers. (Jepson Jr. 2004: 6)'* On the other hand, it is left as a concept that is open to interpretation and to the integration of different perspectives / worldviews. *Interpretative flexibility* (Van Opstal & Hugé 2013) can be of special interest for SD, as it has to be applied and implemented according to specific problems and in particular (locally) varying contexts. Variation in the interpretation of the sustainability concept '*allows for a multitude of actors, possibly the whole of society, to be involved, encouraging local solutions'*. (Kemp & Martens 2007) In other words it allows different worldviews to identify shared goals and co-evolve - through joint worldviews construction – towards co-produced interpretations of SD that can generate sustainable *transformations* of all worldviews. As a person's worldview transforms, awareness can expand leading to enhanced 'prosocial' experiences and behaviour. Increased social consciousness can in turn stimulate further transformations in worldview towards sustainability. (Schlitz, Vieten & Miller 2010)

2.2 Interdisciplinarity from a Worldviews & *Transversal* Perspective

Apostel (2002) stated 4 major motivations for interdisciplinarity starting from a worldviews perspective. Science is subdivided into disciplines, but reality itself is not. Secondly, almost everyone has a psychological need to integrate their experience and perception of nature and culture into a *worldview* or a *total view*. This counts for laymen as well as scientists. Thirdly, environmental (cf. sustainability) issues are extremely complex and constitutively transboundary. A fourth motivation is an evolving relationship between science and society - resulting in a trend towards applied, action-oriented science in synergy with society at large.

To establish the link between science and society and to enhance this synergy (between e.g. local, indigenous & - global?- scientific forms of knowledge) we put forward the concept of *interculturality* as highly significant for the implementation of CD - from a worldviews perspective - in SD. Rist and Dahdouh-Guebas created a typology that reveals an intercultural perspective as the most adequate to relate different knowledges. '*… it encompasses the highest potentials for cooperation based on mutual respect maintaining the autonomy of the different processes of knowledge production. (Rist and dahdouh-Guebas 2006: 473)'* Both authors raise three main issues that need to be addressed for an intercultural approach of knowledge. The typology reveals that no relationship between local knowledge and science can be value-free. It depends on specific ethical positions. Secondly, it implies '*the establishment of the broadest possible field of interaction between different types of knowledge. (Rist and dahdouh-Guebas 2006: 473)'* and a process of deliberation. An agreement on fundamental ethical principles is necessary before going into an intercultural dialogue. The will to accept the possibility that 'the other may be right' is a necessity. Thirdly, intercultural dialogue is better possible when all parties '*have shared questions on fundamental aspects related to the form of knowledge they represent. (Rist and dahdouh-Guebas 2006: 474)'*

Bateson and Guattari drive the link between the social and the natural, man and environment or nature and culture even further by introducing the human psyche, the mind. '*There is an ecology of bad ideas, just as their is an ecology of weeds (Bateson 1972: 484)'* In Bateson's attempt to outline some of the 'epistemological fallacies' of Western civilization, he argues that – scrutinizing Charles Darwin's theory of natural selection – '*the unit of survival is organism plus environment. We are learning by bitter experience that the organism which destroys its environment destroys itself. (Bateson 1972: 484)'* He arrives at the conclusion that the unit of natural selection turns out these days to be identical with the unit of mind. Resulting in a different hierarchy of units: gene-in-organism, organism-in-environment, ecosystem, etc. Ecology in this broadened sense turns out to be the study of the interaction and survival of ideas and programs (e.g. differences, complexes of differences) in *circuits*. Felix Guattari based his *ecosophy*[8] of the three ecologies (Guattari 1989) on this idea that nature cannot be seperated from culture. Based on his theory, he states that in order to comprehend the interactions between eco-systems, the mecanosphere and the social and individual 'Universes', we must learn to think *transversally*. (Guattari 1989: 29) As opposed to traditional environmentalist perspectives – according to Guattari obscuring the complexity between humans and their environment through a dualistic separation of culture and nature – we agree to resist pure holism, in the sense of emphasizing heterogeneity and diversity[9] rather than creating unified and holistic structures.

3 Bridging Cultural and Biological Diversity

Within the perspective of this chapter, we emphasize the mutual dependence, interactions and links between both CD and biological diversity. Many cultural practices depend on specific aspects of biodiversity for their staying into existence. Their expressions - on the other hand - are meaningful constructions of biodiversity, developed, conserved and managed by cultural communities (with language and knowledge as the media of this management). UNESCO summarizes the importance of a combined sustainable approach towards CD and BD by using the word 'knowledge'. (UNESCO 2002) Through this local cultural knowledge an immediate connection between CD and BD is handed. Koïchiro Matsuura declared in 2002 that a step forward has to be made by acknowledging diverse (cultural) views on the well-being of humanity, as essential to fully understand the environment, to protect it and to be able to fulfill the needs of present and future generations: *'Indigenous and traditional communities all over the world developed an extra-ordinary sophisticated insight in biodiversity, the fruit of a rich basis of knowledge and a pattern of values that respects this knowledge. We can no longer ignore the knowledge that connects cultural and biological diversity.'* (WSSD 2002)

3.1 Knowledge as Bridging Factor between Diversities: Biocultural Diversity

Respect for CD and a multiplicity of visions broadens the possibilities for everyone. In combination with BD it is essential for our survival. Loss of diversity brings along an enormous loss in the quality of life. Thereby we restrict and cut down our potential knowledge of the environment and the advantages of our biosystem. Nowadays there is more consensus that the deterioration of BD as well as CD is a threat for global stability. It puts the earth and humanity in an extremely vulnerable position. The Johannesburg Declaration emphasizes that CD and BD are equally significant conditions for SD. (WSSD 2002) In the Millennium Declaration (2000), the U.N. called for respect for nature, as one of the fundamental values for humanity. Contemporary patterns of consumption and production (in developed societies) have to be changed in the interest of our future well-being and that of our relatives. Respect for BD implies respect for human diversity. CD is a source of innovation, creativity and exchange. CD does not offer an unchangeable object that has to be 'conserved', but it offers a framework for a continuous dialogue between all possible expressions of identity. Culture connects individual, community and humanity. CD ensures SD because it connects universal development goals with acceptable and specific moral visions.

[8] For a wider discussion see *The Ecosophic Object* in *Chaosmose*. (Guattari 1992)
[9] Synthesizing assemblages and multiplicities in order to trace rhizomatic structures.

Globalization (especially fast neo-liberal globalization) create new questions and challenges. (Igoe & Brockington 2007, Igoe, Sullivan & Brockington 2009) More than a purely economic phenomenon, globalization is also a cultural, technical and ecological phenomenon. Political and legal measures have to be taken in order to help promotion of CD and BD. Based on the insight that cultural and biological phenomena can not be dissociated, actions are needed.

3.2 Knowledge for SD & Interdisciplinarity

SD should embrace a multiplicity of knowledges (scientific knowledge, local knowledge, etc.), evolving towards an active pluralization of the knowledge-concept for SD. Rist and Dahdouh-Guebas (2006: 471) argue that each form of knowledge can be scientific in nature. Indigenous knowledge is often holistic, functional and adaptive to changes in the environment. Therefore it has high potential for resilience-based ecosystem management. They state that '*it is not the mere fact of this integration of knowledge which is challenged; the critical aspects are related to the questions on who is setting the issues for a particular disciplinary research agenda and how the findings should be re-integrated in function of a societal process oriented in the principles of SD. The roles of conventional scientific knowledge production in the context of societal processes are put under public scrutiny.'* A first key issue within the discourse of 'scientific' knowledge production for SD is interdisciplinarity, in order to achieve a less fragmented view on SD topics. Although it allows the integration of different scientific disciplines, the choice of issues addressed and its ontological foundations will remain exclusively 'academic', encompassing a lack of true participation of the involved society and communities. Thereby creating the same problems as disciplinary-based knowledge production. 'Abuse' of the term interdisciplinarity, as a combination of different sciences *within* a science field or as a compilation of different disciplines without true interaction or integration, has led to the development of newer concepts like *trans*disciplinarity. Rist and Dahdouh-Guebas (2006) emphasize the need for true interdisciplinarity between basic and applied sciences on the one hand, and social and human sciences on the other. They term it as 'interscientific interdisciplinarity'[10], sometimes referred to as '(scientific) transdisciplinarity'. They also plead for a 'transdisciplinary approach' that seeks to go beyond '*the boundaries of western scientific actors'* and aims for a more societal mode of knowledge production. It therefore includes 'interscientific interdisciplinarity' and different forms of traditional / local knowledge. (Hirsch Hadorn 2002) Transdiciplinarity recognizes the plurality of knowledge, worldviews and values. Major challenge is to stimulate dialogue and cooperation between heterogeneous groups, instead of imposing one worldview as a 'universalism'. Thereby we recall the idea of *transversality* (see §2.2) and Guattari's emphasis on heterogeneity rather than the creation of unified and holistic structures. In chapter 4 we will discuss some recent trends in the academic fields of sustainability research, primarily focusing on current recommendations and challenges for SD as a knowledge-based concept and the need for inter- and transdisciplinarity.

4 Knowledge, Science for SD and Interdisciplinarity

The legitimacy of knowledge – for SD - depends on the process by which that knowledge is generated. Knowledge needs to be co-produced and provisional, thereby challenging 'normal' academic science. It demands a 'systems' approach, which emphasizes the primacy of the whole. Bell and Morse (2008) state that '*a system is a perceived whole whose elements hang together because they continually affect each other over time and operate toward a common purpose'*. Any system is an intellectual construct, imposed by some humans on a set of phenomena and their explanations. The boundaries of that system do not always coincide with the actual interactions relevant to a societal problem. (Funtowicz *et al.* 1998) A systems approach is often compared to the contrasting reductionist approach where the well-defined problem is in the mind of the scientist and a part of a complex whole is analysed. In a systems approach, the problem is shared by legitimate stakeholders, has flexible boundaries and is reviewed as a whole. It aims to structure different sources of knowledge around a common topic. It is an evolving process of knowledge construction (through sharing approaches) requiring deep co-operation between disciplines to arrive at a shared understanding of issues. (Blanchard & Vanderlinden 2010) Individuals within teams seek to integrate concepts and methodologies and the individual researchers are based primarily in one discipline but will have familiarity with at least a second discipline. (Sumner & Tribe, 2008) Hulme and Toye (2006) say 'knowledge communities' instead of disciplines.

4.1 Science for SD

Today conditions like uncertainty, growing complexity, diversity and synergy are gaining importance rapidly. For better understanding the type of knowledge generation needed to implement SD, one has to keep in mind these defining features of the context in which sustainability is realized. By recognizing these contextual factors that shape SD in reality, new approaches emerged in the sustainability arena: *sustainability science*, *Mode-2 science* and *post-normal science*. Proponents of these 'sciences for SD' have opened promising avenues for addressing the shortcomings of conventional science. (Kemp & Martens 2007) Funtowicz et al. (1998) mention two key properties of complex systems: the presence of multiple sorts of uncertainty and the multiplicity of legitimate viewpoints on an issue. Convinced that conventional *normal* scientific methodologies are no longer effective for finding solutions of such complexity, Ravetz proposes a *second-order science* or *post-normal science*, '*... where facts are uncertain, values in dispute, stakes high and decisions urgent (Ravetz 1999).'* Kemp & Martens (2007) speak of normal science as *mode 1 science* being academic, mono-disciplinary, technocratic, certain and predictive; versus *sustainability science* or *mode 2 science* being academic ánd social, interdisciplinary, participative, uncertain and exploratory. Sustainability science is then defined as an integrative science, which aims at the integration of different disciplines, viewpoints and knowledges. Its central elements have recently been clarified in literature: '*Inter- and intradisciplinary research; coproduction of knowledge, a systems perspective with attention to the co-evolution of complex systems and their environments; learning-by-doing (and learning-by-using) as an important basis of acquiring experience, besides learning-by-learning (learning through detached analysis); attention to system innovation and transitions. (Kemp and Martens 2007)'* Knowledge for SD needs to analyse a system's deeper-lying structures, needs to project into the future, needs to assess the impact of decisions and has to lead to the design of new strategies for solutions. SD's normative character and its long-term horizon result in specific demands. Knowledge for SD has to consist of: 1) diagnostic knowledge, 2) explanatory knowledge, 3) orientation knowledge, 4) knowledge for action. (Laes & Maes 2007)

This demands a particular way of knowledge creation. Grist (2008) states that it *'is far from the rational, cognitive and technical procedures of science as previously understood. Instead, knowledge creation is perceived as a process or practice. Post-modern perspectives embrace an awareness of multiple knowledges, situated specificities, discourse and narrative analysis and complexities of actor-institutional interactions.*' In order to be relevant for SD, the legitimacy of knowledge depends on the process by which that knowledge is generated. Knowledge for SD needs to be: i) co-produced and provisional, ii) it demands a systems approach, iii) a systems approach requires inter-disciplinarity (and other levels of cross- and trans-disciplinary interaction), iv) it needs to be reflexive[11],

[10] Scientific interdisciplinarity that transcends the science field.

[11] Jepson Jr. (2004) elaborates on reflexivity: sustainability science's interdisciplinarity feature implies that disciplines not only differ in subjects and methods, but also have different worldviews. One has to transcend unconscious thinking by reflecting on personal values, interests and representations.

v) alternative problem framings are an essential element[12], vi) a level of subjectivity awareness is key.

5 Conclusion: Transdisciplinarity as *Inter*science for Sustainability and its Diversities

Starting from a short overview of the shift in the international institutional discourse on SD concerning cultural aspects of development and CD, we introduced worldviews as one of the constitutive elements of SD by proposing to re-interpret SD as a joint worldviews construction in progress. Thereby embracing a plurality of visions (and knowledges) on the topic. From a worldviews perspective, interdisciplinarity, collaboration, identification of shared goals and intra- / intercultural dialogue becomes a prerequisite to bring SD into effect in a fastly globalizing world confronted with (super-)diversification and growing complexity and uncertainty. Following Guattari (1989) we agreed to resist pure holism as a sole goal, in the sense of opting for emphasis on heterogeneity and diversity rather than creating unified and holistic structures. New concepts like biocultural diversity and international reports acknowledge inherent links between both BD and CD – as constitutive aspects of SD. The importance of a combined SD approach to CD and BD is summarized in the one word *knowledge*. Knowledge for SD requires interdisciplinarity as transdisciplinarity, embracing a multiplicity of ‚knowledges' and knowledge systems. We propose an active pluralisation of *knowledge for SD*. Recent trends and insights on knowledge production for SD within academic fields of sustainability reserach confirm this urgent need.

As pointed out, SD's normative character and its long-term horizon result in specific demands for science and a specific way of knowledge creation. The legitimacy of this knowledge depends on the process by which it is generated. It needs to be co-produced and provisional, by aiming at bridging epistemologies, worldviews and viewpoints that are relevant for the context in which SD has to be applied in order to generate '*best available' knowledge* and *know-how* to address the sustainability issues involved. Science for SD is then defined as an *integrative* science, aiming at transcending and reconciling different disciplines, worldviews, viewpoints and their knowledges towards generating shared and co-produced knowledge in the scope of an *integral* and balanced view on sustainability. Elaborated by concepts like e.g. sustainability science, this demands for a *systems* approach, emphasizing the primacy of the whole and respecting heterogeneity. This requires thorough *trans*disciplinarity, that is not limited to the combination of different sciences *within* a science field or to the compilation of different disciplines without true interaction or integration. (Rist & Dahdouh-Guebas 2006: 471, Blanchard & Vanderlinden 2010)[13] Transdisciplinarity acknowledges that science is part of the processes it describes and is therefore focusing on a systemic view of social and natural dynamics that are shaping the world. It also recognizes the plurality of forms of knowing, worldviews and the values connected to them within different social and cultural groups. (Scholz et al. 2000) A certain amount of subjectivity awareness and recognition of *contextuality* is a key element in achieving transdisciplinary knowledge for SD. In this context we suggest *broadening the definition of expertise* and *articulating the global and the local*.

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[12] It will lead to 'outside the box' thinking and to innovative solutions for complex societal challenges.

[13] It is an evolving process of knowledge construction (through the sharing of approaches) requiring deep co-operation between disciplines to arrive at a shared understanding of issues. (Blanchard & Vanderlinden 2010)

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Primary Paper Section: A

Secondary Paper Section: AA, AC, AL, EH

DETAILED ANALYSIS OF GORELIEF DEVELOPMNET IN THE LAKE MOST SURROUNDINGS

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Abstract: There has been a dramatic change of the georelief in the area of the Lake Most (North-West Bohemia, the Czech Republic) caused by the open-cast mining activity which has destroyed even the royal town Most. In the georelief development analysis was used the aerial imagery from the year 1953 and 2008, maps of the 3rd Military Survey reambulated in the year 1938 and State maps 1:500 from the years 1953, 1972 and 1981. Digital terrain models (DTM) and digital surface models (DSM) of the historical georelief were created for visualization and analysis. With the usage of DTM's and DSM's are we able to perform more analysis showing in detail the georelief changes caused by the open-cast mining activity.

Keywords: Lake Most, georelief change, digital terrain models, digital surface models.

1 INTRODUCTION

Landscape influenced by open-cast mining is very typical for the North-West part of the Czech Republic. The mining activity has a great impact on the landscape structure, land-use development, shape of georelief and human life in general. In this paper we would like to focus on a very significant example of landscape transfiguration caused by the open-cast mining. The royal town Most established in the 13th century was destroyed together with the surrounding villages as over 100 million tons of brown coal was mined in this area. The mining itself started in 1950's and was definitely stopped in the year 1999. In the year 2008 started the hydrical reclamation of the depleted mine – which means that the mine was over-flooded into a form of a lake.

Fig. 1 Landscape change in the Lake Most surroundings, PKÚ (2013), FM (2013).

Reconstruction of the georelief in different time periods within this locality is very important for understanding of the total landscape change in this region. The shape of the georelief may be reconstructed from the altimetry information contained in old maps or by processing old aerial photographs by the standard ways of photogrammetry. The resulting Digital Terrain Models (DTM) should be offered to the scientific society and the wide public. This is done by publishing the data through a Geographic information system (GIS) of this locality and the GIS Internet technologies.

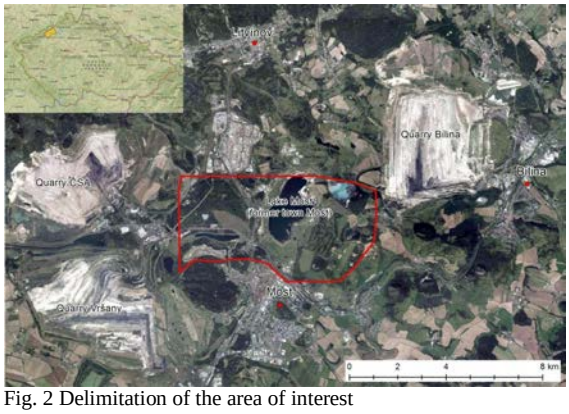

Fig. 2 Delimitation of the area of interest

2 INPUT DATA

The georelief can be reconstructed from two relevant data sources:

- maps with relevant altimetry information,
- photogrammetrically processed aerial imagery.

These two data sources require very different handling and processing. The old maps contains contour lines that have to be hand-digitized and further more interpolated into a form of an elevation GRID (DTM) using a suitable interpolation algorithm. The DTM represents the "bare ground" – a terrain model without any artificial objects (buildings) and vegetation. The Digital Surface Model (DSM) derived from the processed aerial imagery includes on the other hand all the buildings and vegetations – and we need to incorporate this fact into the analyses.

The newest method of LIDAR (LIght Detection And Ranging) allows a precise laser scanning of the surface offering a comprehensive elevation data with high points density and optionally containing the vegetation and buildings or not.

2.1 Old maps

The elevation information is in old maps represented in a very different way. In the very old maps is the georelief described by drawn hills, later on by hachure or similar types of visualization. The terrain reconstruction from these representations is in many cases impossible, or very problematic as shown by Vichrova (2012).

The oldest maps within our area of interest, with terrain represented by contour lines (with interval 5 to 20m), are the 3rd Military Survey maps reambulated in 1930'. The 3rd Military Survey was performed in 1868 based on the cadastral maps. Compared to the 2nd Military Survey is the hypsography described not only by hachure, but as well by contour lines and elevation points. The results of mapping are so called topographical sections (1:25 000), special maps (1:75 000) and general maps (1:200 000). The topographical sections were used in this project.

The other very important source of data for georelief reconstruction is the Derived state map in the scale 1:5000 (SMO-5). The whole Czech Republic is since the year 1950 covered by SMO-5 maps. This map is not based on direct field measurements, but is derived from existing map sources. Elevation data are in these maps presented in the form of contour lines, elevation points and technical hachure. The base contour interval is 1 meter, 2 m or 5 m in addiction to base map elevation data (Veverka, 2004).

In the State regional archive in Most were found complete SMO-5 map series fully covering the period of active coal mining in the area of interest. Altogether 36 map sheets were scanned on the special map scanner and further processed.

Very important part of the workflow is to process the old maps. All the maps have to be georeferenced and the contour lines representing the elevation information hand-digitized. Several methods were used for the map georeferencing as different maps require different treatment. The Czech national S-JTSK coordinate system (Georepository, 2013) is used for all mentioned maps.

Maps of the 3rd Military Survey were processed using the spline transformation implemented in ArcGIS. The spline transformation is a true rubber sheeting method and is optimized for local accuracy, but not global accuracy. It is based on a spline function - a piecewise polynomial that maintains continuity and smoothness between adjacent polynomials (ESRI 2013). The transformation accuracy has been visually tested with the MapAnalyst (Jenny and Weber 2010) application by applying a regular square network on the transformed data. Old maps processing is in detail described in Cajthaml (2012).

The georeference of SMO-5 maps was performed based on the knowledge of the map corner coordinates. The georeferenced maps are stored in an ESRI file geodabase and visualized by mosaic dataset which is used to mask the map frame information producing a seamless map.

On Fig. 4 are presented processed maps of the 3rd Military Survey and SMO-5 with digitized contour lines and DTM's derived using methods described in Chapter 3. Note that the DTM derived from SMO-5 maps has higher resolution thanks to 1m contour lines.

2.2 Aerial imagery

Aerial imagery is the second alternative of georelief reconstruction as the new methods of digital photogrammetry deliver relatively fast way of producing DSM of large areas. Aerial images from the year 1953 and 2008 were processed in this area of interest. The aerial images from 1953 taken shortly after the WWII are showing the landscape partly affected by heavy industry and open-cast mining activity. The images from 2008 are showing the Lake Most shortly before the over-flooding process.

The problem with processing old aerial imagery is the dramatic landscape change in this region. The workflow requires definition of Ground Control Points to "georeference" the aerial images but in this type of an area it is problematic to define them.

Aerial photographs have been processed in the standard way of photogrammetry using the Leica Photogrammetric Suite. For detail description of aerial image processing in this region, see Elznicová (2008) and Weiss (2011).

The aerial imagery from the year 1953 is not of a very good visual quality. The images are noisy, scratched, and affected by the contemporary technology of creation – this affects the automatic DSM creation from aerial images. Nevertheless is this datasource a very important part of this project.

2.3 LIDAR data

A very precise elevation data are available for the year 2012 created using the LIDAR method. The Digital Terrain Model of the Czech Republic of the 4th generation (DMR 4G) represents a picture of natural or by human activity modified terrain surface in digital form as heights of discrete points with X,Y, H coordinates in irregular triangle network (TIN). H means the altitude in the Baltic Vertical Datum - After Adjustment with total standard error of 0.3 m of height in the bare terrain and 1 m in forested terrain. (ČÚZK, 2013)

3 GEORELIEF RECONSTRUCTION

The data sources defined in chapter 2 are offering quality inputs for georelief reconstruction and analysis. Each of the data sets has to be processed in a different way respecting the nature of the data.

3.1 Contour lines interpolation

Various interpolation algorithms are implemented in the common GIS products. Each landscape type requires a specific interpolation method to obtain quality DTM (see Jedlička, 2009). For purposes of this project were tested interpolation algorithms implemented in GIS GRASS and ArcGIS. Small part of the area of interest was used for the testing purposes.

The Regularized Spline under Tension (RST) was tested in the GIS GRASS environment as it was suggested to be the most suitable method. The theory for RST computation is described for example in Cebecauer et al. (2002) and Neteler and Mitasova (2007). The RST interpolation is driven by several parameters, the main are tension and smooth. The tension parameter sets the toughness of interpolated surface for thin steel plate to a rubber membrane. With smooth parameter set to zero is the interpolated surface passing exactly through the input data. The smooths and tension parameters were experimentally tested. All interpolated surfaces had visible artifacts of segmentation used for faster performance of the interpolation. This method was thus evaluated as a not suitable (see Fig. 3).

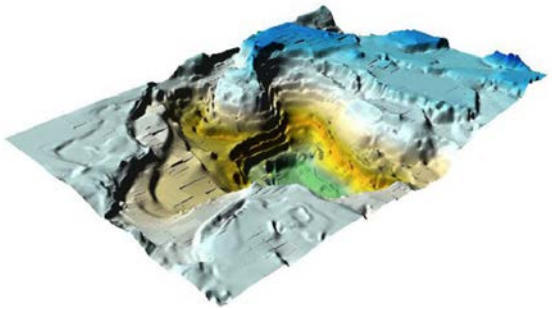

Fig. 3 Segmentation artifacts visible on the DTM interpolated by RST method (GIS GRASS)

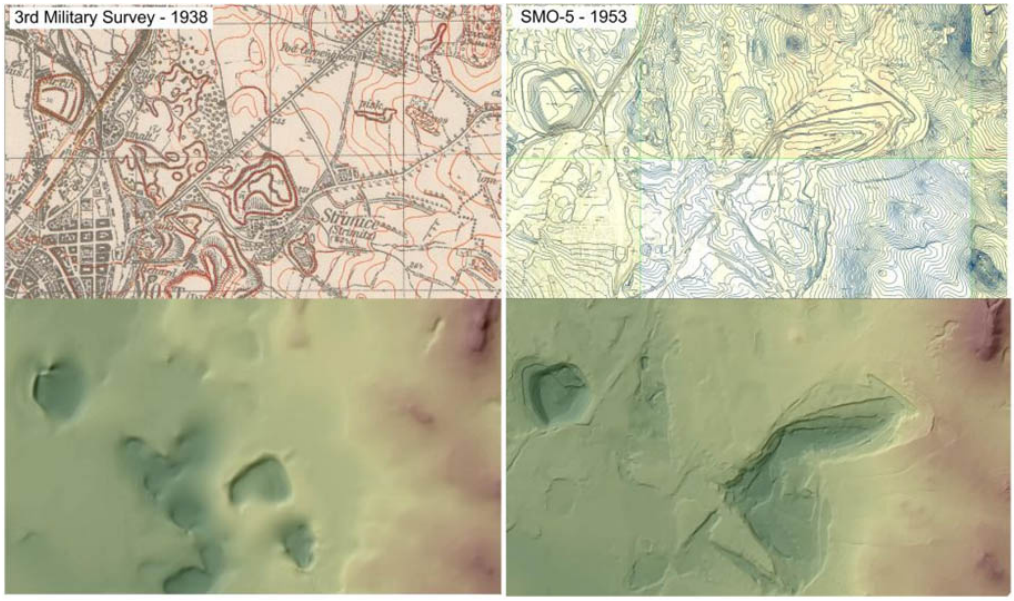

Fig. 4 Digitized contour lines on maps from 1938 and 1953 and the resulting DTM's showing the exactly same area

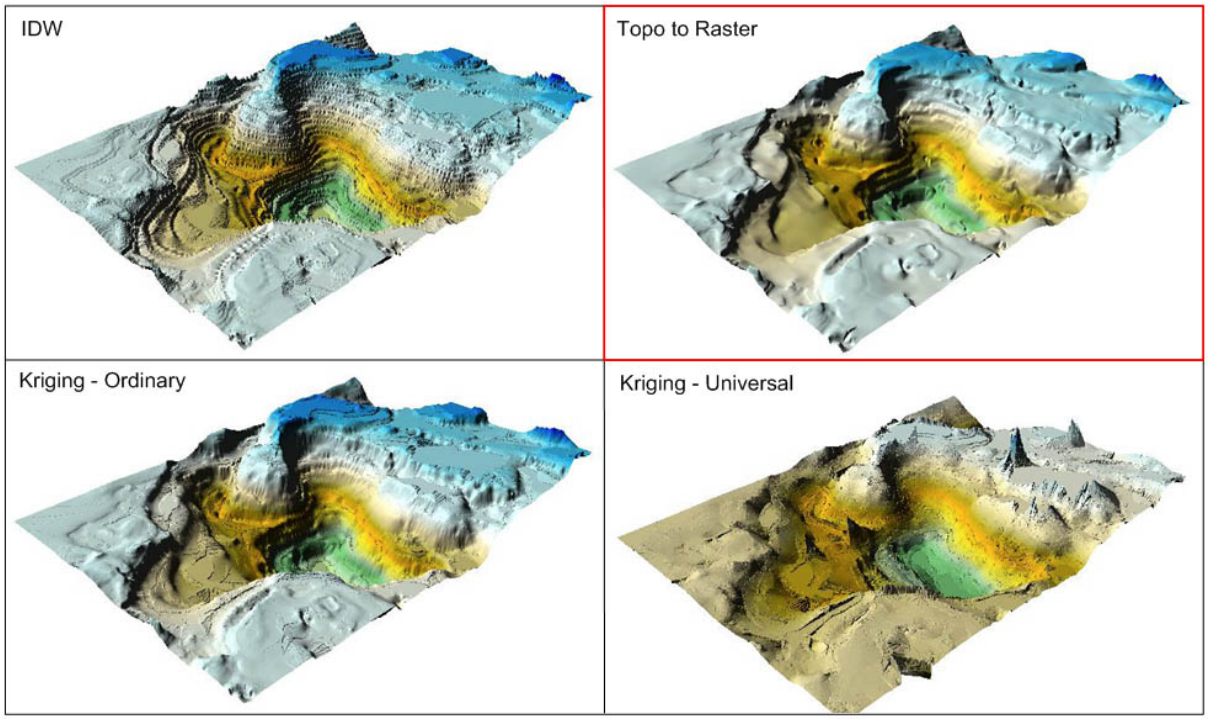

Fig. 5 Interpolations tested in the ArcGIS environment

The following interpolation methods (described in ESRI (2013)) were tested within the ArcGIS with the following results:

- Inverse Distance Weighted (IDW) is producing artificial peaks and pits at the input point's location. The change of the parameter power did not have much effect on the resulting data.
- Kriging – Ordinary and Universal – both interpolation algorithms produced artificially sharp peaks.
- Topo To Raster – produced a natural terrain with no visible interpolation artifacts.

Interpolation examples are presented on Fig. 5.

3.2 Aerial imagery and LIDAR

The DSM's are results of automatic image correlation. This method is used for automatic DSM extraction from aerial images with known orientation parameters with image overlap (60% in our case). The classic ATE module implemented in LPS 2011 was used for the automatic DSM creation. The extracted DSM's are the desired results for historical landscape restoration.

Processing of the LIDAR depends on the data format obtained from the vendor. In our case are the data obtained in the text file in the form of [X, Y, Z] coordinates. These elevation points are imported into GIS and further on converted into DTM (using the function Point to Raster). The resulting dataset is shown on Fig. 6.

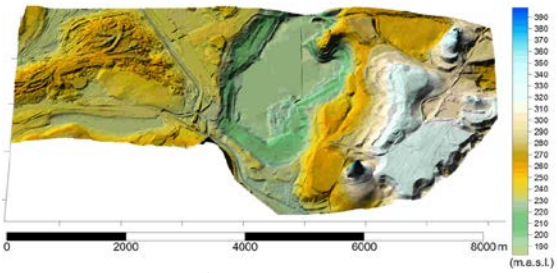

Fig. 6 LIDAR dataset of the Lake Most surroundings

3.3 DTM time-line analysis

All the processed input data were used for DTM and DSM creation and thus we got the following results:

- 1938 – slow start of open-cast mining in the town Most surroundings,
- 1953 – more intense mining, in this year was decided do destroy to old town,
- 1972 and 1981 – the highest mining activity in this area, the town is being mined away,
- 2008 – the mine is depleted and since 1999 is being turned into a hydric recultivation.

The resulting DTM time-line is thus covering the complete DTM development of area of interest. Old maps covering the period before 1938 with usable hypsography does not exist. The created DTM's and DSM are presented on Fig. 8, Fig. 9, Fig. 10, Fig. 11 and Fig. 12. For better understanding of the DTM characteristics are in each model defined four cross-section profiles further visualized by graphs. The detailed cross-section analysis is presented on Fig. 13, Fig. 14, Fig. 15 and Fig. 16. On Fig. 7 is presented the detail of defined area of interest visualized over the 2008 ortho-photo.

Fig. 7 Detail of area of interest (year 2008)

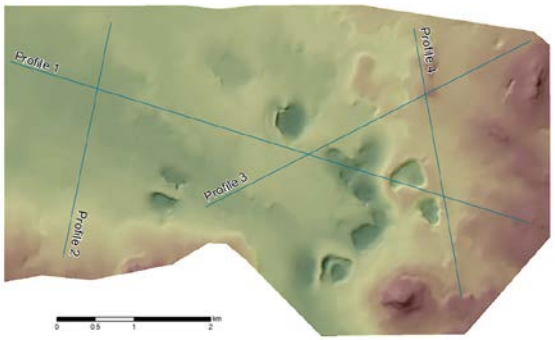

Fig. 8 DTM - year 1938

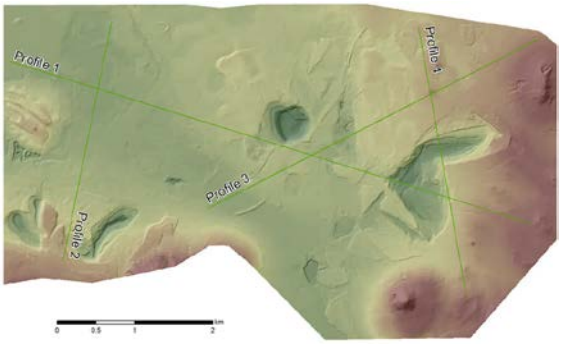

Fig. 9 DTM - 1953

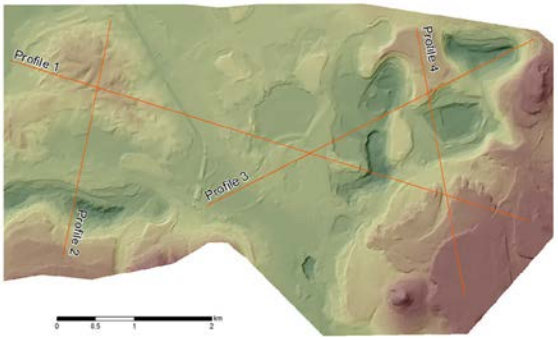

Fig. 10 DTM – 1972

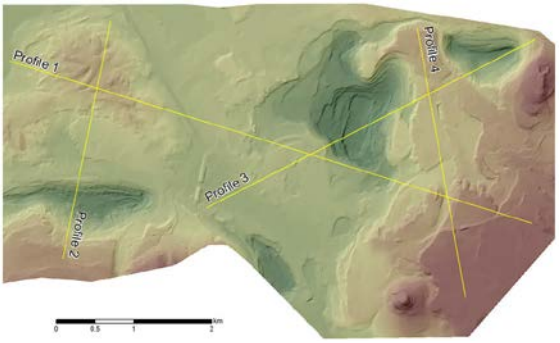

Fig. 11 DTM – 1981

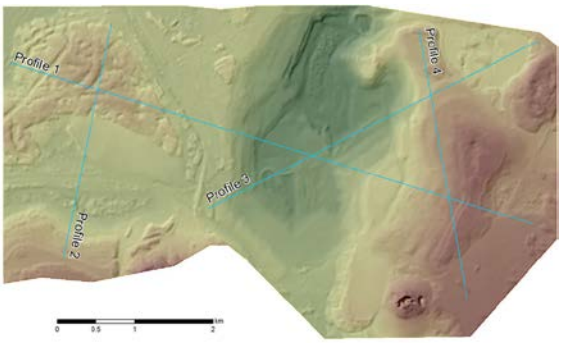

Fig. 12 DSM – 2008

4 CONLUSIONS

A detailed analysis of the area affected by open-cast mining based on data from different time periods are presented in this paper. We used three types of data sources – maps from the 3rd Military survey (year 1938), SMO-5 maps (years 1953, 1973 and 1982), aerial images (year 1953 and 2008) and current LIDAR data.

The elevation data in the form contour lines were extracted from old maps and further interpolated into DTM's. A suitable method for data interpolation was chosen based on performed interpolation tests. The aerial images were processed in a standard way of photogrammetry with DSM's as the resulting elevation grid. For further processing of this area we may consider the usage of aerial images from the year 1938 covering the whole region as well.

Very illustrative analysis of the georelief transfiguration is the profile analysis. Here, we may study the georelief change in detail and we may use the profiles from the all five processed periods. The transect lines were defined in the direction of the major georelief changes.

The resulted DTM's and DSM's have a wide usage in data modeling and may be used in many kinds of applications – visualization, hydrological modelling, recultivation works and much more. All the processed data – maps, aerial photographs and the resulting DTM's and DSM's are available at the university mapserver http://mapserver.ujep.cz as WMS and ArcGIS Server layers. The direct link to the application presenting the data is:
http://mapserver.ujep.cz/Projekty/SZ_Cechy/Jezero_Most_nove/

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Primary Paper Section: A

Secondary Paper Section: D, G, L

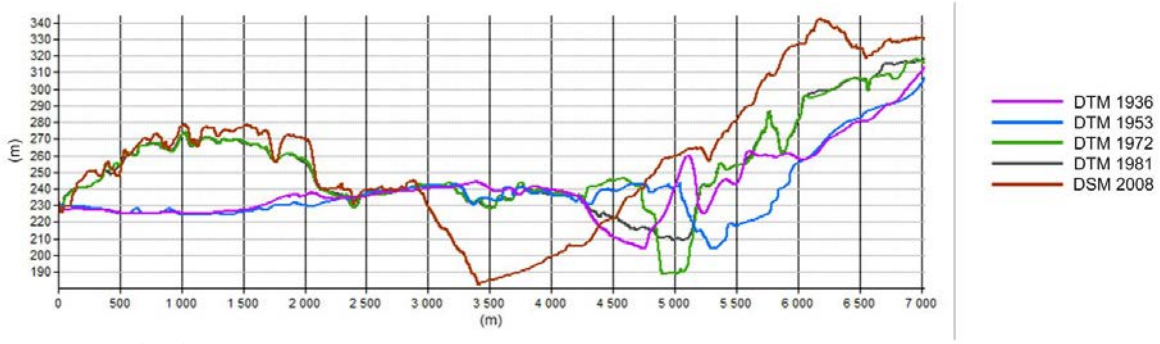

Fig. 13 Analysis of Profile 1

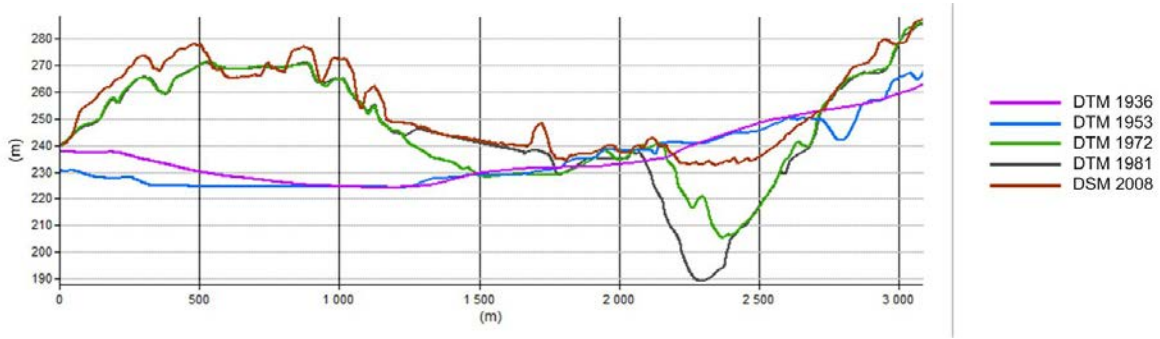

Fig. 14 Analysis of Profile 2

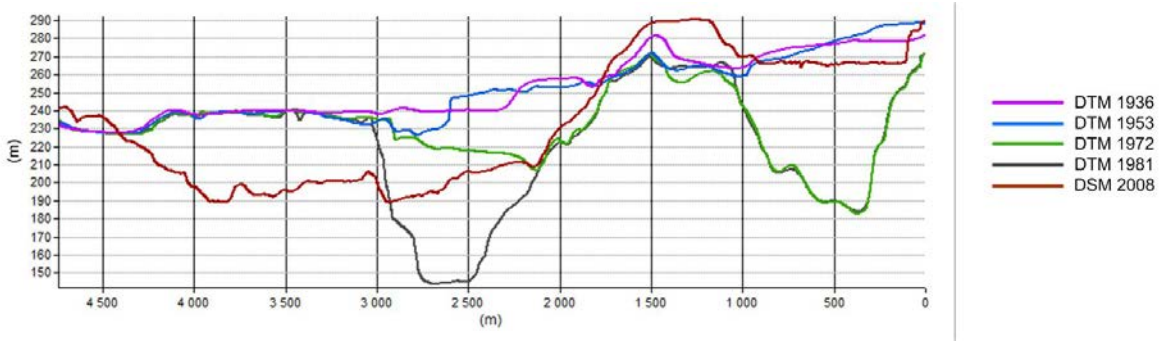

Fig. 15 Analysis of Profile 3

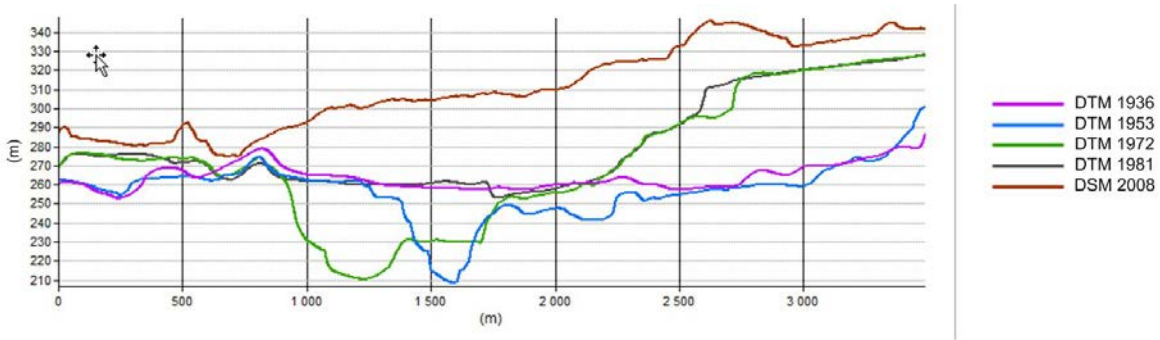

Fig. 16 Analysis of Profile 4

STATUS AND INDEPENDENCE OF PUBLIC RADIO AND TELEVISION IN EUROPE AND IN SLOVAKIA

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Abstract: The article compares the term public corporation with legal norm as public institution is, that has been used in Slovak television Act in December, 1991 for the first time and is uncontrollably expanding from that time. Typical example of public corporation in conditions of public administration of Slovakia is especially Radio and Television of Slovakia, RTVS, that came into being by integration of Slovak radio and Slovak television in January 1st, 2011. The main aim of the article is an analysis of the status and independence from RTVS political subjects and its competitiveness in comparison to chosen European public radio and television corporations.

Keywords: corporation, independence, radio, television, public institution

1 Resources of the solved problems

The new term "public institution" (corporation) presenting one of the basic terms of public administration occurs in Slovak law system in 1990. Public institution and public corporation are understood as synonyms, while public corporation belongs to complex legal terms of the theory of administrative law of no consistent opinion at present and even in the past. Other forms, as public administration and self-government, came historically into being earlier than public corporation. Present juristic theory is prevailed by consistent opinion that public administration involves three structural parts:[1]

1. State administration,
2. Self-government and
3. Public corporations.[2]

Out-off-line, public corporation is "the third and the newest form of government instrumentality". There are many theories regarding public administration and public corporations. The term public corporation is linked with its concern in public authority. Matějka (1929) and Hoetzel (1937) contributed to the explanation of the problem in literature in the time of the first Czechoslovak Republic. Present representatives of administrative law requests completing the following criteria for the public corporation constitution:

- Will of lawmaker,
- Reason for creation – by law or public administration initiative (not by private initiative),
- Activity character – providing public services (not just following the public purposes),
- Some public authority favors.

There is a present state lacking more radical constitutional and legal concept from which we could deduce definition determination of the terms as public sector, business sector or non-profit (third) sector within almost absent legal theory that would reflect stated facts. Based on the stated determination, it is obvious that exact determination of the limits between public sector, business sector and non-profit (third) sector is not quite possible because of two reasons:

1. It is impossible to include any authorities or organizations into one of the sectors definitely,
2. It is difficult to define whether it is public or private activity in terms of activity content.

Furthermore, there is a permanent activity of mutual overlap of particular sectors. There is e.g. direct business of public sector subjects (e.g. Slovak Radio and Slovak Television until 2011, from January 1st, 2011 Radio and Television of Slovakia) on one hand and monopolization of some activities in the public interest (e.g. in the field of energetic etc.) on the other hand within the relation of public and business sector.

There is e.g. the change of public administration capacity to subjects of non-profit sector (e.g. in the field of fishery) and on the other hand, the ingerence of the subjects of non-profit law to creation of state authorities or public institutions authorities (e.g. creating the Council for Broadcasting and Retransmission, RVR) that is an administrative body performing state regulation in the area of radio and television broadcasting, retransmission and delivering audiovisual media services on demand within the relation of public and non-profit sector.[3]

In this regard to public corporation, organizational system of public administration can be constituted of not just state but also private institutions, thus not being the type of self-governmental corporations, marked as "non-governmental organizations" in foreign literature. Generally, they are public corporations instituted by law and financed partially by state resources and liable to state department in its activity. Typical example of public corporation in conditions of public administration of Slovak Republic is especially Radio and Television of Slovakia ("RTVS").
The main aim of the article is to analyze RTVS in comparison to chosen European public radio and television corporations where we aim first of all to:

- RTVS market position, where we compared its competitiveness with public radio and television corporations in chosen European countries,
- RTVS independence, where we compared its independence with radio and television corporations in Central and Eastern Europe as well as in Western Europe. We monitored the turnover of general managers in Slovak Radio (SRo) and Slovak Television (STV) in this relation.

We used the methodology of Hanretty (2011) based on general managers' turnovers in public radio and television that makes the image of their independence from government being in power in measuring independence rate. This methodology of the calculation of political independence of institution comes from the literature dealing with the independence of central banks. Cukierman (1992) and thereafter Cukierman and Webb (1995) developed two indicators of independence:

1. The rate of turnover of central banks governors – TOR;
2. Political vulnerability index – VUL.

Indicator TOR shows reversed value of average time serving the position of central bank governor in years and indicator VUL is a percentage when the government change brought up even the change within the position of central bank governor in six months. For the purpose of calculation of public radio and television independence we consider turnover of its general manager – in countries having dual management structure (control and executive) and in countries with one council (e.g. France, Bulgaria or Portugal) the turnover of public corporation president. In order to get standardized independence indicator and by reason of indication of lower independence rate by the values TOR and VUL, it is necessary to average them and the result should be deducted from a unit.[4]

Independence degree indicator (I) can be calculated as follows:

$$I = 1-(TOR+VUL)/2$$

[1] Prusák, J.: Obsoletná/absoletná právna norma, verejnoprávna korporácia a verejnoprávna Inštitúcia. In Justičná revue, ročník 2006, č. 11.
[2] Public corporation term is positive-legal term in European law. In the most general sense, we understand the term corporation as an association of persons for the purpose of observation of particular aim in the form of how the association constitutes itself based on legal enactment. Corporations, unlike other association forms (communities), are of different legal personality from legal personality of those who established it by their association. Corporation as a legal subject is made by legal independence inwards in relation to their members and also outwards – in relation to other legal subjects.

