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TRENČIANSKA UNIVERZITA ALEXANDRA DUBČEKA V TRENČÍNE
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TECHNICKÁ UNIVERZITA V KOŠICIACH
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Richard Rorty, Stanford University

Časopis vychádza dvakrát ročne pre slovenskú, českú a prípadne aj širšiu európsku odbornú komunitu. Číslo bolo vydané s podporou projektu KEGA 3/6411/08.

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The journal principal content will be articles focused on designing, measuring, monitoring, analyzing and assessing quality and innovations with the objective to arrive at prosperity.

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- Creativity,
- Competitiveness,
- Team spirit,
- Professionalism, etc.

Motto:

“Knowledge is the result of nonviolent exchange of ideas among free-minded and intelligent people “

Richard Rorty, Stanford University

The journal will be issued twice a year for the Slovak, Czech and possibly also for a more general European professional communities. This issue was granted by project KEGA 3/6411/08.

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KATARÍNA KORÁLOVÁ, ALENA PAULIKOVÁ

ISSN 1335-1745

ABSTRACTS

PROCESSES ASSESSMENT AND MONITORING IN A CLINICAL LABORATORY

DANA TRÁVNÍČKOVÁ

Keywords: clinical laboratory, quality control, process, accuracy, precission, capability indexes, control charts with classical and moving control limits

Abstract: The basic view of the assessment of the qality of health care is the quality of the medical treatment or procedures. Associated services are also of a great importance. Among these services there are services provided by clinical laboratories. Decision making on diagnosis, prognosis or way of medical treatment is frequently based on the results supplied by a clinical laboratory and their interpretation. The results of analytical measurings from clinical laboratories can have a decisive impact in the field and can influence (even fatally) the patient´s health, quality of life and sometimes the life itself. The choice of an analytical process can influence the test results and therefore it is important to assess the processes capability.

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BASIC INTERPRETATION OF INFLUENCE OF THE COMPANY PROCESSES' MANAGEMENT ON THE COMPANY'S FINANCIAL INDICES

DITA BEYROVÁ

Keywords: financial analysis, indicator, quality management

Abstract: The object of this article is to point out an influence of an internal processes control to the financial indicators. Each process owner, although he has no economical education, should be able to interpret the company financial results and to see a connection between the state of his process and the indicator value. In the preface there is summarized basic information about the financial analysis – a data resource used for the financial analysis (including possible modifications), receivers of the outputs from the analysis and constituent methods of the financial analysis. The main part of the article than brings constituent parts of the financial analysis: working capital managing, liquidity analysis, profitability analysis, turnover analysis and indebtedness analysis. Described indicators are not interpreted from the economical point of view only, but the aim is to make it obvious, how is possible for the process owners to

influence the indicators value from the perspective of the key processes managing.

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THE MARKETING MIX CONTRIBUTION IN IMPROVING THE NATIONAL MUSEUM OF ROMANIAN HISTORY STRATEGY

RUXANDRA IRINA POPESCU, RAZVAN-ANDREI CORBOS

Keywords: Cultural Institutions, museums, Marketing Mix, strategy, strategic option, goals

Abstract: The National Museum of Romanian History (NMRH) is one of the most important actors in the contemporary Romanian archeology field and leader of the preventive archeology thanks to its big surface and patrimony. Thus, in the context of improving its activity through strategy reshaping, the marketing mix can help develop assets in order to assure NMRH`s leading position. The present paper focuses on the way in which the product policy can mobilize NMRH`s resources in order to build an effective supply, analyses the options for overcoming financing problems (reduced public financing, raising competition for private funds, increasing operational costs, subsidy reduction) and identifies solutions for promotion policies and distribution aimed to effectively inform the target public, as well as other market segments about the cultural products and services NMRH offers.

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THE QUALITY OF HARDNESS TESTER CALIBRATION

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Keywords: calibration, Vickers hardness, uncertainty

Abstract: The objective of submitted work is to compare direct and indirect calibration of the Vickers hardness tester using the analysis of uncertainty. The

indirect calibration was carried out according to respective technical standard. The main sources of uncertainty at direct calibration were the deviation of vertex angle of diamond indenter, the deviation of test force and deviation of diagonals of indentations. Repeated calibration carried out by two appraisers leads to the identification of tester non-conformance by both methods. The influence of the vertex angle deviation on uncertainty is more significant than the influence of test force deviation. The uncertainty obtained by indirect calibration is more significant than that it of direct calibration. This work was supported by the Slovak Grant Agency for Science VEGA 1/4141/07.

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SWARM-BASED OPTIMISATION

LENKA RAUDENSKÁ

Keywords: Swarm-based optimization, Bees algorithm, Particle swarm optimization, Ant Colony Optimization, Genetic algorithm

Abstract: Everyday we are facing problem how to solve different problems with maximum affectivity, what is the best composition, which production process is most efficient etc. For solving these and similar problems are used optimization methods. If there is unknown exact algorithm describing the problem, is impossible to solve the problem by traditional optimization methods as numerical, dynamic, linear and non-linear programming or variation methods. In this case and also when exact solution is very extensive are used Genetic algorithm, Optimization statistical methods, heuristic programming, etc. The paper describes above all methods of Swarm-based optimization and comparison of these methods by benchmarking functions.