[3] www.rvr.sk
[4] Hanretty, CH.: Public Broadcasting and Political Interference. Spojené kráľovstvo: Routledge, 2011. ISBN 978-0-415-66552-0.

Government changes data are sourced in Budge, Woldendorp and Keman (1998), Müller-Rommel, Fettelschoss and Harfst (2003) and later publications of European journal of political research. General managers' turnovers data are available on Internet web pages of public radios and televisions and also we can get them by searching the information in Lexis-Nexis system.

2 Status and independence of radio and television of slovakia in comparison to chosen european countries

Mass media is an important part of political, social and cultural life in Slovakia. Mass media carries its basic functions: informative, educational, cultural, entertaining or relaxation; through the oldest print media such as periodical press, auditory media – radio, audiovisual media – television and the youngest electronic media – Internet. We can say that media in Slovakia strongly influence the public opinion.

In Slovakia, new public institution has been made by integrating Slovak Radio and Slovak Television in January 1st, 2011 – Radio and Television of Slovakia, RTVS, which is public, national, independent, informative, cultural and educational institution; providing public services in the field of radio and television broadcasting. It was established on the ground of Slovak Radio and Television Act no. 532/2010, codes from December, 2010 and is made of two organizational elements – Slovak Television and Slovak Radio. New legal form should stop indebtedness of television and improve the broadcasting of both media.

The scheme of the broadcasting consists of news, publicist, documentary, dramatic, artistic, musical, sport, entertaining and educational programs, various genres for children and youth and other programs *"based on the principles of democracy and humanism and supports legal and ethical knowledge and environmental public responsibility"*. Programs should provide objective, authentic, actual, undistorted, clear and quite balanced and pluralistic information about the situation in Slovakia and abroad. They should also develop cultural identity of Slovak population, reflect the opinion pluralism and support the development of knowledge society.[5]

The main RTVS activity is the broadcasting of at least four radio program stations and two television program stations. According to RTVS statute from May, 2011, other activities are:

- Providing Slovak Radio and Slovak Television archive;
- Providing required broadcasting time for public authorities in case of emergency situations' notifications;
- Attending the activity of international organizations working in the field of broadcasting;
- Forming the network of permanent reporters and unique reporters in Slovakia and abroad.

2.1 Status of public radio and television

In Table 1, we can see the review of public radio and television corporations (PRTC) in chosen European countries that we commingle for each country for the purpose of analysis and as an example, in Belgium, two public radio and television corporations broadcast, separately for Flemish and Walloon part of the population or the case of Czech Republic where public radio is not merged with public television.

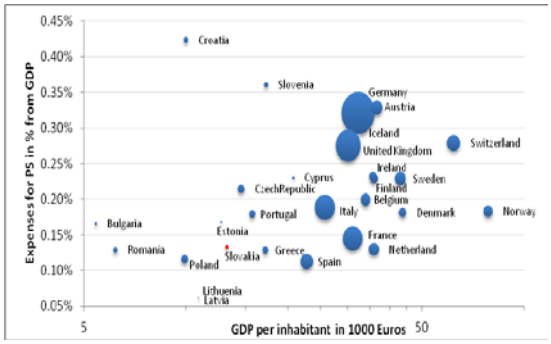
[5] www.rtvs.sk

Table 1 The review of public radio and television corporations in Europe

Country	PRTC	Country	PRTC	Country	PRTC	Country	PRTC
Belgium	VRT, RTBF	France	FT	Latvia	LVRT	Slovakia	RTVS
Bulgaria	BNT, BNR	Greece	ERT	Germany	ARD, ZDF	Slovenia	RTV SLO
Cyprus	Cy/CBC	Netherland	NOS	Norway	NRK	United Kingdom	BBC
Czech R.	ČTV, ČRo	Croatia	HRT	Poland	TVP	Spain	RTVE
Denmark	DK	Ireland	RTE	Portugal	RTP	Switzerland	SRG SSR
Estonia	ERR	Iceland	RUV	Austria	ORF	Sweden	SR, SVT, UR
Finland	YLE	Lithuania	LRT	Romania	TVR	Italy	RAI

Source: self-processing

In Picture 1, we can see absolute (round surface) and relative (vertical axis) size of public radio and television corporations in above mentioned countries expressed by their expenses in €. GDP indicator per one inhabitant (logarithmic measure) is showed on horizontal axis that presents economical progress of the country. Expenses data are drawn mainly from annual reports of monitored public radio and television corporations (per 2011), GDP data per inhabitant are drawn from Eurostat statistics (per 2012).



Picture 1 Characteristics of public radios and televisions in Europe

Source: self-processing based on Eurostat data and PRTC annual reports in Europe

In Picture 1, we can see that Western European countries such as Germany, Austria or United Kingdom, regarding their public radio and television size, have similar characteristics. German ones have mutual budget of 8,3 mld. € that makes 0,32% of GDP. English BBC belongs among other important public radio and television corporations with the budget of 4,8 mld. € that makes 0,28% of GDP of United Kingdom. Italian RAI is of lower relative amount – having the budget of almost 3 mld. € that makes 0,19% of GDP and in France – FTV with the budget of 2,9 mld. € making 0,28% of GDP, similarly as English BBC. Average relative amount of presented public radio and television corporations is 0,2% of GDP and total expenses in monitored countries is approximately 29 mld. €.

We can see similar characteristics in Scandinavian countries, except of western countries. It is the same in Denmark, Sweden and Finland, just Norway differs a lot that is caused mainly by its economic progress. Norwegian NRK is close to the average of other countries' expenses as its total expenses of 345 mil. € makes 0,18% of GDP. Danish DK has the expenses of 469 mil. € making around 0,2% of GDP, Swedish SR, SVT and UR have the expenses of 890 mil. € making 0,23% of GDP and Finnish YLE spend 434 mil. € for its operations making approximately 0,23% of GDP.

Other interesting finding is the state of public televisions in the countries of former Yugoslavia where we monitored Croatia and Slovenia. Croatian HRT has the expenses of 0,42% of GDP making 188 mil. € and Slovenian RTVSLO spend 130 mil. € that makes 0,36% of GDP. This important amount in the countries of

former Yugoslavia can be caused by specific heritage after the conflicts took place there in 90s of the last century.

Reviewing the Baltic countries, we can see that characteristics of Lithuania and Latvia are almost identical. Public corporation of Lithuania – LRT spend 18,8 mil. € and Latvian LVRT 12,5 mil. € that is approximately 0,06% of their GDP. Estonia that is economically more matured, if compared with them, incur expenses for ERR of 27 mil. € that makes approximately 0,17% of its GDP.

Bulgaria and Romania, two economically the least developed countries being monitored, incur relatively low financing of the public radio and television. Bulgarian BNT and BNR spend 64 mil. € making 0,17% of GDP and Romanian TVR 170 mil. €, i.e. 0,13% of GDP.

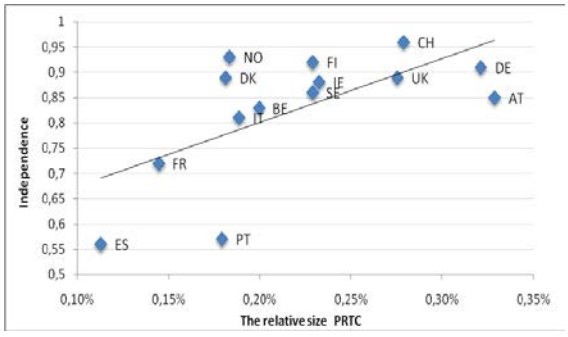
Slovakia (red circle in Picture 1) could be compared to Romania, Poland, Greece or Spain on the grounds of relative size of public radio and television corporations. Radio and Television of Slovakia incurs expenses of 92 mil. € making 0,13% GDP placing 22nd position between Bulgaria that incurs the expenses of 64 mil. € and Slovenia with the expenses of 130 mil. €. If we compare a bit more developed Czech Republic to Slovakia, concerning their mutual history (splitting in January 1st, 1993), the expenses of Czech Television and Czech Radio are 335 mil. €, i.e. approximately 0,21% of GDP.

2.2 Independence of public radio and television

In this part, we will analyze the independence of public radio and television of other authority sources, in our case, it is political authority. More specifically, it is about the independence of democratic institutions – legal order, executive power and political parties. We understand the political independence as the level where the employees make their everyday decisions about the presentations and subfolders without: [6]

- getting instructions and acting upon them, threatening or other forms of influence from politicians or not acting according to expectations of such influence,
- not having changed the presentation with regard to the fact whether it can damage politicians interests.

In data analysis, we did the research whether relative size of public radio and television (their expenses as % from GDP) has the influence on independence. We drew the conclusion that whereas there is a specific dependence between these two indicators in Western European countries, we cannot talk about such relation in post communistic countries of Central and Eastern Europe that is illustrated in Picture 2 where the relation between relative size of public radio and television and independence is not reflected as important. Pearson's coefficient of correlation is 0,39.



Picture 2 Dependence of PRTC size and its independence in Central and Eastern Europe
Source: self-processing based on Eurostat data, Hanretty (2011) and PRTC annual report

[6] Hanretty, CH.: Public Broadcasting and Political Interference. Spojené kráľovstvo: Routledge, 2011. ISBN 978-0-415-66552-0.

In connection to above presented, we were searching for indicator that would represent the state of independence of public radio and television in the country even better. Indicator measuring the quality of public institutions in the country seemed to be the best possibility for us. We can find this indicator in Global competitiveness index made by World economic forum. We used data from Yearbook of global competitiveness 2012/2013, specifically the part 1A of the index expressing the quality of public institutions based on various indicators such as trust in politicians, corruption, court independence, state regulations or transparency. This attitude's weakness is the fact that this indicator expresses public institutional quality per 2012, while independence indicator measures independence in a long-term. But as it has proved, the quality indicator of public institutions is the best indicator of public media independences.

Picture 3 Dependence of institutional quality of the country and PRTC political independence
Source: self-processing based on Eurostat data, Hanretty (2011) and PRTC annual report

Quality indicator of public institutions has the greatest influence on the independence of public radio and television corporations in Europe according to our analysis. Pearson's coefficient of correlation is 0,82. It is obvious that the higher quality of public institutions as one unit, the higher political independence of public radio and television within Western Europe countries, except of Italy, Spain and Portugal. Such dependence is not so important in the countries of Central and Eastern Europe that can be caused, as we mentioned above, by insufficient recalling competence of political independence indicator for these countries. But when we regard his findings as a real picture of independence state, then we can say that the independence of public radio and television in Slovakia, Hungary and Bulgaria is in this case under the line that would be expected in quality of public institutions in these countries. We take the similar view in Lithuania, Portugal and Estonia. On the other hand, public radio and television independence in Romania is above the line that would be expected within the quality of Romanian public institutions.

3 Concluding discussion

The history of state interventions in the area of audiovisual media creates the need of the control and monitoring that leads to establishing supervisory bodies. As public radio and television were under the control of European governments from its beginning, reaching its independence was much greater challenge. The public pressure against political interference began to spread in 80s of the last century and regulatory bodies ceased to be an extended hand of the state. But certain intervention rate was and still is legitimate on the behalf of providing free and equal access to information. Development of the regulation and media supervision reflects the trends and development of this market as well as the response to changing political scene in Central and Eastern Europe.

We drew the conclusions following RTVS analysis in comparison with chosen public radio and television institutions in Europe:

- All public stations in most monitored countries are merged in one institution having its executive and supervisory power.
- Monitored European countries deliver averagely 0,2% of GDP to their public stations; independently of country's economic power.
- Most of public televisions, that are EBU members, had lower market share in 2011 as in 2002. Slovak Television, which had a share decreased in 10 percentage points to approximately 15% market share, is among them.
- Most of public radios, that are EBU members, had lower number of listeners in 2011 as in 2007. Slovak Radio, which had a share decreased in 3 percentage points to approximately 30% market share, is among them.
- There is a soft dependency of relative size of the station and its political independence in Western European public stations. Such a dependence of Central and Eastern European PS is not confirmed.
- Environment and location of monitored public stations strongly affects their political independence – the influence of human development of particular countries and the quality of public institutions in these countries.
- Slovak Television has lower political independence as it would be expected on the basis of human development of Slovak Republic as well as the quality of public institutions in Slovak Republic.
- Great number of Slovak Television managers who had been changed from 1990 and the periods of their change equivalent to the periods of parliamentary elections show low political independence of STV.
- Small number of managers and period of their change of Slovak Radio indicated its higher political independence.
- Even though, RTVS passed over challenging period of reclassification in 2011, it succeeded to manage all appointed tasks by law.

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Primary Paper Section: A

Secondary Paper Section: AH

AGE AND LEVEL OF EDUCATION AS DETERMINANTS OF INTEREST IN INFORMATION/COMMUNICATION TECHNOLOGIES AND COMPUTER SKILLS IN THE CONTEXT OF SENIOR EDUCATION

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Abstract: The paper deals with the digital literacy of students attending the University of the Third Age in Nitra. It brings together partial results of the research the author conducted in the summer semester of the academic year 2012-2013 and focuses on the aspects of age and the degree of education as determinants of interest in ICT and computer skills in the context of the education of seniors. The research sample consisted of participants of two study programmes supervised by the Faculty of Education of Constantine the Philosopher University in Nitra: 40 students in the History of Fine Arts and Creative Art activities study programme under the Department of Creative Arts and Art Education and 34 students enrolled in the Folk Crafts study programme carried out by the Department of Technology and Information Technologies.

Keywords: digital literacy, age, level of education, seniors

1 Introduction

Digital literacy is an indispensable competence of contemporary man. The importance of this issue is, inter alia, illustrated by the fact that since 2005, the Institute for Public Affairs in Bratislava has regularly monitored the topic of digital literacy and informatization of society through sociological surveys which are representative of the entire population of the Slovak Republic over 14 years old in terms of gender, age, education, nationality, size of cities and regions of the Slovak Republic. The research was conducted in 2005, 2007, 2009, 2011 and March 2013. Other research results were published in the publication Velšic, Marián: Digitálna gramotnosť na Slovensku 2013. Správa z výskumu (eng. Digital Literacy in Slovakia 2013. Research report). Bratislava : Inštitút pe verejné otázky, 2013. 15 pgs. ISBN 978-80-89345-40-3. This publication defines digital literacy as "the ability to understand and use information in different formats from different sources presented by modern information and communication technologies (ICT)" (Velšic, M., 2013, p. 2). Digital literacy is a competence which is also considered relevant within the "Recommendation of the European Parliament and of the Council" of 18 December 2006 on key competences for lifelong learning (2006/962/EC). The appended document "Key Competences for Lifelong Learning – A European Reference Framework" sets out eight key competences, including the development of digital competence. We consider the development of digital competence to be of paramount importance in the context of the education of seniors within the University of the Third Age at Constantine the Philosopher University in Nitra. There is a wide variety of possibilities for using ICT in the implementation of the History of Fine Arts and Creative Art Activities study programme. It can be incorporated into the field of visual education in a theoretical as well as a practical and creative context.

1.1 Theoretical background

The theoretical basis for us were the documents Velšic, Marián: Digitálna gramotnosť na Slovensku 2013. Správa z výskumu (eng. Digital Literacy in Slovakia 2013. Research report). Bratislava : Inštitút pe verejné otázky, 2013. 15 pgs. ISBN 978-80-89345-40-3 and the document "Recommendation of the European Parliament and of the Council" of 18 December 2006 on key competences for lifelong learning (2006/962/EC). (Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:sk:PDF).

2 Age and level of education as determinants of interest in information/communication technologies and computer skills in the context of senior education

2.1 Research objectives

The research objectives were to find out which competences the students of the University of the Third Age have in ICT via their self-assessment and to find out how they have developed their digital literacy. Our aim was also to find out whether they use computers in their free time or jobs and what they use computers for. The findings were analyzed from the aspects of age and the level of education of the respondents, searching for the relations between these indicators and the respondents' interest in ICT and computer skills. We also wanted to identify the study participants' interest in educational activities in which computer or digital technologies are used.

2.2 Research hypotheses

We assumed that in our respondent group:

1. There would be more students who acquired their ICT skills informally or recreationally than those who acquired their digital literacy institutionally and formally.
2. There would be more students who use computers in their spare time or jobs than those who do not use computers.

2.3 Research plan and research sample

Our research sample consisted of 74 respondents. 40 study in the History of Fine Arts and Creative Art Activities study programme taking place within the University of the Third Age in Nitra in the Department of Creative Arts and Art Education at the Faculty of Education of Constantine the Philosopher University in Nitra. The other 34 students fall under the Folk Crafts study programme offered by the Department of Technology and Information Technologies at the Faculty of Education of Constantine the Philosopher University in Nitra in the academic year 2012-2013. Of the total number of the respondents (74), 68 (92 %) were women and 6 (8 %) were men.

2.4 Research methods

The data collection method we used was an anonymous questionnaire with closed questions and scaling options in each item as well as open questions with the possibility to develop responses. The questionnaire included 10 items on general information about the respondents in reference to their age, sex, residence district, level of educational attainment and employment status. Our main aim was, of course, to find out how our respondents – students at the University of the Third Age – evaluate their own computer skills, how they acquired these skills, how they use them and what their attitude is towards further education using ICT. The questionnaire consisted of single as well as multiple choice questions. The research was carried out during the summer semester of the academic year 2012-2013. The method of data processing was a quantitative and qualitative analysis of the responses from the questionnaire reflected in the table or verbal interpretation of responses as well as verification and evaluation of hypotheses. Although the results of the findings are presented in tabular form separately for each of the study programmes, our goal was not to examine the differences between the respondents of the two programmes. We analyze the research sample mainly as a whole and only when we find striking differences in quantitative aspects do we compare the study programmes between themselves.

3 Research results

Our research results have some interesting findings. Given the limited scope of this paper, we analyze the results only partially, indirectly referring to some of the findings of the items that are not detailed herein. The results in tabular form are also presented only partially due to the limited scope of this paper. Abbreviations are used in the text and the tables in order to designate the study programmes – HFA for the History of Fine Arts and Creative Art Activities and FC for Folk Crafts.

Table 1
Characteristics of the research sample in terms of age

Students' age	HFA group	FC group	Total
a) Between 40 and 44 years	1 (2.5 %)	1 (2.9 %)	2 (2.7 %)
b) between 45 and 49 years	3 (7.5 %)	3 (8.8 %)	6 (8.1 %)
c) between 50 and 54 years	5 (12.5 %)	6 (17.7 %)	11 (14.9 %)
d) between 55 and 59 years	5 (12.5 %)	3 (8.8 %)	8 (10.8 %)
e) between 60 and 64 years	14 (35.0 %)	11 (32.4 %)	25 (33.8 %)
f) between 65 and 69 years	8 (20.0 %)	7 (20.7 %)	15 (20.3 %)
g) between 70 and 74 years	4 (10.0 %)	1 (2.9 %)	5 (6.8 %)
h) between 75 and 79 years	0	1 (2.9 %)	1 (1.3%)
i) between 80 and 84 years	0	0	0
j) between 85 and 89 years	0	1 (2.9 %)	1 (1.3 %)
Total	**40** (100 %)	**34** (100 %)	**74** (100 %)

Source: Own arrangements

The age of our respondents is between 40-89 years. Taking into account the general interpretation of the "third age" as a period of post-productive age, the functioning of the "University of the Third Age" in Slovakia appears to be in conflict with the name of the educational institution. The age limit of candidates (as well as the tuition fee) is different in each Slovak university. The aim of this paper is not to examine the differences in the age limit for applicants to study at the University of the Third Age, but still we find interesting facts in a cursory comparison of the conditions for admission to study at the universities in the Czech Republic and Slovakia from the viewpoint of the applicants' age. Applicants to the majority of Czech universities have the following as conditions for studying at the University of the Third Age: reaching the retirement age within the meaning of retirement pension (e.g. Charles University in Prague, Masaryk University in Brno, and others), being on a disability pension before reaching senior status (e.g. the University of Economics in Prague) or applying upon reaching the age limit of 55 years (e.g. Jan Evangelista Purkyně University in Ústí nad Labem) or 50 years (e.g. Palacký University in Olomouc, Silesian University in Opava). Compared to the Czech Republic, Slovakia's age limit is extremely low. To illustrate, let us quote a few examples: the minimum age was ascertained, for example, in the case of the Technical University in Košice, the University of Trnava (in Trnva) and Matej Bel University in Banská Bystrica, where the condition of admission to the University of the Third Age is being at least 40 years old. Both Nitra Universities – Constantine the Philosopher University in Nitra and the Slovak Agricultural University in Nitra - stipulate that the applicants' age must be over 40 years in the case of women and over 45 years in the case of men. The Slovak Technical University in Bratislava prescribes the age minimum of 45 years for women and 50 years for men, the University of Prešov uniformly sets it at 45 years, and Comenius University in Bratislava also consistently sets it above 50 years. Among the Slovak universities offering education within the University of the Third Age, the maximum age limit of 55 years is established by the University of Žilina in only one study programme – Man and the Computer – apparently for the great interest of younger and older aspirants. In all other study programmes, the age minimum for admission has been set at 45 years.

Expressed in percentages, 36.5% of our respondents are in the age range of 40-59 years old and 63.5% of our respondents are over 60 years old (see Table 1). It is interesting for us to find that more than half of the current students are over 60 years old. During the research conducted with the University of the Third Age students of our department a few years ago (in the academic year 2008-2009), the author of this paper found out that of the total number of respondents (28) at that time, more than half were less than 60 years old – up to 20 (71.5%) students (Récka, A., 2009).

Table 2
Respondents' level of educational attainment

Students' highest educational attainment	HFA group	FC group	Total
a) secondary	15 (37.5 %)	18 (52.9 %)	33 (44.6 %)
b) higher	25 (62.5 %)	16 (47.1 %)	41 (55.4 %)
Total	**40** (100 %)	**34** (100 %)	**74** (100 %)

Source: Own arrangements

A completed secondary education with a school-leaving examination is the condition of admission to the University of the Third Age. It is therefore natural that the level of educational attainment of our respondents is higher than the current average. Surprising to us, however, is the large percentage (62.5%) of respondents with higher education in the HFA group as well as in the FC group (47.1%). If we compare these findings with the research group in 2009 mentioned above, we find that of 28 respondents, 8 (28.6%) had higher education and the remaining 20 (71.4%) had just a secondary education (Récka, A., 2009).

Table 3
Characteristics of the research sample in terms of employment

Characteristics of the respondents in the context of responses in terms of their employment	HFA group	FC group	Total
a) I am retired and I currently do not work, I am not employed	26 (65.0 %)	21 (61.7 %)	47 (63.5 %)

b)	I am retired but I still work, I am employed full-time	0	0	0
c)	I am retired but I still work, I am employed part-time	2 (5.0 %)	2 (5.9 %)	4 (5.4 %)
d)	I have not reached retirement age and I am employed	7 (17.5 %)	6 (17.7 %)	13 (17.7%)
e)	I have not reached retirement age and I am a freelancer	0	2 (5.9 %)	2 (2.7 %)
f)	I have not reached retirement age and I am employed part-time	1 (2.5 %)	0	1 (1.3%)
g)	I have not reached retirement age but I do not work, I am unemployed	2 (5.0 %)	0	2 (2.7 %)
h)	I am a disability pensioner and I am not employed	1 (2.5 %)	3 (8.8 %)	4 (5.4 %)
i)	I am a disability pensioner and I am employed	1 (2.5 %)	0	1 (1.3%)
Total		**40** (100 %)	**34** (100 %)	**74** (100 %)

Source: Own arrangements

Table 4
Respondents' level of computer skills based on their self-assessments

Students' skills in ICT according to their own assessment		**HFA group**	**FC group**	**Total**
a)	I am a competent beginner on the computer	13 (32.5 %)	8 (23.5 %)	21 (28.4 %)
b)	I have good skills using the computer	17 (42.5 %)	19 (55.9 %)	36 (48.6 %)
c)	I have excellent skills using the computer	6 (15.0 %)	4 (11.8 %)	10 (13.5 %)
d)	I do not master working on the computer at all, but would like to have some skills	3 (7.5 %)	2 (5.9 %)	5 (6.8 %)
e)	I have no command of the computer and it does not bother me	1 (2.5 %)	1 (2.9 %)	2 (2.7 %)
Total		**40** (100 %)	**34** (100 %)	**74** (100 %)

Source: Own arrangements

Table 5
The methods through which respondents acquired digital competence

ICT skills acquisition method		**HFA group**	**FC group**	**Total**
a)	I acquired computer skills during my secondary and/or higher studies	3 (7.5 %)	3 (8.8 %)	6 (8.1 %)
b)	I took a course focused on the use of a PC	12 (30.0 %)	9 (26.5 %)	21 (28.4 %)
c)	I absorbed computer skills at work as part of work performance	11 (27.5 %)	14 (41.2 %)	25 (33.8 %)
d)	I completed my studies at the University of the Third Age (UKF) focusing on information technologies	4 (10.0 %)	8 (23.5 %)	12 (16.2 %)
e)	I have acquired skills thanks to the technical assistance of my family members and friends	16 (40.0 %)	7 (20.7 %)	23 (31.1 %)
f)	I am self-taught in computers - I have acquired skills on the basis of self-study of literature and trying out PC options	9 (22.5 %)	1 (2.9 %)	10 (13.5 %)

Source: Own arrangements

By way of item number 7 in our questionnaire, in which students were able to select more possibilities, we investigated our respondents' ICT skills acquisition method. We bring together the results in tabular form (see Table 5). As stated above, our aim in this study was not to examine data and then make a two study programme comparison; nevertheless, we consider it interesting to bring together some of the findings on this subject. A relatively high percentage (41.2%) of the students in the Folk Crafts study programme marked option c) I absorbed computer skills at work as part of work performance. We were interested in which sector or field our students work or worked and which age group they represent. Of the 14 respondents, all are women, 7 with secondary education and 7 with higher education. 4 of these respondents are from the age group of 40-49 years. The others are from the age group of 50-54 years (4), 55-59 years (1), 60-64 years (4), and 65-69 years (1). 5 respondents have a degree in economics, 3 have a degree in agriculture, 2 have a degree in health, and the other 2 have a degree in pedagogy. 1 respondent completed secondary education in the field of clothing, 1 respondent completed grammar school and stated that he was self-employed. In the group of students in the History

and Art Education programme, 11 respondents chose option c), 10 women and one man. Of these, 5 respondents have higher education and 6 respondents have secondary education. Two respondents with secondary education are in the age group of 45-49 years and the other age groups are represented as follows: 50-54 years (3), 55-59 years (1), 60-64 years (3), 65-69 years (2). In this group, there are respondents with an economics degree (2), a pedagogical degree (2), an agricultural degree (1), and there is a pharmacist (1), a doctor of veterinary medicine (1), a chemist (1), a baker - confectioner (1), a surveyor and cartographer (1), and 1 respondent with construction education. Our findings indicate that the participants whose professions entail the use of ICT skills get highly motivated and involved in digital literacy even though they were not trained in information technology during their secondary or higher education studies. It is also interesting to note that our respondents who marked option c) in item 7 did not rely solely on their employer when acquiring ICT skills, as 14 of them (both HFA and FC groups) identified other options too: a) – 1, b) – 4, d) – 3, e) – 6, f) – 3. Of those who marked three options within this item are three students from the HFA group marking f) as one of the options and 1 respondent who is a student from the FC group. In item 7, the percentage of responses for options b) – 30% and e) – 40% are also an interesting finding to consider in the group of HFA respondents. A striking difference between the HFA and FC groups lies particularly in options e) and f), which show both the social environment of the respondents providing the appropriate conditions to develop their ICT skills and, obviously, the respondents' strong intrinsic motivation for self-study. In item 7 in the HFA group, 9 (22.5%) respondents marked option f) I am self-taught in computers, I have acquired skills on the basis of self-study of literature and trying out PC options. We were interested in getting more detailed information about the respondents who answered like this. Of 9 respondents (3 men and 6 women), 2 have secondary education and 7 have higher education. All three men have a university degree and are over 60 years old, belonging to the following age groups: 60-64 (1), 65-69 (2). One of them is a doctor of veterinary medicine, one is an economist and one has a pedagogical education. The women of this group are over 50 and belong to the age groups as follows: 50-54 (2), 55-59 (1), 60-64 (1), 65-69 (1), 70-74 (1). Two of them are pharmacists, one has a degree in computer science and library science, and one has a degree in teaching. The two secondary-educated women in this group attended a chemistry secondary school and a bakery and confectionary secondary school. One respondent from the FC group who marked option f) in item 7 attended a health care secondary school and belongs to the age group of 65-69 years old.

The results in item 7 are also interesting from another aspect. Of the total number of 40 respondents in this group, 30 (75%) declared that they acquired their ICT skills via an official institution – options a), b), c) and d). In the FC respondent group, digital literacy thus declared is even a bigger surprise for us. Of the 34 respondents in this group, 34 (100%) marked at least one of the options indicating that they acquired ICT skills through institutional education. Naturally, the results of our findings – given the focus of our research – do not reflect the level (quality) of the digital literacy of our respondents. It is interesting to compare our findings with the results of a representative sociological research on the topic of digital literacy and the informatization of society that was carried out by the Institute for Public Affairs in March 2013. This research, to which we referred at the beginning of this paper, had a sample of 1,079 respondents from across the Slovak population aged over 14.

The research report shows the percentage of digitally literate and illiterate people by social groups and environments. In terms of age, the author of the report considers digital literacy an imporatant differentiating parameter among middle and older generations – at 45-54 years of age, the digital literacy in Slovakia is 88%, at 55-59 years of age, it is 73% and in the group of over 60 years old, it is 37%. According to the report, the percentage of digitally literate pensioners in the context of employment is 39%. We consider it important to give the results in relation to other aspects of the report as well – in the context of education, 87% of the secondary school graduate group is digitally literate, and 95% of the university graduate group is (Velšic, M., 2013, p. 4). Taking into account that our respondent group consists mostly of pensioners, we can conclude that the digital literacy of students at the University of the Third Age in Nitra attending the History of Fine Arts and Creative Art Activities study programme and the Folk Crafts study programme is well above the average in relation to the Slovak average. In the HFA group, of the total number of 40 respondents, 28 (70%) are retired, and of the total number of 40 respondents, 30 (75%) declared an institutional form of ICT skills acquisition.

In this group, 4 (10%) indicated that they do not master computer work whatsoever. In the FC group, 23 (67.6%) out of 34 respondents are retired while 40 (100%) out of 40 respondents declared an institutional form of ICT skills acquisition. It is therefore interesting that in this respondent group, 3 (8.8%) indicated that they do not master computer work at all (see Table 4). We recall that the age of our respondents ranges from 40 to 86 years, of which 25 respondents belong to the age group of 60-64 years, 15 are included in the age group of 65-69 years, 5 fall in the age group of 70-74 years and 1 respondent is in the age group of 85-89 years.63.5% of our respondents are more than 60 years old (see Table 1).

Our first hypothesis was not confirmed. We assumed that in our respondent group there would be more students who have acquired their ICT skills informally or recreationally than those who acquired digital literacy institutionally or formally. The finding that 70 (94.6%) participants of the University of the Third Age out of 74 respondents picked up their ICT skills institutionally – in view of the research sample age composition – surprised us.

Table 6
Respondents' computer use in their free time or job-related area

Using the computer in your free time or workplace		**HFA group**	**FC group**	**Total**
a)	The computer is an indispensable working tool (Word, Excel, Internet, etc.)	13 (32.5 %)	9 (26.5 %)	22 (29.7 %)
b)	I use the computer to communicate with my family and acquaintances (via social networks, Facebook, Skype, e-mail, etc.)	29 (72.5 %)	24 (70.6 %)	53 (71.6 %)
c)	I use the computer in education and cultural activities (e.g. targeted information retrieval through Wikipedia, web lexicons, viewing works of art in virtual galleries, etc.)	23 (57.5 %)	17 (50.0 %)	40 (54.0 %)
d)	I use the computer to	15 (37.5 %)	14 (41.2 %)	29 (39.2 %)

	archive and edit photos			
e)	I use the computer to obtain current important information (departures of bus lines, theatre or cinema programmes, news, weather, etc.)	20 (50.0 %)	20 (58.8 %)	40 (54.0 %)
f)	I use the computer for shopping online	9 (22.5 %)	9 (26.5 %)	18 (24.3 %)
g)	None of the previous options have been marked	5 (12.5 %)	1 (2.9 %)	6 (8.1 %)

Source: Own arrangements

Within the item focused on the use of ICT in respondents' free time or jobs, we obtained the following results: option a) the computer is an indispensable working tool (Word, Excel, Internet, etc.) was marked by 22 (29.7%) respondents, option b) I use the computer to communicate with my family and acquaintances (via social networks, Facebook, Skype, e-mail, etc.) was chosen by 53 (71.6%) respondents, option c) I use the computer in education and cultural activities (e.g. targeted information retrieval through Wikipedia, web lexicons, viewing works of art in virtual galleries, etc.) was selected by 40 (54.0%) respondents, option d) I use the computer to archive and edit photos was marked by 29 (39.2%) respondents, option e) I use the computer to obtain current important information (departures of bus lines, theatre or cinema programmes, news, weather, etc.) was identified by 40 (54.0%) respondents, and option f) I use the computer for shopping online was chosen by 18 (24.3%) respondents. Of the total number of respondents, 6 (8.1%) students did not respond at all within this item, i.e. none of the options above were selected.

Our second hypothesis was confirmed, and the results surprised us. Given the respondents' age range, we did not expect such a high frequency of responses in each item. It can be concluded that the students in the Folk Crafts study programme use their digital skills more in practical areas than in education. Conversely, the students in the History of Fine Arts and Creative Art Activities study programme take advantage of the computer mainly in the workplace, educational and cultural activities, and to communicate with their family and friends.

Table 7
Respondents' interest in innovating the educational process by using ICT

Provided that you are given the possibility to use a computer within the lectures at the University of the Third Age (each student would be provided a PC within the lectures to search information and to perform creative art activities on the computer under the guidance of the teacher), would you welcome this?	**HFA group**	**FC group**	**Total**
a) definitely	23 (57.5 %)	15 (44.1 %)	38 (51.4 %)
b) most probably	4 (10.0 %)	3 (8.8 %)	7 (9.4 %)
c) yes	6 (15.0 %)	10 (29.4 %)	16 (21.6 %)
d) no	1 (2.5 %)	2 (5.9 %)	3 (4.0 %)
e) probably not	5 (12.5 %)	2 (5.9 %)	7 (9.5 %)
f) certainly not	1 (2.5 %)	0	1 (1.4 %)
g) no answer	0	2 5.9 %)	2 (2.7 %)
Total	**40** (100 %)	**34** (100 %)	**74** (100 %)

Source: Own arrangements

The last item in our questionnaire reflects our respondents' interest in the innovation of the learning process by using ICT. It is gratifying that 61 (82.4%) of the total number of respondents expressed themselves positively in this regard. It is particularly pleasing to see that 23 (57.5%) marked option a) definitely in the HFA respondent group, as this study programme offers a wide variety of interesting forms of education related to electronic media and digital technology that entail certain digital competences.

4 Conclusion

In conclusion, it may be stated that owing to the currently large expansion of ICT, the educational environment of the University of the Third Age at UKF cannot avoid the modernization of teaching nor the application of innovative methods and forms. However, digital literacy is a must on the participants' part within this type of study. Through our research, we found out that age does not play a significant role in the context of interest in ICT and computer skills, resulting in even the members of the middle and older age groups showing an active interest in digital competence acquisition. Educational level is, however, a key determinant in the context of interest in digital competence. Those possessing secondary or higher education, while taking an interest in various forms of lifelong learning, consider digital literacy essential and an obvious competence of contemporary man, regardless of their age.

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SPECIFICS OF UNIVERSITY EXPERIENTIAL TEACHING OF DIDACTIC DISCIPLINES IN THE FINE ART EDUCATION

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Abstract: Teaching of fine art education in the didactic disciplines may be not only theoretical. It can be also focused on obtaining the skills and experiences. Teaching takes place in terms of the external manifestations in premises of the department, in the university gallery and also in the broader campus. In terms of internal experience the teaching takes place in thoughts, feelings and actions of teacher and student. Effectiveness of our effort show us the results of our qualitative researches. The means of education are carried out in the space of personal centered education, creative-humanistic education and animocentric stream of fine art education. Our goal is development of student's personality and development of student's ability of transfer the acquired skills to the teaching practice.

Keywords: student – future teacher, didactics, fine art education, research, personal development.

1 Introduction

The paper informs about the specifics of university experiential teaching in area of the didactic disciplines of fine art education in the circumstances of Department of Creative Arts and Education of Faculty of Education at Constantin the Philosoper University in Nitra. The paper informs about teaching system of our long-term educational activity and it is aimed at practical side of the education, at the animocentric stream in fine art education and at qualitative researches implemented into the educational process. This article deals with the theoretical basis of meaning and aim of our education and focuses on practical proccess of teaching with regard to goals of education, given to the results of our previous studies.

2 The Basic Principles of the Experiential Fine Art Education

At our Department we teach didactic disciplines the specialization *students of teaching fine art* (previous students of teaching fine art education) - the future students for the second degrese of elementary school, basic art school and high school, and students – the future *teachers for elementary school*. In our view the aim of the fine art education is through developing the personality of fine art teacher to influence the child's personality in all its breadth. It begins from self-perception and self-evaluation, to perception and evaluation of others and of the world. It continues from development of communication with self and with others, through the cultivating the soul, through increasing creativity, to problem solving and coping with the negative aspects of life. It ends in ability to live fully, to understand mission and purpose of life.
Based on it we build our own pedagogical model. We base our education on several principles. We have a new view on artistic **talent** and we see an **interpretations of artwork, gallery animation** and the **cathartic experience** of student's own artistic creation as the means of creating a good relationship with visual art. We see **motivation** as a way of internalising teacher's objectives by students and **self-expression** (verbal, written or practical art creation) as the principle of **freedom**. We see an **evaluation** including **self-evaluation** as a means of self-knowledge. We see an **Internet** as a source of inspiration, information and motivation, and as an enrichment of communication between student and teacher.

3 The Practical Application of the Theoretical Principles

We perceive **artistical talent** in accordance with J. Belko (2001) as ability to accept stimulus openly, find solutions in fulfilling the task of visual art, pick up the new procedures. Then the pupil/student can express boldly, creatively and authentically, and he/her can develop through the artistic creation. In this view each student can feel and experience the individual and pleasant success.

According to Š. Gero and S. Tropp (1999) art helps the teachers and their students to deal with the life situations, to navigate in them, to find the key for issues of the contemporary life. Š. Gero and S. Tropp (1999) referred to various **interpretations** of artwork: verbal – explanation and practical - implementation. Our students cut, glued, illustrate and paint the copy - reproduction of art work, invent stories, poems, the new names for art work, they find association connected with art works, copy them and paraphrase, create **gallery animation** in our university gallery, create the vivid images, make performances and happenings, implement the principles of land-art in the outside area of university.

Well taught lessons have an aesthetic pleasure, which is associated with trouble as a part of the creative problem solving. After initial struggle with the issue and with the chosen art methods, pupil/student transforms these challenges into art through his/her own abilities and ambitions. Then comes a solution, satisfaction and release, which are related with identification of their art work (Štofko, 2010). In order to convey this precious **cathartic experience** to students-nonartist, we focuse on active support of authentic creative self-expression.

The students of teaching fine art underestimate external **motivatio**n and in their imagination of the teaching profession they prefer teaching the talented students against untalented. The reason is that for gifted pupils the students predict the internal motivation for creating, in accordance with their own experience. The aim of our teaching is to offer a new perspective on the motivational part of lessons as an opportunity to create a joyful, playful, inspirational or relaxing experience that enriches not only the lessons, but also a personality of pupil, in addition to educational goals of teaching.

The **s**tudents connect with art work through the verbalised feelings and experiences and they can get easier to demanding verbal interpretation of art work. The reflective nature of assumption formulation is typical for the visual interpretation, which creates the conditions for free expression of opinions (Gero, Tropp, 1999). These principles are conducted with our students by interviews during lessons and by possibility to **express their feelings** and their thoughts in the written reflection. Then they create texts about origin and meaning of fine art, poems and stories inspired by art works, the manifesto of a new artistic trend.

According to creators of guidelines of evaluation in the subject fine art education, L. Čarný and K. Ferliková (2012), the evaluation is difficult, because experience and interpretation of the world by artistic expression is the value connected with the individual characteristics, and the possibility of its objectification is limited. Nevertheless, sensitive resolution, indication and recognition of these values are very important for personal development of pupils.

Our students are faced with issues of evaluation in their lessons and in their practice at schools and self-assessment is a welcome part of evaluation. The students are confronted with self-evaluation of their own seminar and artistic works and their outputs during lessons. The self-assessment is also part of written reflection from their practice. The possible increasing of the self-assessment skills can be achieved by increasing of the self-knowledge by inclusion of specific art therapy creative activities. The another possibility is making a **self-reflective pedagogical diary**. The diary provides teachers the look at him/herself with the neccessary distance, reminding him/her the positives and beauty of profession, but also the negatives, so the teacher knows what to avoid in the future. He/her can review the past and plan the future of the teaching. The diary also helps in

area of mental hygiene, so required in a busy teaching profession.

This generation of the young people, studying at our university, raised with the **information technologies** from their infancy and it is quite natural for them. The use of **Internet** during the lessons requires an interesting unanswered question, a discussion or finding of a lack information. Welcome is listening to music during the practical art activities, as a background or dulcification, but also as an incentive for activity and as an integral part of painting the music. The students use the Internet for prepare their teaching units, where they imitate the art school lesson. The student represented the teacher, before entering the job, has task to encourage classmates for artistic activity and for that purpose students choose almost everytime a picture presentation or video from Internet.

The students often make an account for their class on **Facebook** in order to inform each other about studies and deadlines. They share information, tasks and topics of the term papers, create the state exam questions. In the case of mediation of some information from the teacher, they publish them on the FB account, to ensure the greatest extension of the information. The students like to watch the photos from lessons on the website of our Department (www.kvtv.pf.ukf.sk). They share photos from our experiential teaching at their personal Facebook accounts and many of photos are spontaneously made by them with their mobile phones during our lessons.

4 The Main Streams of the Education

Except of the **Personal centered education** (next only PCE) with the principles of freedom, trust, autenticity and empathy, and except of the **Creatively humanistic education** (next only CHE) as a means of developing creativity through the development of emotional intelligence, empathy and synesthetic perception, we use in our teaching the principles of one of 4 known streams of fine art education - **animocentric stream**, using the principles of **art therapy, artefiletics, spiritual fine art education and sensual fine art education**.

In a spirit of the conception **PCE** (Freiberg, Rogers, 1998), our students are encouraged to selfevaluation, to solve problems of the teaching and artistic processes on they own. They present their own work in front of the class, express their own opinion, lead the discussions. The students can comment a matter of the lessons, atmosphere and results of their and others work. They have freedom in their choice of the themes and techniques, in the processing of visual ideas and they are motivated with the teacher's non-assesment commentary.

Since the **creativity** can be increased, it is also possible to develop the properties useful for development of creativity: curiosity, independence, self-confidence, courage, motivation, self-esteem, fancy, imagination, intuition, empathy and **synesthetic perception** (Zelina, Zelinová, 1990). We include the activities of the directly or indirectly developing creativity into our lessons. The students should choose one from several reproductions with the country theme and they should to associate the music, sounds, smell; to figure out, from which movie could be the shot; to determine, what was in that movie before and after. The conception of **CHE** emphasizes the importance of **affective education**. Students are managed to **express** their **moods** by their fingers, body posture, gesture, grimace, or using the cube illustrated with the various mood expressions. **Empathy** - feeling in, is one of the principles of the conceptions PCE and also CHE. The principle of empathy was realized through the reproductions of the art works (mostly paintings) when are the persons, into which the students can emphatize. The students create a dialogue and situations in which the persons from the picture feel, think and act.

We include into our lessons the principles of the various stress included into animocentric stream. We will list their names, means and goals. The **animocentric stream** of fine art education wants to develop the children's personality through the active fine art creation (Šupšáková, 1999). **Learning, experience and evaluation of the world** has a global and ecological direction, **Spiritual Art Education** finds the **v**alues and meaning of life, **Sensory Art Education,** in artistic creation of the natural processes, including physical sensations, finds the understanding of the world (Roeselová, 2000). **Artefiletics** has aim to harmonize an imbalance between consciousness and unconsciousness through the specific themes based on the archetypes, through the presentation of the opinions in a safe group. The further means of developing the future teacher's personality is the **art therapy**, which has the ability to influence positively on people through the active reflective art creation in the save atmosphere, with the leading of art therapeutist.

We use many various **topics** from the above listed streams**,** but each class is focused on a particular specific **goal**. Many of those topics are already part of our long-termed education, for example Me (Psychological self-portrait, My name, What's in my head, Me here and now, My Two Faces), You, We, Group creation, Territory, My family, Emotions, Place where I cry/laugh, Problem, Relationships, Love, Communication (Misunderstanding, Dialogue, Quarrel), Heroes, Love yourself, My life (Panorama of life, My way of life, From where and whereto I go, Past-present-future, First steps into the future), Watercolor Action, Map of stress, What is my dream, Masks, Archetypes (Love and Hatred, Goodness and Evil, Man and Woman, God, Nature, Elements, Mandala), Mandala diary, Soul (Temple of my soul, Color and shape of my soul), Synesthesia (Music and Sounds in the classroom), Desires and wishes (What I want for Christmas, Country where I am a king, Ideal partner, Ideal myself, Ideal life), Free self-expression without the theme.

The important parts of the lessons take also these activities: visual reflection of the lesson, relaxation with visualization, projective techniques (tree, house, boat in a storm), playful drawing for two, drawing with two hands together, blindfolded palpation of objects and then drawing the objects, blindfolded drawing and modeling, relaxation drawing and painting for relaxing a stress, painting with fingers, using the principles of action-, land- and body-art. In our teaching, the focus is on the positive experience, including a reflection of work and group, as well as on the awareness of the potential pitfalls of the used art therapeutic principles.

The art therapy offers us the methods of **relaxation and imagination** (Šicková, 2000). We use the pictures of some artists with the flowers or trees for support of relaxation and imagination. The students have to imagine that they are in a nice place from the picture with somebody they love. Another way of the imagination was inspired by knowledge and the images of the prehistoric and ancient fine art. The students were transferred by the leaded visualisation to some historical period with an idea of the place, clothing and imagined activities. The relaxation was used also during familiarizing the students with some art tendency. For example the symbolism has motifs, inter alia, angels, and the students should imagine that they are in a beautiful place with an angel.

5 Researches at the University Fine Art education

Area of the fine art education seems perfect for implementing the qualitative research. At first, we devote the theoretical basis of qualitative research and its specifics regarding to the specifics of teaching fine art, next we devote the research results and findings. Our Department has tradition of the researches, as well as the future plans. We discusses a number of the **qualitative pedagogical researches** conducted in the university environment. The results of research are applied almost immediately into teaching practice, what we see like its greatest importance.

5.1 The Theoretical Basis of the Qualitative Pedagogical Researches

A qualitative approach is typical by non-quantification (Miovský, 2006), by its unique and unrepeatable, processuality

and dynamics, therefore for the need of practice we see as the most appropriate the qualitative type of research, as its character match with the specifics of the teaching fine art education. For the purposes of our teaching practice is important to examine one small group (the number of about 40 students studying at our department) more than a large group (students in Slovakia or in other departments), because the applicability of the research findings is rather limited due to the differences in circumstances.