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ADJUSTMENT OF SIX SIGMA TOOLS FOR A BETTER CONTROL OF PROCESS TIME

FILIP TOŠENOVSKÝ

Key words: Six Sigma, Box-Cox transformation, control charts, DMAIC cycle, Box-Jenkins theory

Abstract: The article discusses possibilities of changing some of the statistical methods used in Six Sigma in case the problem to be solved by Six Sigma is process time. The article focuses on replacement of control charts with tools developed in the theory of time series, and on regression modelling of non-normal variables, using Box-Cox transformation.

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ENVIRONMENTAL EDIFICATION AT UNIVERSITIES AS A PART OF SLOVAKIA SUSTAINABLE DEVELOPMENT

KATARÍNA KORÁLOVÁ, ALENA PAULIKOVÁ

Key words: environmental edification, environmental education, sustainable development, environmental management, environmental engineering, environmental dynamics

Abstract: The submitted work describes the historical development introduction of environmental edification and education at universities in the framework of Slovakia sustainable development. There has been a need to accentuate environmental consciousness and to bring closer a current state in an incorporating of environmental aspects for education process at technical universities. An article emphasizes continuous development of observed problems and introduces the possible future visions from point of reorganization and tending of study fields.

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ABSTRAKTY

HODNOCENÍ A MONITOROVÁNÍ PROCESŮ VE ZDRAVOTNICKÉ LABORATOŘI

DANA TRÁVNÍČKOVÁ

Klíčová slova: zdravotnická laboratoř, řízení kvality, proces, správnost, přesnost, indexy způsobilosti, klasické a dynamické regulační diagramy

Abstrakt: Při vnímání kvality zdravotní péče je základním hlediskem kvalita vlastního léčebného úkonu, či postupu. Nezanedbatelnou roli mají také doprovodné služby. Mezi nezbytné doprovodné služby patří služby, poskytované zdravotnickou laboratoří. Rozhodování o diagnóze, prognóze a postupu léčení je často postaveno na výsledcích a interpretaci laboratorních vyšetření. Výsledky analytických měření z klinických laboratoří mají mimořádně silný dopad v praxi, mohou rozhodným a někdy i fatálním způsobem ovlivnit zdraví, kvalitu života a někdy i samotný život pacienta. Volba analytického procesu může ovlivnit výsledek vyšetření a proto je důležité způsobilost procesu hodnotit.

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ZÁKLADNÍ INTERPRETACE VLIVU ŘÍZENÍ VÝROBNÍCH PROCESŮ NA FINANČNÍ UKAZATELE FIRMY

DITA BEYROVÁ

Klíčová slova: finanční analýza, ukazatel, management kvality

Abstrakt: Cílem článku je poukázat na to, jaký vliv má řízení interních procesů na finanční ukazatele. Každý vlastník procesu, i když není ekonom, by měl být schopen interpretovat ekonomické výsledky firmy a vidět základní souvislosti mezi stavem svého procesu a hodnotou daného ukazatele. Úvodem jsou shrnuty základní informace o finanční analýze firmy – zdroje dat využívané pro finanční analýzu (včetně možných úprav), příjemci výstupů z analýzy a jednotlivé metody finanční analýzy. Hlavní část článku pak přináší jednotlivé části finanční analýzy, tedy řízení pracovního kapitálu, analýzu likvidity, analýzu hospodářského výsledku, analýzu obratu a analýzu zadluženosti. Popisované ukazatele nejsou interpretovány jen z ekonomického pohledu, ale též tak, aby bylo patrné, jak lze jejich hodnotu ovlivnit z hlediska řízení hodnototvorného procesu.

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POUŽITIE MARKETINGOVÉHO MIXU PRE ZLEŠOVANIE PROPAGÁCIE RUMUNSKEJ KULTÚRY

RUXANDRA IRINA POPESCU, RAZVAN-ANDREI CORBOS

Kľúčové slová: kultúrne inštitúcie, múzeá, marketingový mix, stratégia, možnosti stratégie, ciele

Abstrakt: Národné múzeum Rumunskej histórie (NMRH) je jedným z najdôležitejších činiteľov v oblasti súčasnej rumunskej archeológie a vďaka svojmu širokému rozsahu a dedičstvu má vedúce postavenie v preventívnej archeológii. V kontexte zlepšovania svojich aktivít pomocou prepracovanej stratégie múzea, môže marketingový mix napomôcť pri vytváraní hodnôt a tak zabezpečiť vedúce postavenie NMRH. Článok je zameraný na produktovú politiku múzea a jej orientáciu na výsledky, ktoré môzu zmobilizovať zdroje NMRH tak, aby sa realizovali vhodné analýzy a vytvorili efektívne predpoklady pre správne riešenia na prekonanie finančných problémov (znížené verejné financie, zvýšenie konkurencie v oblasti súkromného financovania, zvýšenie režijných nákladov, zníženie dotácií). Predkladaným výsledkom riešenia je zlepšenie propagácie, podpory a rozdeľovania financií zamerané na efektívne informovanie určenej verejnosti ako aj ďalších segmentov trhu o produktoch/výstupoch kultúry a služieb, ktoré NMRH ponúka.

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KVALITA KALIBRÁCIE TVRDOMERA

JOZEF PETRIK, PAVOL PALFY

Kľúčové slová: kalibrácia, tvrdosť podľa Vickersa, neistota

Abstrakt: Cieľom príspevku je porovnať priamu a nepriamu kalibráciu Vickersovho tvrdomeru pomocou analýzy neistôt. Nepriama kalibrácia bola realizovaná podľa zodpovedajúcej technickej normy. Najdôležitejšie zdroje

neistoty pri priamej kalibrácii sú odchýlka vrcholového uhla diamantového ihlanu, odchýlka skúšobného zaťaženia a rozdiel uhlopriečok vtlačkov. Pri opakovanej kalibrácii, realizovanej dvoma operátormi, bola pri oboch metódach kalibrácie zistená nezhoda tvrdomera s požiadavkami normy. Vplyv odchýlky vrcholového uhla na neistotu je výraznejší ako vplyv odchýlky skúšobného zaťaženia. Neistota, stanovená nepriamou kalibráciou je výraznejšia ako neistota stanovená priamou kalibráciou. Článok bol pripravený v rámci projektu VEGA 1/4141/07.

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OPTIMALIZACE POMOCÍ ROJOVÉ INTELIGENCE

LENKA RAUDENSKÁ

Klíčová slova: Rojová inteligence, Včelí algoritmus, Optimalizace pomocí částicových hejn, Mravenčí kolonie, Genetický algoritmus

Abstrakt: Každodenně se setkáváme s řadou problémů: jak něco nejefektivněji udělat, jaká je nejlepší kombinace složení, jaký je nejproduktivnější technologický postup apod. Na řešení těchto a podobných problémů se používají optimalizační metody. V případě, že není znám přesný algoritmus řešeného problému, který má byt diagnostikován není možné problém řešit pomocí tradičních metod optimalizace, mezi které patří například numerické, lineární a nelineární programování, dynamické programování nebo variační metody. Zde a taktéž v případě, že řešení by bylo předchozími metodami pro exaktní algoritmus příliš rozsáhlé se používají například genetické algoritmy, statistické teorie optimalizace nebo různé heuristické algoritmy. Následující text bude věnován především metodám Rojové inteligence a srovnání těchto metod pomocí benchmarkingových funkcí.

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ÚPRAVA NÁSTROJŮ SIX SIGMA PRO LEPŠÍ KONTROLU DOBY TRVÁNÍ PROCESŮ

FILIP TOŠENOVSKÝ

Klíčová slova: Six Sigma, Box-Cox transformace, regulačné diagramy, DMAIC cyklus, Box-Jenkins metodológia

Abstrakt: Článek diskutuje o možnostech změny některých statistických nástrojů používaných v Six Sigma v případě, že problémem, který má Six Sigma řešit, je doba trvání procesu. Článek se zaměřuje na náhradu regulačních diagramů nástroji teorie časových řad a na regresní modelování nenormálně rozdělené veličiny při využití Boxovy-Coxovy transformace.

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ENVIRONMENTÁLNE VZDELÁVANIE NA VYSOKÝCH ŠKOLÁCH AKO SÚČASŤ UDRŽATEĽNÉHO ROZVOJA SLOVENSKA

KATARÍNA KORÁLOVÁ, ALENA PAULIKOVÁ

Kľúčové slová: environmentalna výchova, environmentálne vzdelávanie, udržateľný rozvoj, environmentálne manažérstvo, environmentálne inžinierstvo, environmentálna dynamika

Abstrakt: Predkladaný príspevok popisuje historický vývoj zavádzania environmentálnej výchovy a vzdelávania na vysokých školách v rámci udržateľného rozvoja Slovenska. Zdôrazňuje potrebu environmentálneho povedomia a približuje aktuálny stav v zaraďovaní environmentálnych aspektov do vzdelávacieho procesu na technických vysokých školách. Príspevok zdôrazňuje kontinuálny vývoj sledovanej problematiky a predstavuje vízie do budúcna z hľadiska reorganizácie aďalšieho smerovania študijných odborov.

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PROCESSES ASSESSMENT AND MONITORING IN A CLINICAL LABORATORY

DANA TRÁVNÍČKOVÁ

1 INTRODUCTION

Nowadays demands for quality continue to grow not only in production, but also in services. Service is an activity which takes place between a customer and a provider. There is a disadvantage compared to a product – service is more difficult to provide and mainly, it is more difficult to set measurable parameters of a service. Quality of health care services is a very sensitive subject, it is important for not only the health care providers. It is very important for state administration, health insurance payers and mainly the public, the potential patients.

There are three dimensions of the healthcare services quality (Madar, 2004):

- Quality of the service from the client´s view point;
- Quality of the service from the view point of management – the most economical and most efficient use of resources within the framewrk of directives and limits, set by superiors or payers;
- Quality of the service from the professional view point – if the services fulfill the needs in the way as they are defined by professionals who execute them or who send patients to take the service and if the services contain suitable techniques and procedures, which are necessary for fulfilment of client´s needs.

The article focuses on the services provided by a clinical laboratory from the professional view point. Its performance can be measured only when the performance indicators are correctly set and measured.