According to A. Strauss and J. Corbin (1999), the qualitative research is uses to detect the nature of a phenomena or to obtain some new views about a known phenomena. In the teaching process, in the current changing conditions in education, there are a lot of new phenomena. In many ways we enter the uncharted land under current conditions and then is welcome when we do not have a hypothesis, because it provides freedom and authenticity of the research. The researcher is not required to explain the phenomena, more important is their understanding (Jusczyk, 2003), and it allows to remain constantly curious and suppliant in front of the mysteries of the world. The same data can be interpreted in different ways, the more in the visual arts, based on a subjective individual's experience.

The research has become a natural part of the teaching didactic disciplines of fine art. The students are actively interested in purpose of the research in which they participate, and in the research activities related with education, in content of the questionnaire, which are often the impuls for a talk. We treat the sample of students not as "objects", but as the personalities with the changing mood, changing living conditions and with the right to change views on the research subjects.

5.2 Research Findings

Below are some of our previous studies. In all cases was researcher also a teacher. Participants were always the students-future fine art teachers from our university. Research conducted over one or two semesters and data were collected during the lessons. We put a lot of emphasis on the survey of attitudes of students to different aspects of fine art education, because on these attitudes we can build and correct them at the lessons.

In order to optimize the experience of our fine art lessons we verified **the effectiveness of applying the animocentric stream** into our teaching. The research findings confirm that our students feel comfortable in the classroom due to a personal well-being and a meaningfulness of content of the subject. The impact of teaching on the level of their artistic abilities was subjective also objective positive and **art activities had a positive influence on their self-confidence**. While previously they have seen the content of subject only in obtaining information and some craft skills, later they perceived the lessons as their opportunity for self-fulfillment.

In order to find out the students **opinions to meaning and aims of fine art education**, we have found out that our students most often associate fine art education with creativity including fantasy and imagination, with relaxation, personality development including development of skills and emotional intelligence, art techniques, art skills, freedom in self-expression, aesthetic/artistic feeling/percieving, the development of perception with aim to see the beauty, motivation, art therapy including diagnostic, game/play, joy/pleasure and art history with understanding art work.

In order to base our teaching on the real ideas and experiences of our students in the field of evaluation and self-evaluation we conducted two studies. In the first study we have found that **students perceive evaluation of pupil's art work as difficult**. Their pursuit of objectivity in the evaluation is in conflicts with subjectivity of perception and expression of fine art creation and also they cannot find the positive aspects of some art works. They don't know how to boast it and they are afraid of the pupils' injury because of the teacher's assessment. The assessment at university should be also applicable to the teaching practice of students, hence the research contribution includes chosen evaluation criteria from artefiletics.

In the other research we have found that our **students considered self-assessment of their own artworks easy rather than difficult**, but difference is not significant. Some students have a sense of good ability to evaluate their own work, but the self-assessment discourages others students by its subjectivity. Impact on the perception of self-assessment by students as difficult has also present preponderance of external assessment.

In order to align the education with actual knowledge of information technology and the mass media we studied **how our students perceive the mass media**, what they know about them, what attitudes they have, how they use them and how they see their effects. **Attitude to the media is positive more than negative**. We found that some students do not know what the media is and they **have prejudices against them**.

6 How the Students Perceive the Fine Art Education

Except of a few negative reflections, mostly of our students perceive this concept positively, because they can develop without fear of failure. The negative writing reflections reflected the fear of freedom, spontaneity, openness, rare bad feelings from relaxations and fear of presentation of own thoughts. Our students wrote that they found their drawing style, and although at first they were afraid, then they were surprised from themself, they enjoyed painting, they found that they were able to do, what they even did not imagine. During this process, the students were happy and satisfied with results of their artistic creation.

Many students continued their art work at home and they shared their home art works with the teacher. The students in their reflections liked the lessons, a good atmosphere, a friendly relationship teacher-student, tolerance, they thanked for a very nice time with a good humor and openness. The students initially tended to feel fear and uncertainty of creation and its presentation in a classmates group, but with an acceptance from the educator they overcomed it.

7 Conclusion

In the area of our teaching many things happened. The study system changed, the electronic systems was introduced, the evaluation, educational, artistic and scientific work has changed. The teacher will work in the different types of schools, he/she will teach many different age groups in the changing conditions. In this area of changing circumstances we search the base for our education and we have found it in the student's personality.

Personality can be developed through each discipline - theoretical, practical and didactic. The theoretical disciplines of fine art education also have the great potential to develop the student's personality (Récka, 1996, Récka, 2000, Récka, 2010), applying the principles of education through art. In our opinion, the experience with own development, own reflections of maturing, is the most important part of university education. Although we have to conclude, that fine art education is still taught mostly by the unqualified teachers (Fichnová, Satková, Janková, 2008), we can also say, that the new generation of fine art teachers is very promising.

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Primary Paper Section: A

Secondary Paper Section: AM

SEMANTICS OF GENDER MARKED NOMINATIONS OF PERSON IN ENGLISH

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Abstract: The English language is a member of the Indo-European family of languages which had also influenced its grammar. The language is a complex system that was developing for long centuries and this development is still in progress. The development of English was influenced by some other languages, their grammar and vocabulary. Not only other languages and their impact on English had caused the development of gender marked nominations of person but also the changing society. Most of the world countries, not only English speaking, are based on principles of patriarchal society. Therefore, the majority of gender marked nominations of person is of male gender, however, feminism has contributed to development of new nominations of person in such sphere as profession or occupation. The research is based on the semantics of the sample of 660 gender marked nominations of person and their categorization into twelve semantic groups.

Keywords: gender, gender marked nominations of person, gender component, category of gender, semantics

1 The category of gender in grammar and semantics

The status of gender category had been influenced by some other languages and their grammar. If we trace in the history of the English language we will find different categories of gender in different periods of the development of this language. While many Indo-European languages have grammatical gender, English is normally described as lacking of this type of gender, although in the Old English period it was a very productive inflectional category. Gender was no more inflectional category in Modern English.
The development of gender marked nominations of person was also influenced by the development of society and by changing roles of males and females in society. Also the rise of feminism had impact on the development of new nominations marked by gender, especially in the employment sphere. In the process of the language development gender had changed its status in grammar and semantics. Tracing in different periods of language development we come to know about the changes and uses of gender category from grammatical in Old English period to natural in Modern English to nowadays.
"The English gender system is unusual in the family of Indo-Germanic languages, as well as among Indo-European languages more generally."[1]

1.1 Category of gender and its changing status

In order to focus on gender in grammar and semantics in different periods of development of the English language we must research the history of its development.
A. Curzan[2] states that Old English, dated back to 750-1100 or 1150 AD, had grammatical gender categories very similar to those of Modern German, its "sister" language.
According to T. Rastorgyeva[3] Old English nouns had three grammatical or morphological categories: number, case and gender. Nouns distinguished between three genders: Masculine, Feminine and Neutral, but strictly speaking this distinction was not a grammatical category; it was merely a classifying feature accounting, alongside other features, for the division of nouns into morphological classes. Gender in Old English was not always associated with the meaning of nouns. Nouns were distinguished according to their structure rather than meaning. Sometimes a derivational suffix referred to a noun and placed it into a certain semantic group. In case of the nouns denoting the human being the grammatical gender did not necessarily correspond to sex: alongside Masculine and Feminine nouns denoting males and females there were nouns with "unjustified" gender as it is seen on the following examples: OE *widuwa*, masc. (´widower´) - OE *widowe*, Fem. (NE widow); OE *spinnere*, Masc. (NE spinner) – OE *spinnestre*, Fem. (´female spinner´; note NE spinster with a shift of meaning) and nouns like OE *wif*, Neut. (NE wife), OE *mæʒden* Neut. (NE maiden, maid), OE *wifman*, Masc. (NE woman, originally a compound word whose second component –man was Masc.).
In Old English gender was primarily a grammatical distinction; Masculine, Feminine and Neutral nouns could have different forms, even if they belonged to the same stem (type of declension). The division into genders was in a certain way connected with the division into stems, though there was no direct correspondence between them, some stems were represented by nouns of one particular gender, others embraced nouns of two or three genders.

According to A. Curzan[4], Old English had three grammatical genders: masculine, feminine and neuter, and all inanimate nouns belonged to one of the three classes, sometimes for morphological reason, but more often for no obvious reason.

T. Rastorgeyva[5] says the later simplification of noun morphology affected the grammatical categories in different ways and to a varying degree. Gender in Old English as a classifying feature (not being a grammatical category proper) disappeared together with other distinctive features of the noun declensions. While the declension system played a certain role in the decay of the Old English declension system, in Late Old English and Early Middle English nouns were grouped into classes or types of declension according to gender instead of stems. Later development of 11th and 12th centuries brought that gender of nouns was deprived of its main formal support - the weakened and levelled endings of adjectives and adjective pronouns ceased to indicate gender. Semantically, gender was associated with the differentiation of sex and therefore the formal grouping into genders was smoothly and naturally superseded by a semantic division into inanimate and animate nouns with a further subdivision of the letter into males and females.

To prove this here is the example from Chaucer´s time when gender was already a lexical category, like in Modern English, nouns are referred to as *"he"* and *"she"* if they denote human beings and as *"it"* when they denote animals or inanimate thing:

> *She* wolde wepe, if that she saw a mous,
> Cought in a teppe, if *it* were deed or bledde.

She points here to a woman while *it* replaces the noun *mous*, which in Old English was Feminine. (´She would weep, if she saw a mouse caught in a trap, if it was dead or it bled.´)

A. Curzan[6] states that the natural gender system in Modern English, where only nouns referring to males and females generally take gendered pronouns and inanimate objects are neuter, stands as the exception, not the rule among the world´s languages.
In other periods of the English language development gender remained the lexical (semantic) category.

"Gender in language, which can be referred to by general term linguistic gender, can be defined at the most basic level as a system of noun classification reflected in behaviour of associated words."[7]

Therefore the essential criterion of the linguistic gender is taken to be agreement (or concord), or systematic and predictable covariance between a semantic or formal property of one grammatical form and a formal property of another. This is the example from Old English:

[1] Curzan, A.: Gender shifts in history of English. Cambridge University Press, 2003. p.12
[2] Curzan, A.: Gender shifts in history of English. Cambridge University Press, 2003. p.12
[3] Rastorgyeva, T.: The History of The English Language. 2nd edition, Moscow : Moscow High School, 2003. p.96
[4] Curzan, A.: Gender shifts in history of English. Cambridge University Press, 2003. p.12
[5] Rastorgyeva, T.: The History of The English Language. 2nd edition, Moscow : Moscow High School, 2003. p.224
[6] Curzan, A.: Gender shifts in history of English. Cambridge University Press, 2003. p.14
[7] Hockett, Ch. F.: A Course in Modern Linguistics. New York: the Macmillan Company, Sixth Printing; (1963), 1958. p.150

Seo brade lind wæs tilu and ic hire lufode.
That broad shield was good and I loved her. (literally ´her loved´)

The demonstrative pronoun seo ´the, that´ and the adjectives brade ´broad´ and tilu ´good´ appear in their feminine form to agree with the feminine noun lind ´shield´; in the second clause, the shield is then referred back to with the feminine pronoun hire ´her´ in accordance with the noun´s grammatical gender. As the Modern English translation demonstrates, this kind of grammatical agreement of gender has been lost, only the personal pronouns still mark gender and it is semantically, not grammatically based.[8]
According to G. Corbett´s[9] comprehensive cross-linguistic study of gender system noun classification often corresponds to biological distinctions of sex, although frequently it does not. In the case of English, there is the type of strict semantic system (referred to as semantic gender) where the meaning of the noun determines its gender and, conversely, where aspects of a noun´s meaning can be inferred from its gender.

Gender is not only associated with grammar, but it is also a social construct which can be described as the political, social and cultural significance attached to the biological differences between men and women.
***"Gender** describes the characteristics that a society or culture delineates as masculine or feminine. In sociological terms 'gender role' refers to the characteristics and behaviours that different cultures attribute to the sexes."*[10]

1.2 The status of gender component in word meaning

"The study of how meaning is encoded in a language is the central business of semantics, and it is generally assumed that its main concern is with the meaning of words as lexical units."[11]

D. Lančarič[12] states that meaning is a linguistically encoded idea or a message content that is to be transferred from the mind of the speaker/writer to the mind of the listener/reader. It concerns various linguistic forms, and it is differently classified with respect to their relationship to the referent as well as to the language user, his attitudes, social role, etc.

According to P. Kvetko[13] there are two types of word meaning: grammatical and lexical one. In grammatical meaning, the component of meaning is expressed by inflectional endings, individual forms or some other grammatical devices, e.g. word order. For example the words "boys, houses, pens", etc., though denoting different objects, have something in common. This common element of the words (expressed by the ending *–s*) is the grammatical meaning of plurality. As to the lexical meaning, comparing word-forms of one and the same word, we find out that there is another component of meaning - identical in all forms of word, i.e. the meaning of the base (or root) in a set of inflectional forms, e.g.: *go, goes, went, going, gone* (in this case: the component denoting the process of movement). This is the lexical meaning - the component of meaning proper to the word as a linguistic unit, i.e. recurrent in all the forms of this word. The lexical meaning may be understood as a set of basic semantic components (semantic features - semes).
"A sememe can be decomposed into semantic components, also called semes. Hence, the sememe is a complex or hierarchical configuration of semes, which corresponds to a single meaning of a lexeme. The method used in this connection is called componential analysis."[14]

As D. Lančarič[15] points, this analysis consists of identifying some general conceptual categories of expression and of finding some common of different semantic features between words on the basis of which the words are organized into semantic fields and in this way there can be established a whole system of relationships, such as concrete, abstract, static, dynamic, animate, non-animate, etc. The essential purpose of the componential analysis is to identify certain general conceptual categories or semantic principles which find expressions in the particular components. Among such categories are: state, process, causality, class, membership, possession, dimension, location, etc.
Table 1 shows examples of semes that can be found in words *bachelor* and *wife*:

Table 1
Semantic structure of words *bachelor* and *wife*

semes	***bachelor***	***wife***
male	+	-
female	-	+
human	+	+
adult	+	+
married	-	+
unmarried	+	-

"Componential analysis works by comparing and contrasting words within a semantic field, that is, a set of words in single conceptual domain, such as kin, parts of the body, colours, or verbs of motion. A notation of semantic components (also called markers, features or semes) is devised to summarize the similarities and contrasts in the most economical way, a procedure analogous to distinctive features analysis in phonology."[16]

As P. Štekauer[17] says here should be emphasized that semantic components are theoretical constructs, e.g. (+HUMAN), (+ANIMATE), (-CONCRETE), etc., included into semantic theory to designate language invariant but language linked components of a conceptual system that is part of the cognitive structure of the human mind. Semantic components are symbols for the fundamental language relevant features of objects of the extra-linguistic reality. They reflect the structuring of the reality by means of language.

E.g.: *woman* can be represented as the conjunction of the semantic components HUMAN, FEMALE and ADULT.
In this example we are interested in the gender component of word *woman* which is FEMALE.

2. The material under study

The empirical material was selected from Oxford Advanced Learner's Dictionary edited by A. S. Hornby[18] (Hornby, A. S., 2005, 7th edition). A number of lexicographic criteria were applied to form the language corpus, for example:

1) the lexicographic markers of human being *a person who…, somebody who…, used to say that someone is…, a word for….* in the definitions;

2) words, which indicate the gender of the referent, i.e. *a man who…, a woman who…, a male, a female, a girl, a boy, etc.*

For example:
Medicine man: <u>*a person who*</u> is believed to have special powers of healing especially among Native Americans (OALD).
In the definition of this word the first criterion is seen – <u>*a person who*</u>…. The word itself shows the gender marked nomination by the use of the word *man* that is the second criterion.
Widow: <u>*a woman*</u> whose husband has died and who has not married again. (OALD)

[8] Curzan, A.: Gender shifts in history of English. Cambridge University Press, 2003. p.17
[9] Corbett, G. G.: Gender. Cambridge University Press, 1991. p.302
[10] http://www.med.monash.edu.au/gendermed/sexandgender.html
[11] Widdowson, H. G.: Linguistics. Oxford: Oxford University Press, 1996. p.53
[12] Lančarič, D. Linguistics for English Language Students. Btarislava : Z-F LINGUA, 2008. p.51
[13] Kvetko, P.: English Lexicology. Trnava : Univerzita Sv. Cyrila a Metoda, 2005. p.46
[14] Štekauer, P.: Essentials of English Linguistic. Prešov : SLOVACONTACT, 1993. p.65
[15] Lančarič, D.: Linguistics for English Language Students. Btarislava : Z-F LINGUA, 2008. p.51
[16] Goddard, C.: Componential analysis. University of New England, 2009. p.58
[17] Štekauer, P.: Essentials of English Linguistic. Prešov : SLOVACONTACT, 1993. p.71
[18] Hornby, A. S.: Oxford Advanced Learner´s Dictionary. Oxford University Press: 7th edition, 2005.

In the definition of this word we can see the second criterion – *a woman who.* The word woman also denotes that a woman is a human being that is the first criterion.
The semantic structure of the sample of 660 gender marked nominations of person under study was analysed. These words have the same integrating semes of human being and gender. They differ in the nature of the differentiating semes. In the course of the analysis on the basis of the differentiating seme nature the words under study were arranged into the following lexical-semantic groups: Occupation, Behaviour, Relatives, Religion, Age, Social status, Activities, Relationships, Appearance, Titles/forms of address, Sexual orientation and Others. Table 2 shows the number of words in each of these groups, the percentage and examples of gender marked nominations of person for each lexical-semantic group.

Table 2

Lexical-semantic groups of GNP

№	Lexical-semantic groups	Number of words	%	Examples
1	Occupation	170	26	*aircraftwoman, butler, cleaning lady, door man, escort, fireman, Girl Friday, herdsman, jillaroo, lectrice, waiter*
2	Behaviour	84	13	*adventurer, bounder, caveman, dandy, fishwife, gorgon, heel, jessie, libertine, nebbish, queen bee*
3	Relatives	58	9	*amma, bhai, cousin sister, didi, father, grandma, half-brother, maiden aunt, uncle*
4	Religion	53	8	*abbot, bishop, clergywoman, deacon, elder, friar, goddess, lama, monk, nun*
5	Age	42	6	*boy, chica, damsel, geezer, laddie, missy, old dear, spinster, wench*
6	Social status	36	5	*archduke, baronet, count, dauphin, empress, king, marchioness, prince, queen*
7	Activities	36	5	*alderwoman, bellboy, craftswoman, fieldsman, horsewoman, majorette*
8	Relationships	29	4, 5	*baw, common-law husband, fiancé, girlfriend, homeboy, moll, old lady, wife*
9	Appearance	23	3, 5	*adonis, beardie, cracker, doll, English rose, frump, gamine, hunk, manikin, witch*
10	Titles/forms of address	20	3	*boyo, cock, guv, lady, matey, missus, mzee, sir.*
11	Sexual orientation	11	2	*homosexual, fairy, gay, ladyboy, lesbian, nancy, queer*
12	Others	98	15	*attaboy, bloke, chola, dame, enchanter, freemanson, gal, head boy, Jane Doe, madman, widow*
	Total	660	100	

2.1 Opposition of male and female

"The gender opposition female – male is a common opposition in animate nouns. There are many pairs of nouns of which one term is used for the female referent and the other for the male referent. We find this for example in the domain of animals (e.g. dog and bitch) or for terms that denote a profession (e.g. actor and actress). In many cases one of the two opposite terms has a double function: not only does it refer specifically to the female or male member, but it can also refer, in a neutral way, to the kind as a whole. This is the case, for example, in the pair actor-actress. In (1) actor is used to refer to both to the male and female performer (at least, there is no indication that the site is only meant for males). In (2) actors is opposed to actress and specifically refers to males."[19]

Table 3 represents quantitative characteristics of the lexical-semantic groups in terms of the gender seme nature.

Table 3

Quantitative characters of male and female words

Lexical-semantic group	Male words		Female words		Total number of words in groups	
	Number	%	Number	%	Number	%
Occupation	95	56	75	44	170	100
Behaviour	57	68	27	32	84	100
Relatives	28	48	30	52	58	100
Religion	39	74	14	26	53	100
Age	14	33	28	67	42	100
Social status	19	53	17	47	36	100
Activities	16	44	20	56	36	100
Relationships	13	45	16	55	29	100
Appearance	5	22	18	78	23	100
Titles/forms of address	15	75	5	25	20	100
Sexual orientation	8	73	3	27	11	100
Others	63	64	35	36	98	100
Total (words)	**372**	**56**	**288**	**44**	**660**	**100**

As it is seen in the table 3 the number of male gender marked nominations of person in English prevails and makes 371 lexical units or 56 % of the total number of GNP. The number of female nominations of person is 289 words which is 44 % of total. It can be explained by the androcentric nature of the English language.
The percentage of male nominations is the highest in the group Titles/forms of address (75% - *boyo, gentleman, lord, Mac, mister, sir, etc.*) which can be caused by the patriarchal basis of the society where men were the leading heads. Another productive groups are Religion (74% - *abbot, cardinal, god, monk, priest, etc.*) and Sexual orientation (73 % - *homosexual, fag, lady boy, nancy, queer, etc.*). The least productive group is the group Appearance with 22% (*Adonis, beardie, dreamboat, manikin, hunk, etc.*).
The most productive group according to the percentage of female words is Appearance with 78 % (*barbie doll, cracker, doll, English rose, female fatable, witch, etc.*) which can be caused by the fact that ladies are considered the fair or beautiful sex. Another productive groups are Age with 67% (*babushka, bachelor girl, chit, colleen, missy, etc.*) and Activities with 56 % (*jurywoman, horseman, choirgirl, huntress, marksman, etc.*) of female words. The least productive group in terms of percentage of female words is the group Titles/forms of address with 25 % (*gentlewoman, lady, ma´am, miss, missus, etc.*).

Interesting is also the fact that there is not a great difference in number of male and female words pointing to occupation (only 12%). This can be caused by the rise of feminism in the beginning of the 19th century the continuing stream of which has brought into use new words pointing to women. Nowadays we can also speak about political correctness. In this respect new words were created to point neutrally to both sexes, for example – instead of chairman and chairwoman there is a new neutral term – chairperson. The same happened with policeman and policewoman where the neutral word is just police officer or law enforcement officer. According to political correctness also the words containing the component *-man* were replaced: mankind to humankind, man-made to artificial and many others.

[19] Zwarts, J., Hogeweg, L., Lestrade, S., Malchukov, A.: Semantic markedness in gender opposition, blocking and fossilization. STUF - Language Typology and Universals: Vol. 62, No. 4, (2009). p.330

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Primary Paper Section: A

Secondary Paper Section: AI

THE FUNDING OF TERTIARY EDUCATION IN THE CZECH REPUBLIC - THEORETICAL BACKGROUND

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Abstract: The question of funding of tertiary education is among the most discussed topics. The key issue is to determine the proportion of public budgets and private sector involvement (including the student himself). The paper is focused on the theoretical aspects of the financing of tertiary education, which are accompanied by a brief excursion into the existing system of higher education funding in the Czech Republic. The aim of the paper is to analyze current trends in financing higher education. When processing the data and drawing conclusions are applied method of comparison, analysis and synthesis and deduction.

Keywords: tertiary education, public universities, private universities, school reform, tuition

1 Introduction

At Educational policy and the current situation in education is the subject of numerous discussions at both the professional and the general public. The specificity of this relatively wide range of problems is the tertiary education and its financing.

Contemporary Czech higher education is at a crossroads and the problems related to funding, organizational structure, relationship of training activities to science and research, competitiveness of graduates etc. can be solved only by a high-quality reform. The political climate in our country does not create the conditions for major changes in this system. The reason is the reluctance of the ruling party and the opposition to unite their views in almost anything, there is a lack of tolerance for the opinions of others, the ability to talk, compromise perspective of political rhetoric and populism. Strange coalitions also bring the problem of incompetence in senior management positions of various ministries. Ministers (including education) are often not expert in the field, but the politician of the coalition parties, which just was assigned to this resort.

If the Czech education should (or rather must) fundamentally change, it is especially necessary to take into account that: "Educational policy should be the result of consensus finding basic attitudes to the issue of education and training, which could become the basis for solving practical problems of school policy. And regardless of which government is currently in power. It is not the sort of ministry concept, programming ideas of that particular governments or even political parties. Thus conceived educational policy should ensure basic continuity in the development of education."[1]

2 Position of tertiary education in the education system

This part of the paper defines the position of tertiary education within the internationally recognized system ICED whose importance increased after the opening of the European and global labor market. Organizational chart approaches position of universities in the Czech school system. The second circuit is a brief insight into the typology of universities.

2.1 Tertiary education - part of the system

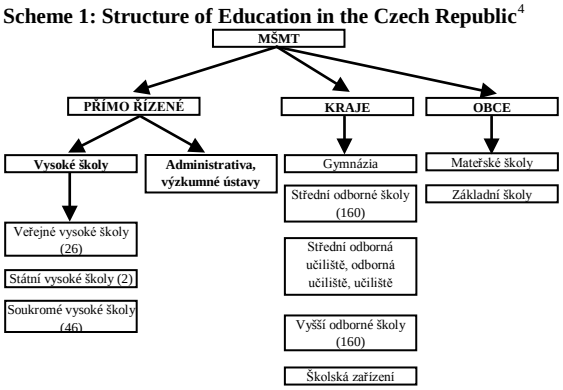
In this part of the paper is very concisely defined the position of tertiary education in relation to other levels of the education system. Internationally, ISCED[2] system is the most commonly applied and was also implemented into the Czech educational system.

Tab. No. 1: Educational level according to ISCED[3]

Level	Type of education	In the Czech Republic is responsible
ISCED 0	preprimary	kindergartens
ISCED 1	primary	primary schools (1. – 5. class)
ISCED 2	lower secondary	upper primary schools (6. – 9. class)
ISCED 3	higher secondary	ISCED 3A - four-year high school (gymnasium), vocational school, culminating in GCSE; ISCED 3C - secondary vocational schools
ISCED 4	post-secondary non-tertiary	- „extension“ respectively additional studies; - post-secondary study at language schools
ISCED 5	tertiary - the first stage (not on track to award scientific classification)	ISCED 5A - bachelor's degree, Master's degree; ISCED 5B - higher professional schools
ISCED6	tertiary - second stage (pointing directly to scientific classification)	- doctoral training culminating by Ph.D.

The inclusion of tertiary education in the organizational structure of the Czech Education presents the following chart No. 1.

Scheme 1: Structure of Education in the Czech Republic[4]



2.2 Typology of public schools

In the literature and in practice, the following are the most common categorization of universities.

Depending on the type of study:

– university: it offers Master's and Doctoral programs and associated scholarly, research, developmental, artistic or other creative activities. It can also offer bachelor's degree programs;

– non-university: offers mainly bachelor's degree programs and related research, developmental, artistic or other creative activities. The non-university type is not divided into faculties.[5]

[1] Brdek, M., Vychová, H.: *Evropská vzdělávací soustava: programy, principy a cíle*. 1. vydání. Praha: ASPI Publishing, 2004. p. 16. ISBN 80-86395-960.
[2] ISCED - International Standard Classification of Education.

[3] Potůček, M.: *Veřejná politika*. Praha: Sociologické nakladatelství (SLON), 2005. P. 292. ISBN 80-86429-50-4.
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[5] Rektořík, J.: *Ekonomika a řízení odvětví veřejného sektoru*. 2. aktualiz. vyd. Praha: Ekopress, 2007, p. 137. ISBN 978-808-6929-293.

The criteria for this division, however, seem to be insufficient at present and current trends lead to greater diversification of both groups of universities. One of the important steps in this area is the issue of the "White Paper on Tertiary Education" and stimulating "the OECD evaluation report" (Thematic Review of Tertiary Education - Country note Czech Republic), which analyzes this document. Czech universities then should be segmented, in accordance with clearly defined criteria considering the position of university in science and research, links with practice and positions of graduates. Therefore, the above breakdown is replaced by a new approach.

A new approach to classification of universities:

– Research Universities - Colleges direction of the university with a master's and doctoral programs strong focus on research and scientific activities. Number of students at these schools should not be accompanied by significant growth.

– Teaching Universities - Colleges focused on bachelor´s studies, providing increase in the number of graduates in practice. Limited scientific and research activities, while training in practical skills. This assumes a significant increase in the number of students.[6]

This approach, of course, brings different forms of financing - a substantial increase in the first category; the second category brings significant savings, but it cannot be taken as any disadvantage of "Teaching Universities" from the present status.

You can not of course overlook the legislative division of universities in the Czech Republic, which sets out the following three categories:[7]

– public universities,

– private schools,

– public schools (University of Defense and Police Academy).

It is clear that each category vary in the form of financing, while in the category of private schools their legal form can also play a significant role (NGOs, trade company).

3 Theoretical bases of tertiary education

3.1 Education as an estate

Education is very often regarded as a public estate. A certain influence has the predominant dependence of education on public budget. Recall the three basic characteristics of pure public estate: the indivisibility of consumption (and non-competition of consumers), it is excludable from consumption and has zero marginal cost of consumption for each additional consumers. In addition apart from private and public estate, it is still necessary to take into account the category of mixed estates - they are such estates, which don´t fully meet any of the conditions of Samuelson characteristics of public estates. It is advantageous to define (particularly in the area of education) as private estates with externalities.

What would be the situation if we perceive education as a pure public estate? Examples would be communist totalitarian systems in the past and present. Indivisibility of consumption excludability of consumption and zero marginal cost for each additional consumer is the reason why there is a non-competitive consumer behavior. Even dressing students in uniform clothes for stronger presentation of uniformity.

F. Ochrana favors inclusion of education into mixed estates, referring the opinions of other authors. According to R. A. Musgrave and P. Musgrave is education in the case a mixed estate - individual appropriates part of the revenues, but the revenues also account to the society. The authors also refer the education as the preferred estate where the individual underestimates the specific benefits that the society wishes him to obtain. Calculation of costs and benefits of school education is by the authors made in a way that „externalities for society that arise as a result of better-educated public are not included."[8]

3.2 Education Market

The literature also encounters the term "education market". It is clear that the education market will be characterized by certain specific features that will differ this area from "traditional market".

For example, are the following:

– educational system is characterized by high complexity and variety of both similar and more or less different institutions. Which of them is in competition with each other for scarce resources and share to cover the demand has to be clarified on the case by case basis;

– most of these institutions are not "single-product enterprise“. Especially at the tertiary level, this fact is significant. To understand some specific offer of education as a function of incurred production factors (the work of teachers, the capital in the form of school facilities and equipment) would therefore be necessary to carry out various sub-calculation according to various aspects of the offer of the institution concerned.[9]

Logically, this concept is aimed particularly at private schools, while all of the following conditions can not be fully applied to private universities of nonprofit type (e.g., public benefit corporation).

„The concept of market-economic offer of education is based on the following assumptions:

– education is a private estate in the economic sense;

– all bidders charge fees to cover costs;

– only the singular offers are taken into account, associated products of training activities shall be broken down to individual educational performance. Offers with distorted costs should be avoided, because otherwise you cannot assign actual costs to individual educational performance;

– all educational institutions behave in competitive conditions as companies that maximize their profits."[10]

3.3 Education and human capital

Another theoretical aspect, which is reflected in the debate on financing education (especially in its higher forms), is the issue of education and human capital. Although there are many definitions of human capital one of the relatively clear and simple definition of human capital defines human capital as the knowledge, skills, experience and initiative, which is owned by the individual. All costs associated with increasing size, increasing efficiency and longer "functioning" of human capital in the economic process, thus lead to an increase in the

[6] Stanovisko České konference rektorů ke Zprávě hodnotitelů OECD o českém vysokém školství. In: Masarykova univerzita Brno [online]. [cit. 2013-01-15]. Dostupné z: crc.muni.cz/pdf/resolutions/91_oecd.pdf.

[7] Česko. *Zákon č. 111/1998 Sb., o vysokých školách – text se zapracovanými novelami*. [online]. Praha: MŠMT, 2010. [cit. 2013-1-15]. Dostupné z: http://www.msmt.cz/vzdelavani/uplne-zneni-zakona-c-111-1998-sb-o-vysokych-skolach-text-se-zapracovanymi-novelami.

[8] Ochrana, F., Pavel, J., Vítek, L.: *Veřejný sektor a veřejné finance: financování nepodnikatelských a podnikatelských aktivit*. 1. vydání. Praha: Grada Publishing, 2010, p. 109-110. ISBN 978-80-247-3228-2.

[9] Roth, O.: *K modelovým koncepcím financování terciárního vzdělávání*. In: [online]. [cit. 2013-01-27]. Dostupné z: http://www.csvs.cz/aula/clanky/03-2004-2-k-modelovym.pdf..

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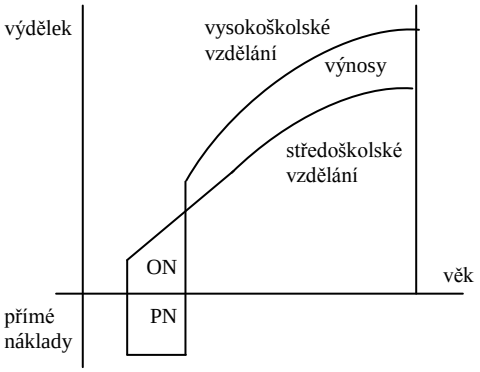
competitiveness of the individual, company or country consider as an investment in human capital.[11]

From this perspective, education can be described as a process of learning new skills, obtaining new information or understanding of diverse phenomena, which can be analyzed by the theory of knowledge, theory and behavior through social science disciplines. From this perspective it is possible to understand education as the creation, accumulation and maintenance of human capital.

The training costs occur during the learning process, i.e. at a time when students are at school, and revenues are expected later in life of the graduate. The cost of human resources development can be either public (public expenditure) and by private (fees for education, spending by companies and other investors, donations, etc.). Also, revenues and profits can be divided into public (economic growth, tax revenues, saving social costs) and private (better competitiveness, higher wages). Private revenues or profits with the public in many ways overlap.

Fig. No. 1: Costs and benefits of education in the life cycle[12]



There is only one path that allows the "crowding out" investment in social position, which allows to break the trend of "the rich getting richer and the impoverishment of the poor", the deepening of economic segregation of society, etc. - and this is the way to create the conditions under which it will be possible and profitable to invest private funds in developing people skills."[13]

3.4 Model of financing education

Following the concept of education as an estate several basic models of higher education can be drawn.

J. Vostatek defines the following basic types:

Social-democratic model of higher education - This model is based on the right to higher education and is applied mainly in the Scandinavian countries. The essential role in funding play public budgets, tuition is virtually impossible. A wide range of support and benefits for students, a significant proportion of government expenditure on education with respect to VAT. Education is considered as a public estate.

The neoliberal model of higher education - Education is considered a mixed estate. There is a possibility of choice between public and private universities. Even at public universities, however, there is the share of private funding (United Kingdom - ratio may be 50:50). The state, however, does not renounce its responsibility, availability of study is not lower thanks to the support socially weaker talented students. This model is applied in the USA, UK, Japan etc.

Conservative model of higher education - In many countries, education (acquired title) is perceived as an expression of social status and ability. There is not accordingly fully appreciated its social and also private significance (higher competitiveness on the market). On one hand, public spending clearly outweigh, but with not sophisticated differentiation and often vague efficiency. The problem is the lack of clearly specified proportion of private funding. This model is applied in many countries, including the Czech Republic.[14]

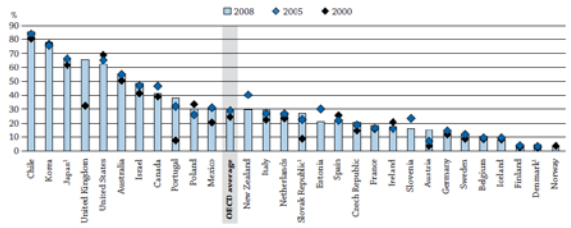
4 Tertiary education funding in the Czech republic

4.1 Pillars of tertiary education funding

This chapter includes a brief excursion into contemporary higher education funding following the theoretical aspects presented in the previous chapters.

The overwhelming part of the Czech education system is financed by the public budget of some kind, because schooling is largely regarded as a public estate.[15] Experience from abroad, but also the involvement of non-profit and business sectors in the Czech education system extends the social model by other approaches to finance this sector.

Fig. No. 2: Share of private expenditure on tertiary education in 2000, 2005, 2008[16]



Generally we can talk about four pillars of Czech higher education funding:

– normative public education funding,

– student financial aid from public funds,

– private resources of individuals and enterprises,

– public funding of research.[17]

4.2 Normative public education funding

For the objectification of expenditure on individual school subjects is used a system of normatives (nationwide, regional), which set the minimum coverage subsidy of costs per pupil per year.[18]

[11] Ochrana, F., Pavel, J., Vítek, L.: *Veřejný sektor a veřejné finance: financování nepodnikatelských a podnikatelských aktivit*. 1. vydání. Praha: Grada Publishing, 2010, p. 109-110. ISBN 978-80-247-3228-2.
[12] Ochrana, F., Pavel, J., Vítek, L.: *Veřejný sektor a veřejné finance: financování nepodnikatelských a podnikatelských aktivit*. 1. vydání. Praha: Grada Publishing, 2010, p. 115. ISBN 978-80-247-3228-2.
[13] Valenčík, R.: *Lidský kapitál a kapitálový trh*. Praha: Nakladatelství Ivo Ulrych – Růžičkův statek, 2001. ISBN 80-86579-00-X.
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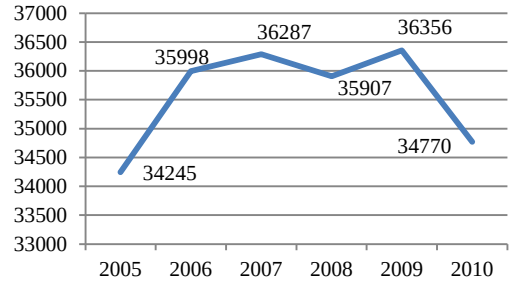
[18] Červenka, M.: *Soustava veřejných rozpočtů*. 1. vydání. Praha: Leges, 2009, p. 73. Student. ISBN 978-808-7212-110.

Fig. No. 3: The development of the average normative from 2005 to 2010 (CZK)[19]



Determination of the amount of normative is the subject of debate of unequal conditions of preparation of students of different fields of study since the beginning. Other is e.g. technical requirements on teaching philosophy, other on the study of chemical fields or medicine. Therefore, normative were added by the so called demand coefficients, which multiple with the value of normative is the state's contribution per student in the particular field.

Tab. No. 2: Coefficients of economic demands of faculties

No. of group	Group of faculties	economic performance coefficient
1	philosophy, law, theology, economics	1,00
2	pedagogical	1,20
3	technical, physical education and sports, informatics	1,65
4	natural science, agricultural, pharmaceutical, architecture, social health	2,25
5	medical, chemical, MFF, FJFI	2,80
6	veterinary	3,50
7	art	5,90

While lower levels of education are paid from local budgets, especially public universities funding is the prerogative of the state budget (Chapter 333). I would like to draw attention to the most neglected support of the regional higher education establishments. Universities have become important players in regional development and local and regional authorities have developed mainly at the beginning of the new millennium, significant efforts to have on their territory at least one branch of the major Prague universities or other centers universities. Similarly, however, acted the universities themselves. Based on the localization theories they sought to find the optimal location for its operations in the regions.

"The basic objective of localization theories and models is to define the localization factors and assuming rational behavior of economic subjects to determine the optimal placement of these entities. Localization theories are nothing more than standard microeconomic analysis of the company projected into the area.[20]

Under these conditions, of course, municipalities and regions "nurture" "their" universities and quite unpredictably contribute in areas such as investments, specific activities. One of aid is e.g. free use of property.

4.3 Financial support for students from public sources

The aim of this support is to ensure equal opportunities in terms of social or regional isolation. This includes, for example, social grants and scholarships so-called accommodation contribution.

A number of other scholarships and grants are used to support and appreciate the activities of talented students, in the case of European funds also for foreign study visits (Erasmus program). Some regions within stabilizing the work of graduates during the study provide so-called regional scholarships.

4.4 Private resources of individuals and enterprises

The question of proportion of students in financing their studies is quite clear in private universities. The student in the moment of choosing this educational institution decides whether to accept the tuition fees or not. If so, student typically enters in the contract with the university, which also includes the proper payment of tuition fees.

Tuition at public universities is still the subject of debate. On the one hand it is clear that this step is necessary to proceed, on the other hand, this issue becomes by a big part of the political scene buck passing, especially in the period preceding the elections.

Businesses subjects can enter into the system of financing universities by e.g. paying school fees of combined studies student, who is also an employee of the company. Another form is the sponsorship, shares in private schools, which operate as a trade company, etc.

Specific group are foundations and endowment funds supporting disabled and underprivileged people interested in learning (e.g. Foundation of Livia and Václav Klaus).

4.5 Public funding of research

It is a very interesting financial resource that creates space for scientific and research activities of teachers and students. Funds are obtained through successful projects that are based on the programs of the national grant agencies, Ministry of Education, regions, and to a significant extent the European Structural Funds (respectively the operational programs).

5 Conclusions

Czech higher education faces a series of major changes. It is mainly a question of concept of so-called research universities and teaching universities, i.e. desertification of tertiary education. Equally important is the fundamental reform of the financing of tertiary education. The problem is escalating in connection with the austerity measures of the government that very negatively interfere in the activities especially of public universities. One way is to go to the neoliberal model of financing tertiary education with a balanced proportion of public and private finance. It is necessary to enforce the not very popular idea that not only the state but also the individual is responsible for their position in society. Postponement of unpopular measures (such as tuition at public universities) only shifts the problem and threatens the activity and even the existence of some universities. On the other hand, there must be a system to ensure equal opportunities for all talented students, the social situation of the family should not be an insurmountable barrier.

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Primary Paper Section: A

Secondary Paper Section: AH, AM, AE

MONO VERSUS MULTIPLE CRITERIA EVALUATION OF BIDS IN PUBLIC PROCUREMENTS

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Abstract: Public procurements, contracting entities, and other subjects particular to the field of public procurements are often criticized. The media, subject matter experts and others have sufficient reasons for this criticism. The opinions on public contracts are not uniform. One of the important parts of this discussion is the criteria used to evaluate the bids. The Act on Public Contracts offers two basic evaluation criteria: the lowest tender price and the economic advantageousness of the tender. The aim of this paper is to state the pros and cons of each and to determine what criteria the contracting entities use. Equally, to identify what are the differences when using the criteria according to the subject-matter and according to contracting entity, specifically hospitals and districts of the Czech Republic.

Keywords: Public Procurements, Evaluation of Bids, Mono-criteria evaluation, Multiple-criteria Evaluation, Award Criteria, Price.

1 Introduction

The total value spent via public procurements based on the annual report by the Ministry of Regional Development fluctuates between thirteen and 16.4 percent of GDP in the Czech Republic in last six years. The value differs based on the source. The methodology to measure the total value of public procurement is not uniform. Regardless of the methodology and specific value, public procurement accounts for an important part of our national economy.

Public procurements are a frequent topic of criticism by the media, opposition politicians and others. The critics have many aspects upon which to focus. One central reason is the Act on Public Contracts (no. 137/2006 Coll.) and its' frequent amendments. Lately, the discussion on the choice of the basic evaluation criterion has increased.

2 Legal Regulation

The central legal regulation on public procurements in the Czech Republic is the Act Public Contracts. This Act incorporates the relevant legal regulations of the European Union (such as Directive 2005/75/EC of the European Parliament and of the Council, of 16 November 2005 amending Directive 2004/18/EC, on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts and Directive 2004/17/EC of the European Parliament and of the Council, of 31 March 2004, coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors).

The Act defines the evaluation criteria in general through two options for the basic evaluation criterion: economic advantageousness of the tender and the lowest tender price (§ 78). In the case of the competitive dialogue that is one type of the award procedure, the criterion economic advantageousness is used. In other types of the award procedure, the contracting entity selects the best evaluation criterion according to the tender specifics.

The economic operator is the tenderer with the lowest price in the case of the lowest tender price. In the case of the economic advantageousness of the tender, the contracting entity establishes partial evaluation criteria. The partial evaluation criteria are determined to express the relationship between the use value and the price. The set of evaluation criteria usually consists of criteria such as "*tender price, quality, technical merit of the performance offered, aesthetical and functional characteristics, environmental characteristics, impact on the employment of people with disabilities, operational costs, cost-effectiveness, sales and after-sales service, technical assistance, delivery period or period of completion*". (§ 78) The Act prohibits some partial evaluation criteria such as, the contractual terms and conditions or the terms of payment.

The contracting entity has to establish the basic evaluation criterion, respectively partial evaluation criteria, individually for each public contract. The decision as to the evaluation criteria depends on the contracting entity. Some contracting entities struggle with selecting the evaluation criteria (Ochrana, 2008). Using the incorrect criteria to evaluate bids leads to the choice of wrong operator. Subsequently, this leads to dissatisfaction, additional costs and terms extension. The worst case scenario of incorrect set of evaluation criteria is the violation of the law and it can be the subject of investigation by Office for the protection of competition. The evaluation criteria as well as all other parameters of public contract must comply with the principles of transparency, equal treatment, and non-discrimination (§ 6).

The Act on Financial Control (no. 320/2001 Coll.) adds the obligation to fulfill the principles of economy, efficiency and effectiveness labeled as 3E.

3. Comparison of Mono and Multiple Criteria Evaluation

Criteria are an important part of the process of decision-making. The criteria are the tools to measure how the alternatives fulfill the objectives (Keeney, a další, 2005). In general, criteria should be determined according to the objectives.

The professional community is not unanimous in the preferences of the basic evaluation criterion in public procurements. Both criteria have their advantages and disadvantages. The next paragraphs summarize the pros and cons of both basic evaluation criteria.

The multiple-criteria evaluation is common in real life decision-making. Even when buying yogurt, people use more than one criterion, such as flavor, price, size, brand, and some people may consider used ingredients or previous experience. Using multiple-criteria evaluation process leads usually to choice of a compromise alternative (Fiala, 2008). Finding an alternative that is the best according to all criteria is rare. Criteria usually work in opposite directions; better values according to one criterion are usually connected with those worse according to other criterion (e.g., price and time or price and quality).

As previous research demonstrates, tenderers do not trust and take less part in contracts evaluated with more criteria. The average number of bids in the case of the lowest tender price as the basic evaluation criterion is 2.75 and in the case of the economic advantageousness of the tender is 1,79 (Nikolovová, a další, 2012). According to public opinion, contracts with more criteria are pre-arranged. Receiving more bids is positive because with more bids the end price decreases. The truth of the negative relationship between number of bids and the price was proved with empirical research based on data from the Czech Republic (Pavel, 2010) and also from other countries (Carr, 2012).

Evaluation using one criterion is much easier than evaluating according multiple criteria. This does not mean that the whole process is easier. The difficulty is to determine other parameters of the item. The contracting entity has to set the desired parameters of quality into the subject-matter description, the technical specification, tender condition (Ochrana, 2008). In the yogurt example, the subject-matter description would consist of the desired flavor, size and ingredients. The tenderers would than compete only in price.

The selection of the basic evaluation criterion is the choice of parameters in which the tenderers compete (Hotra, 2008). The result of using the lowest tender price as the only evaluation criterion is lower end price. Tenderers offer only the lowest level of all parameters to reach the lowest price. Evaluating according to more criteria leads to higher end price. (Ryšavý, 2012)

In their effort to win the contract, tenderers sometimes offer such a low price that they cannot fulfill. The task of the evaluation committee is to request justification in the case of abnormally

low tender price. "*If the tenderer has failed to justify in writing the abnormally low tender price within a fixed time limit, if it has failed to turn up to offer explanations or if the evaluation committee has found the justification thereof to be insufficient, the tender shall be rejected.*" (§ 77). The survey performed by OTIDEA in 2013 proves that contracting entities do not work with abnormally low tender price properly. Only 25 percent of respondents have not met with the situation when the winning bid had the abnormally low tender price. This signifies that 75 percent of respondents have met with abnormally low tender price and this bid won the contract. Some of the respondents have met with this situation repeatedly. (OTIDEA a.s., 2013)

Some experts on public procurements criticize using the criterion of the lowest tender price as they miss evaluating the quality. The Forum for Public Procurement with High Quality was established with the goal to increase the 3E principles of public procurements. It promotes principles such as the return to quality criteria and using abnormally low tender price. The Forum is a joint project of the Chamber of Public Contract Administrators and the Ministry of Industry and Trade of the Czech Republic.