The objective of this article is: To set indicators for measuring the ancillary processes capability and to amend the quality indicators in a clinical laboratory with capability indexes as far as processes assessment is concerned, and with control charts with moving limits for analytic phase processes monitoring .

Contribution of the article is expected in following areas:

- Assessment of the analytical phase processes performance;

- Based on the processes performance, setting up of a metodology for usage of the tools to determine frequency of running control samples within the internal quality control;
- Reduction of the laboratory services costs by setting up a suitable frequency of running control samples;
- Assessment of the use of moving control charts for processes monitoring.

2 METHODOLOGY

The services provided by clinical laboratories are unavoidable in the health care system. The results of analytical testing have a strong impact in medical treatment. The results can influence (even fatally) the patient´s health, quality of life and sometimes the life itself. The results of tests are the basis for important decisions on diagnosis, prognosis and the way how to proceed with medication. That is why the quality of the tests results is so important (precise and accurate) and the laboratory response time (time from receipt of samples to despatch of results) minimal. Nowadays, when laboratories use fully automated analysers, the response time is not a problem any more. The quality of results is closely connected with assessment of capability of all processes and sub-processes in a laboratory.

The quality level assesment is based on comparison of what really is with the vision what should be the optimum of quality. The result of the assessment therefore has influence on determination of what should be and detection of what really is. In the health care this problem is long time focused on by the Joit Commission on Accreditation of Healthcare Organization (JCAHO) and the national or international standards are considered as the vision of the optimum of quality (Zgodavová, 2006).

In the Czech Republic the capability of clinical laboratories is being assessed according to the standard ČSN EN ISO 15189:2007 – Clinical laboratories – Special demands on capability and quality. This European standard has been approved by CEN and it is used by clinical laboratories to develop their quality management systems and self-assessing of their capability. It is also used by accreditation bodies to assess the clinical laboratories capability.

Clinical laboratories can supply 70% of information about patients, When these information are irrelevant, they cannot help neither the doctor, nor the patient – more to the contrary. How to define quality in a clinical laboratory? The American Institute for Quality (Richardson, 2003) suggested to define the quality in a clnical laboratory as the „Laboratory system for collection, examination and issuing of results of human samles, which :

- Supports diagnosis, prevention and management of ill conditions;
- Gives information of a clinical importance about patient´s health status;

- Meets the requirements on accuracy, repeatibility and traceability;
- Tries to minimise mistakes;
- Is quick, safe, efficient and is not expensive;
- Is focused on patients satisfaction and continual improvement.

Laboratory examinations should fit to the clinicians needs, laboratories should ensure the confidence of doctors and patients to the examinations results and to guarantee that the costs were spent efficiently. The definition of quality differs according to view point and needs of stakeholders (Westgard, 2008).

The quality of laboraory examinations depends on many factors. Some of them can be influenced by the laboratory managemet, some originate outside the laboratory, mostly within the pre-analytical phase. Suitable quality indicators can be selected on the basis of three different principles, which represent three different concepts (approaches, models) of quality. The concepts are based on three models: analytical, biological and clinical ones (Hyloft, 1994).

In the laboratory it is possible to identify processes and class them into groups:

- Managing processes – are used to control the laboratory functioning;
- Main process – examination of biological samples, the output of which is determined for laboratory customers;
- Processes of resources management – are used to control resources the laboratoty uses;
- Ancillary processes – these processes support the above mentioned groups of processes.

The main process – examination of biological samples – can be devided into three sub-processes: pre-analytical phase, analytical phase and post-analytical phase. For the main process to functionate well it is necessary to ensure that also the ancillary processes are set and function well (Fig. 1).