The risk in using the criterion of the lowest tender price is in selecting the bid with inferior quality and a slightly better price. Tenderers are not motivated to offer quality.

The contracting entity has the opportunity to evaluate quality of the bids with quantitative and qualitative criteria. Qualitative criteria are not appealing to the tenderers. The higher importance (weight) the qualitative criteria have, the less bids are received. Nikolova et al have calculated the relationship between the importance of the qualitative criteria and number of bids – lowering the importance of qualitative criteria by 14 percent adds one extra bid (Nikolovová, et al, 2012).

The criterion of the lowest tender price is suitable for easily definable and standardized subject-matters such as, simple construction works or consumer goods. The utility of these subject-matters does not differ much on the market. If the purchased item is input or material it has probably well-defined parameters and the lowest price is suitable criterion (Pavel, 2008). Alternately, the lowest price is recommended to use to evaluate complex procurements where is hard to define the criteria such as consulting services (Hotra, 2008).

The economic advantageousness of the tender is convenient criterion where is a need to evaluate operating costs and in the cases when different parameters of the procurement significantly change the utility but not the price (Hotra, 2008).

Some risks are connected witch each type of basic evaluation criteria. Evaluation according to the lowest price may lead to receiving less quality, to excluding some potential tenderers due to strict tender conditions and technical specification. The economic advantageousness of the tender discourages the tenderers to compete. With economic advantageousness of the tender comes the danger of violating the principle of transparency.

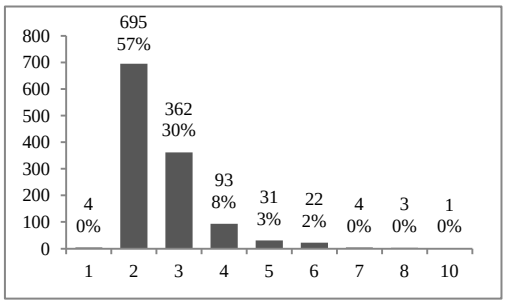
4. Research

In our research, we have analyzed contract notices publicly available on Information System on Public Contract (www.isvzus.cz). A total of 8 395 forms of contract notices were announced in 2012. Some forms just corrected previous information. We have removed duplicate public contracts. The number of analyzed contracts was 6 085.

64 percent of analyzed public procurements evaluated the bids according to the lowest tender price. In 47 public procurements the contracting entity did not complete the basic evaluation criterion (0.7 % of contracts).

The rules on the presentation of the public procurement allow not publishing the partial evaluation criteria on the Information System on Public Contract. The partial evaluation criteria are then specified in detailed documentation available on request. In 1217 cases the contracting entity specified the partial evaluation criteria on the Information System on Public Contract.

Figure 1 Number of partial evaluation criteria



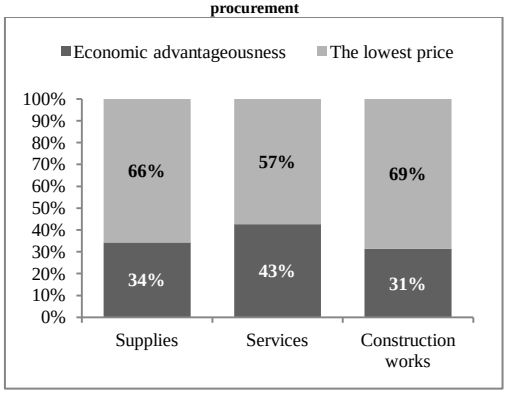
Source: Information System on Public Contract, own calculations

The number of procurements according to the partial evaluation criteria portrays the Figure 1. The highest number of criteria was ten. Only one contracting entity used ten partial evaluation criteria. The most common number of partial evaluation criteria used to evaluate bids is two. Two partial evaluation criteria were used in more than half of public procurements using the economic advantageousness of the tender. 99 percent of public procurements used two to six partial evaluation criteria. Using more than six criteria is rare.

In four cases, the contracting entity used only one partial criterion. It indicates improper completion of the form on the Information System on Public Contract.

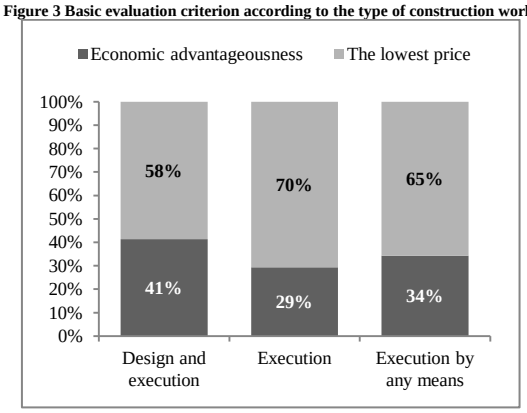
Recommendations on the use of the basic evaluation criterion advise to use them according to the specifics of the contract. The lowest tender price is suitable for some contracts while the economic advantageousness of the tender is suitable for others. The proportion of procurements with the lowest price on the total number of procurements according to the subject-matter displays Figure 2. The lowest price is used the most often to evaluate bids of construction works, least in services.

Figure 2 Basic evaluation criterion according to the subject-matter of procurement



Source: Information System on Public Contract, own calculations

Figure 3 Basic evaluation criterion according to the type of construction works



Source: Information System on Public Contract, own calculations

The subject-matter of construction works covers three different types of procurements: design and execution, execution and execution by any means, in accordance with the requirements specified by the contracting authority. According to theoretical assumptions, criteria used in these types should differ as the character of these types. Numbers of procurements evaluated according to the two basic evaluation criteria for the types of construction works are displayed on the Figure 3. Based on the Figure 3, we can see differences between the levels of using the price.

To find out if the differences in the proportion of procurements used to evaluate bids between the subject-matter are statistically significant, we used chi square test. We tested the hypothesis that the choice of the basic evaluation criterion is not dependent on the subject-matter of the contract. Alternatively the choice is dependent so the difference in the percentage of using price is significant.

The authors performed a standard chi-square test for association. The outcome from the Minitab 16 Statistical Software is Chi-Sq = 52,776; DF = 2; P-Value = 0,000 (Table 1). We can reject the null hypothesis. There is very strong evidence, that the basic evaluation criterion is not independent on the subject-matter of the contract.

Table 1 Results of Chi-Sq test on the association between subject-matter and basic criterion

	Economic advantageousness of the tender	The lowest tender price	Total
Supplies	864 901,34 1,547	1661 1623,66 0,859	2525
Services	715 598,27 22,774	961 1077,73 12,642	1676
Construction works	576 655,39 9,616	1260 1180,61 5,338	1836
Total	2155	3882	6037

Source: Information System on Public Contract, own calculations

The Table 2 displays results for chi-square test for association performed to find the association between the basic evaluation criterion and the type of construction work. The outcome is Chi-Sq = 13,457; DF = 2; P-Value = 0,001. The results are similar to the previous but a little less strong. Still the test offers strong evidence against the hypothesis about the same proportion of procurements with price among the types of construction works.

Table 2 Results of Chi-Sq test on the association between types of construction works and basic criterion

	Economic advantageousness of the tender	The lowest tender price	Total
Design and execution of construction works	91 69,20 6,868	129 150,80 3,152	220
Execution of construction works	395 422,75 1,821	949 921,25 0,836	1344
Execution of construction works by any means, in accordance with the requirements specified by the contracting authority	72 66,05 0,535	138 143,95 0,246	210
Total	**558**	**1216**	**1774**

Source: Information System on Public Contract, own calculations

Based on the recommendations, the basic evaluation criterion should differ in contracts by the same contracting entity if the purchase different items. We considered only contractors with more than five public procurements to examine if they tend to use the same criterion or not. We excluded public procurements when the contractor did not complete the type of criterion. The total number of contracting entities with more than five public procurements is 199. 77 percent of these contracting entities used both types of basic evaluation criterion. 71 percent of contracting entities who used only one type of basic evaluation criterion used the lowest tender price.

The analysis of the number of procurements with each type of criteria according to subject-matter used by different types of contracting entities brings interesting results. Significant part of contractors with more than five procurements is hospitals. Hospitals used the lowest tender price in 76 percent of procurements.

The most common subject-matter purchased by hospitals was supplies, specifically in 83 percent of cases. In 73 percent of procurements with hospitals purchasing supplies were the bids evaluated according to the lowest tender price.

Table 3 Number of public procurements according to subject-matter and type of basic evaluation criterion

	Supplies	Services	Public works	Total
Economic advantageousness of tender	95	21	13	**129**
The lowest tender price	349	34	24	**407**
Total	**444**	**55**	**37**	**536**

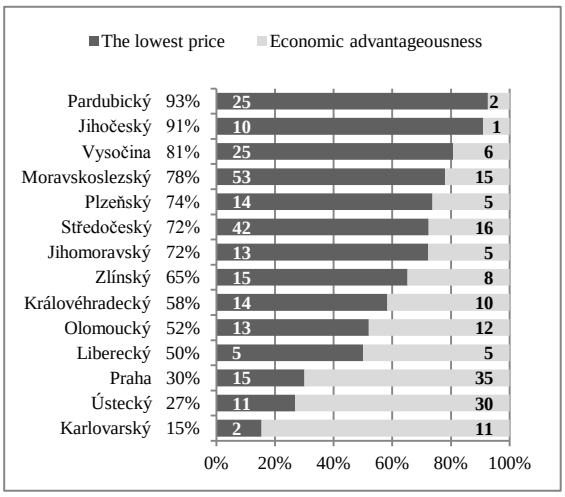
Source: Information System on Public Contract, own calculations

The items purchased by hospitals are devices such as blood separator, ultrasound device, incubator, material such as plasters, gauze, different kinds of implants and solutions. These items are purchased often, are well known by hospitals, it is not the first time they purchase them. These characteristics indicate using the lowest tender price. Hospitals followed the recommendations about using the lowest tender price.

The next analyzed type of contracting entity is districts. Czech Republic is divided into 14 districts. Situation with using the types of criteria among the districts is not as clear as with hospitals. The level in using the lowest tender price as the basic evaluation criterion differs among the districts. The Figure 5 shows the number of procurements evaluated according to the lowest tender price and number of procurements evaluated according to the economic advantageousness of the tender and proportion of procurements evaluated according to price on the total number of procurements by the districts.

The level of using the price as the basic evaluation criterion differs among the districts (see Figure 4).

Figure 4 Number of procurements evaluated by the two types of criteria by district



Source: Information System on Public Contract, own calculations

The minimum proportion of procurements evaluated according to price was 15 and it was used by Karlovarsky district. On the other side, the maximum proportion was 93 percent. The difference in using each type of evaluation criterion among the districts is significant. No conclusion can be made based on this

data. The purchases among the districts differ. The districts do not purchase the same items so they do not use the same criteria.

Jihočeský district purchased eleven times, eight of the ten was execution of construction work. In this case, using price to evaluate bids make perfect sense. Ústecký district purchased sixteen times services, four supplies and 21 executions of construction works. This explains the use of both types of criteria.

5. Conclusion

Both types of basic evaluation criterion have its advantages, and disadvantages as risks. The contracting entity has to weigh pros and cons of each other and also asses the subject-matter of procurement.

The performed analysis proves that contracting entities differentiate procurements and based on the specifics of the procurement select the basic evaluation criterion. This behavior is in compliance with the general recommendations.

In 36 percent of procurements the contracting entities used the economic advantageousness of the tender as the basic evaluation criterion. To select the best bid they performed multiple-criteria evaluation. Next analysis was focused on two groups of contracting entities with more than five procurements in 2012 – on hospitals and districts. Hospitals use the price evaluation criterion in most cases and the most common subject-matter is supplies. The authors believe that the reason for this choice is well known and repeating supply, and the contracting authority is able to thoroughly describe the tender subject. In the case of the districts this conclusion cannot be made as the subjects of the tenders differ.

Contacting entities use different criteria for different subject-matters of contract. This conclusion is positive. Some information indicates that contracting entities are forced to use only the lowest tender price (OTIDEA a.s., 2013). It was not proved based on analysis of procurements in total as by districts and hospitals.

Topics for next research are technical specifications, tender specifications and subject-matter description. The contracting entity has to set these parts of the procurement to define the desired quality. Well defined technical specifications, tender specifications and subject-matter descriptions are assumption to evaluate the bids according to price without problems.

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Primary Paper Section: A

Secondary Paper Section: AE

SELECTED ASPECTS CONNECTED WITH EBIT DETERMINANTS IN THE LARGEST POLISH QUOTED COMPANIES

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Abstract: The Earnings Before Interest and Taxes (EBIT) issues constitute the significant role in enterprises decisions. In that area particular attention should be put on the identification of determinants, which may influence on the EBIT level. The main purpose of this paper is the estimation of EBIT determinants of enterprises qualified to the largest polish quoted companies. The special attention was put on such determinants as: operating revenues, operating costs, other operating revenues and other operating costs. The examinations are based on simple linear regression method. The researches are based on data from financial statements of analysed enterprises from period 2001–2011.

Keywords: EBIT determinants, the largest polish quoted companies.

1 Introduction

Nowadays enterprises nowadays have to constantly adjust to changes, which occurred in their surroundings. The quickness of enterprises reaction might result in their maintenance on market as well as the efficiency of strategy realization. In that area the significant role plays effective decision taking process, which should take into consideration many external and internal indicators connected with functioning of enterprises in turbulent environment.

The essential area of enterprises decisions are related to EBIT (Earnings Before Interest and Taxes) as the important financial result of enterprises' activity. In its essence EBIT establishes the principal measure, which allow (in vicariously way) the enterprises strategy effectiveness estimation as well as its market position. EBIT are also treated as the one of important component, which should be taking into consideration in enterprise value estimation. The significance of EBIT caused the necessity of examination the potential determinants, which may impact on the level of enterprise financial result.

The main objective of the paper is the identifications of EBIT determinants. The researches are focused on the largest polish quoted companies. The examinations are based on financial data from financial statements of enterprises quoted on the Warsaw Stock Exchange.

2 The essence of EBIT and its determinants – theoretical studies results

The contemporary enterprises financial theories emphasize the significance of constantly maximizing company value[1]. According to A.C. Shapiro, S.D. Balbirer (2000) maximizing company value is treated as specific compromise between enterprise and its personnel, customers and contractors[2]. That occurrence consequences in the necessity of enterprise management orientation on increasing benefits for owners through maximizing expectations value of interest groups connected with company. The above theory constitute in Value-Based Management conception, which are treated as the principle enterprise attitude. R.A. Morrin, S.L. Jarrell (2001) indicates that Value-Based Management conception is treated as a culture, which embrace all enterprise – from managers to direct workers[3].

It should be remarked that company value are dependent on determinants, which are usually entitle as the "value drivers"[4]. The literature analysis indicates heterogeneous „value drivers" classifications, which generally emphasize the rank of micro and macro-economical factors. To the significant corporate value determinants depiction is recon A. Rappaport (1999) classification, which accents the importance of strategic "value drivers" connected directly with enterprise board activity[5]. Through selected "value drivers" A. Rappaport special attention puts on EBIT, especially on its margin, which impact on the value of net profit, cash flows from operational activity and, in consequences, on enterprise value[6].

The importance of EBIT is also expressed as the essential component in the majority of methods, which allow the estimation company value. The special attention on EBIT emphasise especially income based valuation methods, which base on establishment that the principle of enterprise value constitute incomes from company activity in particular period of time in future[7]. The significance of EBIT in company value calculation is epecially seen in Equity Cash Flow (ECF) method, Free Cash Flow (FCF) method, Capital Cash Flow (CCF) metod as well as Adjusted Present Vaule (APV) metod[8].

The conducted consideration indicates the significance of EBIT in enterprise. Therefore, there is essential to hold examinations connected with the identification the determinants, which influence on the level of company Earnings Before Interest and Taxes. It has to be said that the estimations should concentrate on such determinants as: operating revenues, operating costs, other operating revenue, other operating costs.

3. The methodology of examinations

The researches were concentrated on EBIT determinants identification. To the examinations were chosen the largest polish companies quoted on Warsaw Stock Exchange. The selections of enterprises were based on WIG20 Index, which consists of twenty dominant and the most liquid companies from main stock market[9]. According to WIG20 Index at the end of 2011, to the researches were chosen the following companies[10]: POWSZECHNA KASA OSZCZĘDNOŚCI BANK POLSKI S.A. (PKO), KGHM POLSKA MIEDŹ S.A. (KGHM), BANK POLSKA KASA OPIEKI S.A. (PEKAO), POWSZECHNY ZAKŁAD UBEZPIECZEŃ S.A. (PZU), POLSKI KONCERN NAFTOWY ORLEN (PKNORLEN), PGE POLSKA GRUPA ENERGETYCZNA S.A. (PGE), TELEKOMUNIKACJA POLSKA S.A. (TPSA), TAURON POLSKA ENERGIA S.A.

[1] See more among others: Jensen, M.C., Meckling, W.H.: *Theory of the Firm: Managerial Behaviour, Agency Costs and Ownership Structure*. "Journal of Financial Economics" 1976, vol. 3, no. 4; Harris, M., Raviv, A.: *A Capital Structure and the Informational Role of Debt*. "Journal of Finance" 1990, vol. 45; Masulis, R.W.: *Changes in Ownership Structure. Conversion of Mutual Savings and Loans to Stocks Charter*. "Journal of Financial Economics" 1987, vol. 18.

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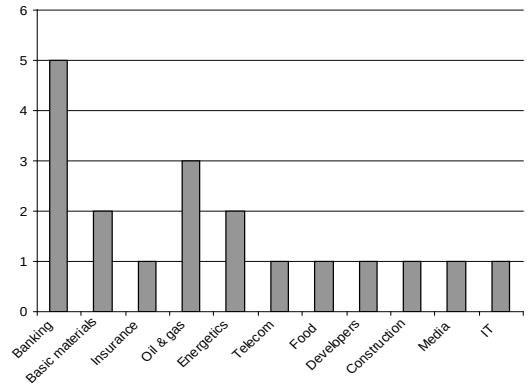
(TAURONPE), POLSKIE GÓRNICTWO NAFTOWE I GAZOWNICTWO S.A. (PGNIG), BANK ZACHODNI WBK S.A. (BZWBK), GETIN HOLDING S.A. (GETIN), BRE BANK S.A. (BRE), ASSECO POLAND S.A. (ASSECOPOL), KERNEL HOLDING S.A. (KERNEL), LUBELSKI WĘGIEL BOGDANKA S.A. (BOGDANKA), GLOBE TRADE CENTRE S.A. (GTC), ČEZ. A.S. (CEZ), GRUPA LOTOS S.A. (LOTOS), TVN S.A. (TVN), PBG S.A. (PBG).

It has to be said that from examinations was excluded company CEZ, because approximately 70% of its shares belonged to Czech Republic Treasury[11]. The sector's structure of analysed enterprises indicates that the majority of them representing banking sector (graph 1). Significant group of enterprises from WIG20 Index compose also oil and gas companies as well as basic materials and energetics enterprises.



Graph 1. The sector's structure of largest polish quoted companies (according to WIG20 Index at the end of 2011)
Source: Own calculations.

The researches contain period 2001–2011. In studies were used financial data from financial statements of analysed enterprises.

The examinations concern on the EBIT determinants in enterprises qualified to the largest polish quoted companies were based on simple linear regression[12]:

$$Y = \alpha_0 + \alpha_1 x + \varepsilon \quad (1)$$

where:
Y – endogenous variable,
α_1 – regression coefficient variable Y in regard to variable X,
α_0 – intercept,
x – exogenous variable,
ε – random component.

The significance of estimated models structural parameters was verified using t-Student test with n-(k+1) degrees of freedom.

The identification of the level of model matching to empirical data were conduct using the coefficient of determination (R^2)[13]:

$$R^2 = \frac{\sum_{i=1}^{n} (\bar{y}_i - \bar{y})^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2} \quad (2)$$

where:
$\bar{y}_i$ – theoretical value of variable Y,

To first order autocorrelation testing was used Durbin – Watson test. In that area was applied empirical statistics d [14]:

$$d = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2} \quad (3)$$

where:
e_t – the rest of the current period,
e_{t-1} – the rest delayed by one period.

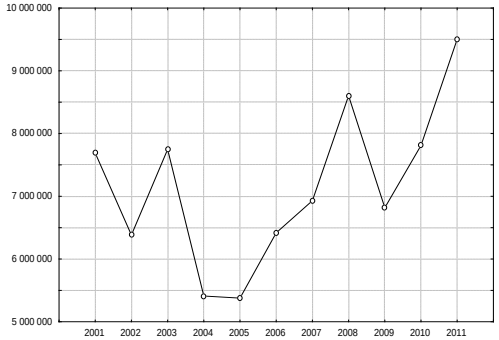
In reserchers as endogenous variable Y was accepted the arithmetic average value of EBIT of the largest polish companies quoted on Warsaw Stock Exchange.

The exogenous variables were comprised the following EBIT determinants: net sales revenues (X_1), operating costs (X_2), other operating revenues (X_3) and other operating costs (X_4). The above variables were quantifiable as the following:
- (X_1) was expressed as the arithmetic average of the analysed companies operating revenues value,
- (X_2) was described as the arithmetic average of the analysed enterprises operating costs value,
- (X_3) was expressed as the arithmetic average of the analysed companies other operating revenues,
- (X_4) was described as the arithmetic average of the analysed enterprises other operating costs value.

The examinations indicate the sufficient variation of exogenous variables (the coefficient of variation was higher than 0,1) as well as the lack of collinearity between them.

4. The results of EBIT determinants' estimation in the largest polish quoted companies

The examinations indicate the lack of homogeneous tendency of the level of analysed EBIT determinants in the largest polish companies quoted on Warsaw Stock Exchange (graph 2 – graph 5).



Graph 2. The presentation of the arithmetic average of operating revenues in the analysed companies in period 2001–2011 (in thousand PLN).
Source: Own calculations.

The calculations show that from analysed EBIT determinants the highest changes appeared in period 2001–2011 in the value of operating revenues in the largest polish companies quoted on Warsaw Stock Exchange (graph 2). That situation is especially seen in periods 2003–2004 and 2008–2009 and might constitute the consequences of polish economic slowdown, which were observed in the above periods, on enterprises operating revenues. Moreover, the analysis shows the positive occurrences of operating revenues value increasing in the period 2009–2011, especially in the face of the significant decreasing level of operating cost in analysed companies (average value).

[11] http://www.gpw.pl/karta_spolki/CZ0005112300/#akcjonariat [05.06.2013].
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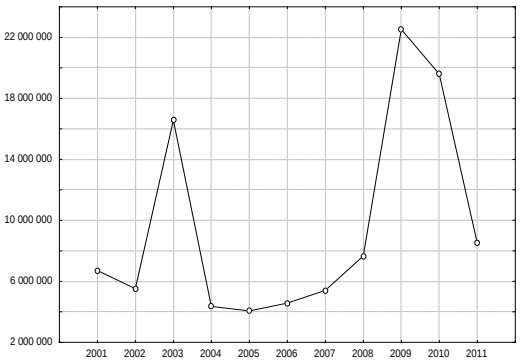
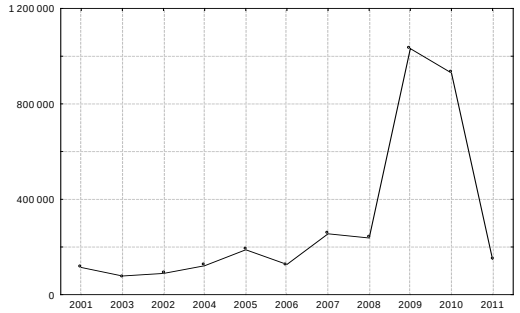
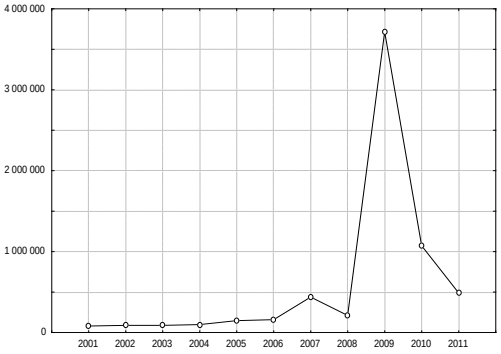


Graph 3. The presentation of the arithmetic average of operating costs in the analysed companies in period 2001–2011 (in thousand PLN).
Source: Own calculations.



Graph 4. The presentation of the arithmetic average of other operating revenues in the analysed companies in period 2001–2011 (in thousand PLN).
Source: Own calculations.



Graph 5. The presentation of the arithmetic average of other operating costs in the analysed companies in period 2001–2011 (in thousand PLN).
Source: Own calculations.

The results of studies emphasize that average value of other operating costs are higher than average value of other operating revenues in period 2001–2011 in the largest polish companies quoted on Warsaw Stock Exchange (according to WIG20 Index at the end of 2011) (graph 4–graph 5). The effects of examinations show that in three quarters of analysed enterprises the value of other operating costs was on average higher than 10908 thousand PLN while in the same three quarters of companies the value other operating revenues was on average higher than 8853 thousand PLN. Furthermore, the estimations indicate that analysed enterprises characterized the similar tendency between other operating revenues and other operating costs.

The statistical significance verification of exogenous variables was conducted on the base of the following hypothesis:

H_0: exogenous variable insignificantly impact on endogenous variable *Y*,
H_1: exogenous variable significantly impact on endogenous variable *Y*.

The results of simple linear regression, which described the influence of exogenous variables on endogenous variable *Y* present table 1.

Table 1. The simple linear regression results of exogenous variable X_1, X_2 , X_3, X_4, and endogenous variable Y in the largest polish companies quoted on Warsaw Stock Exchange

Variable	Coefficient	t_{ei}	Value p	R^2
a_0	4569245,193	0,170	0,869	
X_1	0,134	1,723	0,119	0,248
a_0	26782293,818	0,565	0,586	
X_2	0,263	0,064	0,950	$0{,}454 \cdot 10^{-3}$
a_0	34005921,375	0,951	0,586	
X_3	-15,541	-0,193	0,950	0,004
a_0	26698705,732	0,878	0,403	
X_4	4,326	0,169	0,869	0,003

Source: Own calculations.

The results of the estimations emphasise the lack of statistical significance impact exogenous variables X_1, X_2, X_3, X_4 on endogenous variable Y. Therefore, the effects of examinations indicate that operating revenues, operating costs, other operating revenues as well as other operating costs not affect on Earnings Before Interest and Taxes in the largest polish companies quoted on Warsaw Stock Exchange.

Moreover, the calculations show that the level of model matching to empirical data was very low, especially for X_2, X_3 and X_4, and amount in the range $0{,}454 \cdot 10^{-3} \leq R^2 \leq 0{,}248$.

Conclusions

The effects of examinations conduct to the conclusions that the largest polish companies quoted on Warsaw Stock Exchange (according to WIG20 Index at the end of 2011) characterize lack of EBIT dependence on operating revenues, operating costs, other operating revenues and other operating costs in whole period 2001–2011. Thereby, the above determinants, which might be treated as internal, do not influence directly on Earnings Before Interest and Taxes in analysed enterprises. It means, that the largest polish companies quoted on Warsaw Stock Exchange have not got possibility to influence on their value through proper shaping of EBIT determinants. Furthermore, the achieved results show that in the largest polish companies quoted on Warsaw Stock Exchange the EBIT might be determined by other factors, which might be connected with macro-economic surroundings of companies.

The complexity of EBIT determinants require further studies. They should be connected with the identification other factors, which might statistical significant influence on Earnings Before Interest and Taxes in the largest polish companies quoted on Warsaw Stock Exchange. On the other hand, the future examinations should continued the undertaken researches in the other analysed period context.

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Primary Paper Section: A

Secondary Paper Section: AH

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BN ASTRONOMY AND CELESTIAL MECHANICS, ASTROPHYSICS
BO BIOPHYSICS

OPTIMAL CAPITAL STRUCTURE OF THE ENTERPRISE

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Abstract: The aim of the paper is a holistic review of the issues associated with optimal capital structure. In the first part of the paper, there is the description and comparison of the analyses sample, i.e. enterprises operating in construction businesses. Then, the paper analyses the impact of factors determining capital structure and empirical verification of validity of theories related to optimal capital structure in conditions specific for the Slovak Republic.

Keywords: Capital structure, size of the business, tangibility, profitability.

1 Introduction

While studying domestic and foreign literature pertaining to the issue of optimal capital structure, one could say that Slovak literature deals with models designed and verified abroad. However, these models have not yet been entirely applied and tested on businesses operating within the Slovak Republic.
We tried to carry out empirical research related to capital structure issues of Slovak businesses in the Slovak Republic by applying models designed in developed economies, e.g. Titman and Wessels (1988), Rajan a Zingales (1995), Graham a Harvey (2001). We examined their reporting ability and statistical significance and based on observed results the applicability of models was either recommended, modified or entirely rejected.

2 Description and comparison of the analyses sample

We gathered necessary data from forty enterprises operating in construction business for the years 2010 to 2012. For our own analysis of compliance with the conclusions of the theory of optimal capital structure, it was first necessary to identify and quantify the variable which could serve as basis for the construction of models as well as for the examination of selected hypotheses. This variable is clearly an indicator of total indebtedness.[1]

We have observed development of this variable both for the industry as such as well as for our sample. Table 1 shows the evolution of total indebtedness according to the industry and sample.

Table 1 Total indebtedness

Year	2010	2011	2012
Total indebtedness of the sample	0,71	0,74	0,77
Total indebtedness of the industry	0,76	0,79	0,76

As we can see, during the analysed period the total indebtedness of our sample rose from 0.71 to 0.77. Conversely in the industry, we can see that after an initial increase from 0.76 to 0.79 in the year 2011, in the year 2012, the total indebtedness fell to its original value of 0.76. We can also conclude that the values representing industry and our sample do not differ significantly.

In addition to the total indebtedness, it is necessary to analyse given debt's structure, i.e. to analyse the respective amount of short-term and long-term liabilities. For this reason we focused on long-term indebtedness, which is quantified as the ratio of long-term liabilities to total assets. Its development for the industry and our sample is stated in Table 2.

Table 2 Long-term indebtedness

Year	2010	2011	2012
Long-term indebtedness of the sample	0,05	0,06	0,06
Long-term indebtedness of the industry	0,10	0,09	0,10

Long-term indebtedness for the entire analysed period, both for industry and analysed sample did not exceed 10%, which means that it is significantly lower than total indebtedness. The fact that the importance of the long-term indebtedness is marginal in capital structure of Slovak businesses may seem quite surprising at first sight. However, taking into account the amount and proportion of equity to total assets, it is clear that most businesses do not hold life of assets and maturity of financial resources used for their purchase in time line. Reasons for this cannot be found on side of businesses, but in their surroundings, i.e. in commercial banks and capital markets. It is because in order to minimize risk associated with long-term loans, Slovak banking institutions prefer short-term loans with short maturity periods, after repayment of which a new loan may be drawn. In other words, Slovak banks prefer revolving financing. The state of development of capital market (this type of market is rather undeveloped in the Slovak Republic) has also considerable impact on this fact. Businesses have limited opportunities for obtaining long-term financial resources in the form of bonds issued on the financial market.

3 Capital Structure Determinants

While searching for determinants of businesses` capital structure we have used conclusions obtained during study of foreign literature. Based on confrontation of these theoretical approaches and empirical data obtained by analysis of Slovak businesses capital structure and based on results of models designed abroad (e.g. Bradley, Jarrell, -1984; Kim Sorensen, -1986; Friend, I., Lang, L.-1988; Titman, S., Wessels, R.-1988; Chaplinsky, S., Niehaus, G.-1993; Frank, M. Z., Goyal, V. K.-2004; Kester, C. W.-1986; Rajan, G., Zingales, L.-1995; Wald, J.-1999; Bevan, A., Danbolt, J.-2000; Gaud, P.-2003; Wiwattanakantang, Y.-1999; Booth, L.-2001; Huang, S.-2002) we have chosen following factors determining capital structure:

1. size of a business,
2. tangibility,
3. profitability,
4. non-debt tax shields,
5. risk,
6. growth (investment) opportunities,
7. results from previous years (i.e. delay in timing),
8. dummy variables.

In this paper, we will focus on the first three factors, i.e. the size of a business, tangibility and liquidity of assets and profitability.

3.1 The size of the business

We presumed that there is an inverse relationship between the size of a business and the probability of bankruptcy. Larger businesses achieve higher and more stable cash flows. These flows are also secured by a number of business activities, i.e. these are diversified. Therefore, the probability of bankruptcy of larger businesses is lower than one of the smaller businesses.

This fact is resulting from the trade-off theory which presumes that the size of the business and its debt are positively correlated. A positive relationship between the size of a business and its debt is suggested also the Agency Theory. This theory stipulates

[1] Total indebtedness shall be determined as ratio of difference between total assets and equity and total assets of given business.

that agency costs of small and large businesses are not the same due to the relatively higher costs of monitoring for small businesses. Probably due to lower informational asymmetry, larger companies have easier access to bond market, and can borrow at a lower cost.

On the other hand, relatively lower information asymmetry has exactly the opposite interpretation as regards the Pecking Order Theory. According to this theory, businesses with lower information asymmetry (e.g. large companies) prefer equity more than smaller businesses. In order to express the size of the business most published studies use the natural logarithm of sales.[2]

3.2 Tangibility

Term "tangibility" could be easily translated as the collateral value of assets. According to the Trade-off Theory, businesses can use their tangible assets as collateral for repayment of debt, which allows gaining secured debt that is usually cheaper than the unsecured one. Trade-off Theory together with Agency Costs Theory stipulates that the fact that ownership of tangible assets by businesses is positively tied up with its debt capacity.

On the other hand, Agency Costs Theory points out the cost of existing debt negotiation together with the fact that business may reorient on riskier investments by issuance of debt and to transfer wealth from creditors to stakeholders. If the business´s tangible assets are sufficiently "large", these could be used as collateral to reduce the creditor´s risk. In general, high proportion of tangible assets is usually associated with higher indebtedness.

For businesses with a higher proportion of tangible asset, lower information asymmetry brings exactly the opposite conclusions when Pecking Order Theory is applied. As we already mentioned when discussing the variable "size of a business", fewer "troubles" with informational asymmetry lead to preference for equity. In other words, a negative relationship between tangible assets and indebtedness may be expected. As a variable, a ratio of tangible assets and total assets was used.

3.3 Profitability

Various theories do not offer a single prediction for profitability. While the Trade-off Theory, Signalling Theory and Agency Cost Theory expect a positive relationship between profitability and indebtedness, Packing Order Theory expects negative relationship. The argumentation is as follows:

The Trade-off Theory model assumes that the profitable businesses should lend more due to the fact these have a greater need for reduction of corporate taxes which is enabled by debt through tax shield. Agency Costs Theory, using different reasoning, considers the debt as a mean of discipline to ensure that managers procure for paying out of profits instead of building their own power. In businesses with free cash flow or high profitability, high debt may help keep manager´s caution under control. In both cases then, a higher profitability should lead to higher indebtedness. Signalling Theory suggests that profitability and indebtedness are positively related. In case of informational asymmetry, the increase in debt gives the market signal on the value of the business, i.e. its expected profitability.

Packing Order Theory, on the other hand, argues that businesses prefer financing of new investments from profits retained during previous years, and that increase in own capital is used only if other forms of obtaining capital are not available. The ability to create internal capital resources depends on the profitability of business. Hence, according to this theory, it could be argued that there is a negative relation between debt and profitability.

[2] To reflect the size of the business, however, we can use the natural logarithm of total assets, tangible assets, etc.

As a criterion for measuring profitability, we have selected the respective share of operating profit EBIT on businesses´ total assets as a criterion for measuring profitability, due to the fact that EAT and EBT levels of profit do not seem to be an adequate measure.

4 Testing Hypothesis

Based on data on forty Slovak businesses operating in construction business we have designed three models. Model I. has been designed on the basis of econometric analysis. Using this model, we have tried to describe indebtedness of Slovak businesses. Model II was designed as a standard linear regression model of dependence of total indebtedness of construction businesses on variables as are profits, tangibility, profitability and non-debt tax shield. Model III was designed based on the previous values, i.e. based on the delay in timing.

In the following part of this paper we would like to refer to testing of hypotheses related to given set of variables. In order to test the hypotheses, we have used our own empirical researches, analysis and respective mathematical and statistical instruments.

Prior to testing, it was necessary to determine critical values of Student and Fisher distribution. It also seemed necessary to follow relevant degrees of freedom, because these are different for almost any type of models. Their values are in the table 3.

Table 3 Critical values of Student and Fisher distribution

degree of freedom		t - test					F - test				
		35	34	33	114	115	(4;35)	(5;34)	(6;33)	(5;114)	(4;115)
level of signific.	α = 0,1	1,69	1,6909	1,6923	1,6583	1,6582	2,1128	2,0244	1,9607	1,8985	1,9944
	α = 0,05	2,0301	2,0322	2,0345	1,9809	1,9808	2,6415	2,4936	2,3894	2,2939	2,4506
	α = 0,01	2,7238	2,7283	2,7332	2,6196	2,6192	3,9082	3,6106	3,4059	3,182	3,4867

Source: Own calculations

Hypothesis 1: The size of a business affects its capital structure.
Based on data in Table 4 we have tested given hypothesis for all types of models and respective years. The size of a business was expressed as natural logarithm of sales. As we can see, the relationship between sales and indebtedness is positive for all models and years (positive mark by estimator). Based on this, we could state that by increasing volume of sales the volume of indebtedness also rises. However, statistical significance of this factor is low. It is due to the fact, that neither level of significance showed the absolute value of t-calculated higher or equal than critical values of respective degrees of freedom of Student distribution.

We have rejected hypothesis 1, that the size of business expressed by natural logarithm of sales is statistically significant.

Table 4 Testing Table

ln sales		Model I				Model II				Model III
		2010	2011	2012	10-12	2010	2011	2012	10-12	10-12
estimator		+	+	+	+	+	+	+	+	+
t-calculated		0,01330	0,4090	0,9998	0,1407	0,9676	0,7954	0,0373	0,98967	0,7157
level of significance	α = 0,1	1,6895	1,6895	1,6895	1,6582	1,6909	1,6909	1,6909	1,6583	1,6923
	α = 0,05	2,0301	2,0301	2,0301	1,9808	2,0322	2,0322	2,0322	1,9809	2,0345
	α = 0,01	2,7238	2,7238	2,7238	2,6192	2,7283	2,7283	2,7283	2,6196	2,7332

Source: Own calculations

If the size of a business is determined by natural logarithm of assets, the obtained results will appear slightly different if compared to previous model. The relationship between total indebtedness and natural logarithm will be positive again. However, the statistical significance of estimator in various models will change. As we can see in the Table 5, the estimator for assets will be statistically significant in respect to Model I in 2010, Model II in 2010and also during years 2010-2012. This could mean that in order to describe relationship between total indebtedness and size of a business, a variable of total assets appears to be more suitable. Taking into account this fact, the rejection of hypothesis 1 seems questionable.

Table 5 Testing Table

ln assets		Model I				Model II				Model III
		2010	2011	2012	10-12	2010	2011	2012	10-12	10-12
estimator		+	+	+	+	+	+	+	+	+
t-calculated		**2,4306**	1,0776	0,2815	1,2569	**2,5309**	1,5503	0,9713	**2,6978**	0,8999
level of significance	α = 0,1	1,6895	1,6895	1,6895	1,6582	1,6909	1,6909	1,6909	1,6583	1,6923
	α = 0,05	2,0301	2,0301	2,0301	1,9808	2,0322	2,0322	2,0322	1,9809	2,0345
	α = 0,01	2,7238	2,7238	2,7238	2,6192	2,7283	2,7283	2,7283	2,6196	2,7332

Source: Own calculations

Hypothesis 2: Tangibility of business affects its capital structure
The results of comprehensive testing of this hypothesis are summarized in Table 6. With the exception of the Model I in 2010, the relationship between total indebtedness and tangibility, expressing collateral value of assets, is negative. This shall mean that the total indebtedness decreases if the value of ratio of long-term tangible assets to total assets of business increases and vice versa.

Table 6 Testing Table

Tangibility (ln T)		Model I				Model II				Model III
		2010	2011	2012	10-12	2010	2011	2012	10-12	10-12
estimator		+	-	-	-	-	-	-	-	-
t-calculated		1,6386	0,3661	**2,0872**	0,1407	1,5979	0,4210	**2,1119**	1,3481	**4,9988**
level of significance	α = 0,1	1,6895	1,6895	1,6895	1,6582	1,6909	1,6909	1,6909	1,6583	1,6923
	α = 0,05	2,0301	2,0301	2,0301	1,9808	2,0322	2,0322	2,0322	1,9809	2,0345
	α = 0,01	2,7238	2,7238	2,7238	2,6192	2,7283	2,7283	2,7283	2,6196	2,7332

Source: Own calculations

In Table 7, we focus on development of tangibility estimator if the size of business is expressed by natural logarithm of assets.

Table 7 Testing Table

Tangibility (ln A)		Model I				Model II				Model III
		2010	2011	2012	10-12	2010	2011	2012	10-12	10-12
estimator		+	-	-	-	-	-	-	-	-
t-calculated		1,9870	0,2456	1,9516	1,1100	1,9429	0,2643	1,8369	0,9986	**4,4202**
level of significance	α = 0,1	1,6895	1,6895	1,6895	1,6582	1,6909	1,6909	1,6909	1,6583	1,6923
	α = 0,05	2,0301	2,0301	2,0301	1,9808	2,0322	2,0322	2,0322	1,9809	2,0345
	α = 0,01	2,7238	2,7238	2,7238	2,6192	2,7283	2,7283	2,7283	2,6196	2,7332

Source: Own calculations

With the exception of the Model III and selected years of Model I and Model II, we rejected the hypothesis of statistical significance of tangibility. This means that:

We reject the hypothesis 2 that tangibility is a statistically relevant variable of the model.

Hypothesis 3: Profitability of business affects its capital structure.

There is a negative relationship between profitability and total indebtedness of a business. With the exception of Model I and Model II in the year 2012 when the profitability estimator is statistically insignificant, we accepted the hypothesis of statistical significance of a given variable. It is also notable, that this variable is statistically significant even at the level of significance $\alpha = 0.1$.

Table 8 Testing Table

Profitability		Model I				Model II				Model III
		2010	2011	2012	10-12	2010	2011	2012	10-12	10-12
estimator		-	-	-	-	-	-	-	-	-
t-calculated		**3,5014**	**4,3037**	1,4436	**4,3666**	**3,0704**	**3,8626**	1,4075	**3,9218**	**2,9703**
level of significance	α = 0,1	1,6895	1,6895	1,6895	1,6582	1,6909	1,6909	1,6909	1,6583	1,6923
	α = 0,05	2,0301	2,0301	2,0301	1,9808	2,0322	2,0322	2,0322	1,9809	2,0345
	α = 0,01	2,7238	2,7238	2,7238	2,6192	2,7283	2,7283	2,7283	2,6196	2,7332

Source: Own calculations

Table 9 Testing Table

Profitability		Model I				Model II				Model III
		2010	2011	2012	10-12	2010	2011	2012	10-12	10-12
estimator		-	-	-	-	-	-	-	-	-
t-calculated		**4,1626**	**4,5124**	1,4647	**4,6834**	**3,4967**	**4,0965**	1,5867	**4,2980**	**3,1720**
level of significance	α = 0,1	1,6895	1,6895	1,6895	1,6582	1,6909	1,6909	1,6909	1,6583	1,6923
	α = 0,05	2,0301	2,0301	2,0301	1,9808	2,0322	2,0322	2,0322	1,9809	2,0345
	α = 0,01	2,7238	2,7238	2,7238	2,6192	2,7283	2,7283	2,7283	2,6196	2,7332

Source: Own calculations

We see (Table 9), that the statistical significance of variable of profitability was also confirmed for this model reflecting the size of a business by natural logarithm of assets. Therefore:
We accepted hypothesis 3 that profitability is statistically significant variable of the model.

5 Conclusion

One of the key areas of financial management of business is deciding on the composition of its resources. Capital structure is essential for successful development of business as it provides for its healthy financial development, overall prosperity and it also decides on its further existence. In other words, the importance of capital structure is determined by its effect on financial risk, profitability and future financial disposition of the business. In addition, suitable adjustment of capital structure is a way to maximize market value of respective business. This means that every business should pay sufficient attention as regards the issues pertaining to capital structure.

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Primary Paper Section: B

Secondary Paper Section: A

LOCOMOTION MECHANISM FOR PIPE INSPECTION TASKS

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Abstract: The pipe mechanisms play significant role for applications like inspections, wearing of cables, materials and other devices. The paper deals with motion analysis of pipe mechanism with shape memory effect actuator. At first, the principle of motion and design solution of experimental pipe mechanism is introduced. Then the mathematical model is established by means of Newton´s mechanics. The mechanism (robot) can be used for pipes with circular section with diameters 10 – 15 mm. For real behavior determination the experiments with robot were done. Then the experiments were compared with mathematical model. In the conclusion the advantages and disadvantages of pipe robot using SMA spring – steel spring actuator are discussed.

Keywords: friction, locomotion, mechanism, pipe

1 Introduction

There are several kinds of areas where the pipes are used which have to be researched or explored, for example nuclear power plant, heat-exchanger, etc. Often they cannot be researched by man because of its dangerous environments and conditions or its unavailability. Hence there should be used some kind of robot which is able to moves through the pipe. In the paper the in-pipe robot will be investigated, which is for small pipe diameter designed.

There are a several issues what are under the research concerning in-pipe robots like difficult task to choose suitable actuators, sensors, power supply, etc. [1] There are two basic approaches for robots motion design, namely wheeled and bristled locomotion [2][3]. Different approach is unconventional way of motion using several SMA springs creating body in square shape according to work [4].

In our study bristled in-pipe robot will be investigated. The bristled locomotion on the friction differences is based. In other words, coefficient of friction is lower in the forward direction in comparison with backward direction [5]. It can be reached by suitable design solution of bristles [6][7]. As an actuator the SMA spring in conjunction with steel spring will be used.

The paper is divided into following sections: At first mechanical design of in-pipe robot consisting of SMA and steel spring is introduced. Next section is dedicated to the mathematical model of robot motion in the pipe. Fourth chapter deals with experimental analysis of SMA spring. In the fifth chapter the experiment with robot is done in order to verification of locomotion with mathematical model can be done. In the conclusion the advantages and disadvantages of used in-pipe bristled robot are discussed.

2 Mechanical design of pipe robot

There are several issues concerning the in-pipe robots. One of them is design of their actuator. In the past there were investigated in-pipe robots with different actuators like geared DC motor, actuators based on magnetic field impact, actuators based on SMA (shape memory alloy) wires, etc. [8][9][10]

For our study unconventional approach was chosen by using actuator consisting of two subjects, namely SMA spring and steel spring. The actuator uses SME (shape memory effect) what means, that by heating of SMA spring, the spring is widen. In the next phase the SMA spring is cooling and now it becomes shapeable. In this phase the steel spring plays its role by shortening the SMA spring. So, by repeating of heating and cooling of SMA spring we can reach forward motion of robot. The principle of mentioned actuator in the Fig. 1 is shown. The red color denotes heating phase of SMA spring and blue color denotes cooling phase of SMA spring.

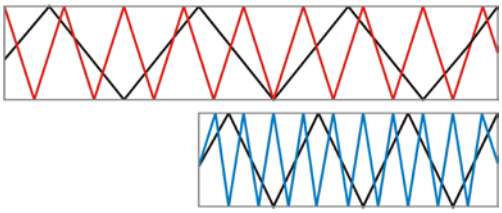

Figure 1 Heating and cooling of SMA spring

During the cooling phase the SMA spring can be shortened to 16 mm. During the heating phase the SMA can be lengthened to 30 mm with over 4 N/m force. In software SolidWorks 3D model of in-pipe robot was designed, see Figure 2.

Figure 2 CAD model of in-pipe robot

To ensuring that cooled SMA spring will moves forward not backward is achieved by bristles, attached to front and back part of robot. As will be mentioned later, expected forward motion will be reached by difference of friction between forward and backward direction of bristles.

3 Mathematical model of pipe robot locomotion

The mathematical model of bristled locomotion has its foundation in the nature. The model is inspired by earthworm or inchworm, which can move by means of difference of friction causes by bristles. The sequence of motion in the Figure 3 is shown.

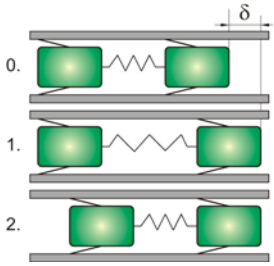

Figure 3 Sequence of in-pipe robot locomotion

The locomotion is divided into two phases. The traveled distance during one locomotion sequence is δ. By repeating of these two phases the robot performs forward motion through the pipe.

3.1 First phase of locomotion

During the first phase the second mass moves forward because of difference of bristles friction. The first mass motion can be expressed by following equation

$$F_S + F_{fS} - F_{SMA} = 0 \tag{1}$$

where *Fs*, *Ffs* and *FSMA* are force of steel spring, static friction and force of SMA spring, respectively. Static friction force is

$$F_{fS} = \mu_S F_N \eta \tag{2}$$

where μs is static friction coefficient and *FN* is load force. The symbol η represents function, described by

$$\eta = \begin{Bmatrix} 0 \forall v \neq 0 \\ 1 \forall v = 0 \end{Bmatrix} \tag{3}$$

The second mass motion can be expressed by following equation

$$F_{SMA} - F_S - F_f > 0 \tag{4}$$

where *Fsma*, *FS* and *Ff* are force of SMA spring, force of steel spring and friction force, respectively. By consideration of dry friction between in-pipe robot bristle and wall of pipe, the friction force by Coulomb friction can be represented, according equation (5).

$$F_f = \mu_C F_N \operatorname{sgn}(v) \tag{5}$$

where μc is Coulomb friction coefficient and *FN* is load force. Sgn(v) represents signum function, which can be expressed by equation (6).

$$\operatorname{sgn}(v) = \begin{Bmatrix} 1 \forall v > 0 \\ 0 \forall v = 0 \\ -1 \forall v < 0 \end{Bmatrix} \tag{6}$$

Coulomb friction force depends only on mass velocity direction, not on velocity magnitude. From the equations (1) and (4) can be obtained terms for friction coefficients.

$$\mu_S = \frac{F_{SMA} - F_S}{wg\eta} \tag{7}$$

$$\mu_C < \frac{F_{SMA} - F_S}{wg \operatorname{sgn}(v)} \tag{8}$$

where *w* is weight of in-pipe robot mass. It is obvious, that the higher difference between static and Coulomb friction coefficient is, the higher average velocity the robot can reaches. The difference between these two coefficients can be reached by suitable design solution of bristles.

3.2 Second phase of locomotion

During the second phase of locomotion, the SMA spring is cooled. When SMA spring is cooled enough it loses its force and the steel spring starts pull the first mass forward. The second phase can be described by similar way as first phase and friction coefficients are

$$\mu_C < \frac{F_S}{wg \operatorname{sgn}(v)} \tag{9}$$

$$\mu_S = \frac{F_S}{wg\eta} \tag{10}$$

4 Experimental analysis of SMA spring and pipe robot bristles

As was mentioned above, the SMA spring changes its length by means of two actions, namely heating and cooling. The heating phase is reached by connecting of SMA spring ends to the voltage supply, what allows to current flowing through the spring, whereby the spring heats and its length expands. During the second phase the supply of current is prevented and during this time the SMA spring cools and its length is shortened by affecting of steel spring.

4.1 SMA spring testing

For testing of SMA spring the package of steel linear springs was used. The stiffness of each steel spring was determined and these springs were used as opposite spring to the SMA spring in order to obtain a load for SMA spring.
In the Figure 4, the displacement in dependence on current is shown.

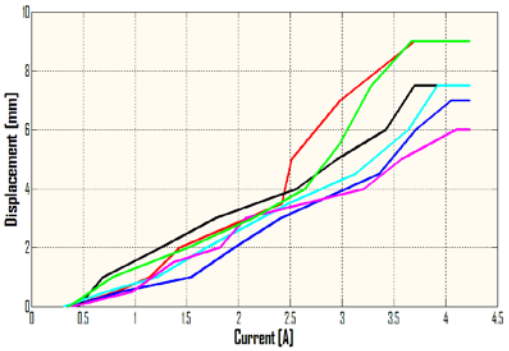

Figure 4 Displacement of SMA spring with focus on current flow

The current flowing through the SMA spring is relatively high, over 4 A for 2 V. We can see that SMA spring is very demanding for current consumption what is ineligible from the view of autonomous of system, because accumulators of small dimensions for this task are inapplicable.

4.2 Friction coefficient measuring of pipe robot bristles

Friction coefficient of in-pipe robot bristles plays very significant role for its locomotion through the pipe. The lower Coulomb friction coefficient of bristle in comparison with static friction coefficient is, the higher velocity the robot will has. The basic assumption of robot forward motion is that the friction coefficient in forward motion in lower that friction coefficient in backward motion.

Friction coefficient in both direction by means of tribometer is determined. Friction coefficient from the next equations in obtained.

$$F_f - wg \sin\alpha = 0 \tag{14}$$

$$F_N - wg \cos\alpha = 0 \tag{15}$$

By next adjustment the static friction coefficient is expressed by equation (16):

$$\mu_S = tg\alpha \tag{16}$$

Tribometer is connected to the linear potentiometer in vertical axis. The output from potentiometer through the measuring I/O card MF624 is recorded in Matlab / Simulink which cooperates with measuring card by Real Time Toolbox. The output from Simulink is measured coefficient of friction. From measuring of friction coefficient was found that

$$\mu_{Forward} = 0.449 \tag{17}$$

$$\mu_{Backward} = 0.589 \tag{18}$$

Friction coefficient in forward direction is lower than friction coefficient in backward direction, whereby the forward motion is achieved. Friction coefficient in forward direction can of course be reduced by suitable mechanical modification according to user need.

5 Experimental analysis of pipe robot locomotion

For experiment the glass pipe with circular section with diameter 13 mm is used. The first aim of experiment is find out

the differences between the real model and mathematical model. The second aim is analysis of power consumption which is necessary to robot locomotion. The third aim of experiment is to analyze SMA spring as actuator, its advantages and disadvantages for these purposes.

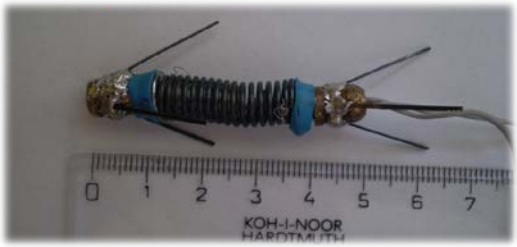

Figure 5 In-pipe robot in the pipe

In the third chapter was mentioned that one motion cycles consists of two phases. But difference between real and theoretical model is that SMA spring heats and cools the time which is significantly higher than the time which was considered in mathematical model. From the view of mathematical model the average velocity of in-pipe robot can be increased by suitable design solution of bristles what causes higher difference between static and Coulomb friction coefficient. In the reality this difference between these two coefficients is not very significant, rather negligible. This is caused because the time, necessary to heat the SMA spring and the time, necessary to cool, is very high. For example, when the current flow to the SMA spring is prevented, it takes a significant time while SMA spring cools and its force is lower in comparison with force of steel spring, which shortens SMA spring.

Connection and disconnection SMA spring to the voltage supply was automatized by means of 32-bit microcontroller BasicAtom Pro-28M. The problem with long time for cooling was partly solved by blower, which was directed to the heated place. Because of microcontroller dimensions, it could not be part of robot and it is placed out of the pipe.

Next point of experimental part is investigation of electric power consumption by actuator SMA spring – steel spring. The electric current and electric power consumption by means of MF624 were measured according to scheme, which in Matlab / Simulink was created.

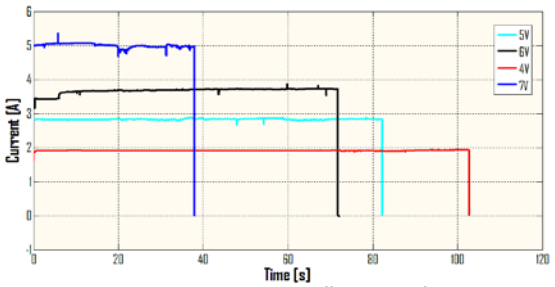

Figure 6 First phase duration caused by different value of current input

As can be seen in the Fig. 11, the higher current input is, the lower time the first phase lasts. In other words, by higher current we can achieved faster heating of SMA spring and then first phase duration lasts lower time. Nevertheless, the time of heating is still too high even if we use higher value of current for heating. Given results are results that were obtained using blower for faster cooling phase.

The highest disadvantage of this kind of in-pipe robot is SMA spring heating and cooling phase which takes a lot of time what causes very slow locomotion, in our case only 2 mm/min.

6 Conclusion

In the paper motion analysis of in-pipe robot moving in the pipe with circular section with 13 mm diameter was investigated. At first mechanical design of experimental in-pipe robot is introduced. From the mathematical model the coefficients of friction in both directions are expressed.

In-pipe robot using actuator SMA spring – steel spring has advantages like very simple control, low weight, small dimensions. In spite of these advantages its disadvantages are very significant. One of the most disadvantage is the duration of heating and cooling phase. They can be a little bit modified but this modification is highly limited.

The system is autonomous in the straight pipes through the microcontroller BasicAtom Pro28-M. The next disadvantage of SMA spring is that it required high electric power consumption, whereby classical battery utilization becomes useless.

In the future the SMA spring – steel spring actuator should be modified by suitable solution of SMA spring cooling. For the tasks where does not matter on the velocity of robot and application time this kind of robot can be useful.

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Primary Paper Section: B

Secondary Paper Section: JD, JQ, JR, JT, BE

G AGRICULTURE

GA	AGRICULTURAL ECONOMICS
GB	AGRICULTURAL MACHINES AND CONSTRUCTION
GC	PLANT GROWING, CROP ROTATION
GD	FERTILIZATION, IRRIGATION, SOIL TREATMENT
GE	PLANT CULTIVATION
GF	DISEASES, PESTS, WEEDS AND PLANT PROTECTION
GG	ZOOTECHNICS
GH	NUTRITION OF FARM ANIMALS
GI	FARM ANIMAL BREEDING AND FARM ANIMAL PEDIGREE
GJ	BDISEDAISES AND ANIMAL VERMIN, VETERINARY MEDICINE
GK	FORESTRY
GL	FISHERY
GM	FOOD INDUSTRY

EFFECT OF INCREASED DOSES OF COMPOST TO PREPARE RECLAMATION SUBSTRATE ON SOIL RESPIRATION AND CONTENT OF MINERAL NITROGEN IN THE SOIL

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Abstract: This paper deals with the effect of increased doses of compost in reclamation substrate on soil respiration and content of mineral nitrogen in soil. To demonstrate the effect of increased doses of compost (300 % of recommended dose) on soil respiration and content of mineral nitrogen in soil, the pot experiment was performed. Five variants with the same doses of compost and different doses of mineral organic fertilizers were prepared. The highest respiration was determined in variant with compost addition. And the highest content of mineral nitrogen was found in variant with only addition of mineral fertilizers. These results point to the positive effect of higher doses of compost on microbial activity in the soil and the availability of soil nutrients.

Keywords: compost, respiration, mineral nitrogen, arable land, soil fertility

1 Introduction

Modern agriculture is facing many problems: decline of soil fertility, compaction of soils, and contamination of water sources, which have different causes.
In many countries throughout the world, agricultural soils are being degraded at an alarming rate by wind and water erosion, salinization, nutrient depletion and desertification (Abdel-Sabour & Al-Seoud, 1996). This is due to the lack of organic matter in the soil (SOM). These problems can be solved only by a change of farming systems. The fundamental change is to increase the content of organic matter in the soil.
Abdolahi et al. (2013), Naeth & Wilkinson (2013) and Diaz et al. (2007) state the compost is a source of organic matter and nutrients for soil microorganisms. Moreover, compost has positive effect on soil properties (content of nutrients, soil structure etc.).
In agriculture, the main positive aspect of compost use is probably related to the sustainability of this practice. To society as a whole, the production of compost gives the opportunity of closing the cycles of nutrients (Diaz et al., 2007).
Quality of soil organic matter is the cornerstone of sustainable agriculture. To maintain a productive and sustainable agricultural system, agricultural soils must be managed as an ecological system using diverse plants and organisms, to provide a suitable energy flux and nutrient cycling, to prevent nutrient and soil loss and to provide pest and disease control (Franco & De Faria, 1997). Therefore, it is necessary to use waste organic matter obtained after harvest.
The transformation of fresh OM into compost is carried out mainly for three reasons: (1) to overcome the phytotoxicity of fresh non-stabilized OM; (2) to reduce the presence of agents (viruses, bacteria, fungi, parasites), that are pathogenic to man, animals and plants to a level that it does not further constitute a health risk, (3) to produce an organic fertilizer or a soil conditioner and to recycle organic wastes and biomass (Diaz et al., 2007).
Diaz et al. (2007), Tandy et al. (2011), Abdolahi et al. (2013) and Naeth & Wilkinson (2013) confirm positive effect of compost and addition of reclamation substrates made from it on soil fertility. This positive effect is based on chemical composition of compost, because more than 80 % of the total nitrogen content in compost is organic. This form of nitrogen is very suitable for microorganisms so it can be used for further development of soil microbial communities. Development of soil microorganisms is very important for plant growth and for the retention of nitrogen in soil.
In the present paper, effect of increased doses of compost to prepare reclamation substrate on soil respiration and content of mineral nitrogen in soil samples was tested. This research was conducted with soil samples from the protection zone of underground drinking water source "Březová nad Svitavou". This protection zone is located in the northern part of the Czech-Moravian highland and aims to protect this source against contamination by pollutants. Unfortunately, this protection is not effective proven by increase of the mineral nitrogen concentration in the drinking water from this area. It is caused by excessive application of mineral fertilizers in the second half of the 20th century. Excessive use of mineral fertilizers caused disruption to soil microbial complex. At present, this microbial complex is disrupted by atmospheric deposition containing nitrogen.
Hypothesis, which claims that increased addition of compost stimulates growth of soil microbial communities, was tested. This paper presents the results of a laboratory experiment, carried out by the Department of Microbiology. The aim was to detect the consequences of the high amount of compost application (300% of recommended dose) on soil respiration and content of mineral nitrogen in soil samples.

2 Materials and methods

The present experiment is sub-section of a larger experiment, which was focused on monitoring the impact of increased doses of compost on soil phytotoxicity, leaching of mineral nitrogen from arable soil, soil pH and conductivity.

2.1 Experimental design

Cumulative production of carbon-dioxide (CO_2) and concentration of mineral nitrogen (N_{min}) were determined in soil samples, which were removed from pot experiment after 35 days.
Fifteen experimental containers with same proportions were used for the experiment (see Figure 1).

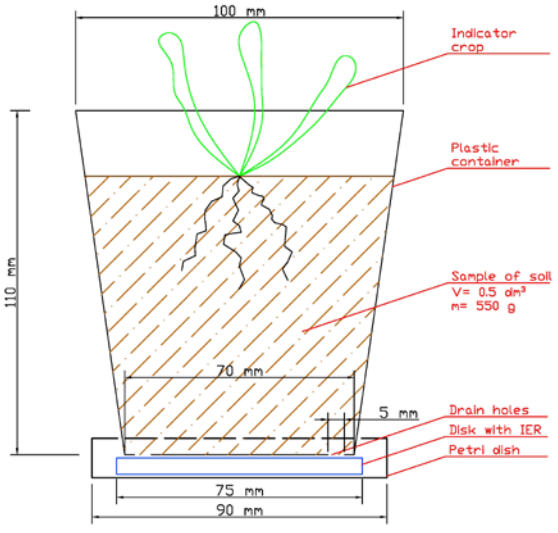

Fig. 1 Experimental container

These containers were filled with 550 g of soils with or without the addition of compost and mineral fertilizers. Soil samples were removed on the 10th of November 2012 from field in the protection zone of underground drinking water source "Březová nad Svitavou" in accordance with ČSN ISO 10 381-6. Compost samples were taken on the 30th of November 2012 from the company "CKB a.s" in accordance with ČSN EN 46 5735.

Special type of organic waste compost (Black Dragon – BD) was used for the experiment. BD is registered for agriculture use in the Czech Republic. BD was applied into the experimental containers together or without organic (Lignohumat Type B - LGB) and inorganic (mineral fertilizers GSH) fertilizers.
These fertilizers are also registered and Elbl et al. (2013) defines these fertilizers as follows: Lignohumat is a product of chemical transformation of lignosulfonate. This material is completely transformed into the final product: solution containing 90 % of humic salts (humic and fulvic acids in the ratio 1:1). GSH is a common mineral fertilizer containing N, P, K and S in the ratio 10:10:10:13.
Before the establishment of the experiment, samples of compost and soil were sieved through a sieve (grid size of 2 mm). After the end of the experiment, soil sampling was done from rhizosphere of the model plant. These soil samples were sieved again through a sieve (grid size of 2 mm) and then used for the determination of the N_{min} content and production of CO_2.

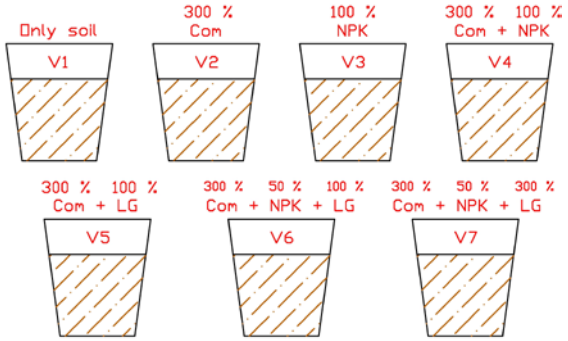

Fig. 2 Distribution of the laboratory experiment

Seven variants of experiment were performed (see Figure 2). Individual variants of experiment in detail: V1 – control variant (only soil) without addition of compost or another fertilizer. Into variants V2, V4 – V7, doses 90 g of compost were applied. This dose of compost is three times greater in comparison with the recommended dose in accordance with ČSN EN 46 5735 (50 Mg ha^{-1}). In conversion, this dose represents 150 Mg ha^{-1}. These variants (V4 – V7) were further complemented by: V4 – application of 90 g m^{-2} GSH; V5 – application of 50 ml m^{-2} of LG B; V6 – application of 50 ml m^{-2} of LG B + 45 g m^{-2} GSH (50 % of the recommended dose); V7 – 150 ml m^{-2} LG B (300 % of the recommended dose) + 45 g m^{-2} GSH. Furthermore, variant 3 (V3) was fertilized with only mineral fertilizer. Dose of 90 g m^{-2} GSH (100 % of the recommended dose) was applied in this variant.

2.2 Determination of N_{min} in soil samples

The amount of N_{min} in soil samples was determined by distillation-titration method after extraction with 2 M KCl .
This method was described by Bundy & Meisniger (1994). The content of N_{min} was performed by extraction with 2 M KCl. Extraction was realized in sealed glass containers. From each replication (V1 a, b, c; V2 a, b, c; V3 a, b, c etc.), 20 g of soil was collected. This sample was inserted into glass containers and shook for 60 minutes with 2 M KCl. After shaking, the determination of N_{min} was performed by distillation and titration method according the Peoples et al. (1989).
The results were expressed in mg of N_{min} per kg of soil.

2.2 Determination of cumulative CO_2 production

Cumulative CO_2 production (respiration) was measured using soda lime granules according Keith & Wong (2006). Soda limes granules consist of NaOH and $Ca(OH)_2$ and about 13-18 % of absorbed water. Water is required for chemical absorption of CO_2 in the form of Na_2CO_3 and $CaCO_3$. Carbonate formation is reflected in weight gain of granules. Weight gain of soda lime must be measured on oven-dried granules so that differences in water content of the initial batch of soda lime and water absorption during exposure do not interfere with measured weight gain of CO_2 (Keith & Wong, 2006; Elbl et al., 2013).
Soil samples (20 g) from each repetition of individual variants (V1, V2 etc.) were inserted into the 1000 ml airtight bottles. Glass beaker with 4.52 g of soda lime was inserted into each airtight bottle on metal tripod. This amount of soda lime is 0.06 g cm^{-2} of soil surface in airtight bottle. Before application, soda lime was dried at 105 °C for 14 h. After 24 h incubation, soda lime was dried again at same conditions and weighted with an accuracy of four decimal places. Control of measurements was ensured by creating blank samples. These samples represented soda limes that were placed into the same airtight bottles (V = 1000 ml) without soil. Soda lime was dried and weighed the same way as the previous ones.
The results of cumulative CO_2 production were expressed in g of C m^{-2} day^{-1} and calculated by the modified formula, which was adjusted according Keith & Wong (2006):

$$\text{Soil } CO_2 \text{ efflux (g C m}^{-2}\text{ day}^{-1}) = \left\{\frac{\text{sample weight gain (g) - mean blank weight gain (g)} \times 1.69}{\text{chamber area (m}^2)}\right\} \times \left[\frac{24\text{ h}}{\text{duration of exposure (h)}}\right] \times \left[\frac{12}{44}\right]$$

2.2 Statistical analysis

The measured values of cumulative CO_2 production and content of N_{min} in soil samples were analyzed by one-way analysis of variance (ANOVA) in combination with Tukey´s test. All data were analyzed in Statistica 10 software. Graphic processing of measured data was performed in Microsoft Excel 2010.

3 Results and discussion

3.1 Content of N_{min} in soil samples

Content of mineral nitrogen (consisting of NH_4^+-N and NO_3^--N) in the rhizosphere soil is an important indicator of threats to soil by nitrogen saturation.

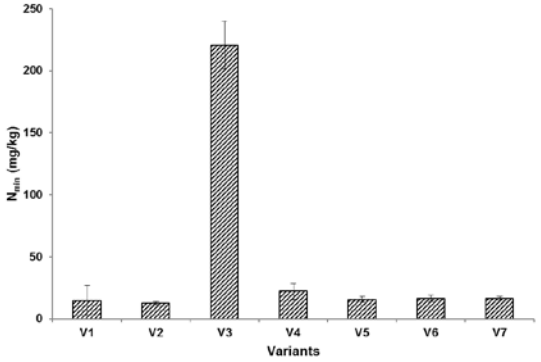

Fig. 3 Content of N_{min} in rhizosphere soil (mean values ± standard error are shown, n = 3)

The above Figure 3 shows a significant difference ($P<0.05$) between variant "V3" and other variants. The highest content of N_{min} was found in this variant (220.64 mg/kg). Conversely, the lowest content of N_{min} was measured in variant "V2" (12.53 mg/kg). Only mineral fertilizer was applied in V3 and only compost was applied into V2-V7, V1 was a control sample.
Various scientific works (Chalhoub et al., 2002; Nevens & Reheul, 2003; Weber et al., 2007; Diaz et al., 2007) confirm that application of compost has a positive impact on the availability of organic nitrogen in the soil. The content and availability of mineral nitrogen is then mainly influenced by microbial activity, because the SOM is firstly decomposed into ammonia nitrogen and subsequently to nitrate nitrogen. These beneficial effects are limited by time by mineralization of soil organic matter.

After application of compost, SOM was decomposed into ammonia nitrogen by microorganisms and it is quickly adopted by plants. Effect of organic matter content and microbial activity in the disclosure of ammonium nitrogen was demonstrated by Rennenber et al. (2009).
Application of mineral fertilizers increased the content of mineral nitrogen in the soil, but it the nitrogen was not used (see Figure 3) for development of microbial communities due to absence of organic matter. For comparison, consider data in the Table 1. The highest amount of mineral nitrogen was found in variant with the lowest production of CO_2. Data in the Table 1 show how productions of CO_2 increase in variant with compost addition. The relationship between content of N_{min} in soil and CO_2 production was analyzed by regression analysis. This analysis confirmed possible relationship between both parameters ($R = 0.5967$; $P < 0.004$; $F = 10.5103$). This situation was caused by the presence of organic carbon and organic nitrogen in the compost. Positive effect of compost application on microbial activities in soil was confirmed by Weber et al. (2007) and Leroy et al. (2007).

3.2 Cumulative CO_2 production

Soil respiration is an important component of terrestrial carbon cycling and can be influenced by many factors that vary spatially (Martin & Bolstad, 2009). Soil respiration was determined as cumulative CO_2 production during 24 h incubation and it expresses activity of microorganisms.

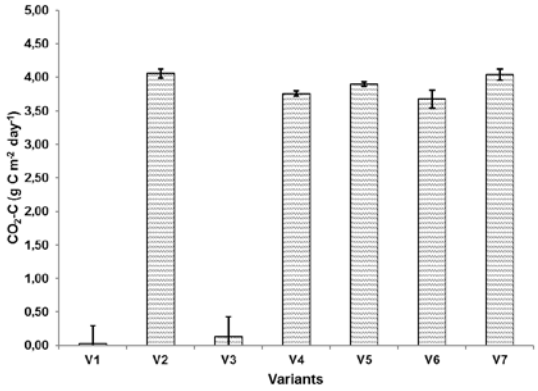

Fig. 4 Cumulative CO_2 production (mean values ± standard error are shown, n = 3)

The above Figure 6 shows the measured values of cumulative CO_2 production in g of C per m^{-2} day^{-1}. Graph shows how values increase in variant with compost addition compared to variants without (V1 and V3). From the graph, we can see that the respiration reaches a peak at the variant with compost addition (V2 = 4.0576 g m^{-2} day^{-1}). Conversely, the lowest value were detected in variants without compost (V1 = 0.026 g m^{-2} day^{-1} and V3 = 0.1329 g m^{-2} day^{-1}). The decline of respiration can perhaps be explained by the fact that variants without compost did not contain enough nutrients for soil microorganisms. This was confirmed by Borken et al. (2002).

Table 1 Production of CO_2 and N_{min} content in rhizosphere soil

Variants	N_{min} (mg/kg)	±SE	CO_2 (g C/m^2 day)	±SE
V1	14.61	11.88	0.02	0.02
V2	12.53	1.12	4.06	0.07
V3	220.64	19.33	0.13	0.29
V4	22.17	6.53	3.76	0.03
V5	15.65	2.27	3.90	0.03
V6	16.32	2.68	3.67	0.13
V7	16.40	1.65	4.03	0.08

Microorganisms need mainly organic carbon in the form of soil organic matter for their development. The organic carbon (C_{org}) is a source of energy. Martin & Bolstad (2009) confirm influence of C_{org} content on soil respiration. Positive influence of compost addition on content of soil nutrients, which are necessary for soil microorganisms, was confirmed by Naeth & Wilkinson (2013).

Conclusions

Our experiment with increased doses of compost showed the potential positive effects. Increased dose of compost can have a positive effect on cumulative CO_2 production and on the use of nitrogen in the soil. The significantly highest respiration was determined at variants with compost addition compared to variant without compost addition. Based on the results of content of mineral nitrogen in the soil, we conclude the positive effect of

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Primary Paper Section: G

Secondary Paper Section: DF, GD, EE

I INFORMATICS

IN INFORMATICS

PERFORMANCE MODELLING OF NOV AND GRID PARALLEL COMPUTERS

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This work was done within the project Modelling, optimisation and prediction of parallel computers and algorithms at University of Žilina supervised by Prof. Ing. I. Hanuliak, CSc. The authors, as the co-workers of this project, gratefully acknowledge the help of all co-workers taking part in this project.

Abstract: The paper describes development, realization and verification of analytical models for the study of the basic performance parameters of parallel computers based on connected computer systems (NOW, Grid).The suggested model considers for every node of the NOW or Grid networks one part for the own workstation´s activities and another one for node's communication channel modelling of performed data communications. In case of using multiprocessor system as modern node's communication processor the model for the own node's activities then is M/D/m system and for every node's communication channel M/D/1 system. The achieved results of the developed models were compared with the results of the common used analytical and simulation model to estimate the magnitude of their improvement.

Keywords: parallel computer, network of workstation (NOW), Grid, analytical modelling, queuing theory, performance evaluation.

1 Trends in parallel computers

In the first period of parallel computers between 1975 and 1995 dominated scientific supercomputer which was specially designed for the High performance computing (HPC). These computers have used computing model based mostly on data parallelism. Increased processor performance was caused through massive using of various parallel principles in all forms of produced processors. Parallel principles were used so in single PC´s and workstations (scalar and super scalar pipeline architecture, symmetrical multiprocessor or multicore systems (SMP) as on POWER PC or in their common using in connected network of workstations NOW (Network of workstations). The gained experience with the implementation of the parallel principles and the extension of computer networks, leads to using interconnected powerful workstations for parallel solution. This trend is characterised through downsizing of supercomputers as Cray/SGI, T3E and from other massive parallel systems (number of used processor >100) to cheaper and more universal parallel computers in the form of a network of workstations (NOW). This period we can name as the second period. Their large growth since 1980 have been stimulated by the simultaneous influence of three basic factors [7, 14]

- high performance processors and computers
- high speed interconnecting networks
- standardized tools for development of parallel algorithms.

The developing trends are actually going toward building of wide spread connected NOW networks with high computation and memory capacity (Grid). Likewise new or existed supercomputers could be a member of NOW as its workstation [20]. Conceptually Grid comes to the definition of the metacomputer. Metacomputer can be understood as the massive computer network of computing nodes built on the principle of the common use of existing processors, memories and other resources with the objective to create an illusion of one huge, powerful supercomputer. Such higher integrated forms of NOW (Grid module) named as Grid systems or metacomputers we can define as the third period in trends of parallel computers.

2Architecture of dominant parallel computers

The actual dominant asynchronous parallel computers are based on various forms of computer networks (cluster), network of workstation (NOW|) or more integrated network of NOW networks (Grid) [1, 19]. They are composed of a number of fully independent computing nodes (processors, cores or powerful workstations). From the point of programmer there is typical at developing parallel algorithms (co-operation and synchronization of parallel processes) inter process communications (IPC). According the latest trends synchronous based on PC computers (single, SMP) and asynchronous parallel computers are dominant nowadays.

2.1 Network of workstations

There has been an increasing interest in the use of networks of workstations (NOW) connected together by high speed networks [17] for solving large computation intensive problems. We illustrated at Fig. 1 integrated parallel computer consisted of NOW workstations. The used workstations are mainly extreme powerful personal workstations based on multiprocessor or multicore platform [1, 5]. This trend is mainly driven by the cost effectiveness of such systems as compared to massive multiprocessor systems with tightly coupled processors and memories (Supercomputers). Network of workstations (NOW) [8, 9] has become a widely accepted form of high performance computing (HPC). It is clear that any classical parallel computers (massive multiprocessor, supercomputers) could be a workstation of such NOW [20].

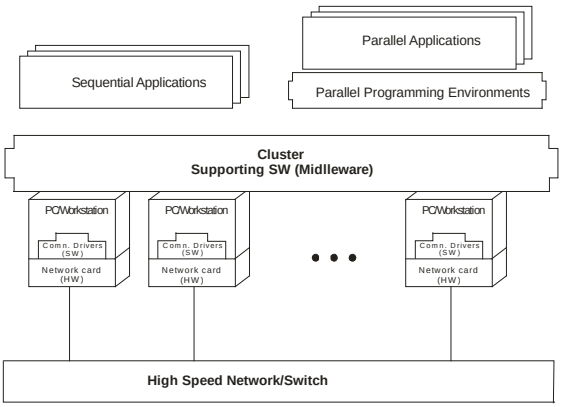

Fig. 1.Architecture of NOW.

2.2 Grid systems

In general Grids represent a new way of managing and organising of resources generally in clusters like network of NOW networks. This term define massive Grid with following basic characteristics

- wide area network of integrated all free computing resources. It is a massive number of interconnected networks, which are connected through high speed connected networks during which time whole massive system is controlled with network operation system, which makes an illusion of powerful computer system (virtual supercomputer)
- grants a function of metacomputing that means computing environment, which enables to individual applications a functionality of all system resources
- system combines distributed parallel computation with remote computing from user workstations [22].

2.3 Conventional HPC environment versus Grid environments

In Grids, the virtual pool of resources is dynamic and diverse, since the resources can be added and withdrawn at any time according to their owner's discretion, and their performance or load can change frequently over the time. The typical number of resources in the pool is of the order of several thousand or even more. For all these reasons, the user has very little or no a priori knowledge about the actual type, state and features of the resources constituting the pool.

An application in a conventional HPC parallel environment typically assumes a pool of computational nodes from (a subset of) which a virtual concurrent machine is formed [18]. The pool

consists of PC's, workstations, and possibly supercomputers, provided that the user has access (valid login name and password) to all of them. Such virtual pool of nodes for a typical user can be considered as static and this set varies in practice in the order of 10 – 100 nodes. Table 1 summarize mine differences between conventional distributed and Grid systems. From performed comparisons we can say that

- HPC environments are optimised for to provide maximal performance
- Grids are optimised to provide maximal resource capacities.

Table 1.Comparison HPC and Grid of environments.

	Conventional HPC environments	Grid environments
1.	A virtual pool of computational nodes	A virtual pool of resources
2.	A user has access (credential) to all nodes in the pool	A user has access to the pool but not to individual nodes
3.	Access to a node means access to all resources on the node	Access to a resource may be restricted
4.	The user is aware of the applications and features of the nodes	User has little or no knowledge about each resource
5.	Nodes belong to a single trust domain	Resources span multiple trust domains
6.	Elements in the pool 10 – 100, more or less static	Elements in the pool >>100, dynamic

3 Performance evaluation of parallel computer

The study of the performance of computers attempts to understand and predict the time dependent behaviour of parallel computers. It can be broadly divided into two areas – modelling and measurement. These can be further divided by objective and by technique. These two apparently disjoint approaches are in fact mutually dependent and are both required in any practical study of the performance of a real or planned system. The overall process of estimating or predicting the performance of a computer system is sometimes referred to as performance analysis or performance evaluation.

4 Performance evaluation methods

Several fundamental concepts have been developed for evaluating parallel computers. Tradeoffs among these performance factors are often encountered in real-life applications. To the performance evaluation we can use following methods

1. analytical methods
   - application of queuing theory [3, 11, 12]
   - Petri nets [4]
   - asymptotic (order) analyse [9, 10]
2. simulation methods [15]
3. experimental measurement
   - benchmarks [11, 13]
   - direct parameter measuring [16].

4.1 Analytic techniques

There is a very well developed set of techniques which can provide exact solutions very quickly, but only for a very restricted class of models. For more general models it is often possible to obtain approximate results significantly more quickly than when using simulation, although the accuracy of these results may be difficult to determine. The techniques in question belong to an area of applied mathematics known as queuing theory, which is a branch of stochastic modelling. Like simulation, queuing theory depends on the use of computers to solve its models quickly. We would like to use techniques which yield analytic solutions.

4.2 The simulation method

Simulation is the most general and versatile means of modelling systems for performance estimation. To reduce the cost of a simulation we may resort to simplification of the model which avoids explicit modelling of many features, but this increases the level of error in the results. If we need to resort to simplification of our models, it would be desirable to achieve exact results even though the model might not fully represent the system. At least then one source of inaccuracy would be removed. At the same time it would be useful if the method could produce its results more quickly than even the simplified simulation. Thus it is important to consider the use of analytic and numerical techniques before resorting to simulation. The result values of simulation model have always their discrete character, which do not have the universal form of mathematical formulas. The accuracy of simulation model depends therefore on the accuracy measure of the used simulation model for the given task. Simulation can contribute to the behaviour analyse of the parallel computers to analyse of the large modern parallel computers is very unpractical and unusable. His disadvantage is also that the achieved results are not universal. But it is very useful in these cases in which we are not able to apply no analytical method and so the simulation methods is the only analytical tool or in cases in which exist only approximate analytical methods and the simulation became the verification tool of achieved analytical results.

4.3 Asymptotic (Order) analysis

In the analysis of algorithms (serial, parallel), it is often cumbersome or impossible to derive exact expressions for parameters such as run time, speedup, efficiency, issoefficiency etc. In many cases, an approximation of the exact expression is adequate. The approximation may indeed be more illustrative of the behaviour of the function because it focuses on the critical factors influencing the parameter. We have used an extension of this method to evaluate parallel computers and algorithms in [9].

4.4 Experimental measurement

Evaluating system performance via experimental measurements is a very useful alternative for parallel systems and algorithms. Measurements can be gathered on existing systems by means of benchmark applications that aim at stressing specific aspects of the parallel systems and algorithms. Even though benchmarks can be used in all types of performance studies, their main field of application is competitive procurement and performance assessment of existing systems and algorithms. Parallel benchmarks extend the traditional sequential ones by providing a wider a wider set of suites that exercise each system component targeted workload.

5 Application of queuing theory systems

Queuing theory systems are classified according to various characteristics, which are often summarised using Kendall`s notation [6, 12]. This describes a queue as, for instance, M/M/m. The first letter describes the distribution of arrivals into the queue, the second letter describes the distribution of service times for entities which reach the front of the queue and the third number describes the number of servers for the queue. Distributions are identified by code letters, so that M means exponential times (from the name Markovian), D means constant or deterministic times, G means generally distributed (i.e. only the mean is considered significant).

5.1 Little's law

One of the most important results in queuing theory is Little's Law. This was a long standing rule of thumb in analyzing queuing systems, but gets its name from the author of the first paper which proves the relationship formally. It is applicable to the behaviour of almost any system of queues, as long as they exhibit steady state behaviour. It relates a system oriented measure - the mean number of customers in the system - to a

customer oriented measure - the mean time spent in the system by each customer (the mean end-to-end time), for a given arrival rate. Little's law says

$E(q) = \lambda . E(t_q)$ or it's following alternative

$E(w) = E(q) - m . \rho$ (m – services).

where the needed parameters are as

- λ - arrival rate at entrance to a queue
- m - number of identical servers in the queuing system
- ρ - traffic intensity (dimensionless coefficient of utilization)
- q - random variable for the number of customers in a system at steady state
- w- random variable for the number of customers in a queue at steady state
- $E(t_s)$- the expected (mean) service time of a server
- E (q)- the expected (mean) number of customers in a system at steady state
- E (w)- the expected (mean) number of customers in a queue at steady state
- $E(t_q)$- the expected (mean) time spent in system (queue + servicing) at steady state
- $E(t_w)$- the expected (mean) time spent in the queue at steady state.

5.2 Queuing networks

Continuing the examination of analytically tractable models, we look for useful results for networks of queues. These can be divided into two main groups, known as product form and non-product form. Product form networks have the property that they can be regarded as independently operating queues, where steady state can be expressed as both a set of global balance equations on customer flow in the whole network and a set of local balance equations on each queue. Local flow balance says that the mean number of customers entering any queue from all others must equal the number leaving it to go to all others, including customers which leave and rejoin the same queue immediately.

5.3 Jackson theorem

Consider the case of a network of U queue/server nodes (workstations). Customers enter the network at node j in a Poisson stream with rate γ_j. Each node has a multiple servers m (workstations based on multiprocessor with m services) and service times are distributed exponentially, with mean $1/\mu_j$, (j = l,…, U). When a customer leaves node i it goes to node j with probability r_{ij}. Customers from i leave the network with probability

$$1-\sum_{j=1}^{U} r_{ij}$$

Now let λ_i be the average total arrivals at node i, including those from outside (external input) and those from other nodes (internal inputs). If the network is in steady state, $\lambda_i$is also the rate of customers leaving i node (including intern output). Overall we can formulate a set of „flow balance equations" which express these flows.

$$\lambda_i = \gamma_i + \sum_{i=1}^{U} \lambda_i r_{ij} \quad j=1,2,\ldots, U$$

As long as the network is open, i.e. at least one γ_i is not zero, this represents a set of linear simultaneous equations with an obvious solution. Let be traffic intensity at i node

$\lambda_i / m_i \cdot \mu_i < 1$

The joint distribution of the number of customers p (k_1, k_2, ...k_U) at each of the U nodes, $p_1(k_1)$, $p_2(k_2)$, … $p_U(k_U)$, can be expressed as

$$p(k_1, k_2, ..., k_U) = p_1(k_1) \cdot p_2(k_2) \cdot ... \cdot p_U(k_U) = \prod_{i=1}^{U} p_i.k_i$$

This is Jacksom theorem for M/M/m system. The individual probabilities $p_i(k_i)$ are given as

$$p_i(k_i) = \begin{cases} p_0 \dfrac{(m\rho)^i}{i!}, & \text{pre } 1 \le i \le m \\ p_0 \dfrac{\rho^k m^m}{m!}, & \text{pre } i > m \end{cases}$$

, where $p_0 = \left[\sum_{i=0}^{m-1} \dfrac{(m\rho)^i}{i!} + \dfrac{(m\rho)^m}{m!(1-\rho)} \right]^{-1}$.

Jackson's theorem describes each node as an independent single server system with Poisson arrivals and exponential service times. The total average number of customers in the whole NOW module $E(q)_{now} = \sum_{i=1}^{U} E(q)_i$,where $E(q)_i$ is given as

$$E(q)_i = \frac{(\rho m)^{m+1}}{(m-1)! \left[\sum_{i=0}^{m} \dfrac{(m\rho)^i}{i!} \left[(m-i)^2 - i \right] \right]}$$

Then from Little's Law, total time spent by customers in the network $E(t)_q$ is $E[t_q]_{now} = \sum_{i=1}^{U} \dfrac{E(q)_i}{\lambda_i}$

Jackson theorem assumes for its applying verification of assumed independence of individual network computing nodes. Every element on its right side is a solution of isolated M/M/m geeing system with their independent average input value λ_i . We can get the intensities of this individual inputs λ_i with solving a system of linear differential equations for concrete values of extern inputs γ_i and for given transition matrix r_{ij} .

6 Modelling of the NOW and Grid

NOW is a basic module of any Grid system (network of NOW networks as for example Internet). In principle we are assumed any constraints on structure of communication system architecture. Then we are modelling one workstation as a system with two dominant overheads

- computation overheads (processor´s latency)
- communication latency.

To model these overheads through applying queuing theory we created mathematical model of one i-th computing node according Fig. 6, which models

- computation overheads (processor´s latency) as queuing theory system
- every communication channel of i-th node LI_i i=1,2, …U (Link interface) as next queuing theory systems (communication system).

Such communication network in NOW module we can represent by a weighted graph where their nodes are individual workstations (Fig. 2.).

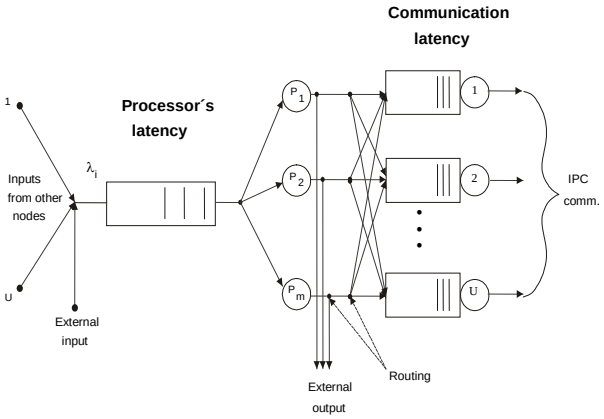

Fig. 2.Mathematical model of i–th node of NOW.

IPC data arrive at random at a source node and follow a specific route in the networks towards their destination node. Data lengths of communicated parallel processes in data units (for example in words) are considered to be random variables following distributions according Jackson theorem. Those data units are then sent independently through the communication network nodes towards the destination node. At each node a queue of incoming data units is served according to a first-come first-served (FCFS) discipline.

6.1 Suggestion and derivation of precised models

Model with M/D/m and M/D/1 systems

The used model were built on assumptions of modelling incoming demands to program queue as Poisson input stream and of the exponential inter-arrival times between communication inputs to the communication channels.

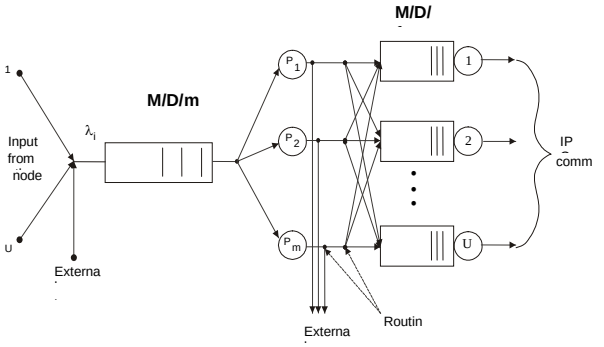

Fig. 3.Precise mathematical model of i-th node.

The idea of the previous models were the presumption of decomposition to the individual nondependent channels together with the independence presumption of the demand length, that is the demand length is derived on the basis of the probability density function $p_i = \mu\ e^{-\mu t}$ for t > 0 and f (t) = 0 for t $\leq$ 0 independent always at its input to the node. On this basis it was possible to model every used communication channel as the queuing theory system M/M/1 and derive the average value of delay individually for every channel. The whole end-to-end delay was then simply the sum of the individual delays of the every used communication channel.

These conditions are not fulfilled for every input load, for all architectures of node and for the real character of processor service time distributions. These changes could cause imprecise results. To improve the mentioned problems we suggested the behaviour analysis of the modelled NOW module improved analytical model, which will be extend the used analytical model to more precise analytical model (Fig.3.) supposing that

- we consider to model computation activities in every node of NOW network as M/D/m system
- we consider an individual communication channels in i- th node as M/D/1 systems. In this way we can take into account also the influence of real non exponential nature of the inter-arrival time of inputs to the communication channels.

These corrections may to contribute to precise behaviour analysis of the NOW network for the typical communication activities and for the variable input loads. According defined assumption to modelling of the computation processors we use the M/D/m queuing theory systems according Fig. 3. To find the average program queue delay we used the approximation formula for M/D/m queuing theory system according as

$$E(t_w)\,(M/D/m_i) = \left[1+(1-\rho_i)\cdot(m_i-1)\cdot\frac{\sqrt{45m_i}-2}{16\rho_i m_i}\cdot\frac{E(t_w)\ (M/D/1)}{E(t_w)\ (M/M/1)}\cdot E(t_w)\ (M/M/m_i)\right]$$

, in which

- ρ_i - is the processor utilization at i-th node for all used processors
- m_i - is the number of used processors at i-th node
- $E(t_w)$ (M/D/1), $E(t_w)$ (M/M/1) and $E(t_w)$ (M/M/m) are the average queue delay values for the queuing theory systems M/D/1, M/M/1 and M/M/m respectively

The chosen approximation formulae we selected from two following points

- for his simply calculation
- if the number of used processors equals one the used relation gives the exact solution, that is W(M/D/1) system
- if the number of processors is greater than one chosen relation generate a relative error, which is not greater as 1%. We verified and confirmed it through simulation experiments.