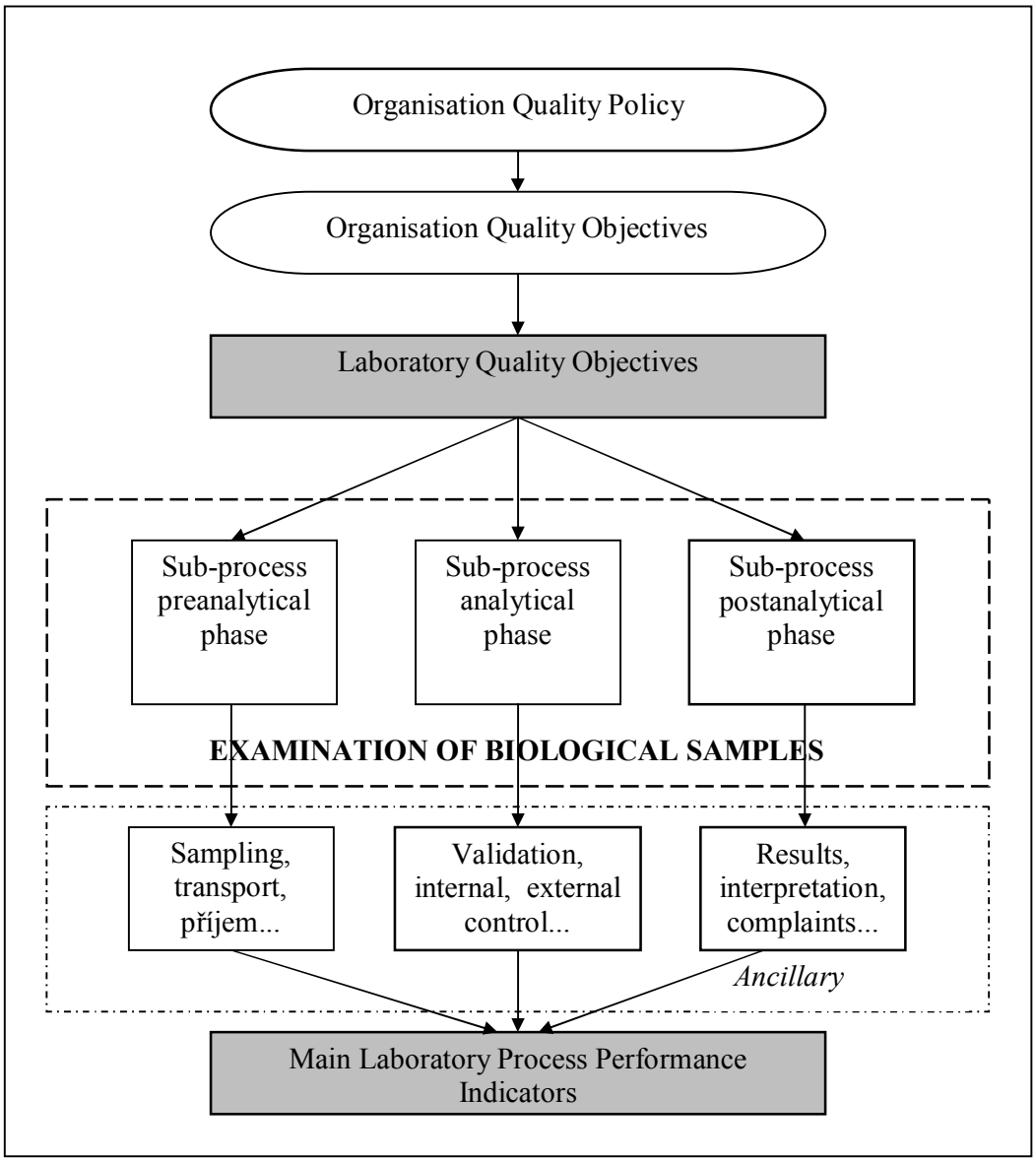

Fig. 1 - Algorithm of processes performance indicators (modified with author permition) (Nenadál, 2001)

Sub-process Analytical phase performance indicators

The performance of the sub-process Analytical phase is measured through assessment and monitoring of examinations performed. After the Internal Qualty Control has been mastered, the process performance is measured also by the External Quality Control. Monitoring of the examinations is a logical follow-up

of validation, resp. verification. When the IVD (In-vitro diagostics) validated by their manufacturer are used, verification only is enough to measure examinations.

Verification

To measure the sub-process „Analytical phase“ by the ancillary process Verification we use following parameters: accuracy, precission, process capability.

Accuracy indicators:	SD, CV
Precission indicators:	Bias %
Capability indicators:	sigma capability, capability indexes

For measuring – monitoring of the ancillary process internal quality control the Control Charts are used.

Parameters: control charts,

Indicator: SD, data mean

For measuring of the ancillary process external quality control we focus on how the laboratory succeeds in the given cycle of controls:

Parameters: success in the given cycle, success in the last 2 years

Indicators: TE, Z – score

Verification of the analytical process contains, according to recommendation of the professional associations, the parameters accuracy and precission. In this article also capability will be included to these parameters and it will be described by capability indexes.

Processes monitoring

For monitoring of the analytical processes laboratories use control charts, which are valuable quality control tools. They are very significant, because when they are rightly chosen and interpreted, they give valuable information about the process (examination procedure, testing of a sample) behaviour and performance. Basically, the control charts should be used as a diagnostic tool to assess if the process tested behaves in the way we expect. Analysis of the control charts can detect in advance significant deviations of the process from the set levels, find and explain the causes and perform corrective actions.

The choice of a control chart depends on character of the measured data and their probability distribution. Then we are able to calculate the control limits. When the control chart is chosen incorrectly, the probability of detection of process deviations decreases. In reality it means that, for example, we can get data points out of control limits even in cases of no change in the process. To be able to fully utilise the advantages of control charts, the data distribution must be Gaussian (normal). This is the requirement also of the Shewhart´s i Levy Jenning´s control charts, which are mostly used in clinical laboratories (ISO 8225).

When the data distribution is not Gaussian, it is necessary to use an alternative control chart instead of the Shewhart´s one, for example the EWMA chart with moving control limits. As shown on Figs 2 and 3 (analyte fT4), when the EWMA is used, the number of rules violation is significantly reduced. The charts have been constructed with the use of real data, analyte fT4 (free-Thyroxine).