Let $\overline{x_i}$ define the fixed processing time of the i-th node processors and $E(t_w)_i$ (PQ) the average program queue delay in the i-th node. Then ρ_i of the i-th node is given as

$$\rho_i = \frac{\lambda_i . \overline{x_i}}{m_i}$$

Then the average waiting time in PQ queue $E(t_w)_i$ (M/D/m$_i$) is given through the following relations

$$E(t_w)_i(M/D/1) = \frac{\rho_i \cdot \overline{x_i}}{2(1-\rho_i)}\quad E(t_w)_i(M/M/1) = \frac{\rho_i \cdot \overline{x_i}}{1-\rho_i}$$

$$E(t_w)_i(M/M/m_i) = \frac{\frac{(m_i\cdot\rho_i)^{m_i}}{m_i!(1-\rho_i)}}{\sum_{j=0}^{m_i-1}\left[\frac{(m_i\cdot\rho_i)^j}{j!}+\frac{(m_i\cdot\rho_i)^{m_i}}{m_i!(''1-\rho_i)}\right]\cdot\frac{\overline{x_i}}{m_i}(1-\rho_i)}$$

By substituting relations for ρ_i, $E(t_w)_i$ (M/D/1), $E(t_w)_i$ (M/M/1) and $E(t_w)_i$ (M/M/m$_i$) in the relation for $E(t_w)$ (M/D/mi) we can determine $E(t_w)_i$ (PQ). Then the total average delay for the communication activities in i-th node is simply the sum of average message queue delay (MQ) plus the fixed processing time

$$E(t_w)_i = E(t_w)_i(PQ) + \overline{x_i}$$

To find the average waiting time in the queue of the communication system we consider the model of one communication queue part node as M/M/1 queuing theory system according Fig.7. Let $\overline{x_{ij}}$ determine the average servicing time for channel j at the node i. x_{ij}. Then ρ_{ij} as the utilization of the communication channel j at the node i is given as

$$\rho_{ij} = \frac{\lambda_{ij}\,\overline{x_{ij}}}{S_{ij}}$$

,where S_{ij} defines the speed of communication channel at j-th node. For simplicity we will assume that S_{ij}=1. The total incoming flow to the communication channel j at node i which is given through the value λ_{ij} and we can determine it with using of routing table and destination probability table in the same way as for a value λ_i. Let $E(t_w)_{ij}$ (LQ) be the average waiting queue time for communication channel j at the node i. Then

$$E(t_w)_{ij}(LQ) = \frac{\rho_{ij} \cdot \overline{x_{ij}}}{(1-\rho_{ij})}$$

The total average delay value is the queue $E(t_w)_{ij}$ is given then as $E(t_w)_{ij} = E(t_w)_{ij}(PQ) + \overline{x_{ij}} = \frac{\rho_{ij} \cdot \overline{x_{ij}}}{(1-\rho_{ij})} + \overline{x_{ij}}$

If we now substitute the values for $E(t_q)_i$ and $E(t_q)_{ij}$ to the relation for $E(t_q)_{now}$ we can get finally the relation for the total average delay time of whole NOW model is given as

$$E(t_q)_{now} = \frac{1}{\gamma}\left[\sum_{i=1}^{U}\left(E(t_w)_i(PQ) + \overline{x_i}\right) + \sum_{j=1}^{u_i}\left(E(t_w)_{ij}(LQ) + \overline{x_{ij}}\right)\right]$$

7 Results

The achieved results we illustrated at Fig.4. They are representing the results and relative error for the average value of the total message delay in the 5-noded communication network of classical analytical model (M/M/m + M/M/1) and developed precised analytical model ((M/D/m + M/D/1) in which we considered the fixed delay for the multiprocessor latency. The same fixed delay was included to the average communication delay at each node and in simulation model too. In both considered analytical models (M/M/m + M/M/1, M/D/m + M/D/1) decreasing of processor utilization ρ cause decreasing of total average delay in NOW module E $(t_q)_{now}$. Therefore parallel processes are waiting in the processes queues shorter time. In contrary decreasing of communication channel speeds increase channel utilization and then data of parallel processes have to wait longer in communication channel queues and increase the total node delay of parallel processes. The tested results are the part of all done tests with developed analytical models. The whole set of experimental results has proved, that the analytical model (M/D/m + M/D/1) provided best results and the analytical model (M/M/m + M/M/1) the worst ones. The deterministic time to perform parallel processes at node´s multiprocessor activities that is the servicing time of PQ queue was settled to 8 μs and the extern input flow for each node was the same. To vary the processor utilization we modified the extern input flow in the same manner for each node. The best analytical model (M/D/m + M/D/1) provides very precision results in the whole range of input workload of multiprocessors and communication channels utilization with relative error, which does not exceed 6.2% and in most cases were in the range up to 5%.

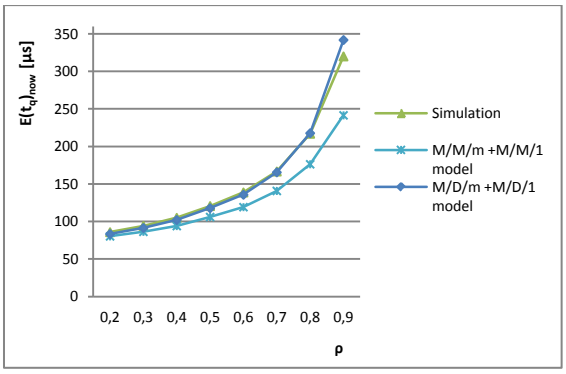

Fig. 4.Comparison of analysed models.

This is important in the range of heavily loaded network (about 80 to 90%) the accurate results are needed to avoid effectively the bottleneck congestions and other system instabilities. Comparison of this best analytical model to analytical model (M/M/m + M/M/1) according Fig. 4 show the improvements in all range of input multiprocessor loads (from 20 to 90%). The relative errors of worst analytical model are from 7 to 25%. This is due influences of processes queues delays, the nature of inter-arrival input to the communication channel in the case of high processor utilization. Developed analytical model could be applied for large NOW networks practically without any increasing of the computation time in comparison to simulation method. Simulation models require oft three orders of magnitude more computation time for testing such a massive metacomputer. Therefore limiting factor of the developed analytical models was not computation time but space complexity of memories. The needed tables RT and DPT require O (n^2) memory cells, thus limiting the network analysis to the number of computing nodes N about 100-200. In case of using system of linear equations to find λ_i and λ_{ij}, most parallel algorithms use to its solution Gauss elimination method (GEM) with its computation complexity O (n^3) [2, 21]. These values are however adequate to handle most existing communication network. In addition also for future massive metacomputers we could use a hierarchically modular architecture (decomposition).

8 Conclusion and perspectives

Performance evaluation of computers (sequential, parallel) generally used to be a very hard problem from birthday of computers. It was very hard to apply any analytical methods (queuing theory results) to performance evaluation of sequential computers because of their high number of not predictable parameters. Actually dominant using of multiprocessor and multicore parallel computers open more possibilities to apply a queuing theory results to analyse their performance. This implies the known queuing theory knowledge, that many inputs, which are inputting to queueing theory system and are generating at various independent resources by chance, could be a good approximation of Poisson distribution. Therefore we could model multiprocessor workstation as M/D/m or communication channel as M/D/1 queuing theory systems in analysed dominant parallel computers (NOW, Grid, metacomputer). In relation to it we began applying queuing theory results to existed multiprocessor systems at first as an individual workstation [11]. Then secondly in this article we have been applied queuing theory results to connected multiprocessor systems in NOW (networks of queuing theory systems) or network of NOW networks as massive Grid or metacomputer.

Then such applications of the network queuing theory systems showed paths to a very effective and practical performance analysis tool mainly for the large NOW networks or another massive number of computer networks (metacomputer, Grid). The achieved results we can apply to performance modelling of dominant parallel computers mainly in following cases

- NOW based on workstations (single processors, multiprocessors or multicores)
- Grid (network of NOW networks)
- mixed parallel computers (SMP, NOW, Grid)
- metacomputers (massive Grid etc.).

Now according current trends in parallel computers (SMP, NOW, Grid), based of powerful workstations, we are looking for flexible analytical model that will be supporting both parallel (SMP) and distributed computers (NOW, Grid, metacomputer). In such unified models we would like to study load balancing, inter-process communication (IPC), transport protocols, performance prediction etc. We would also like to analyse

- the role of adaptive routing
- to prove, or to indicate experimentally, the role of the independence assumption, if you are looking for higher moments of delay
- to verify the suggested model also for node limited buffer capacity and for other servicing algorithms than assumed FIFO (First in First out).

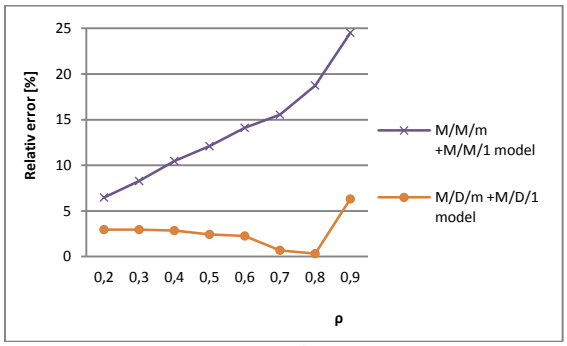

Fig. 5.Relative errors of analysed models.

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Primary Paper Section: I

Secondary Paper Section: IN, JD, BA

PERFORMANCE EVALUATION OF SMP PARALLEL COMPUTERS

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Abstract: Recent trend in parallel computers is to use networks of workstations (NOW) as a cheaper alternative of parallel computer in comparison to in the world used massively parallel multiprocessors or supercomputers. As workstations are used mainly powerful personal computer (PC) or PC´s based symmetrical multiprocessors (SMP).
This paper is devoted to performance evaluation of parallel computers based on SMP, describes the typical parallel computers and analyses basic concepts of performance evaluation. Then it demonstrates how to apply queuing theory results to model computing nodes of parallel computer or parallel computers based on SMP systems.

Keywords: parallel computer, SMP, NOW, Grid, performance evaluation, queuing theory, SPEC tests.

1 Introduction

For the actual parallel computers there are dominating various forms of the parallel principles (Pipeline, super pipeline, cashes etc.). Recent trends in high performance computing (HPC) use network of workstations (SMP, NOW) as a cheaper alternative of parallel computer in comparison to used massively parallel multiprocessors [7,14]. A workstation in NOW can be also a parallel system based on symmetrical multiprocessors (SMP). In such parallel computer workstations are connected through widely used communication standard networks and co-operate to solve one large problem. All existed parallel computers build some form of virtual parallel computer according Fig. 1.

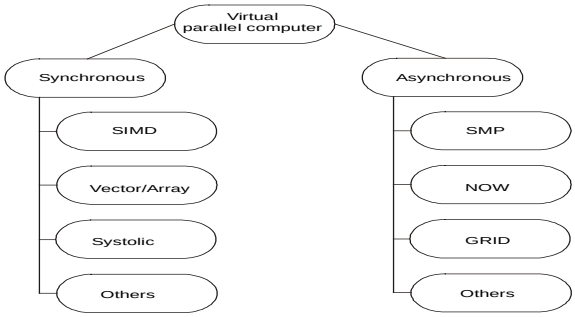

Fig. 1. System´s classification of parallel computers.

2 Classification of parallel systems

It is very difficult to classify the various existed forms of parallel computers. But from a system point we can divide parallel computers [1, 9] to the two following different groups

- synchronous parallel computers. The dominant system property is the concentration on massive data parallelism. The typical examples of synchronous parallel computers illustrate Fig. 1. on its left side. Some of used parallel principles are applied in actually modern parallel computers for example in a form of SIMD (Single instruction multiple data) instructions within their computing nodes [5, 18]
- asynchronous parallel computers. They are composed of a number of fully independent computing nodes (processors, cores or computers). To this group belong mainly various forms of computer networks (cluster), network of workstation (NOW|) or more integrated network of NOW networks (Grid). The typical examples of asynchronous parallel computers illustrate Fig. 1. on its right side. Typical computing node of actual parallel computer consists on SMP.

3 Architecture of modern parallel computers

3.1 Symmetrical multiprocessor system

Symmetrical multiprocessor system is a multiple using of the same processor or cores which are implemented on motherboard in order to increase whole performance of such parallel computer. Typical characteristics are following

- each computing node can access main shared memory
- I/O channels are allocated to computing nodes according their demands
- integrated operation system coordinates cooperation of whole multiprocessor.

Typical concept of such multiprocessor illustrates Fig. 2.

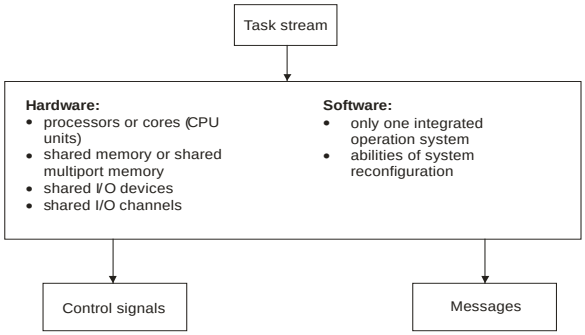

Fig.2. Typical characteristics of SMP multiprocessor systems.

Typical practical example of eight multiprocessor systems Intel Xeon illustrates Fig. 3.

3.2 Network of workstations

There has been an increasing interest in the use of networks of workstations, which are connected together by high speed networks [17, 19] for solving large computation intensive problems. This trend is mainly driven by the cost effectiveness of such systems as compared to massive multiprocessor systems (Supercomputers). Network of workstations (NOW) [11] has become a widely accepted form of high performance computing (HPC). Each workstation in a NOW is treated similarly to a processing element in a multiprocessor system. However, workstations are far more powerful and flexible than processing elements in conventional multiprocessors (Supercomputers). Network of workstations (NOW) [11] has become a widely accepted form of high performance computing (HPC). Each workstation in a NOW is treated similarly to a processing element in a multiprocessor system. However, workstations are far more powerful and flexible than processing elements in conventional multiprocessors (Supercomputers). To exploit the parallel processing capability of a NOW, an application algorithm must be paralleled [21]. A way how to do it for an application problem builds its decomposition strategy.

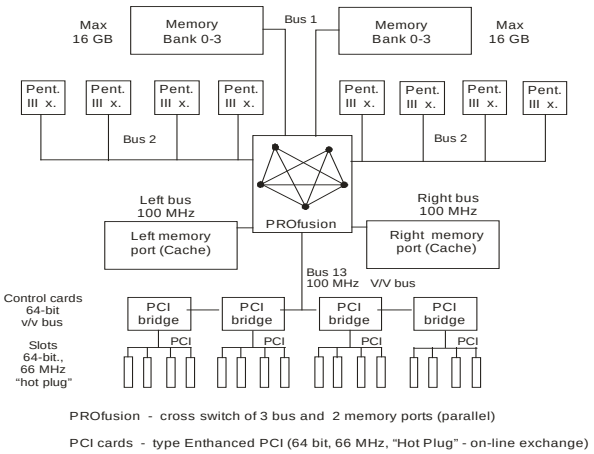

Fig. 3. Architecture of 8-Intel multiprocessor.

3.3 Grid

In early years of twenty-first century, high speed, highly reliable Internet connectivity is as commonplace as electricity in commercial, governmental, and research/educational institutions, and individual consumers are not far behind. This observations led researchers, in the mid – 1990's, to propose the notion of computational Grids [22], where computing resources would be available as universally and easily as for example electric power enabled the utilization of resources on external computing devices over commodity networks.

Grid systems are expected to operate on a wider range of other resources as processors (CPU), like storages, data modules, network components, software (typical resources) and atypical resources like graphical and audio input/output devices, sensors and so one (Fig. 5.). All these resources typically exist within nodes that are geographically distributed, and span multiple administrative domains. The virtual machine is constituted of a set of resources taken from a resource pool. It is obvious that existed HPC parallel computers (supercomputers etc.) could be a member of such Grid systems too [20].

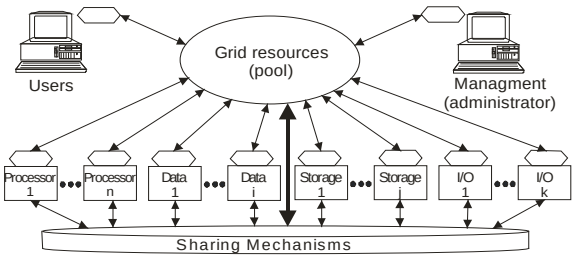

Fig. 4. Architecture of Grid node.

3.4 Metacomputing

This term define massive computational Grid with following basic characteristics

- wide area network integrated free computing resources. It is a massive number of interconnected networks, which are connected through high speed connected networks during which time whole massive system is controlled with network operation system, which makes an illusion of powerful computer system (virtual supercomputer)
- grants a function of metacomputing that means computing environment, which enables to individual applications a functionality of all system resources
- system combines distributed parallel computation with remote computing from simple user workstation.

4 The role of performance

Quantitative evaluation and modelling of hardware and software components of parallel systems are critical for the delivery of high performance. Performance studies apply to initial design phases as well as to procurement, tuning and capacity planning analysis. As performance cannot be expressed by quantities independent of the system workload, the quantitative characterization of resource demands of application and of their behaviour is an important part of any performance evaluation study. Among the goals of parallel systems performance analysis are to assess the performance of a system or a system component or an application, to investigate the match between requirements and system architecture characteristics, to identify the features that have a significant impact on the application execution time, to predict the performance of a particular application on a given parallel system, to evaluate different structures of parallel applications.

4.1 Performance evaluation of parallel computers

The study of the performance of computers attempts to understand and predict the time dependent behaviour of parallel computers. It can be broadly divided into two areas – modelling and measurement. These can be further divided by objective and by technique. These two apparently disjoint approaches are in fact mutually dependent and are both required in any practical study of the performance of a real or planned system. The overall process of estimating or predicting the performance of a computer system is sometimes referred to as performance analysis or performance evaluation.

5 Performance evaluation methods

Several fundamental concepts have been developed for evaluating parallel computers. Tradeoffs among these performance factors are often encountered in real-life applications. To the performance evaluation we can use following methods

- analytical methods
  - application of queuing theory results [3, 6, 12]
  - asymptotic (order) analyze [2, 8]
  - Petri nets [4]
- simulation methods [15]
- experimental measurement
  - benchmarks [13]
  - direct parameter measuring [16].

When we solve a model we can obtain an estimate for a set of values of interest within the system being modelled, for a given set of conditions which we set for that execution. These conditions may be fixed permanently in the model or left as free variables or parameters of the model, and set at runtime.

5.1 Analytic techniques

There is a very well developed set of techniques which can provide exact solutions very quickly, but only for a very restricted class of models. For more general models it is often possible to obtain approximate results significantly more quickly than when using simulation, although the accuracy of these results may be difficult to determine. The techniques in question belong to an area of applied mathematics known as queuing theory, which is a branch of stochastic modelling. Like simulation, queuing theory depends on the use of computers to solve its models quickly.

5.2 Petri nets

A Petri net is essentially an extension of a finite state automaton, to allow by means of tokens several concurrent threads of activity to be described in one representation. It is essentially a graphical description, being a directed graph with its edges defining paths for the evolution of a system's behaviour and its nodes or vertices being of two sorts, places and transitions. An example of simple Petri net illustrates Fig. 8. Places S11, S12,

S13, S21 and S22 represent states, transition t represents event and existed vertigos are connected through oriented edges. Points in places define tokens. All incoming edges to a place must come from a transition and vice versa. Tokens are held in places and when all the input places to a transition are marked, i.e. have at least one token, that transition is enabled and fires, depositing a token in each of its output places.

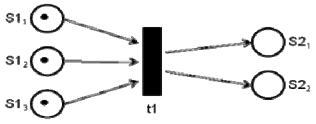

Fig. 5. Simple Petri network.

There are a number of extensions to these simple place/transition nets, mostly to increase the ease of describing complex systems. The most widely used is to define multiplicities for the edges, which define how many tokens flow down an edge simultaneously.

5.3 Simulation

Simulation is the most general and versatile means of modelling systems for performance estimation. It has many uses, but its results are usually only approximations to the exact answer and the price of increased accuracy is much longer execution times. Numerical techniques vary in their efficiency and their accuracy. They are still only applicable to a restricted class of models. Many approaches increase rapidly in their memory and time requirements as the size of the model increases. To reduce the cost of a simulation we may resort to simplification of the model which avoids explicit modelling of many features, but this increases the level of error in the results. If we need to resort to simplification of our models, it would be desirable to achieve exact results even though the model might not fully represent the system. At least then one source of inaccuracy would be removed. At the same time it would be useful if the method could produce its results more quickly than even the simplified simulation. Thus it is important to consider the use of analytic and numerical techniques before resorting to simulation.

5.4 Experimental modelling

Benchmark
We divide used performance tests as following
- classical
  - Peak performance
  - Dhrystone
  - Whetstone
  - LINPAC
  - Khornestone
- problem oriented tests (Benchmarks)
  - specialised tests
  - SPEC tests.

SPEC ratio
SPEC (Standard Performance Evaluation Corporation - www.spec.org) defined one number to summarise all needed tests for integer number. Execution times are at first normalised through dividing execution time by value of reference processor (chosen by SPEC) with execution time on measured computer (user application program). The achieved ratio is labelled as SPEC ratio, which has such advantage that higher numerical numbers represent higher performance, that means that SPEC ratio is an inversion of execution time. INT 20xx (xx means year of latest version) or CFP 20xx result value is produced as geometric average value of all SPEC ratios.

5.5 Experimental measurement

Evaluating system performance via experimental measurements is a very useful alternative for parallel systems and algorithms. Measurements can be gathered on existing systems by means of benchmark applications that aim at stressing specific aspects of the parallel systems and algorithms. Even though benchmarks can be used in all types of performance studies, their main field of application is competitive procurement and performance assessment of existing systems and algorithms. Parallel benchmarks extend the traditional sequential ones by providing a wider a wider set of suites that exercise each system component targeted workload.

6 Application of queuing theory systems

The basic premise behind the use of queuing models for computer systems analysis is that the components of a computer system can be represented by a network of servers (or resources) and waiting lines (queues). A server is defined as an entity that can affect, or even stop, the flow of jobs through the system. In a computer system, a server may be the CPU, I/O channel, memory, or a communication port. Awaiting line is just that: a place where jobs queue for service. To make a queuing model work, jobs are inserted into the network. A simple example, the single server model, is shown in Fig. 9. In that system, jobs arrive at some rate, queue for service on a first-come first-served basis, receive service, and exit the system. This kind of model, with jobs entering and leaving the system, is called an open queuing system model.

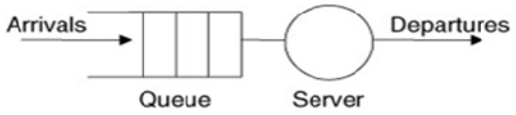

Fig. 6. Queuing theory based model.

6.1 Kendall classification

In addition to the notation for the quantities associated with queuing systems, it is also useful to introduce a notation for the parameters of a queuing system. The notation we will use here is known as the Kendall notation in its extended form as A/B/m/K/L/Z [1, 2], where
- A means arrival process definition
- B means service time distributions
- m is number of identical servers
- K means maximum number of customers allowed in the system (default = ∞)
- L is number of customers allowed to arrive (default = ∞)
- Z means discipline used to order customers in the queue (default = FIFO).

Three symbols used in a Kendall notation description also have some standard definitions. The more common designators for the A and B fields are as following
- M means Markovian (exponential) service time or arrival rate
- D defines deterministic (constant) service time or arrival rate
- G means general service time or arrival rate.

The service discipline used to order customers in the queue can be any of a variety of types, such as first-in first-out (FIFO), last in first out (LIFO), priority ordered, random ordered and others.

6.2 Little's law

One of the most important results in queuing theory applications is Little's law. This was a long standing rule of thumb in analysing queuing systems, but gets its name from the author of the first paper which proves the relationship formally. It is applicable to the behaviour of almost any system of queues, as

long as they exhibit steady state behaviour. It relates the mean number of customers in the system to mean time spent in the system by each customer, for a given arrival rate. Little's law says

$$E(q) = \lambda \, . \, E(t_q)$$

The main parameters in queuing theory application are as following

- λ - arrival rate at entrance to a queue
- m - number of identical servers in the queuing system
- ρ - traffic intensity (dimensionless coefficient of utilisation)
- q - random variable for the number of customers in a system at steady state
- w - random variable for the number of customers in a queue at steady state
- E (t_s) - the expected (mean) service time of a server
- E (q) - the expected (mean) number of customers in a system at steady state
- E (w) - the expected (mean) number of customers in a queue at steady state
- E (t_q) - the expected (mean) time spent in system (queue + servicing) at steady state
- E (t_w) - the expected (mean) time spent in the queue at steady state.

6.3Poisson distribution

The Poisson distribution models a set of totally independent events as a process, where each event is independent of all others. Knowledge of past events does not allow us to predict anything about future ones, except that we know the overall average, the Poisson distribution represents the likelihood of one of a given range of numbers of events occurring within the next time interval. The definition of Poisson distribution probabilities p_i is as

$$p_i = \frac{\lambda^{\,i}}{i\,!} e^{-\lambda}$$

, where the parameter λ is defines as the average number of successes during the interval.

6.4Exponential distribution

If the Poisson distribution represents the likely number of independent events to occur in the next time period, the exponential distribution is its converse. It represents the distribution of inter - arrival times for the same arrival process. Its mean is inter - event time, but it is often expressed in terms of the arrival rate, which is 1/inter - arrival time. Exponential distribution function p_i and its mean value E (t_s) are

$$p_i = \mu \; e^{-\mu t} \qquad E(t_s) = 1/\mu$$

The Poisson distribution models a set of totally independent events as a process, where each event is independent of all others. It is not the same as a uniform distribution. Where knowledge of past events does not allow us to predict anything about future ones, except that we know the overall average, the Poisson distribution represents the likelihood of one of a given range of numbers of events occurring within the next time interval.

6.5M/M/m queue model

The basic needed derived relations for M/M/m queue model (Fig.7) are following.

Average number of customer in the queue

$$\rho = \frac{\lambda}{\mu \, . \, m} < 1 \qquad E(w) = \frac{\rho \, (\rho \, m)^m}{m\,!\,(1-\rho)^{\,2}} \; p_0$$

where the probability

$$p_0 = \left[\sum_{i=0}^{m-1} \frac{(m\,\rho)^i}{i\,!} + \frac{(m\,\rho)^m}{m\,!} \frac{1}{1-\rho} \right]^{-1}$$

The further parameters E(t_q) and E(t_w) we can derive using the Little´s law.

Fig. 7. M/M/m (m=3) model of multiprocessor or multicore systems.

6.6 M / D / m queue model

In this queue model traffic intensity ρ and the service time are as

$$\rho = \frac{\lambda}{\mu \, . \, m} < 1 \qquad E\,(t_s) = \frac{1}{\mu} = constant.$$

For the mean number of customers in the queue we have chosen approximate relation [11]

$$E(t_w)\left[M/D/m\right] \doteq \left[1 + (1-\rho_i)\cdot(m-1)\frac{\sqrt{45\,m}-2}{16\,\rho_i\,m} \cdot \frac{E(t_w)\left[M/D/1\right]}{E(t_w)\left[M/M/1\right]} E(t_w)\left[M/M/m\right]\right]$$

Average number of customer in the system is given as

$$E(q) = E(w) + m\,\rho$$

The further parameters E (t_q) and E (t_w) we can derive using the Little´s law.

7 Results

7.1 Application of THO models

We have modelled multiprocessor system as M/M/m and M/D/m queuing models, where we were supposed parallel activity of used processors or cores. The differences between multiprocessor or multicore are in their performance (input parameters).

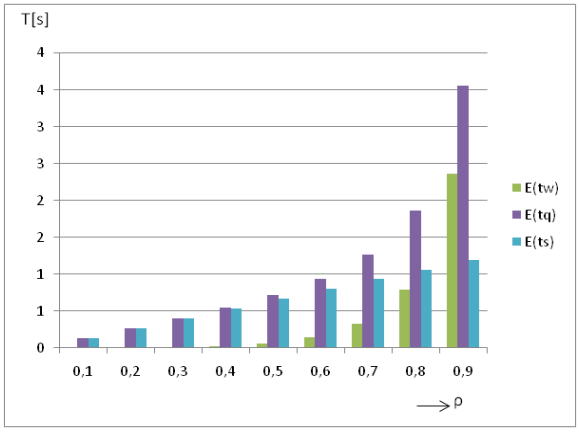

Fig.8 Mean values E(t_w),E(t_q), E(t_s) for M/M/4 model (λ=3).

Graphics illustration at Fig. 9 compare queuing models M/M/4 and M/D/4 (λ=3, ρ = λ . E (t_s) / 4) for average time in system (queue + servicing).

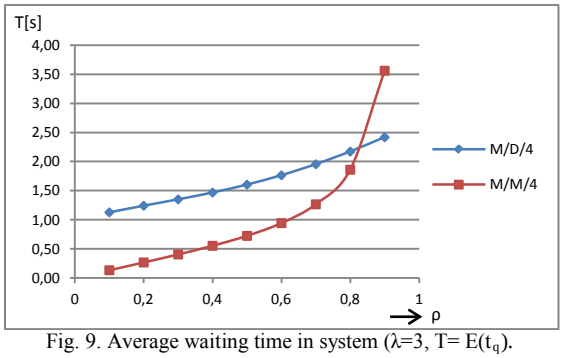

Fig. 9. Average waiting time in system (λ=3, T= $E(t_q)$.

7.2 Spec test ratio

We have been performed various tests (benchmarks) to verify analytical results. We illustrate some achieved results using Spec test ratio to compare performance of following processors

- AMD Athlon X2 6000+
- Intel Core2Duo E7300
- Intel i7-950.

At Fig. 10. we illustrated tested results for mentioned processors using SPEC tests. We have chosen SPEC tests because these tests are from various really applications in order to come to more universal tested results. To compare any computers using SPEC ratios test we preferred to use geometric mean value therefore, it defines the same relative value regardless of used normalised reference computer. If we were evaluating normalised values using arithmetic mean value results would be depended from the type of used normalised computer. According our expectations processor Intel i7-950 achieved the highest SPEC ratio value.

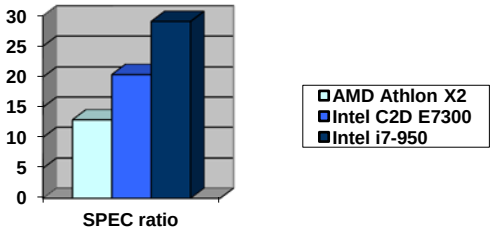

Fig. 10. Comparison of tested processors

8 Conclusions

Performance evaluation of computers generally used to be a very hard problem from birthday of computers. It was very hard to apply any analytical methods to performance evaluation of sequential computers because of their high number of not predictable parameters. Any analytical method is to be preferred in comparison with other possible methods, because of transparent using of achieved analytical results.

Actually dominant using of multiprocessor and multicore computers opens more possibilities to apply a queuing theory results to analyse their performance. This implies the knowledge that outputs from more than single processor approximate closer assumed Poisson distribution. Second the outputs from one multiprocessor system (workstation) are going to another multiprocessor system (neighbouring workstation) in dominant parallel computers (SMP, NOW, Grid).

The achieved results we can apply to performance modelling of multiprocessors or multicores) in following cases (input parameter $\rho = \lambda . E(t_s) / m$, for m=1 we can model performance of single processor)

- running of unbalanced parallel processes where λ is a parameter for incoming parallel processes with their exponential service time distribution as $E(t_s) = 1/\mu$ (M/M/m)
- running of parallel processes (λ parameter for incoming parallel processes with their deterministic service time $E(t_s) = 1/\mu$ = constant). The same deterministic servicing time is a very good approximation for all optimal balanced parallel processes (M/D/m)
- in case of using M/D/m model we can consider λ parameter also for incoming computer instructions with their average service time for instruction t_i, where $E(t_s) = 1/\mu = t_i$=constant.

We have choose the analysed models M/M/m, M/D/1, and M/D/m from this causes

- to finish performance analysis of networks of queuing theory system [10] we need results of chosen queuing theory systems
- we need their results to compute approximation relation for M/D/m
- based on models in this article together with application of Jackson theorem [10] we are able to analyse also more complicated network of NOW networks (Grid etc.).

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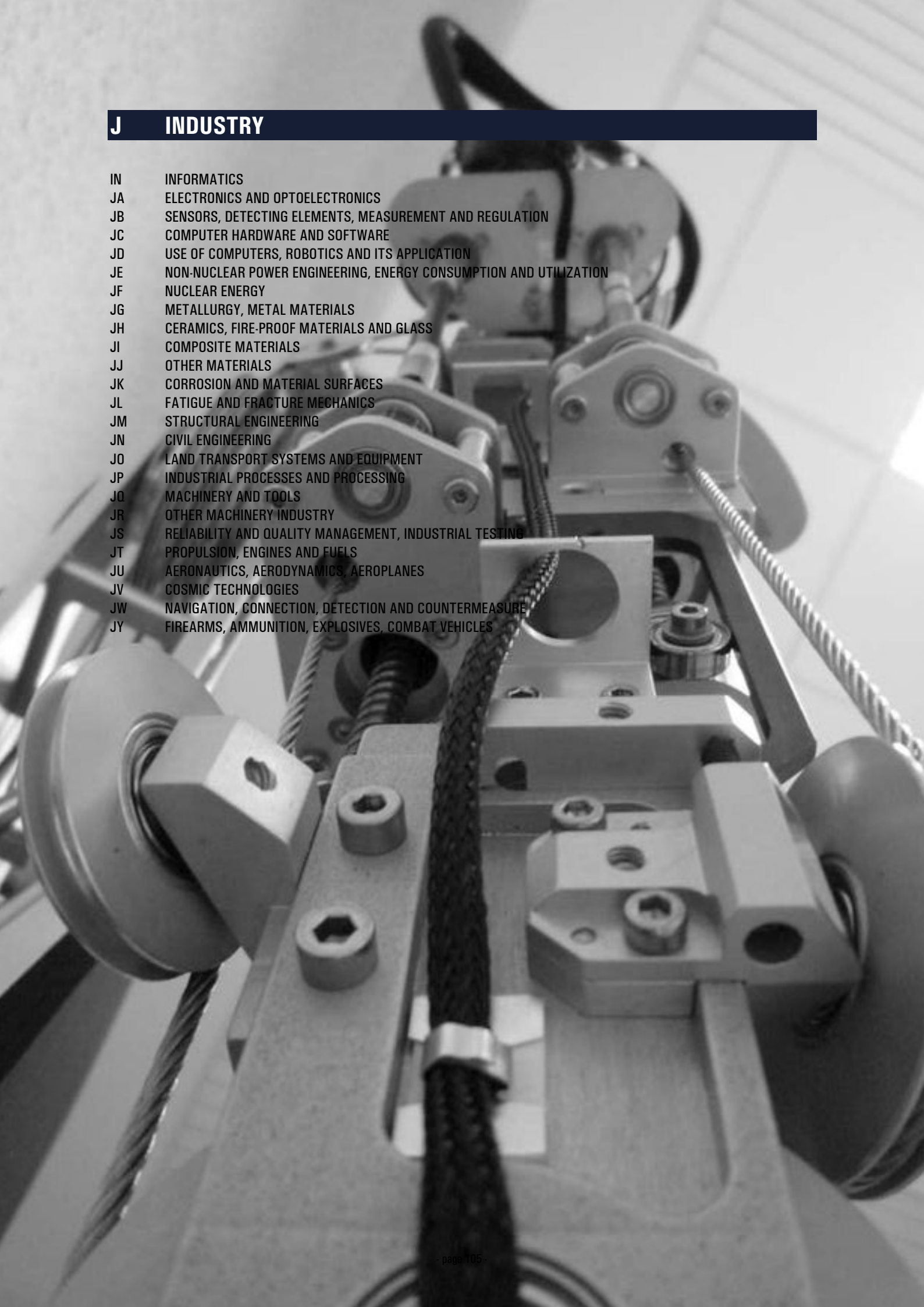
Primary Paper Section: I

Secondary Paper Section: IN, JD, BA



J INDUSTRY

IN	INFORMATICS
JA	ELECTRONICS AND OPTOELECTRONICS
JB	SENSORS, DETECTING ELEMENTS, MEASUREMENT AND REGULATION
JC	COMPUTER HARDWARE AND SOFTWARE
JD	USE OF COMPUTERS, ROBOTICS AND ITS APPLICATION
JE	NON-NUCLEAR POWER ENGINEERING, ENERGY CONSUMPTION AND UTILIZATION
JF	NUCLEAR ENERGY
JG	METALLURGY, METAL MATERIALS
JH	CERAMICS, FIRE-PROOF MATERIALS AND GLASS
JI	COMPOSITE MATERIALS
JJ	OTHER MATERIALS
JK	CORROSION AND MATERIAL SURFACES
JL	FATIGUE AND FRACTURE MECHANICS
JM	STRUCTURAL ENGINEERING
JN	CIVIL ENGINEERING
JO	LAND TRANSPORT SYSTEMS AND EQUIPMENT
JP	INDUSTRIAL PROCESSES AND PROCESSING
JQ	MACHINERY AND TOOLS
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JS	RELIABILITY AND QUALITY MANAGEMENT, INDUSTRIAL TESTING
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JU	AERONAUTICS, AERODYNAMICS, AEROPLANES
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JW	NAVIGATION, CONNECTION, DETECTION AND COUNTERMEASURE
JY	FIREARMS, AMMUNITION, EXPLOSIVES, COMBAT VEHICLES

THE ALTERNATIVE SOLUTION OF ABSORPTIVE NOISE BARRIERS

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Abstract: The noise from traffic on roads can unpleasantly affect humans, and therefore we must search for means to reduce the intensity of the noise. It can be achieved either by reducing the sound intensity at the source (active measures) or by preventing the transmission of sound by shielding structures (passive measures). In both cases this can be achieved in several ways, which are briefly described in the article. Two main ways are typical for passive measures - either the sound is absorbed by a solid construction and it is subsequently converted to another energy (heat), or the sound is reflected off a monitored area. The combination of these two methods of noise reduction brings modern combined acoustic barriers with higher efficiency. One of such method is presented here, but the idea of sound absorption massive structure is replaced by the idea of damped oscillation lightweight construction.

Key words: noise, traffic, barrier, stop, alternative solutions

1 Introduction

Long-term effects of noise on humans are gradually reflected on their mental and physical health. Therefore, efforts to increase protection of people from exposure to excessive noise in both at home and at a workplace, as well as outdoors. These efforts are supported by the European Union regulations, which are gradually incorporated and harmonized with the legislation of the Czech Republic. The reason for finding new ways to suppress noise is the limit values tightening.
The dominant noise source is road transport, which grows every year. Solutions to reduce this burden on the population has to be sought. One of the ways is to build noise barriers, which, together with other measures, significantly contribute to improving the conditions for a good life. Finding new ways to prevent the spread (transmission) of noise or streamlining existing barriers is still a current topic.

2 Absorption and sound reflection

The ratio of the reflected intensity Ir and the total intensity I0 creates a reflectance factor ρ [-], the ratio of the absorbed intensity Ia and total intensity I0 creates an absorption coefficient α [-]. The absorbed intensity Ia progresses further through the obstacle to its end, then the intensity It [W/m2] is radiated out. The ration of the radiated intensity It and the total incident intensity I0 is a transmittance coefficient (sound reduction) τ [-]. During the transmittance of the absorbed intensity Ia a part of intensity Iq [W/m2] converts into heat and then it is further conducted out through the structure. The image describing reflection and absorption of a sound intensity is shown in Fig.1.

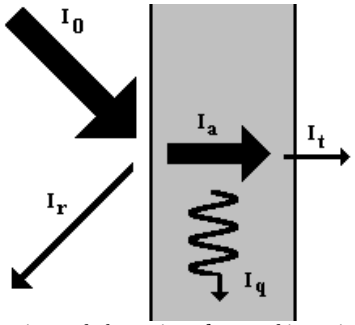

Fig.1: Reflection and absorption of a sound intensity impacting on an obstacle (Reichel, Všetička, 2009)

It is evident that factors ρ, α, τ can take values in the interval <0, 1>. (In laboratory conditions, the absorption coefficient α can take value greater than 1, but this is caused by multiple reflections of sound in a reverberation room in the lab.)
Absorption of sound waves is dependent on several other factors, i.e. the roughness and porosity of the barriers and the frequency of the incident sound. The sound waves with high frequency (short wavelength) are better absorbed. The incident sound waves cause that the grains and other particles, which is the elementary structure composed of, start to vibrate. Vibrations cause friction and immediate conversion of acoustic energy into heat. To convert a sufficient amount of energy, the area where the friction occurs, has to be adequately large. For this reason, porous substances or flawed structure substances are suitable for sound absorption. Sound is spread through fine pores, whose total area is, due to the volume, very large, respectively, the sound is well absorbed by the incurred spaces (Rubáš, 2011). On the contrary, surfaces that are smooth (glass, tile, etc.) have a low absorption coefficient, but they reflect the sound well and they have a high reflexion coefficient.

3 The measures to reduce traffic noise

Regarding unwanted traffic noise, we look for measures to reduce the noise to an acceptable level represented by health limits. For this reason, we choose active and passive methods of protection against noise pollution from transport.

4 Active methods of protection against traffic noise

Active protection means a method of reducing noise emissions from the sound source. The road traffic has started to develop this kind of protection in the 1970s due to the increasing number of cars.

4.1 Reducing vehicle noise

The European Union adopted a directive "Directive 70/157/EEC - Council Directive of 6 February 1970 on the approximation of the laws of Member States relating to the permissible sound level and the exhaust system of motor vehicles." This Directive sets limit values for noise emissions from vehicles, which push on car manufacturers to reduce noise motor vehicles. The Directive has been amended several times with stricter limits. The professionals generally considered the directive being ineffective because cars had fulfilled the emission value before the introduction of the Directive.

4.2 Reducing speed limits

The movement of a vehicle on a road makes noise, which consists of individual sound sources - engine noise, aerodynamic friction, tire rolling, bodywork vibrations etc. The dominant source of noise depends on the speed. In practice, the situation is following: in low speeds of the vehicle the overall noise defines the dominant engine noise. In a turning point and at a certain speed - the dominant source of noise is rolling. Bendtsen, Andersen (2005) mention a value inflection point at 40 km/h for motorcars and 60-70 km/h for trucks (Chocenský, 2010).
Fig. 2 shows that the reduction of speed under 50 km/h in municipalities does not produce a significant effect.

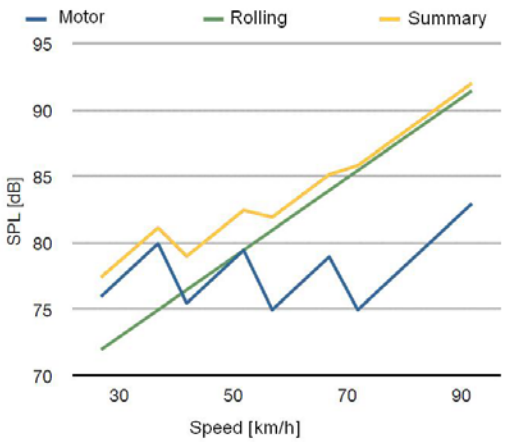

Fig. 2: The projection of the relationship between the overall vehicle noise, rolling noise and engine noise (Chocenský, 2010)

4.3 Noise reduction of tire rolling over communication

The current development of active measures focuses on finding options to reduce noise from the tire rolling on road surfaces. This is done by monitoring of properties of a road, surfaces and type of tires. The investigation revealed that the occurrence of noise on the road is caused by a particular texture (roughness) of the surface of the distortion from 0.5 m to 0.5 mm and by porosity of the surface. Therefore, new asphalt and concrete road surfaces are designed in that way to be able to moderate charater of a surface. Due to the great amount of kilometers of existing road the application of the new designed surfaces is a long-term issue, even not currently performed in a newly constructed roads in the Czech Republic, because it is expensive comparing to existing materials and commonly used materials. Examination of tire parameters (width, hardness, pattern coats, etc.) currently provides ambiguous and often divergent results, which are probably caused by non-unified assessment methodology.

5 Passive methods of protection against traffic noise

There are used various forms of barriers that protect the outside environment and inside protected spaces of buildings against noise spread. Barriers are placed either as close as possible to the source of noise (barriers along roads), or in place of immission noise (in front facade of the building or soundproof glazing). Another option might be to change the route of transport outside the protected outdoor environment (ring roads, tunnels).

5.1 Acoustic barriers landscaping

The easiest way to create a barrier is landscaping. The road is usually below the surrounding terrain (in a slot), or soil layers are swept along the road and form a terrain wall (a bank). When building a new road there is possible to use existing undulations, but it requires careful preparation at the time of processing of the project documentation. It is understandable that sometimes neither careful planning ensure expected result (an example might be the territorial area of the Netherlands). Another advantage of terrain walls is their good sound absorption due to grassing and planting of greenery, or their increase by absorption or reflective barriers, which are described in the following paragraphs.
The considerable terrain wall dimensions to achieve the same effect as a vertical barrier can be understood as a disadvantage of that solution. (Fig. 3).

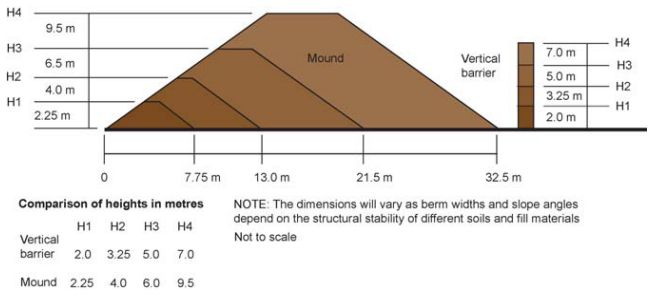

Fig. 3: The ratio of height (and width) of the terrain wall and its effectiveness in comparison with a vertical green (Kotzen, English, 2009)

5.2 Absorption barriers

Absorption barriers are the most common type of barriers in countless variations. Their popularity has been gained due to its relatively low production and assembly demands. From the technical point of view, mostly supporting dense structure with a highly porous surface exist. It could be for example the following: the reinforced concrete structure and the outer surface is profiled from cellular (porous) concrete, as it is shown in Fig. 4.

Fig. 4: Absorption wall with the surface of the autoclaved cellurar concrete (porous concrete) (Fotogalerie | Liadur.cz , 2012)

Very similar solution of an absorption barrier is the use of fibreboard concrete instead of a porous concrete. Wooden tiles which form a perforation surface can be another modification of the barrier. The improved absorptive properties can be achieved by the so called “sandwich” structure where mineral wool is added into the middle layer of the construction. There are many variations of a “sandwich” structure. As an example there can be mentioned a composition, where the structural frame consists of an outer shell of aluminum perforated plate and the inner part is filled with mineral wool with an air gap.
An interesting solution seems to be the use of natural materials, where the structural frame is covered by vines, small shrubs or scrub pines. The disadvantage of most absorbent barriers is their low aesthetics, robustness, and (often underestimated) opacity. Creating a continuous solid opaque barrier can divert the spreading sound, but it could affect human psyche – it could trigger feelings of uneasiness and isolation from society.

5.2 Reflective barriers

The principle of sound reflection was explained in the second paragraph. The reflective barrier is a barrier with a smooth surface with minimum of pores for a perfect reflection of sound. The material is chosen from the field of thermoplastics, often in clear or tinted transparent form. This type of barrier is younger than an absorption barrier. Color glazing creates an interesting aesthetic solution and transparency adds lightness in volume to the construction. The disadvantage is the fact that they do not diminish the energy of the incident sound, but only reflect it elsewhere in the environment.
Current reflective barriers are usually made of transparent thermoplastic synthetic polymer - polymethyl methacrylate (PMMA) - colloquially also called Plexiglas or acrylic glass. Contractors usually guarantee over 10 years to degradation by UV radiation.

5.3 Greenery

Greenery itself has a rather low insulation and it is chosen as a supplement to other types of barriers to decorate long lines of sound barriers. Despite the fact that the greenery varies with the seasons, creating a compact continuous greenery is not an easy process which lasts relatively long time.

5.4 The combination of reflective and absorbent barriers

There is represented noise level of passing vehicles along the measuring station in Fig.5. In the diagram the blue curve presents the progress of the sound level without a barrier. The green curve presents a flow chart of sound pressure level in the following situation: the same vehicle is passing the measuring station with an absorption barrier. The red curve shows a similar

situation, only with the usage of a reflective barrier. We can observe that the effectiveness of the reflective barrier is radically reduced in the time interval when the vehicle passes close to the measuring station.

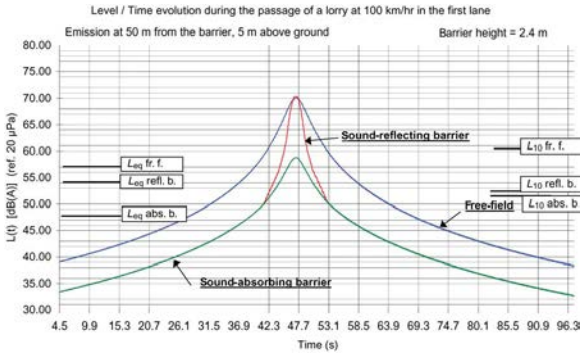

Fig.5.: Monitoring of the variations in noise level during passing a vehicle along a measuring station (Kotzen, English, 2009)

A combination of reflective and absorbent barrier seems to be interesting as it is shown in Fig. 6. Note the upper part of the barrier consists of reflective solar collectors.

Fig. 6: A combination of reflective and absorptive barrier in Copenhagen, Denmark

Absorbent panels and acrylic panels are alternately held in the area of the barrier. A similar principle of the barrier dividing on a reflective and absorptive function is used by many other manufacturers (or a combination of a barrier assembled of some products of two different suppliers). This system seems to be a reasonable compromise of absorptive and reflective barriers.

6 Absorption of sound energy by the reflective barrier vibrations

As there has been already mentioned, the reflective barrier only changes the direction of spreading the sound, but it does not reduce its intensity. Therefore, it is appropriate to ask whether it is possible to ensure at least some possibility of absorption of a reflected sound – as the combined barrier mentioned in the previous paragraph. The disadvantage of this system is to reduce the glass surface at the expense of absorption plates.

6.1 Damped oscillation

During the spreading of a sound there occur oscillating movements (waves) of molecules in a flexible environment around its equilibrium position. If these movements are periodic in time with sine curve, it is called the harmonic oscillation. Dealing with the harmonic oscillation it is useful to understand these phenomena, but these are highly idealized conditions and they almost do not occur in the real world. In fact, when a hanging weight vibrates on a spring, after a certain period the oscillation stops. This is caused by the surrounding forces (in this case in particular, the force of gravity). It dampens vibrations, and therefore such a vibration is called damped. In the real environment it is influenced by many more factors and to design such a system model is very complicated and very exacting task of calculations.

6.2 The design of alternative construction

Contemporary urban planning and architectural conception of the environment gives a clear direction to the use of advanced (composite) materials with an emphasis on increasing efficiency, "multifunctionality" and aesthetics. This is also applied to building of noise barriers, especially in the developed countries of Western Europe, North America and Japan. Although the noise level in the Czech Republic is a discussed topic, it is rather the result of commitments towards the European Union. In addition, the modern trends in the field of noise barriers are generally received slightly half-hearted by the professional public.

The most built noise barrier in the Czech Republic is the absorbent barrier made of the load-bearing reinforced concrete panel with porous outer layer (or a modification of wood-fiber concrete, etc.), which is inserted between concrete pillars. In some cities there are often promoted reflective barriers made of acrylic glass which are rather complementary absorbent barriers.

6.3 Flexible setting of the barrier

The idea of a reflective surface vibration is based on the concept of flexible setting of the reflective surface under the condition that the setting is rigid enough to prevent sagging, and at the same time flexible to dampen vibrations. Schematic setting of the barrier is shown in Fig.7.

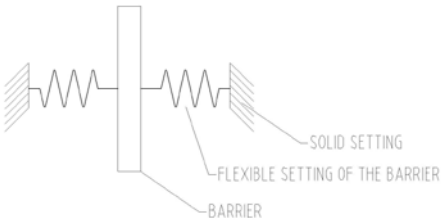

Fig. 7: Flexible setting of the reflective barrier

Assuming flexible setting of a shape variability structure, such as wraps, seems to be appropriate. The fact is that for perfect efficiency of a reflective barrier the structure must not contain any interruptions. When achieving this requirement there may be a problem in the junction of two slabs that move independently of each other. The parts which can move just in one direction of the anticipated direction of sound would be a solution of such a situation. The solution avoids the possibility of crossing slabs and the mutual displacement in one direction. Schematic representation is shown in Fig. 8.

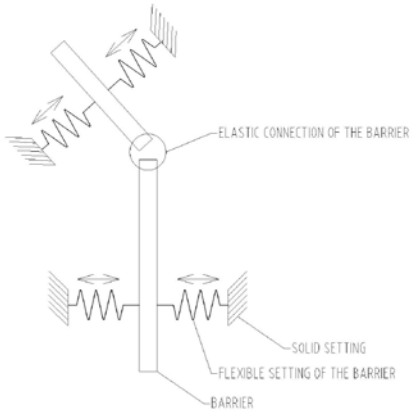

Fig. 8: Diagram of a flexible setting of two bent slabs

It is worth considering the use of laminated safety glass. Laminated glass consists of several layers of glass panes with different properties. The outer layer of glass can form a so-called self-cleaning glass. Safety and reliability increases bonding (the broken glass pane is maintained by an inner foil). Another advantage is the density, which is approximately double of PMMA. Higher weight could contribute to damping of vibrations. As the selling price of laminated glass is similar to PMMA, it would be interesting to do a more detailed analysis of these two materials.

6.4 Laboratory measurements of the effectiveness of the noise barrier

As there has been already mentioned, the model description of such a system to determine efficiency is very difficult. In practice an effectiveness of acoustic barriers is determined by a test pattern and the actual effectiveness is detected in a laboratory. The laboratory measurements and assessing the effectiveness of noise barriers were issued in technical standards "CSN 1793-1 Device for reducing road traffic noise - Test method for determining the acoustic properties - Part 1: Determination of sound absorption laboratory method" and the other "CSN 1793-1 Facilities for road traffic noise reducing - Test method for determining the acoustic properties - Part 2: determination of air sound insulation by laboratory methods." These standards assign a code, according to the identified values of sound absorption and sound insulation, that indicates their effectiveness in shielding sound.

7 Conclusion

In the first part of the article the theoretical foundation of ways to prevent the spread of the sound through a space are described. There are also presented and described the original and current trends in the construction of noise barriers, which are divided into two main streams - absorptive and reflective barriers - including their advantages and disadvantages.
In the second part the consideration that each oscillation of the system is damped by surroundings is discussed. This consideration is applied to the reflective acoustic barriers and thus presented as a possible way to improve the reflective barriers in the absorption of sound energy rather than other ways that are typical for absorptive barriers. The idea of damped oscillation of the reflective barriers, is not supported by any calculations, but generally there can be expected that an absorption of sound energy occurs. In the technical practice, to measure the effectiveness of the proposed amendments, laboratory measurements on an actual element that has the most accurate predictive value are performed.

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Primary Paper Section: J

Secondary Paper Section: M, N, O

INTEGRATION OF PHASE CHANGE MATERIALS IN BUILDING STRUCTURES

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This work was supported by the Czech Grant Agency under project No. P104/12/1838 "Utilization of latent heat storage in phase change materials to reduce primary energy consumption in buildings".

Abstract: The paper presents the results from the comparative measurement of indoor environment in two attic rooms. The effect of phase change materials was researched within the operative room temperature. System utilizes simple heating of the material and reversible changes of phase for heat storage. The phase change materials increase the heat storage capacity of the building. This fact has the effect of temperature in the experimental room and its maximum value during the summer. As PCM is used a microencapsulated paraffin in the experimental implementation. Its integration into building structures is a modification of plaster. Activation of phase change materials is carried out by capillary cooling. The paper presents the results of measurements for different modes of operation of passive cooling.

Keywords: Phase change materials (PCMs), Gypsum plaster, Capillary tubes, Latent heat storage, Passive cooling, Overheating, Indoor environment.

1 Introduction

The development of prices and consumption of energy has long-term continuous growth. For common Czech household price of electricity increased about 229 % between 2001-2011 [1]. Energy operating performance of the building is composed mainly of heating, cooling, ventilation, lighting and domestic hot water. One consequence of this development is the emphasis on reducing the operating costs of buildings in winter. This is achieved by insulation of the building envelope, optimizing air exchange and design sophisticated heating systems. The result is to provide thermal comfort while reducing operating energy consumption.

In the summer time there is often the overheating of buildings, particularly for the construction of lightweight materials or objects with high glass facade elements. Thermal stability of the internal environment in the summer largely depends on the heat gains from solar radiation that penetrates by the transparent parts of openings into the interior. It can largely affect the orientation of the object to the cardinal, rational glazing on the south and west sides, and proposing appropriate shielding devices. These design principles are often neglected when designing buildings and so air conditioners are used to ensure the summer heat stability. These devices, however, are inappropriate from an economic and environmental point of view. Mechanical cooling has affected the consumption of electricity in peak summer temperatures and in recent years there is a trend that differences between the amount of energy consumption in the winter and summer months begin to approach [2].

Energy storage plays an important role when the production or supply of energy don´t coincide with immediate demand for it. The energy storage is crucial for the development of such conversion of electrical or thermal energy from renewable sources. A typical example is the conversion of electrical and thermal energy from solar energy to covering the energy performance of buildings for housing.

The development and using of the passive cooling is one of the measures against overheating inside buildings, which should be directed attention to [3]. Passive cooling can be used as a supplement or, ideally, as a substitute for air conditioning. Additionally it is possible a reversible using for radiant heating in winter.

2 Thermal comfort a stability

Thermal comfort means that the thermal conditions reached when a person is neither cold nor too hot - the person feels comfortable [4]. This definition implies that thermal comfort is a subjective term and its level is different for each individual. Each person has got own somatotype, age, gender and otherwise dressed, so all these factors affecting thermal comfort. Others are air temperature, mean radiant temperature, humidity and velocity of flow.

Summer thermal stability directly depends inter alia on the thermal storage capacity of the building envelope. In the event there is no space or we do not want to increase the storage mass of the building in the plane of the mass, it can proceed to the application of materials with phase change material (PCM) and it is increased storage capacity of latent heat storage.

3 Heat storage

Building materials are able to store heat or cold for a while and then they have to be able to provide this heat energy back into the environment. In the literature we have met three ways heat storage:

- sensible heat storage
- latent heat storage
- thermochemical storage

The objects building with traditional technologies (brick, monolithic) have a relatively large heat capacity. This is due to the ability of these materials store a large amount of sensible heat and thus contributes to the summer heat stability. The stored heat in this case leads to an increase in temperature of the storage medium.

It is preferred to use the accumulation of latent heat for objects with a light envelope of low thermal storage capacity of the envelope and buildings constructed of lightweight building materials. For this reason it is necessary to integrate the structures with phase change materials (Phase Change Materials - PCMS). Using PCMS can increases thermal storage capacity of the building.

These materials are using physical phenomena in which the temperature of the substance does not change even when it is delivered or collected heat. Such action usually associated with phase change. For example, if you deliver thermal energy of the solid, whose initial temperature was below the melting point, the substance is heated at first. After reaching the melting temperature, the growth stops and remains at a constant level so until it retains the state of coexistence of solid and liquid phases. Once complete conversion of solid to liquid is over, the substance temperature begins to rise again [5]. Since the latent heat of the substance consumed or subscribed to increase or decrease the temperature of the storage medium: this is called the latent heat.

These storage systems can be called passive because for its operations they do not use non-renewable energy sources [6]. Passive cooling can thus be an alternative or complement to air conditioning and thus reducing the energy consumption for cooling.

4 The phase change materials

Organic and inorganic materials are used as PCMs in practical applications [7]. Their main representatives are paraffins (organic materials) and hydrates of salts (inorganic materials). Organic materials are characterized by chemical and thermal stability. Organic media are compatible with metals and have a lower thermal conductivity compared to inorganic materials. The main disadvantage is their flammability. Inorganic materials have higher enthalpy of phase change process. Inorganic media are non-flammable and have corrosive effects. The phase

separation and supercooling is also a problem for inorganic media (Tab. 1).

Tab. 1: Comparison of organic and inorganic materials [8]

Organic materials	Inorganic material
Advantages	
No corrosives	Greater phase change enthalpy
Low or none supercooling	Non-flammable
Chemical and thermal stability	Cheaper
Disadvantages	
Lower phase change enthalpy	Supercooling
Low thermal conductivity	Corrosion
	Phase separation

Phase change process, suitable for use in construction, is from solid to liquid and vice versa. It is necessary therefore to deal with the proper encapsulation of heat storage materials. The encapsulation can serve as a construction element of the building structure. A compatibility problem between PCMs and container have to be verified and the container have to be sufficiently thermally conductive to be able to quickly transfer heat during charging and discharging. Encapsulations are usually classified by their size into macro and microencapsulation [9].

The possible methods of integration are:

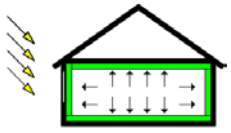
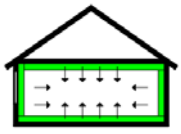
- PCMs penetration into building materials;
- micro-encapsulation;
- macro-encapsulation;
- dimensionally stable.

5 Activation of the phase change material in passive cooling systems

An important part of the design of each system with PCMS is to ensure the activation of this material. During the day, in a time of high heat loads the interior, a phase change material begins to charge after reaching a melting point (there is a latent transformation). It´s necessary to take away stored heat for repeating this process. The activation takes place at night when the temperature in the interior is under the PCMS crystallization temperature (Fig. 1). It is often necessary the natural convection of air supply by an another cold source for right taking place latent transformation throughout the volume. This source is consumed electrical energy, but the consumption of energy is transferred from day to night-time and it is thus removed from the network at the time of the lower tariff.

The charging and discharging of heat into and out of thermal storage is naturally reversible in the Czech Republic from autumn to spring.

Fig. 1: Scheme of charging and discharging of PCMs

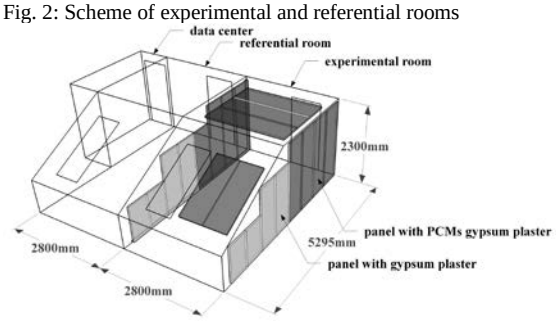
Passive cooling by charging of PCMs	Discharging of PCMs at night
	
$\Theta_i > \Theta_m$	$\Theta_i < \Theta_m$

A system that utilizes a special circuit of air in a wall cavity for the discharge of stored energy is much more suitable for residential buildings with occupants at night. On the other hand this system requires the special air cavity for cool air and therefore the use is limited by technical possibilities.

6 Verification of the effects of integration into the PCMS structures

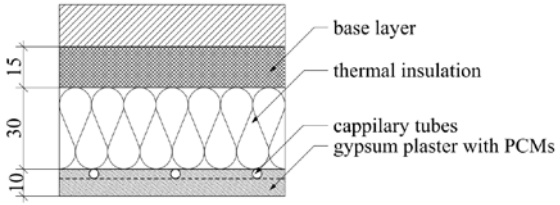
At Institute of Building Structures at Faculty of Civil Engineering are located two rooms for comparative measurements. The both rooms have the same geometry, composition of envelope and orientation of skylights (Fig. 2). By their size and location they correspond with for example an attic living room or an office. Packaging design are insulated mineral insulation in thickness 200 mm. There is a skylight in the sloping part of the ceiling in each room to ensure daylight and to fix a solar radiation. The volume of air inside each test room is 29,7 m^3.

Fig. 2: Scheme of experimental and referential rooms



There were located thermal storage modules in the experimental room. Panels are composed of a base layer made from recycled beverage cartons, polystyrene foam layer with thickness of 30 mm and modified plaster with thickness of 10 mm (Fig. 3).

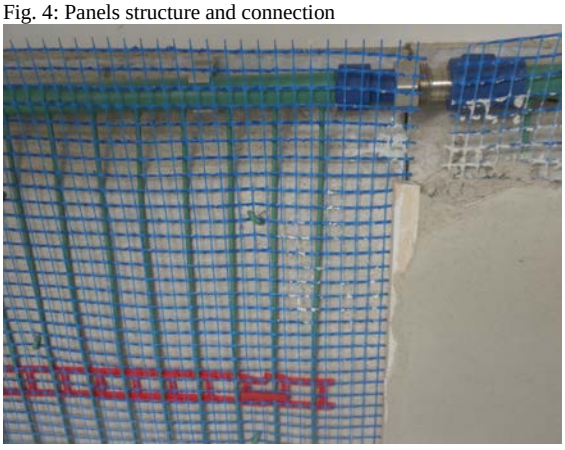
Fig. 3: The schematic sectional view of an accumulation panel



The plaster isn´t supplied commercially, but it was prepared to order by the manufacturer plaster mixture LB CEMIX Ltd. The plaster is included with phase change material Micronal DS 5008X from BASF. Quantity PCMS is 30 % of the total weight of the mixture.

For activating the PCMs the capillary tubes are mounted into a panel. The inlet and outlet pipe is connected through the distributor and collector to a heat pump (air-water) that is able to generate the required cooled water (Fig. 4).

Fig. 4: Panels structure and connection



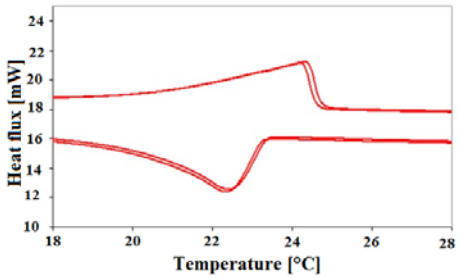
Assembled panels are installed on the side walls, oblique and horizontal ceiling in the area about 17 m^2. Air exchange in experimental and reference room was ensured during the entire period by opening skylights in the ventilation positions.

7 Results and discussion

7.1 Analysis of the material used the phase change

The melting point is one of the main characteristics of selecting a suitable representative for use PCMS because of the stabilizing interior temperature. The melting and solidification of the mixture of plaster and PCMS the temperature ramp 1 °C.min^{-1} were found with thermal analysis (Fig. 5).

Fig. 5: DSC curves for two cycles Micronal PCM ® DS 5008X for ramp 1 ° C.min^{-1}



The monitored quantity of sample buffer material named Micronal PCM ® DS 5008 X and plaster sample with 30 % buffer substances are compared in the Tab. 2. The measurement was carried out in a Perkin Elmer PYRIS1 equipped with a cooling device Perkin Elmer Intracooler 2P.

Tab. 2: Comparison of DSC analysis for PCM and gypsum plaster with 30 % PCM with a heating / cooling ramp 1 °C.min^{-1}

Material	PEAK temperature melting [°C]	ONSET temperature melting [°C]	Stored heat [kJ.kg^{-1}]
Micronal DS 5008X	24.3	19.8	86.8
Plaster with 30 % Micronalu	26.2	24.5	23.4
Difference	1.9	4.7	63.4
Material	**PEAK temperature solidification [°C]**	**ONSET temperature solidification [°C]**	**Released heat [kJ.kg^{-1}]**
Micronal DS 5008X	22.4	23.3	-82.7
Plaster with 30 % Micronalu	24.6	25.5	-23.6
Difference	2.2	2.2	59.1

The comparison given in the Tab. 2 shows that the addition of micro pellets into plaster leads to reduced the storage capacity to a level of 27 %. Peak temperature was also moved as the melting and the solidification. This reduction in thermal storage capacity is quite essential and responsible mass proportion of PCMS in the plaster.

7.2 Effect of PCMs and capillary cooling to room temperature operative

Comparative measurements of the effects of capillary cooling system coupled with a thermal storage layer containing PCMs were realized in July and August 2012. The effect on the indoor environment depended on different types of setting control of activation of storage medium.
Three modes of operation room were studied:

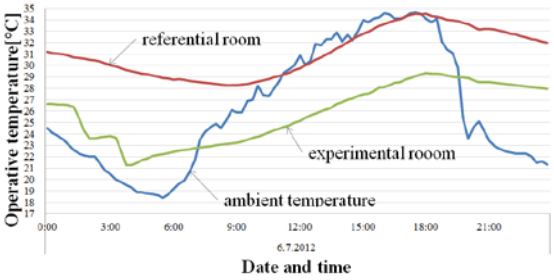
- PCMs are activated by briefly cooling performed during the night. This method is suitable for the summer without extreme values of maximum daily temperatures.
- PCMs are cooled at night and during the day it is cooled according to actual requirements for thermal comfort. This operation is suitable with high cooling loads during the day.
- Regeneration PCMs is carried out by natural air convection in the period when the temperature at night drops below the temperature range of phase change.

In the first mode was PCMs activation at night. The system worked in the following mode:

- during night periods from 1:00 to 1:45 a.m. and from 3:00 to 3:30 a.m. the chiller was switched on due to the activation of stored energy in PCMs;
- during day the chiller was switched off.

The temperature in the experimental room during the day wasnt' influenced in another active way. Integrated PCMs and 1.25 hour night cooling reduce the temperature peaks in the room about 4-5 °C (Fig. 6).

Fig. 6: Progressions of operative temperature in the testing rooms from 6. 7. 2012

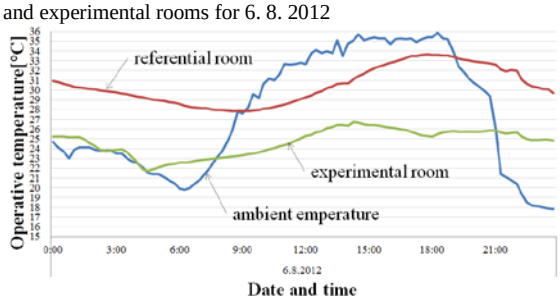


Other mode is activation PCMs during the night and cooling during the day. In the reporting period the system worked in the following mode:

- working of chiller was allowed by timer at the time of 0:00-5:00 and 7:00 a.m. to 10:00 p.m. In this mode the operating of chiller can also be controlled by a thermostat so that between 1:00 to 2:00 a.m. and 3:00 to 4:00 a.m. has been set cooling to 20 °C due to the activation energy stored in PCMs;
- in the other time the chiller started to work after indoor temperature reached 26.5 °C

With this setting the temperature in the experimental room remained between 21 and 27 °C and the daily temperature peaks were reduced up to 7.5 °C (Fig. 7).

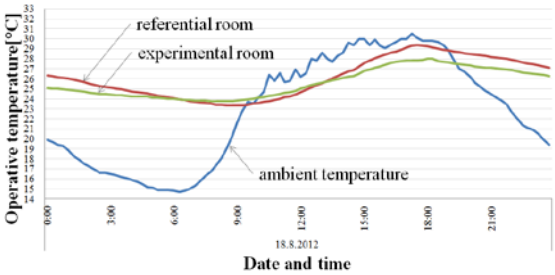
Fig. 7: Progressions of operative temperature in the referential and experimental rooms for 6. 8. 2012



Last mode is activation PCMs by natural air convection. In the reporting period PCMs was activated by natural air convection (cooling unit was off). There is no problem with activating the storage media in the period when the temperature drops during the night under the phase change temperature range of PCMs. Thus it is possible to reduce the temperature in the room during the day about 1.5 to 2.0 °C (Fig. 8). If the temperature doesn´t

drop under the phase change temperature range, PCMs isn´t fully activated and the next day is reduced thermal storage capacity.

Fig. 8: Progressions of operative temperature in the testing rooms from 18. 8. 2012



8 Conclusions

The tested system combines the heat storage material with a phase change in the form of micro pellets, which are dispersed in the gypsum plaster, and capillary cooling for their activation so that the secondary effect is possibility of a direct cooling of the room. Individual building materials and components are assembled into modules that allow their installation in both new buildings and the renovation of existing buildings.

Passive radiant cooling is one of the ways to reduce energy consumption for cooling. Conventional air conditioners have to work in parallel with the effects of heat stress, i.e. at times of peak electricity consumption. The installed system can set with regimes respond to outdoor temperature conditions. This system primarily shifts electricity consumption into the night off-peak time. The time interval when the electricity is consumed from the network, it is also much less compared to common air-conditioning. It should be noted that the system cannot ensure a constant temperature in the interior, but it can maintain a state of indoor environment in the required temperature range and it can reduce temperature maxima.

The cooling system using the latent heat storage should be designed as a whole. It is necessary to select so cooling device which can activate recrystallization PCMS without affecting the internal environment and contribute to the required internal microclimate.

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Primary Paper Section: J

Secondary Paper Section: JN, BJ

DESIGN OF THE SOUND ABSORPTION COEFFICIENT OF THE NOISE BARRIER SURFACE

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Abstract: The purpose of this paper is to verify whether the image sources method used for the calculation of the sound wave reflected from a vertical obstacle is precise enough to be used in noise mapping. Numerical modelling with the boundary element method was used as a tool for the verification of the method precision. The insertion loss of the obstacle was calculated with the BEM in many receivers. Two variants of sound absorption coefficient of the noise barrier surface were included in the calculation. Results obtained by the BEM calculations were fitted with the quadratic curve and compared with the values obtained by the image sources method. It was concluded that the image sources method is on the safe side. Nevertheless, the deviation on the safe side was acceptable.

Keywords: image sources, boundary element method, insertion loss, noise barrier, absorption coefficient, sound wave reflection.

1 Introduction

When designing a noise barrier the following variables must be specified: dimensions, the sound reduction index and the absorption coefficient of its surface. Accordingly, when calculating the sound pressure level in the receiver a direct sound ray must be taken into account as well as a sound ray reflected from a terrain and vertical obstacles. The absorption coefficient of these obstacles plays an important role in both cases.
Currently, the process of strategic noise mapping is running in the EU member states on the basis of the Directive 2002/49/EC of the European Parliament and of the Council (Ref. 2). In this directive interim methods for the strategic noise mapping were established.
The French method NMPB-Routes-1996 was chosen as recommended interim method for the prediction of the noise caused by road traffic. This method describes the calculation of the sound wave reflection from a vertical obstacle using the image sources method (Ref. 12).
Initially, this interim method was supposed to be replaced by the method Harmonoise, which also uses the image sources for the calculation of the sound wave reflection (Ref. 9). Fresnel zones in the Harmonoise method enable to predict even reflections from surfaces with inconstant absorption coefficients.
The image sources method was also used in the method CNOSSOS-EU, which was eventually chosen for the strategic noise mapping in the EU member countries (Ref. 6).
The image sources method is an engineering method suitable for practical use. Its main disadvantage is that it does not take into account the interference of the direct and reflected sound wave. Contributions from various sources are summed energetically.
In contrast, the boundary element method (the BEM) takes into account the interference of the direct and reflected sound wave (both constructive and destructive). The purpose of this paper is to find out the error caused by using the energetic sum in the image sources method.

2 The Boundary Element Method

The BEM belongs to numerical methods which are used for solving many problems ranging from heat conduction in building constructions to propagation of sound in the outdoor environment. The Matlab implementation 2D OpenBEM (Ref. 5) is very convenient for situations regarding noise barriers.
2D BEM considers a linear coherent source and homogenous conditions of sound propagation, which means that it is impossible to model with the 2D BEM meteorological phenomena like temperature and wind gradients. The partial differential equation, which is valid for pure tones and solved with the BEM, is called the Helmholtz equation (Ref. 8):

$$(\nabla^2 + k^2)\hat{p} = 0 \tag{2.1}$$

Where (Ref. 8):

$$\hat{p} = p(x,y)\mathrm{e}^{-\mathrm{i}\omega t} \tag{2.2}$$

Where ∇^2 is the Laplace operator, k [m^{-1}] is the wave number, $\hat{p}$ [Pa] is the sound pressure expressed by a complex function, p [Pa] is the sound pressure, x and y [m] are the coordinates of a Cartesian coordinate system, e is the Euler number, i is the imaginary number, ω [rad.s^{-1}] is the angular frequency and t [s] is the time.
The BEM can be used merely for cases when a fundamental solution of a partial differential equation is known. The fundamental solution is used as a weighting function in the derivation of the formulas used in the calculation (Ref. 4).
The Green's function is used for the boundary element formulation on the barrier and for the source modelling. It is defined as a solution of a non-homogenous linear differential equation (Ref. 1):

$$(\nabla^2 + k^2)\, G_\beta(\mathbf{r}, \mathbf{r}_0) = \delta(\mathbf{r} - \mathbf{r}_0) \tag{2.3}$$

Where ∇^2 is the Laplace operator, k [m^{-1}] is the wave number, $G_\beta(\mathbf{r}, \mathbf{r}_0)$ is the Green's function and $\delta(\mathbf{r} - \mathbf{r}_0)$ is the Dirac delta function, $\mathbf{r}$ and $\mathbf{r}_0$ are the position vectors of the receiver and the source.
To find a solution of $G_\beta(\mathbf{r}, \mathbf{r}_0)$ two boundary conditions are needed. These are: the Sommerfeld radiation condition (for the domains with the infinite extent), which states that energy emitted by the source must be scattered in infinity; and the impedance boundary condition (for the domains with boundaries) which expresses the relation between the particle velocity normal to the boundary with the admittance and the sound pressure (Ref. 8).

3 Image Sources

The image sources are applied in the methods in references 6 and 12 as well as in the standard DS/ISO 9613-2 (Ref. 3), which is the Danish version of the international standard for sound propagation in the outdoor environment.
The image sources are used solely for the calculation of reflections from the obstacles that are declined from the vertical direction less than 15° and with both dimensions bigger than 0.5 m (Ref. 6).
The obstacle (i.e. the noise barrier or the building) is simulated here by an image source. The formula for the calculation of the sound power level of the image source has been described in several methods. Let's quote the new version of French method NMPB 2008 (Ref. 10):

$$L_{w'} = L_w + 10\log_{10}(1 - \alpha_r) \tag{3.1}$$

Where $L_{w'}$ [dB] is the sound power level of the image source, L_w [dB] is the sound power level of the real source, α_r [-] is the absorption coefficient and $0 \leq \alpha_r < 1$.
Fig. 1 shows the situation sketch with the image source.

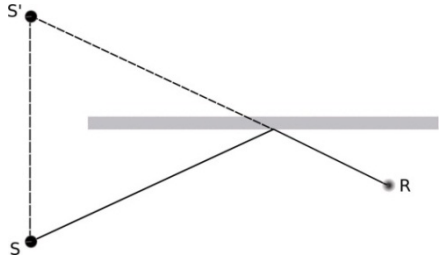

Fig. 1: Reflection from the obstacle calculated using the image sources – S: the source, S´: the image source, R: the receiver (Ref. 10)

Contributions from individual sources are summed energetically in the receiver (Ref. 10):

$$L_{eq,LT} = 10\log_{10}\left(\sum_i 10^{0.1\,L_{i,LT}} + \sum_{i'} 10^{0.1\,L_{i',LT}}\right) \qquad (3.2)$$

Where i are all real sources, i' are all image sources, $L_{i,LT}$ [dB] are the contributions from the real sources, $L_{i',LT}$ [dB] are the contributions from the image sources and $L_{eq,LT}$ [dB] is the equivalent continuous sound pressure level.

4 Setting of the Calculation

There was modelled a situation which consisted of an obstacle with two variants of the absorption coefficient α [-] (the first variant was the reflective surface: α = 0, the second variant was a rather absorbing surface: α = 0.74).
The 2D OpenBEM software, which was programmed in the Matlab language, does not enable to input the absorption coefficient directly but enables to input the flow resistivity [N·s·m^{-4}]. This parameter can be converted to the absorption coefficient for a specific frequency with formulas mentioned in Ref. 7. The terrain was not considered in the model to avoid a distortion by the ground effect. A mono-frequency 500 Hz source was selected.
Two variants of mutual position of the source and the receiver were calculated. The first variant in which the receiver remains in the same position and the source is being moved is depicted in Fig. 2. The second variant in which the receiver is being moved and the source remains in the same position is depicted in Fig. 3.

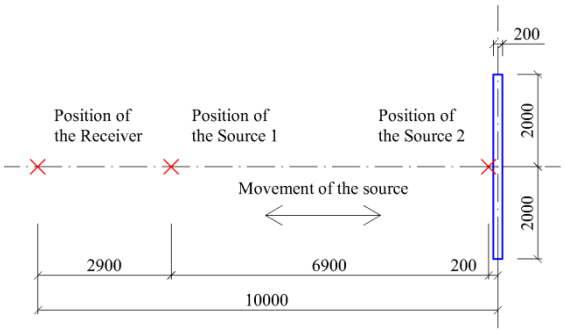

Fig. 2: Geometry of the modelled situation, variant 1

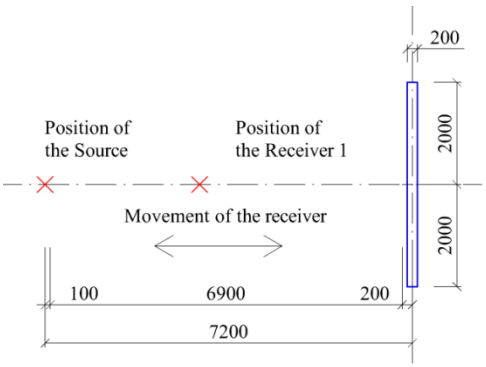

Fig. 3: Geometry of the modelled situation, variant 2

5 Sound Field

The aim of the calculation was to obtain the insertion loss of the noise barrier in the receiver. This receiver was always in the axis of the noise barrier.
The insertion loss is defined as a difference between the sound pressure level in the receiver without considering the noise barrier and the sound pressure level in the receiver with considering the noise barrier.
The term "the insertion loss" is rather confusing in this context. It is usually used to describe the sound field on the other side of the barrier. Its value is usually positive, which means that the noise barrier has reduced the sound pressure level. On the source side of the barrier the value of the insertion loss can be both positive and negative, which indicates the interference between the direct and reflected sound wave.
The sound field in terms of the sound pressure level is showed in Fig. 4 (the source is placed in the position [-5, 0] where zero is the axis of the noise barrier). The insertion loss is showed in Fig. 5.
Fig. 4 and Fig. 5 depict that the standing wave pattern emerges between the noise barrier and the source. In greater distance from the source, the phase difference between the direct and the reflected wave is constant and therefore the insertion loss is also more or less constant.

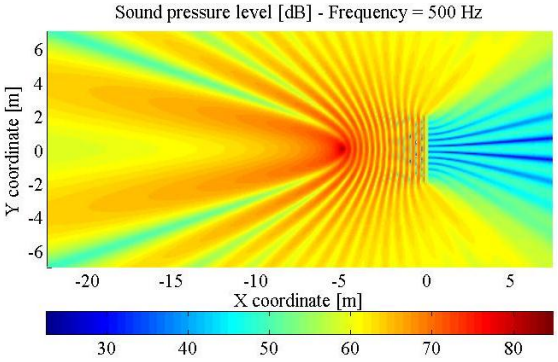

Fig. 4: Sound field – the sound pressure level

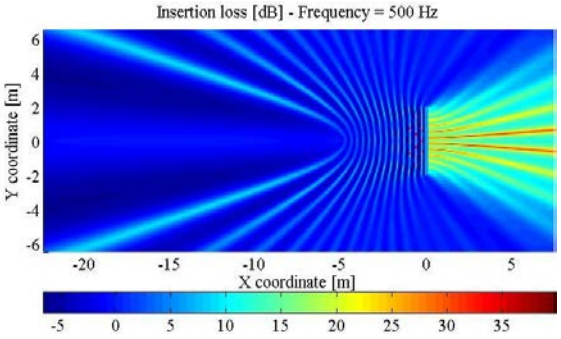

Fig. 5: Sound field – the insertion loss

6 Results of the Calculation

The two variants of the absorption coefficient and mutual position of the source and the receiver resulted in four graphs. The distance of the source or of the receiver from the noise barrier is shown on the x-axis. Using the Matlab tools, the values obtained with the BEM were fitted with a quadratic curve, what made easier to compare the progress of the values calculated using the BEM and NMPB 2008.

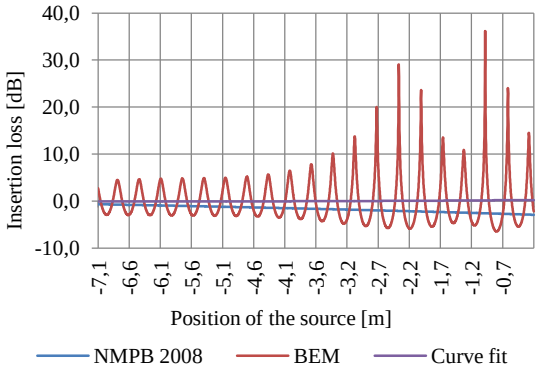

Fig. 6: The insertion loss, variant 1, α = 0

The average value of the insertion loss in Fig. 6 is -1.71 dB (NMPB 2008) and 0.006 dB (the BEM); the difference being 1.71 dB. The correlation between NMPB 2008 and the fitted curve is very high but negative (-0.95).

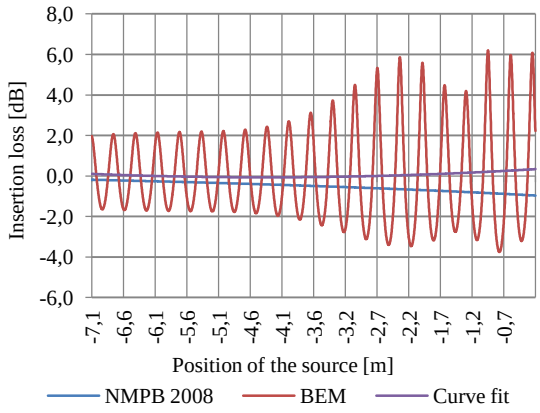

Fig. 7: The insertion loss, variant 1, α = 0.74

The average value of the insertion loss in Fig. 7 is -0.52 dB (NMPB 2008) and 0.035 dB (the BEM); the difference being 0.56 dB. The correlation between NMPB 2008 and the fitted curve is high but negative (-0.72).

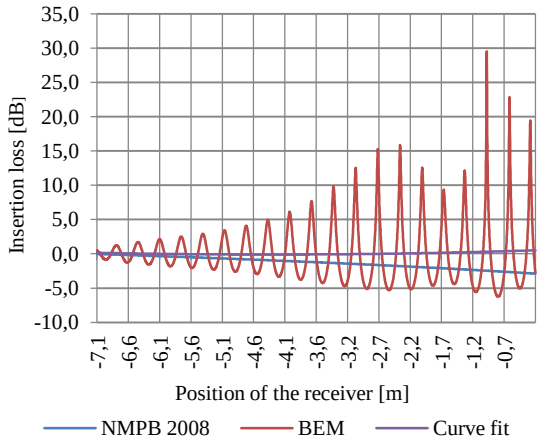

Fig. 8: The insertion loss, variant 2, α = 0

The average value of the insertion loss in Fig. 8 is -1.30 dB (NMPB 2008) and 0.049 dB (the BEM); the difference being 1.35 dB. The correlation between NMPB 2008 and the fitted curve is high but negative (-0.70).

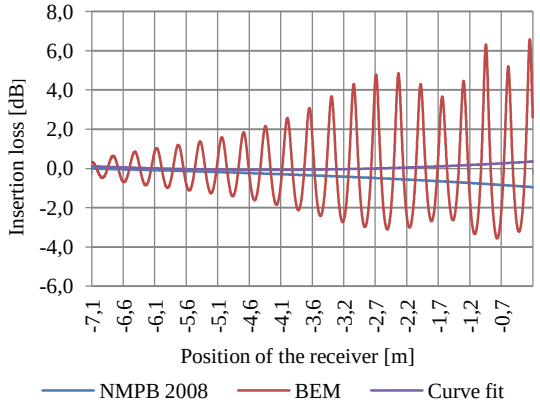

Fig. 9: The insertion loss, variant 2, α = 0.74

The average value of the insertion loss in Fig. 9 is -0.39 dB (NMPB 2008) and 0.038 dB (the BEM); the difference being 0.43 dB. The correlation between NMPB 2008 and the fitted curve is high but negative (-0.72).

7 Comparison of the Absorbing and the Reflecting Noise Barrier

To get an idea about how the absorption coefficient influences the resulting sound pressure level another two graphs are depicted in Fig. 10 and Fig. 11. One can see that the values of the sound pressure level calculated with a lower absorption coefficient are decreasing. This statement is true both for the BEM and NMPB 2008.

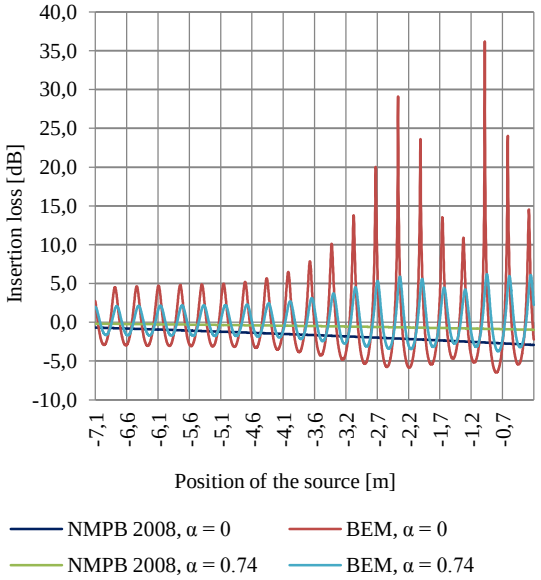

Fig. 10: The insertion loss, variant 1

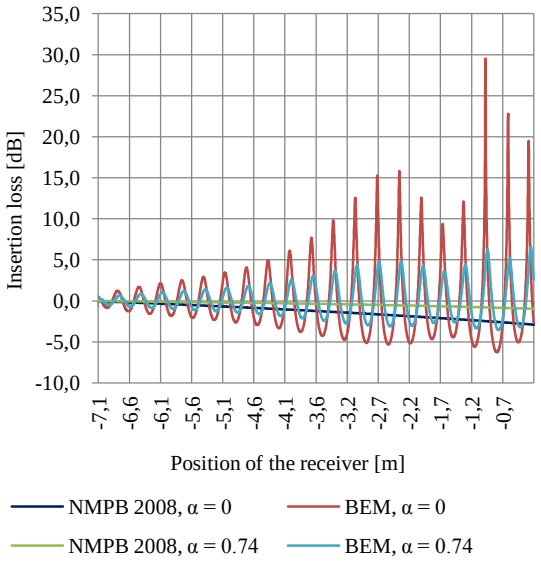

Fig. 11: The insertion loss, variant 2

8 Conclusion

The strategic noise mapping and consequent action plans were supposed to reduce the number of inhabitants in the EU member countries who are affected by excessive noise load. The process of noise mapping initiated several research projects. The aim of these research projects was to find out the best way how to

determine the noise load caused by road, railway and air traffic and industrial activities.

It can be stated that to this day nearly each EU member country has its own calculation procedures for accessing noise levels and different legislation concerning this topic. Although united standards for strategic noise mapping are compulsory, there are no obligatory international regulations for common acoustic studies.

The problem of choosing the right method is also complicated by the necessity to find a compromise between the precision on one side and the calculation time and verifiability on the other (an interested reader can learn more about this problem in Ref. 11).

It is convenient when an engineering calculation procedure can be checked easily with a spreadsheet processor; otherwise the calculations become non-transparent and difficult to revise. As an outcome not only different engineers but also different implementations of software packages might vary in their results.

Precision is a quality which is appreciated primarily by researchers and scientists. It is a quality which is undoubtedly important but it is practically restricted by the possibility of getting the precise input data. When calculating the noise load in large areas (even entire cities) the input data are usually not very precise. After that, the calculation procedure can be far more precise than the input data itself.

The boundary element method is a numerical method based on the solution of the Helmholtz equation. Due to high demands on the calculation time, this method is not used in ordinary noise mapping. It is, however, very suitable for the verification of common engineering algorithms.

The image source method (the disadvantage of which is the energetic sum of the reflected and the direct sound ray) is mostly used nowadays for the reflection from a vertical obstacle. In this paper the verification of this weakness was processed with the BEM. The results calculated by the image sources method were compared with the quadratic curve fitted to the values obtained by the BEM.

It can be concluded that the image sources method is on the safe side. For a reflective screen the average deviation from the BEM was more than 1 dB (the average differences were 1.71 dB and 1.35 dB). When the absorption coefficient was modified (α = 0.74) the average differences were still on the safe side but lower (0.56 dB a 0.43 dB). Provided that the precision of other parts of the overall calculation procedure is taken into account these differences are acceptable.

Higher precision is probably not possible without considering the sound wave interference but, on the other hand, implementing this physical phenomenon into the calculation would prolong the calculation time and make the calculation more complicated. The calculation procedure would therefore become less transparent and more difficult to check.

It is also useful to mention the fact that the measurement of the sound pressure level close to a road includes many moving point sources with different sound power levels. Such measurement also proceeds for a certain time and consequently the result of this measurement tends not to differ much from the result calculated by an engineering algorithm.

It is therefore impossible to make a simple conclusion that a more precise method is also more convenient for practical purposes. The key to success is to find a compromise between a complexity of a method and taking into account of all the physical phenomena which can occur in a particular situation. The calculations shown in this paper confirmed that the image source method fulfils this principle.

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Primary Paper Section: J

Secondary Paper Section: JN

DYNAMIC TESTS OF GEARING

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Abstract: The paper deals with an experimental assessment of the dynamics of gears. The experimental station for dynamic tests of gears is described and methodic for assessing their dynamic characteristics is chosen. The results of the tests made to verify the correct function of the test station and the appropriateness of the chosen methodic for measurement of assessed parameters are listed.

Keywords: dynamics, gearing, technical diagnostics.

1 Introduction

The role of technical diagnostics of transmission mechanisms is to provide informations about technical condition of gearboxes, under which it is possible to:

- In the case of gear manufacturers to optimize the production technology, their design, to verify the data on performance parameters and the selection of recommended oils, respectively method of gear greasing.
- In the process of operation can be identified a damage of machine parts, respectively to ensure strategic planning and managing the maintenance of machinery and equipment and thus prevent the occurrence of disrepair of machinery.

2 Experimental stations for dynamic tests of gearings

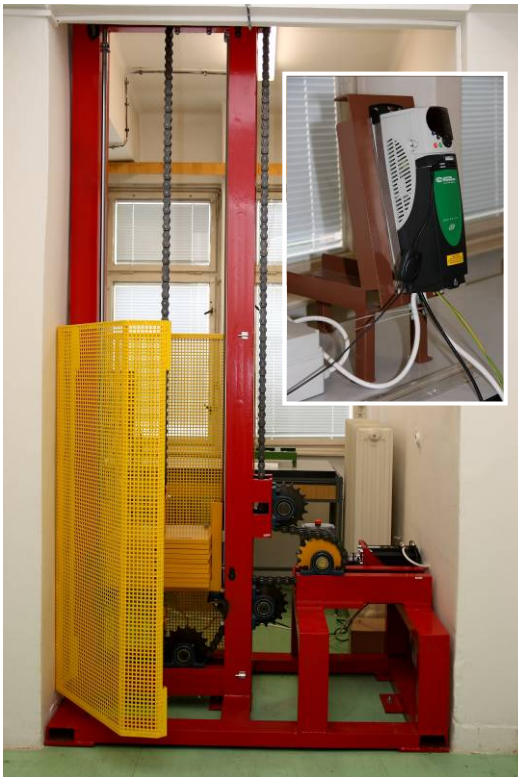


Fig. 1 Experimental station for dynamic tests of gearings with members of the management (The real view)

As part of project solution focused on impact research of dynamic load to the lifetime of the gear drives in the Department of technical systems design Faculty of Manufacturing Technologies, TUKE with a seat in Prešov was built experimental station (Fig. 1) for the implementation of comparative tests of the gear drives, [1], [3].

With this experimental station can be realized short-term and long-term stress tests of transmissions with purpose to improve their parameters and to increase their lifetime. Further has been developed metodology for assessment of technical condition of gear mechanisms using several methods of non-destructive diagnostics.

The appropriateness of the proposed methodology for the assessment of gearings technical condition was verified by a series of experimental measurements of two commonly produced worm reducers of the same type and parameters. The role of these tests were also to verify if the experimental station meets the specified requirements from a functional point of view. The measurements were realized under the accelerated process of load to the experimental station [1], [3], which allows the simulation of real operating conditions of gearbox, respectively entire fuel station and working machine.