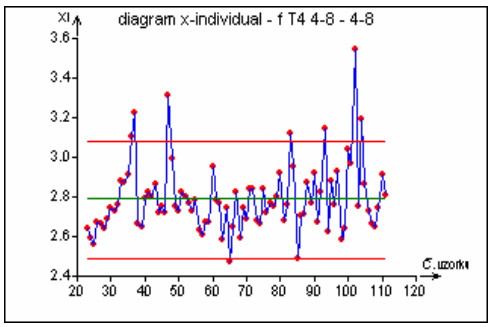

Fig. 2 Shewhart´s chart x – individual with dependant data fT4

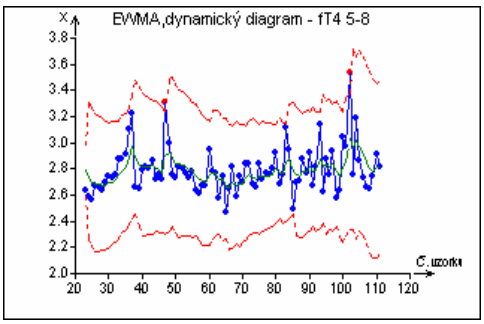

Fig. 3 EWMA chart with moving limits, analyte fT4

Ancillary process Verification – the use of Capability Indexes

Processes capability

Capability of a process is a measure of the process real quality compared to a standard (specification). We asses it after all the systematic effects have been removed, i.e. in the status when the process is under statistic control. When assesing the process capability, we then assess only the variance caused by random effects. When the variance is too high, process cannot have results which would be permanently „within range“. Such process must be examined and after that corrective action(s) must be taken.

As for verification the Cpk indexes were used, other indexes are not mentioned in this article. Index Cpk takes to account not only the variability of tested quality parameter, but also the real capability of the process to keep within prescribed tolerance limits. Its value then reflects the ratio of distance of the mean of the tested quality parameter from the closer tolerance limit to a half of real data

variability. Index Cpk can be calculated for both one-side and two-sides tolerances.

$$C_{pk} = \min\left\langle C_{pU}; C_{pL} \right\rangle, \qquad C_{pU} = \frac{USL - \bar{x}}{3SD}, \qquad C_{pL} = \frac{\bar{x} - LSL}{3SD} \qquad (1, 2, 3)$$

It is possible to say, that analytical processes with Cpk between 1,0 and 1,33 are reliable. Processes with the Cpk value below 1,0 are less reliable and the probability of incorrect result (non-conformity) occurance is higher. Processes with the Cpk value above 1,33 are well reliable and with the value above 1,67 they are highly reliable with a very low probability of incorrect result (non-conformity) occurance (Plura, 2001). Example shown on Fig.4.

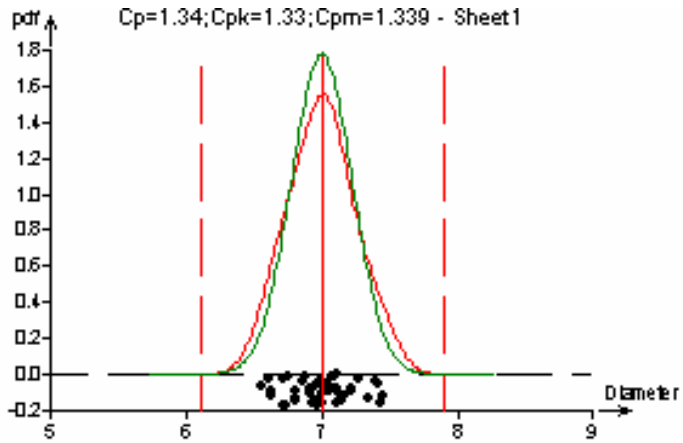

Fig. 4 Probability density curves for Cpk = 1,33

For verification, which is sufficient for an analytical process assesment, it is nowadays enough to asses accuracy (trueness) and precision, or good results in the External Quality Control. To be able to calculate these indicators, it is necessary to obtain data, which have usually no further use. But, the data could be used for calculation of other processes performance indicators, like, for example, the suggested capability indexes.

The capability indexes provide information about another property of the analytical process. The calculation takes to account tolerable and real process variability, like the Six sigma metrics. The Cpk capability index contains information about accuracy and trueness together. The accuracy is described by means of the standard dviation SD or the coefficient of variability CV% and gives information on accuracy achieved only, but without assessment, if it is still acceptable or not. But the required accuracy of analytes in the biological samples differs according to the biological variability. If the required accuracy is added to the capability criterion, for example min. Cp ≥ 1,3, the capability index value returns clear information about acceptability of the variability.

3 APPLICATION

The application part of this work contains evaluation of the use of capability indexes, which were incorporated into verification parametres. The capability indexes were calculated and evaluated for 98 tests at two or three levels. It was found out that 41,06% of all the 263 tests have not reached required capability. Such a high number of incapable tests was caused by including of immunochemical methods of testing. These methods have usually higher variability than other tests (analyzers Architect, Unicel a Stratec). When the capability indexes were assessed without these methods, the number if incapable processes was significantly reduced, down to 27,51%. A very good capability (Cpk ≥ 1,33) was achieved at 40,1% of all tests, respectivelly 53,44% without the immunochemical methods. The worst results were noted at the low levels of the analytes, the best results at the high levels.

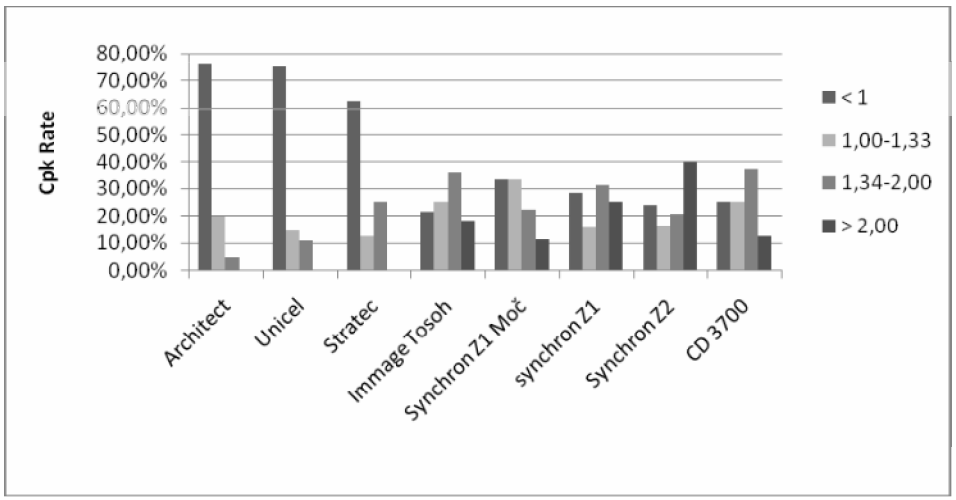

Fig.5 - The Cpk values rate per analyzer

Further on the analyzers have been assessed independently. As we can see at Figs. 5 and 6, there is a significant difference betwen immunochemical methods and the other principles. As far as all other principles than the immunochemical methods are concerned, the differences among them are minor. For the Synchron Z 1 a Z 2 analyzers, where tests are performed the same way, there is a difference visible on Fig. 5 in the number of tests with Cpk ≥ 2,0. This difference is caused by different age of the analyzers. The analyzer Synchron Z 2 has been in use for significantly shorter time than the Synchron Z 1. It means, that capability of analytical processes is indispensably influenced also by the age of equipment.

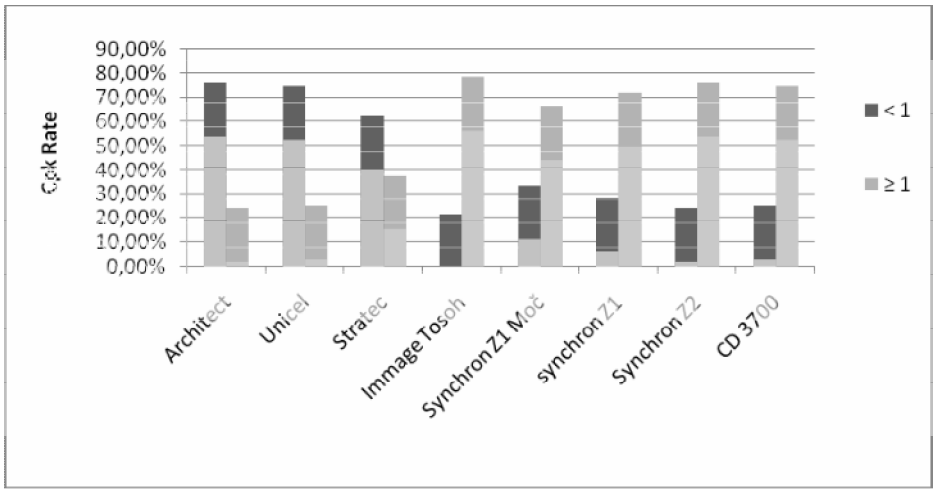

Fig.6 - The rate of Cpk < 1 and ≥ 1 per analyzer

The Cpk value depends a lot on the required variability. The tolerance range was set according to the recommendation of SEKK (www.sekk.cz). In some cases (for example ALT) it would be wise to adapt the tolerances to concentration levels. If the required test variability is set correctly, it is possible to use the capability indexes for determination of frequency of the control tests performance, as recommended in the Table 1.

Tab. 1 – Calability indexes and frequency of control tests

C_{pk} Value	**Capability**	**Control testing frequency**
> 1,0	low	In each series (for example of 20 samples), if the level ifs physiologically important
1,01 –1,32	acceptable	2 x in each series (for example at the beginning and at the end). Series up to 1 day.
1,33 – 1,67	very good	1 x in each series (serie 1 day)
> 1,67	high	each 2 to 3 series (series 1 day)

Frequences, shown in the table, are valid for particular levels of concentration of the control sets. In the 1 day series minimally one level must be measured. Correct application of the capability indexes into the clinical laboratories operation can bring significant quality improvement and also reduction of costs, connected with possible reduction of running control tests.

The ancillary process Internal Quality Control – monitoring by classical EWMA chart and EWMA chart with moving limits.

In the last few years we can see comments in professional literature and also comming from laboratories calling attention to frequent cases of automated processes, where regulation by the classical control charts (Shewhart´s type) is inadequate or impossible. These charts were introduced at the break of the twenties and the thirties of the last century and were intended for controlling measurable and attributive parameters (Michálek 2003, Montgomery 2001, Zvárová 2002).