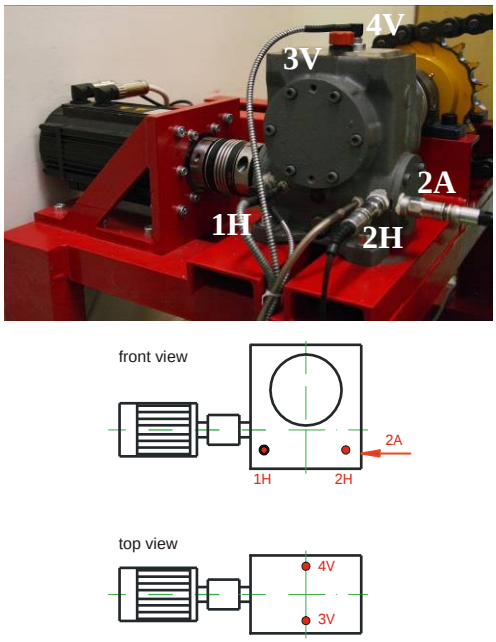


Fig. 2 Location of sensors at the surface of the worm gearbox

3 Description of measurement

During the experimental operation the technical condition of worm gears was monitored in two different working modes. Running conditions of Operational mode 1 were designed so that the work performance achieves 70 ÷ 80 % of nominal gearbox performance guaranteed by its producer and stables oil temperature under limitations. In case of Operational mode 2 the load on gearbox was lower.

Dynamical values (temperature, vibrations, ultrasound) were monitored during the operation in selected measure points of gearbox (Fig. 2).

Table 1 Parameters measured online

Measuring	Measured parameter	Device
1H	Vibrations	NI PXI
1H	Temperature	Oktalon 2K
2H	Temperature	Oktalon 2K
4V	Vibrations	NI PXI

In measuring points 1H, 2H and 4V individual values (Table 1) were measured in online mode. Dynamical data (vibrations and ultrasound) from measuring points 2H and 2A were collected in offline mode.

3.1 The measuring instruments

Sensors:
- accelerometers PCB IMI of type 607A11 with integrated cable (sensitivity 100 mV / g, frequency range up to 10 kHz),
- accelerometers SKF SEE.

NI PXI:
- data acquisition was performed by NI PXI measurement system (measurement card type PXI 4472B, 8-channel simultaneous acquisition, 24-bit A/D converter, sampling frequency up to 102kHz, dynamic range 110 dB),
- Data were analysed using Lab View Professional Development System, including the Sound and Vibration Toolset and Order Analysis Toolset.

Octagon 2K:
- double-channel online system Octagon 2K from company Technical diagnostic, spol. s.r.o. Prešov, based on the LWMONI2 module, through which the power supply of sensors and the evaluation of vibrations were realized.
- application programmed in the system Promotic for the realization of data acquisition.

Microlog GX a CMVA 55:
- dataloger and frequency analyser from SKF Company.

3.2 Used methods of technical diagnostic

Gear functional surfaces attrition was evaluated on the basis of these measurements:
- gearbox temperature measurement and determination of the temperature gradient,
- low-frequency vibrations versus time (DTMF - measuring the speed of vibration),
- High frequency vibrations (MFA (Acceleration) - measuring the acceleration of vibration),
- low-frequency and high-frequency vibrations, depending on temperature of the gearbox,
- determine the natural frequencies of mechanical system,
- ultrasonic emission See - measured offline by Microlog CMVA 55,
- high-frequency vibrations - measured offline by Microlog CMVA 55 (ENV 1,2,3,4 (Enveloping) - measuring the envelope of the acceleration of vibration),
- continuous measurement of the oil temperature,
- tribotechnical diagnostics of oil,
- continuous measurement of the tooth thickness,
- visual assessment of the gear functional surfaces.

4 Results of the measurements and discussion

In relation with wear in contact points of teeth sides were described by all used diagnostic methods in section 3.2 determined the same rundowns of attrition. Based on this fact, the proposed methodology of dynamic tests was evaluated as suitable for testing of gearings. In relation to the objective assessment of the technical condition of the tested worm reducer gear set, it can be stated that within six hours of service there was a significant attrition in the worm wheel in contact surfaces with the spiral worm.

The results of the measurements are processed and evaluated in detail in, [2] and [3]. To significant deterioration of meshing ratios on gearing was due to significant resonant actions, high mechanical vibrations above the recommended limiting values according to ISO 10816-3. Unfavourable were running conditions for motor acceleration and deceleration (of gearbox), especially at higher loads - vibration of the supporting structure of the experimental station and inadequate conducting of chain, what resulted in the transmission of vibrations up to the gearbox. Under these circumstances it was not possible to make an objective assessment of the technical condition of the tested reducer.

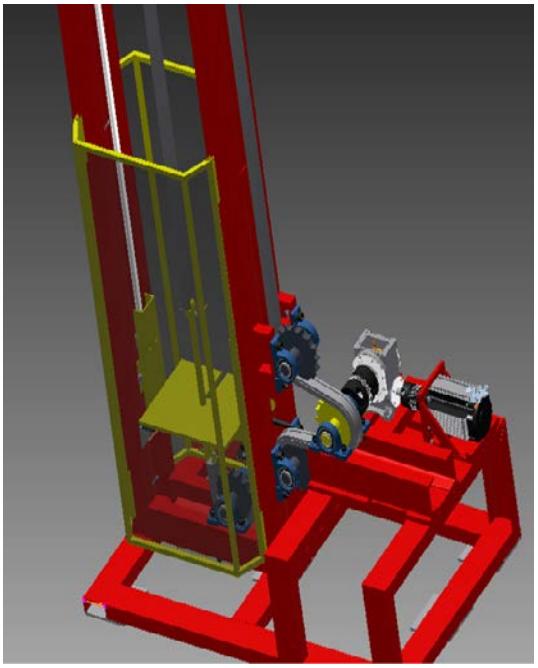


Fig. 3 Experimental station for dynamic tests of gearings (3D model created in Autodesk Inventor)

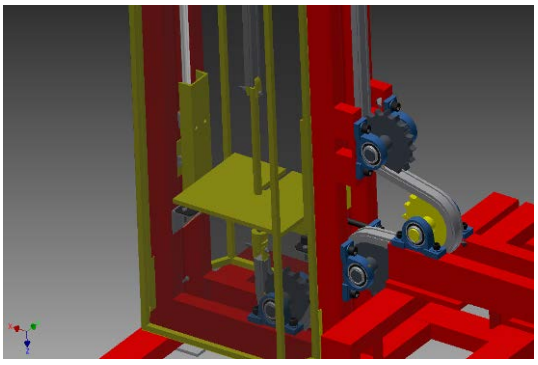


Fig. 4 3D model experimental station gearings (detail)

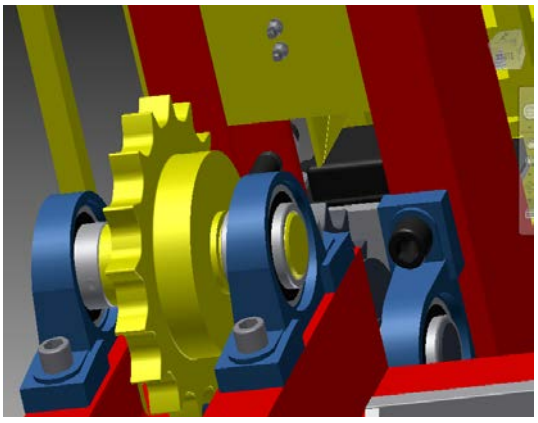


Fig. 5 Detail of 3D model experimental station gearings

Fig. 6 3D model of the test worm gear

The results of monitoring of the technical condition of worm, respectively other tested gearings will be acceptable only after optimization of the supporting frame design (stabilization). Several alternative solutions for modification of the supporting structure of the experimental station was developed. Optimal modification will be selected on the basis of the results of computer simulations realized on a 3D model of the test station. Fig. 3, 4 and 5 show the 3D model of the test station in the original version created in Autodesk Inventor Professional 2011. Fig. 6 shows a 3D model of the test worm gear. 3D model of the test station is modified according to the proposed design changes. Dynamic analysis of the worm gear and the supporting frame of the test station will be performed by Dynamic simulation module in Autodesk Inventor

Significant attrition illustrates the state of the surface of the tooth flanks of the worm wheel of tested worm gears. The appearance of the surface of the tooth flanks of the gearbox worm wheel No.1 before the experimental running is shown in Fig. 7. The appearance of the teeth side at the end of the first phase of laboratory tests is shown in Fig. 8. Attrition of the tooth flanks is unequal and it has not the same character. Fig. 8a shows the tooth side status in the course of upward stroke of the weight with visible signs of attrition surface elements and pitting. Fig. 8b shows the changed status of the tooth side surface from the other side, when sinking the weight.

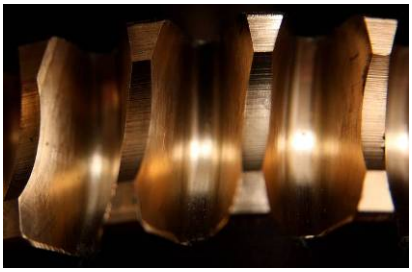
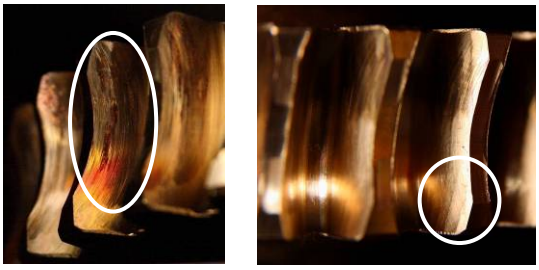


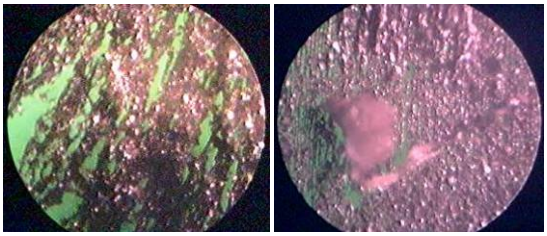
Fig. 7 The tooth flanks surface of unused gearbox worm wheel.



a) b)

Fig. 8 The tooth flanks surface of the worm wheel at the end of the first phase of experiment

By magnetic separation of attrition elements by using Ferro graph from the taken oil sample were obtained samples for investigation under a microscope. For both adjudicated oil samples in Fig. 9 are clearly visible particles of Cu and Sn alloys (bronze coloured particles). In the worm gear is worm wheel made from bronze. The presence of Cu and Sn alloys elements confirms significant attrition of contact surfaces of the tooth flanks of the gearbox worm wheel. Other measured values are specified and evaluated in [3].



Operation mode 1 Operation mode 2

Fig. 9 Particle identification – traces of bronze

5 Conclusion

The results of the assessment of the technical state of the test gears by different methods led to the same conclusion within the assessment [3].

The proposed methodology for assessing the technical state of gears has been assessed as suitable for obtaining objective measurement results of the dynamic characteristics of the gear. There was also prepared a proposal for elimination of identified failures of the test station.

Test device after modification and removal of identified failures can be used primarily for testing these parameters of gears, respectively parts of the gearing station:

- durability, reliability, wear (change of geometry - abrasion of contacts);
- efficiency, temperature, temperature gradient, thermal expansion, friction performance, friction moment, axial load;
- running actions, intensity and duration of running, change of load carrying capacity after running, the impact of abrasion on the contact surfaces, effect on grease, effect on durability;
- assessment of individual components, mainly gearing, bearings, grease, chain wheel and chain.

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Primary Paper Section: J

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CHILDREN'S ANTHROPOMETRY IN RELATION TO SCHOOL FURNITURE

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- IGA LDF MENDELEU project, id. no. 32/2010 (Anthropometry of children with disabilities in relation to furniture);
- NIS MPO ČR FR-TI1/050 project (Information system to support research, development, innovation and quality of furniture)
- OPVK IPo, CZ.1.07/2.2.00/18.0017 project: (The inovation of pregradual secondary teacher education in part-time form).

Abstract: The paper presents results of a research investigation obtained under the support to the IGA LDF MENDELU project, NIS MPO ČR project, and OPVK project. It gives an account of theoretical and methodological starting points, presenting the project's research aims. Its chief objective is to introduce professionals to the existing results of the completed research investigation focusing on the determination of dimensional requirements for furniture intended for children with disabilities. The questions raised belong to a broader context of the issue at hand, related to the project of setting up protection and safety standards in relation to the health condition of children and youth, in the context of the "Long-term programme to improve the health status of the population of the Czech Republic - Health for everybody in the 21st century" paper, namely objective 4: YOUTH HEALTH – TO YIELD CONDITIONS FOR YOUNG PEOPLE TO BECOME HEALTHIER AND APTER TO FULFILL THEIR ROLE IN THE SOCIETY BY 2020.

Keywords: Furniture for children, education; anthropometry; functional capacity; disability.

1 Introduction

The issues covered by the paper are related to the methods of anthropometric measurements and the actual research conducted on groups of kids classified as per school division. Taking somatic measurements produces primary input to define the methodology of requirements for furniture intended for children with disabilities. The terms functional ability, disability and health as defined in the International classification of functional abilities, disabilities and health paper (hereinafter referred to as the MKF) must be included in the research conducted with a great deal of emphasis. Depending on the classification of disability, degree of functional ability of children and the somatic measurements taken, relations must be sought in order to determine the optimum evolution index to serve as key input to dimensional requirements for children furniture. In principle, children, and people with a limited functional ability and disability must be given a chance to lead dignified lives and integrate them adequately into society.

2 Aim

The aim of the paper is to introduce professionals to the existing results of the completed research investigation focusing on the determination of dimensional requirements for furniture intended for children with disabilities. The research results will be used within the arising assessment methodology for requirements applying to furniture for children with disabilities, which forms the object of a dissertation paper by one of the originators of the present paper. Presently, the research is based on the measured somatic measures for healthy children belonging to several children age categories. Mutual relations are sought between these values, taking the shape of body segment indices having an impact on the determination of dimensional requirements applying to furniture for children.

3 Material and methods

3.1 Material

The supporting expertise used throughout the paper consists of the following specialised interdisciplinary documents, standards, methodologies and other specialised literature used as sources:

- Methods of Anthropological Research [academic support Biology UJEP];
- ČSN EN ISO 7250 Basic human body dimensions for technological design [ČSN EN ISO 7250];
- The long-term programme to improve the health condition of the population of the Czech Republic - Health for everyone in the 21st century [Ministry of Health];
- Information concerning assessment of the degree of dependence for persons aged 18 or less [Ministry of Labour and Social Affairs];
- International classification of functioning, disability and health [MKF];
- International Classification of Diseases [MKN];
- Information system to support research, development, innovation and quality of furniture [NIS], etc..

The aforementioned sources were used by the originators of the paper to obtain information they complement with their own views regarding the issues of children with disabilities and discuss the need for determining dimensional requirements for children furniture with regard to the needs of children with disabilities.

The originator of the paper (Ing. Martin Zach) is a researcher/co-researcher for the projects below, with whose support the results of the research instigation were processed. Namely, these involve the IGA LDF MENDELU project, id. no. 32/2010 (Anthropometry of children with disabilities in relation to furniture) and NIS MPO ČR FR-TI1/050 project (Information system to support research, development, innovation and quality of furniture).

3.2 Methodology

3.2.1 Research methodology – anthropometry

Anthropometry is a science, which deals with measurements of the human body and the method of functional anthropology. At the same time, the science is a set of techniques to measure the human body. The discipline where the intention is to capture the body shape of living people is referred to as **Somatometry**. On the contrary, the discipline where the intention is to reconstruct proportions of the human body based on the skeletal remains is referred to as **Osteometry**. Anthropometric methods are subject to global standardisation drawing on precisely defined anthropometric points. (Řeháková et al., 2010). Standardised anthropometric tools are used to determine standardised anthropometric points and measures.

3.2.1.1 Anthropometric instrumentation

Anthropometric instrumentation is required for the measurements of body dimensions to be measured. The **basic anthropometric** and, by inference, somatometric **instrumentation** includes:

- anthropometer (picture 1);
- personal scale (lever, precision step-on)
- large contact calliper = pelvimeter (picture 4);
- anthropometric sliding calliper (picture 2);
- tape meter to measure circumferential dimensions (picture 3);
- standardised plug to measure reach distance.

Picture 1: Anthropometer
(source: URL: <http://alumet.republika.pl/>)

Picture 2: Sliding calliper to measure width dimensions (source: URL: <http://www.fsps.muni.cz/laborator>)

Picture 3: Tape meter - length 150 cm (source: URL: <http://www.optingservis.cz>)

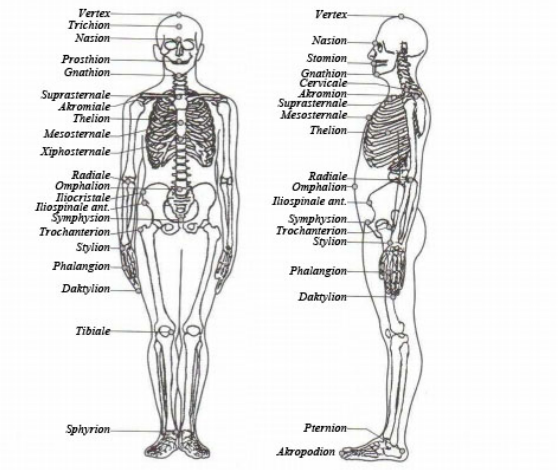
Picture 4: Pelvimeter (source: URL: <http://www.trystom.eu>)

3.2.1.2 Measured indicators – body dimensions

Taking the measurements on children using indicators recorded in the measurement report for each individual. In addition to the measured indicators, the measurement record states an identification code, date and time of examination and date of birth of the proband.

Examples of measured indicators: *body mass; chest circumference; width of the pelvis – (bicristal); body height in a sitting position, eye line height in a sitting position; thigh height above the seat; arm length bent in the elbow; reach distances, etc.*

The indicators are based on anthropometric points that are identical with the points defined in the human skeleton (see: picture 5) and are reflected on the surface of the human body.



Picture 5: Anthropometric points (source: ŘEHÁKOVÁ, a kol., *Metody antropologického výzkumu;* own.)

The anthropometric points are generally measured on:

- the trunk and limbs;
- on the head.

Somatic dimensions based on the anthropometric points are divided to height, width and circumferential points. The anthropometer is used in measuring the height dimensions (see: picture 1). The width dimensions on the trunk are measured by a small and large contact caliper = pelvimeter (see: picture 4). The width dimensions on the limbs are measured by a modified sliding calliper--under our research, limb widths were not measured. picture 2). Circumferential parameters are measured using a tape meter (the tape meter resembles a measuring tape but is made of soft steel or waxed canvas - see: picture 3) while a standardised plug is used for measuring the reach distance (the proband grips the plug in the palm of their hand and their reach is measured - forward towards the grip and the elbow-grip length). Moreover, a modified sliding anthropometer is used in anthropometric measurements, using which height dimensions may be measured.

Measuring the human body is based on the so-called basic anatomical position. Healthy individuals (probands) are measured on the right half of the body standing upright next to a wall with the heels, buttocks, shoulder blades, head and the feet remaining together. The head is in the so-called reference plane, which is defined by the edges of the ear canal circumference (tragion) and the lower edge of the orbit (orbitale). The plane is horizontal. The anthropometer is always held perpendicular to the ground when determining the dimensions. (Řeháková et al., 2010).

As an example, somatic dimensions may be used to determine the maximum reach zones for storage furniture, height and width of the seat, the minimum space per person for dining purposes, etc. The current average human body dimensions are laid down in related standards while furniture designing is governed by ČSN EN ISO 7250 Basic human body measurements for technological design. (Brunecký et al., 2011).

The ČSN EN ISO 7250 standard defines the dimensions to be measured when standing upright and in a sitting position, dimensions of the individual body parts (such as palm length, head width, etc.), functional dimensions (such as the forward reach toward the grip, chest circumference, gripping height, etc.), and mass. The standard follows the total of 56 anthropometric dimensions. As part of the measurements, 36 somatic dimensions are investigated while 32 somatic dimensions are based on the ČSN EN ISO 7250 standard, and the following dimensions to be measured are added: height of the suprasternale, elbow height in 90° flexion, stylion point height and arm span. (Brunecký et al., 2011).

People/children with disabilities generally exhibit impaired mobility due to the disability. With regard to furniture and operating the, this applies to: ***seating depth and height, maximum reach while using storage furniture,*** etc.

3.2.2 Statistic methods

In ontogenetic development, the major changes in growth and individual development mainly occur in the pre-school age, school ages and in adolescence. The change processes are primarily determined by hereditary factor, on the other hand, though, factors of the environment surrounding the individual also have a role to play. Ontogenetic changes are best described by the so-called **Rohr's index**, or the physical fullness index and **F-index**, or the stout lean index. For adult population, the **BMI** (body mass index) is most commonly used.

$$BMI - index: \ H / V^2 \text{ (in meters)}$$
$$Rohr's\ index: \ H \,.\, 10^5 / V^3$$
$$F - index: \ (H^{1/3} / V) \,.\, 10^3$$

The indices are determined from the absolute dimensions measured. Mostly, this involves a mutual ratio of two

dimensions expressed in per cent. The indices give an indications as an individual's proportionality or non-proportionality. The values of most indices vary as a function of the individual's ontogenetic development.

As part of our research, it will be more appropriate to keep a track of the **physical segment indices** and their evaluation. Specifically, we mean the "**evolution index**", which is used to monitor growth development of the lower limbs. It is appropriate that *the length of the trunk (height in a sitting position), width of the pelvis (bicristal width)* should be monitored; in relation to the use of furniture (seating important where the height, width and depth of the seat are the crucial factors). The aforementioned physical segment indices thus have an impact on the determination of dimensional requirements for children's furniture.

Country-wide anthropometric researches were carried out in 10-year intervals, with the last one taking place in 2001. In principle, no other anthropometric measurements are performed on children at the time being in the territory of the Czech Republic.

3.2.3 Percentile method

Use of the Percentile method--an alternative to statistic data treatment--is recommended for evaluating the measurement results. The averages are insufficiently applicable as a result of major differences in the individual body parts, and therefore, a range must be worked with instead. It was proven statistically that measuring the human body in any given population sample will be distributed in such a way that (majority) will fall somewhere to the middle while a small number of extreme measurements will alternatively be recorded in either end of the spectrum. As it is impossible to carry out the design for the entire population sample, it is crucial that the segment be chosen out of the middle portion. As a result, today, it is customary to ignore the extreme results on both ends of the range and work with the 90% of the population group. Most anthropometric data is therefore expressed in terms of percentiles. For the purposes of the present study, the population is divided into 100% categories ranked from the smallest to the biggest with regard to some specific types of body measurements. The initial percentile for the figure or height, as an example, indicates that 99% of the population sample the study deals with is of a bigger height. And similarly, the 95th percentile implies that only 5 % of the study's population is of a bigger height and 95 % of the study's population is of either the same or smaller height. The percentiles indicate the percentage of persons within the population (population sample), which have body dimensions of a certain size (or smaller). (Brunecký et al., 2011).

4 Theoretical background

The furniture used by children should be "tailor made". Both in terms of the material used in production, shapes, weight, dimensions, coloration and functionality in use, or for children who are "disadvantaged" by a certain degree of disability, and their increased operability and linkage to the aforementioned aspects.

4.1 Disability

First of all the degree of physical handicap must be realised for the individual concerned and their handicap must be classified=disability. The term handicap is here already replaced by the term disability, which is one of the pillars of the MKF paper by the World Health Organisation (WHO). The MKF paper defines disability as follows: *"Disability denotes reduced functioning on the level of the body, individual or society, which emerges once encounters external barriers as a result of their health state (heath condition).* (National Council of People with Disabilities of the Czech Republic, 2010, p. 9). The MKF paper does not classify the persons but rather describes and classifies the situations of each individual in a number of circumstances relating to their health. This may be considered to imply that each individual has a specific health state that confronts them with various life situations and therefore often gets them into diversely disadvantaging positions.

According to the World Health Organisation, people with disabilities account for 9 to 13 % of Europe's population. The indication reveals that people with disabilities account for a "sizable minority of the population". National Council of People with Disabilities of the Czech Republic, 2010).

4.2 Functioning

It refers to all functions of the body, activities and participations as an overarching term; similarly, disability is used to express disorders, reduced activity or limited participation. The MKF paper also registers environmental factors that contribute to all the constructions. They have an impact on all components of functioning capacities and disability and are organised across the range from the individual's immediate vicinity to the environment in general. National Council of People with Disabilities of the Czech Republic, 2010).

The functioning and disability of individuals are conceived of as dynamic interactions between health issues (diseased, accidents, injuries) and co-factors.

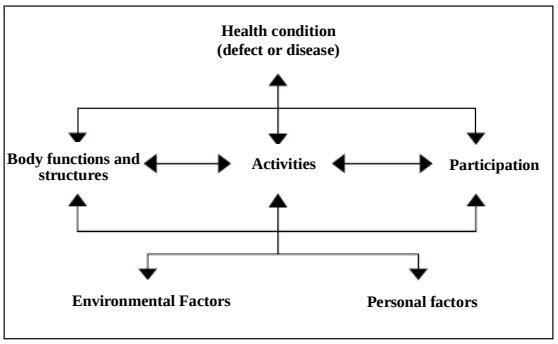
4.3 Heath/disability classification

Health and health-related states associated with all health problems. The unit used in the classification is a ***category*** inside each health domain and health related state. Situations of individuals are described rather than personal classification. The description is created in the context of the environment and personal factors.

4.4 Co-factors - according to the MKF paper

Representing the integral background of an individual's life. They contain two components: *environmental factors and personal factors*, which may have an impact on the indivdiual's health problems and health-related states (see: see Chart in picture 6).

The environmental factors form the physical, social and positional environment, in which people live their lives. These involve external factors, to which the individual may be exposed and which may either have a positive or negative impact on the specific manner in which the individual performs their activities as a member of the society, or on their capacity or functions of the body, or the structure of the given individual. The environmental determinants co-factor alongside the components of bodily functions and structures and activities and participation. Disability is regarded as an outcome or result of a complex relationship between health problems of an individual and personal and external factors that represent the circumstances surrounding the individual. National Council of People with Disabilities of the Czech Republic, 2010).



Picture 6: Chart – mutual interactions of the components (source: own)

4.5 Disability classification

The commonest internal differentiation of people with disabilities employs a model based on the prevailing disability. Disability classification into:

- **physical**;
- mental;
- visual;
- auditory;
- speech.

Physical disability corresponds to a single group only. The issue of subdivision within the physical disability group may be conceived of according to a number of criteria. The commonest is the one that employs ***depth (degree)*** of disability. A number of criteria, including the official, employ a division of physical disability to:

mild - moderate - severe.

In principle, it is a very generic classification since each of the aforementioned groups includes a very diverse group of states, diseases, disabilities and, in particular their bearers=the individuals. (Michalík a kol., 2011).

Tracing the results of the selected investigation among people with disabilities conducted in 2007 by the Czech Statistical Office, we reach the conclusion that the number of people with disabilities towards the end of 2006 was 1,015,548 in total. Out of that number, 46 208 of people with disabilities belonged to the group 0 – 14-year-olds. There were 16,687 ***people with physical disabilities*** within the age group. (ČSÚ, 2007).

For the group of 0-14 year-olds, there were 26,264 people with inborn disabilities. On the other hand, people with acquired disability had 19,944 representatives in the group. Inborn disability within the said group accounted for 56.84 %. (ČSÚ, 2007).

<u>*People with physical disabilities may be further subdivided to:*</u>
- inborn and acquired musculoskeletal defects;
- inborn upper limbs defects;
- finger deformations;
- pelvis defects;
- deformations of the femoral neck;
- lower limbs defects, knee defects;
- foot defects;
- acquired spinal deformity - scoliosis;
- acquired through injury, operation - infections of bones and joints, etc.

4.5 Requirements for furniture for children with disabilities

The requirements for furniture are looked at from the following viewpoints: workmanship, testing, structure, materials, dimensions, safety, ergonomics, equipment, main defects and conditions.

The general requirements define that marketed furniture must reliably, safely and reasonably meet the purposes, for which it has been designed. It must be constructed in such a way as to guarantee its utility properties in the long run. At the same time, it must be constructed using materials and joints customary for the given typological group of products, or verified by an accredited testing centre, or at least such that possess a material certificate. The product structures and components must adequately allow for the replacement of the elements crucial for its utility properties. In addition to the utility parameters and the prescribed features, the furniture must also display adequate resistance to dynamic loading when used. (Brunecký et al., 2011).

If the requirements are met, the furniture for children with physical disabilities should be fully functional, easily operable so as to ensure easy usage for the children.

If these results based on a thorough investigation among children are taken into account, the principles may easily be adhered to in the relationship of the furniture to children with disabilities with a view to removing the "barrier" the children must overcome so as to be able to use the furniture in very much the same way as their peers, classmates or brothers and sisters,

5 Results and Discussion

The classification of children, on whom the following measurements have been provided, takes place in keeping with the values used for the classification for the purposes of school attendance.

- **pre-school age** (4 - 7-year olds);
- **junior school age** (7 - 11-year-olds);
- **senior school age** (11 - 15-year-olds);
- **teenagers** (15 - 18-year-olds).

36 somatic dimensions were investigated while 32 somatic dimensions are based on the ČSN EN ISO 7250 standard, and the following dimensions to be measured were added: *height of the suprasternale, elbow height in 90° flexion, stylion point height and arm span*.

The outcome of the anthropometric measurements completed was summary statistics of somatic dimensions of healthy children divided as per the classification for school attendance purposes to be used for research and development of a model example for both healthy children and, by inference, children with limited functioning and disabilities. The measurement results imply an increase in the median values for the basic somatic dimensions within the development of the individual groups of children divided as per the classification used for school attendance purposes. It is important for the determination of requirements to be imposed on the furniture intended for children with physical disabilities that the basic somatic dimensions, and, by inference, the **body segment indices**, and/or the ***"evolution index"***, which is used to monitor growth of the lower limbs, be followed. This primarily applies to the ***length of the trunk (height in a sitting position), width of the pelvis (bicristal width)***; in relation to the use of the furniture. In a sitting position where height, width and depth of the seat are the crucial factors. The "evolution index" referred to above will thus have an effect on the determination of the dimensional requirements for children's furniture.

The provisional values obtained through measurements may only be worked with as long as they are regarded as aggregate statistics for children divided as per the classification used for school attendance purposes (4 to 7 year-olds; 7 to 11-year-olds; 11 to 15 year-olds; 15 to 18-year-olds) as only 126 probands have been measured by December 2012. The measured values are not statistically valid (as of yet, they do not correspond to 400 probands), if for no other, than for the reason that the statistical sample within the measurement is insufficient (proband = an individual submitted to the investigation). Once a sufficient number of children have been submitted to the measurements in all of the age groups (6 to 18-year-olds), adequate values for all measured somatic dimensions may be obtained for all individual one-year categories. Then, the somatic dimension, using which the current **dimensional requirements for children (school) furniture** will be determined, will be regarded as statistically proven.

At the present, it is virtually impossible to ensure the measurement are statistically valid. This is due to a number of factors referred to below:

- consent of the parents is required for the measurement;
- the staff of the health care establishment and the anthropologists must be trained to carry the measurements out (and the consent of their superior must be obtained);
- children may no longer be measured at educational establishments as the latter introduce restrictions that

prevent anybody else from touching the children. In a health care setting, that is a part of the medical profession.

These facts render it impossible for us to complete the research in the short run and still arrive at a valid sample. Therefore, the measurements take place gradually and individually with an account taken of the aforementioned facts.

The values that have been measured so far under the aggregate statistics for the individual age groups of children imply that the number of **N** values is not identical for all somatic dimensions measured. The reason is that the probands concerned had injuries during the measurements that made it impossible to measure the given somatic dimension. The **SD** value determines the standard deviation for each somatic dimension measured. The ***Median*** value - a range of mean values - is used to process the indices and dimensional requirements for children furniture. It is given by the 50th percentile of the series of measured values (see table 1 - 4) and for explanation of the method see chapter 3 Material and Methods, and subchapter 3.2.3 Percentile method.

The development of children in terms of anthropometry is highly variable in time, After all, development of somatic dimensions may be followed for the individual age groups of children on charts 1 and 2 below. The variability is also observed within ethnicities. If the attempt to determine dimensional requirements for children furniture is based on the currently measured somatic values, an account must be taken of the variability of children development in the time frame of the upcoming decades.

The measured values will be the input for a model example that may be applied to school children furniture (in terms of the age groups of children and their division as per the classification for school attendance purposes).

Table 1: **Pre-school age 4 – 7-year old**

Aggregate statistics All children 4-7-year olds	**N**	**Average**	**Median**	**Minimum**	**Maximum**	**SD**
Mass	13	22.7	21.8	18.8	29.6	3.5
Height	13	119.7	118.1	110.0	132.5	6.4
Head circumference	11	50.6	50.5	48.2	52.5	1.3
Chest circumference	11	59.4	58.7	55.2	64.6	3.4
Eye line height	13	109.0	108.2	99.8	123.8	6.5
V_ac	13	95.0	94.2	86.4	109.3	6.2
V_sst	13	94.9	94.4	85.5	107.5	6.2
V_ra	13	72.5	72.5	66.0	82.5	4.8
V-elbow	13	70.8	70.9	64.5	80.5	4.1
V_iliospin	13	66.3	66.4	60.5	77.2	5.1
V_ti	12	33.9	33.8	29.7	38.9	2.6
V_sty	13	56.7	56.3	51.3	64.5	3.6
Hrud_sagit	13	13.9	14.0	12.8	15.2	0.9
Hrud_trans	13	20.1	20.2	19.0	22.7	1.0
Bicristal width	13	20.1	20.2	17.8	21.1	1.0
Biacrom_width	13	26.1	26.0	22.0	29.0	2.1
Bideltoid_width	13	30.1	29.8	28.0	32.3	1.3
Reach_grip	12	52.5	52.0	47.5	61.7	3.6
Elbow_grip	12	24.2	24.3	20.9	26.2	1.7
Arm_span	12	116.4	115.7	107.0	133.0	7.8
Height_sitting	12	64.0	64.3	59.7	68.4	2.6
Eye-line_height_sitting	12	51.6	51.5	46.4	56.1	3.2
Cervicale_height_sitting	11	43.4	43.3	40.0	47.1	2.4
Acr_height_sitting	12	39.0	38.9	35.3	42.3	1.9
Shoulders_height_sitting	12	18.2	18.8	15.5	19.9	1.5
Elbow_Height_sitting	12	15.5	14.6	13.0	18.4	2.0
Popliteal_height_sitting	12	30.4	30.5	27.0	35.0	2.3
Thigh_above_seat_height	12	8.9	9.1	7.1	10.4	1.0
Knee_height_sitting	12	36.6	35.9	32.9	41.8	2.5
Arm_length_sitting	12	23.8	23.6	21.0	28.8	2.0
Foreoarm_length_sitting	12	19.3	18.9	17.8	21.7	1.3
Elbow_width_sitting	12	42.4	42.8	28.5	61.1	10.2
Width_sitting	12	25.1	25.5	20.7	29.0	2.2
Stomach_depth_sitting	12	16.6	16.8	15.1	17.7	0.9
Chest_depth_sitting	12	15.2	14.7	13.3	17.9	1.4
Popliteal_length_sitting	12	31.7	31.7	27.7	34.9	2.1
Knee_length_sitting	12	38.8	39.2	34.2	43.5	2.6

(source: own)

Table 2: **Junior school age 7 - 11-year-olds**

Aggregate statistics All children 7-11-year olds	**N**	**Average**	**Median**	**Minimum**	**Maximum**	**SD**
Mass	29	29.9	28.1	21.6	49.6	7.8
Height	29	134.6	135.5	121.4	149.4	8.1
Head circumference	30	52.0	51.6	48.4	56.3	1.9
Chest circumference	30	65.4	63.3	58.1	82.3	6.9
Eye line height	29	123.6	123.9	109.6	139.5	8.3
V_ac	29	108.3	108.7	94.5	122.1	7.4
V_sst	28	107.8	108.2	96.9	121.1	7.1
V_ra	28	83.5	83.5	73.1	95.3	5.9
V-elbow	27	81.0	81.5	70.2	93.4	5.7
V_iliospin	29	76.3	75.9	67.6	88.6	5.9
V_ti	29	38.1	37.9	33.4	43.0	2.8
V_sty	29	65.3	66.3	56.8	75.0	4.6
Hrud_sagit	30	14.7	14.7	12.3	19.6	1.6
Hrud_trans	30	21.8	21.5	19.1	26.4	1.9
Bicristal width	30	21.2	20.9	18.8	27.0	2.1
Biacrom_width	30	29.4	29.1	26.0	35.0	1.9
Bideltoid_width	30	33.6	32.3	29.1	40.8	3.5
Reach_grip	29	58.1	58.1	49.1	66.4	4.0
Elbow_grip	29	27.1	27.1	23.4	32.2	2.1
Arm_span	29	131.3	130.5	118.0	147.0	8.0
Height_sitting	29	71.0	70.8	64.1	78.1	4.1
Eye-line_height_sitting	29	59.1	58.3	53.2	66.9	4.3
Cervicale_height_sitting	28	48.9	48.1	43.3	54.9	3.5
Acr_height_sitting	29	44.3	44.9	39.5	50.8	3.2
Shoulders_height_sitting	28	18.9	18.8	14.7	24.7	2.3
Elbow_Height_sitting	27	16.7	16.4	11.2	21.5	2.2
Popliteal_height_sitting	29	33.5	33.5	29.0	38.0	2.1
Thigh_above_seat_height	29	10.2	9.9	7.9	13.9	1.6
Knee_height_sitting	29	41.4	41.9	36.7	48.8	3.0
Arm_length_sitting	28	27.0	27.1	23.9	31.3	1.8
Foreoarm_length_sitting	28	21.6	21.7	18.8	24.1	1.2
Elbow_width_sitting	26	49.1	48.1	27.7	73.3	11.4
Width_sitting	29	27.5	26.4	23.2	40.3	3.7
Stomach_depth_sitting	29	17.5	16.7	13.2	27.1	3.1
Chest_depth_sitting	29	16.8	16.2	13.9	22.3	2.4
Popliteal_length_sitting	29	37.1	36.9	32.0	44.0	2.9
Knee_length_sitting	29	45.0	45.1	38.9	52.8	3.6

(source: own)

Table 3: **Senior school age 11 - 15-year-olds**

Aggregate statistics All children 11-15-year olds	**N**	**Average**	**Median**	**Minimum**	**Maximum**	**SD**
Mass	41	51.0	45.9	29.1	96.1	17.2
Height	41	159.2	159.2	133.6	187.6	12.4
Head circumference	39	53.8	53.6	49.8	59.0	2.0
Chest circumference	38	79.0	77.3	59.5	106.5	11.8
Eye line height	41	148.5	147.7	123.2	176.7	12.4
V_ac	41	130.0	128.7	107.9	154.3	10.8
V_sst	41	129.5	129.5	108.1	154.7	10.7
V_ra	41	100.3	100.2	84.6	119.3	8.6
V-elbow	40	98.1	97.8	81.8	117.1	8.5
V_iliospin	41	91.5	90.4	76.7	107.8	7.4
V_ti	41	46.0	45.0	39.5	56.2	4.4
V_sty	40	78.1	77.4	65.0	92.0	6.8
Hrud_sagit	41	17.5	17.0	13.0	24.0	2.6
Hrud_trans	41	25.7	25.0	20.0	34.9	3.5
Bicristal width	41	25.3	24.5	19.9	35.4	3.6
Biacrom_width	41	34.5	34.0	29.0	41.0	3.3
Bideltoid_width	41	39.6	38.8	31.8	49.0	4.6
Reach_grip	41	67.8	66.5	54.2	81.7	6.0
Elbow_grip	41	32.1	32.3	25.2	37.2	2.8
Arm_span	39	158.2	156.8	132.0	188.0	12.6
Height_sitting	41	81.6	80.4	70.2	95.7	6.8
Eye-line_height_sitting	41	70.1	68.7	58.9	82.6	6.6
Cervicale_height_sitting	41	58.3	57.1	49.5	69.4	5.5
Acr_height_sitting	41	52.7	51.8	44.3	64.1	5.1
Shoulders_height_sitting	41	22.1	21.9	14.8	28.8	4.0
Elbow_Height_sitting	41	19.9	19.5	13.5	27.8	3.7
Popliteal_height_sitting	40	39.9	38.9	34.0	46.0	2.7
Thigh_above_seat_height	41	12.8	12.2	8.8	18.9	2.3
Knee_height_sitting	41	49.5	48.8	42.2	58.6	3.8
Arm_length_sitting	41	32.2	32.2	25.9	38.4	2.9
Foreoarm_length_sitting	41	26.1	26.1	21.2	31.9	2.4
Elbow_width_sitting	40	64.2	65.9	39.6	85.7	9.9
Width_sitting	41	33.8	33.4	25.3	47.3	5.5
Stomach_depth_sitting	40	21.3	20.1	16.9	32.8	4.0
Chest_depth_sitting	40	20.6	18.9	15.7	30.6	4.1
Popliteal_length_sitting	40	44.7	43.9	39.8	53.0	3.5
Knee_length_sitting	41	54.2	53.8	48.1	64.9	4.5

(source: own)

Table 4: **Teenagers 15 - 18-year-olds**

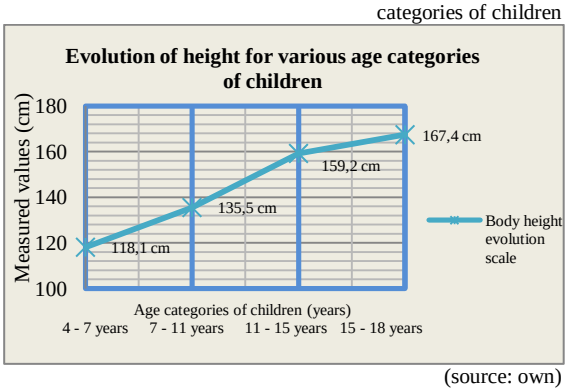
Aggregate statistics All children 15-18-year olds	**N**	**Average**	**Median**	**Minimum**	**Maximum**	**SD**
Mass	42	57.9	56.2	36.6	87.8	12.0
Height	42	168.5	167.4	153.8	192.3	8.4
Head circumference	42	55.2	54.9	52.0	61.0	1.8
Chest circumference	42	84.4	83.6	42.0	104.8	7.1
Eye line height	42	158.0	157.2	143.9	179.3	8.11
V_ac	42	137.6	136.7	124.0	157.8	7.4
V_sst	42	137.0	136.6	124.0	157.8	7.4
V_ra	42	106.7	106.4	96.4	125.1	5.9
V-elbow	41	104.3	103.8	93.7	124.4	6.0
V_iliospin	41	94.8	94.2	84.1	107.5	5.7
V_ti	41	47.4	47.2	41.2	52.9	2.9
V_sty	41	83.7	83.2	74.5	98.9	4.7
Hrud_sagit	42	17.7	17.1	13.8	26.7	2.9
Hrud_trans	42	26.4	26.7	15.2	35.0	3.4
Bicristal width	42	26.9	26.5	21.6	34.2	2.5
Biacrom_width	42	37.0	37.0	34.0	42.0	2.2
Bideltoid_width	42	41.9	42.0	36.2	51.3	3.5
Reach_grip	41	71.5	70.7	65.7	81.0	3.7
Elbow_grip	41	33.8	33.7	30.3	38.9	2.0
Arm_span	38	166.8	167.0	149.0	191.0	9.7
Height_sitting	41	88.1	87.5	80.2	102.3	4.2
Eye-line_height_sitting	41	76.6	75.7	68.5	87.6	4.0
Cervicale_height_sitting	41	63.6	63.1	56.4	74.0	3.4
Acr_height_sitting	41	57.1	56.5	50.7	67.3	3.2
Shoulders_height_sitting	41	25.5	25.5	19.4	30.4	2.4
Elbow_Height_sitting	41	23.6	23.2	19.4	29.5	2.3
Popliteal_height_sitting	41	40.6	41.1	34.0	50.0	3.0
Thigh_above_seat_height	41	13.5	13.3	10.5	19.7	1.8
Knee_height_sitting	41	51.3	51.6	45.2	55.9	2.5
Arm_length_sitting	41	33.7	33.6	30.0	39.0	2.1
Foreoarm_length_sitting	41	27.0	27.0	23.3	30.8	1.7
Elbow_width_sitting	39	65.3	67.0	41.3	87.5	10.1
Width_sitting	41	37.3	37.2	30.0	47.4	4.4
Stomach_depth_sitting	40	20.8	19.8	15.4	28.4	3.0
Chest_depth_sitting	41	22.6	22.4	18.5	30.4	2.8
Popliteal_length_sitting	41	47.6	47.2	42.3	54.2	2.7
Knee_length_sitting	41	57.4	57.7	50.4	64.4	3.1

(source: own)

The measurements are taken by the Institute of Anthropometry of the Faculty of Natural Sciences, Masaryk University, under the leadership of Mgr. Martin Čuta, Ph.D.

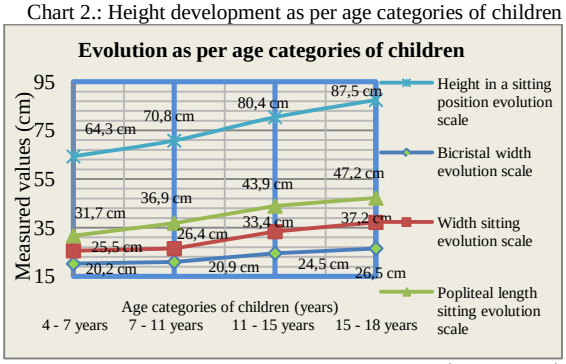
Based on the ongoing measurements, requirements are stipulated for children furniture as well as dimensional requirements. As regards the priorities, these concern sitting, working (school) and bed furniture for children.

Chart 1.: Development of somatic dimensions as per age categories of children



(source: own)

Chart 2.: Height development as per age categories of children



(source: own)

The MKF paper notes it is not only ethical and moral but also cost efficient to objectively and as soon as possible evaluate the functioning capacities of patients following diseases, injuries or inborn defects and restrict or mitigate their disability by physiotherapy. In the event the defects persist, the people concerned must be given an opportunity to lead a dignified life and optimally integrate them into society. National Council of People with Disabilities Czech Republic, 2010). The same applies to children and their disabilities. In our opinion, we have the obligation to offer to them not only in the school environment, standard school furniture that will optimally integrate them into the group of their peers and will not pose barriers in regular usage.

6 Conclusion

The selected issue discussed by the paper is in accord with Oliver Speck (1991 in Horňáková, 1999, p. 30), who notes that "*everyone lives in a real environment as its integral part*" The quote corresponds to the new theories of treatment and education (a term coined by Dannemann, Schober and Schulze, 1911), it is based on anthropology, namely its object of study, which was and is in accordance with the investigation carried out and described by the originators of the text in the previous chapters. Generally, the issues of treatment and education form a part of the current attempts at integrating its area of expertise, which defines it, into Czech special education, for which the knowledge obtained by the former become an added value in terms of building a higher-quality environment for individuals and the society with varying degrees of disability. The facts described form a part of a broader discussion which is connected with integration and, ideally, inclusive reception of such excluded individuals (pupils and students) in full-fledged social life (including the school environment). The discipline referred to above mainly focuses on the ecological factors, where it points to the importance of dealing with the variables, in this case the

furniture parameters in relation to children anthropometry, where their true knowledge is an undisputed factor in the healthy development (growth) of individuals and forms conditions for the successful implementation of the said societal processes, which is supported by the National Action Plan for Inclusive Education of 15 March 2010, which is compatible with (Government Resolution no. 1046) Health 21 - Long-term programme to improve the health state of the population of the Czech Republic – Health for everyone in the 21st century. (Government of the Czech Republic, discussed on 30 October 2002).

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Primary Paper Section: J

Secondary Paper Section: JP, AM, FS