Classical SPC methods, developed for the conditions prevailing in production, perform well only if following criteria are met:

- The details about process are obtained in regular intervals by collection of data in selections of the range n>1
- Collected data are statistically independent within the selection and among themselves
- The selections are made the way to form logical sub-groups (it must be ensured that among the elements of the selection there are no determinable causes of variability)
- Data come from identical statistical distribution (for continuous stochastic variables we usually expect Gaussian – normal distribution).

When these assumptions are not adhered to, the classical SPC methods fail. The SPC system in this case more frequently than it was estimated falsely signals that there are determinable causes influencing the process and therefore that the process is not under statistic control (Noskievičová 2003; Michálek 2003).

EWMA Charts

EWMA charts were introduced in 1959. It is abbreviation of Exponentially Weighted Moving Average (sometimes called exponential forgetting). Its use is simmilar to Shewhart´s charts. With advantage it is used in cases when we cannot guarantee conditions necessary for use of the Shewhart´s charts (normal distribution, independent data).

In situations, when data are dependant, it is possible to use a modification of the EWMA chart – the EWMA with moving limits, a chart with one step prediction of mean and variability.

The EWMA chart with moving limits is suitable for processes, where the parameters show possitive autocorrelation and the proces has a non-constant mean which changes slowly.

Interpretation of the EWMA chart with moving limits is identical to interpretation of other control charts. If all the values of measured parameter xk are within the control limits, the process is considered under statistic control and changes in the process are slow. If some of measured values lies outside the control limits, it should be considered a signal that the process is out of statistic control (Tošenovský, 2000).

On Figs. 7 and 8 there is an example shown where for the same dependant data the classical EWMA chart and EWMA chart with moving limits are used. The classical chart requires higher necessity of intervention to the process, which proves the false signal. Also the quickness of detection is different (Kupka, 2001).

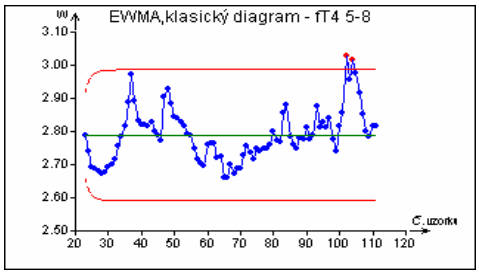

Fig. 7 Classical EWMA Chart, analyte fT4

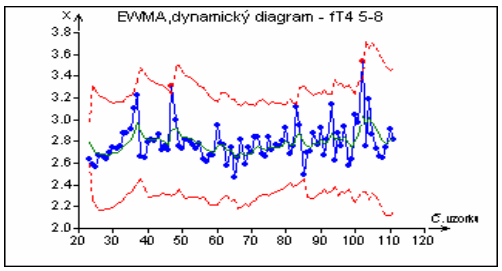

Fig.8 – EWMA Chart with moving limits, fT4

To compare the Shewhart´s control charts X-individual + R and the EWMA charts several representatives of clinical examinations were chosen on the basis of the explorative analysis. The data have been processes by means of statistical software QC-Expert. Creation of the Shewhart´s regulation charts depend on data Gaussian distribution and data inependency. The explorative analysis found several variants of the requirements violation. In some cases the data had Gaussian distribution and were independent, which is the requirement for Shewhart´s charts creation, in some cases the data did not have Gaussian distribution but were independent. The last case was that the data did not have Gaussian distribution and were dependant. Each of the mentioned variants has been processed. Further on the examinations were chosen, for which both of the chart types were created. The examinations were chosen taking in mind that they should cover most of the analytes, according to their structure and function (enzymes, sacharides, lipides, proteins, ionts, tumor markers a hormons).

For 29 compared analytes the Shewhart´s charts, classical EWMA charts and EWMA charts with moving limits were created. With the total number of 4605 data, the numbers of data outside limits for Shewhart´s and classical EWMA charts do not differ significantly (229, resp. 239); the classical EWMA chart refused more data only by 4,4%. There is a significant difference between those

two charts and the EWMA chart with moving limits. When it was used, the number of refused values is only 53, i.e. 4,4 times less.

4 CONCLUSION

Analytical processes assessment

Within the frame of verification, which is enough to assess the analytical processes, nowadays only accuracy, resp. trueness are evaluated, eventually also the success in the External Quality Control. To be able to assess the parametres we need to measure data which are not used further more. The same data can be used for calculation of other process performance indicators, like the suggested capability indexes, namely the Cpk, which contains both the information about accuracy and presission. If the required accuracy is included into the capability criterion, for example min. Cp ? 1,3, the capability index can give a clear information that the variability is acceptable or not. Using the Cpk capability index we get information how the process performs against the required target value, i.e. about the process trueness, which is normally described by bias%. Incorporation of the capability indexes to the parametres of validation/verification would mean that more information about analytical processes could be obtained.

Verification of analytical processes was extended by the use of capability indexes. 98 different examinations have been assessed, each at min. two levels. The assessment of analytical processes by means of capability indexes can be used for determination of control samples testing frequency. Correct monitoring of the processes is very important for the quality of the examinations results, which are used for treatment of both ill and healthy patients.

Monitoring of the analytical processes

The assessment of EWMA chatrs useability for monitoring of processes was performed at different combinations of dala properties. When the conditions for Shewhart´s charts were met (i.e. independent data with Gaussian distribution), the classical EWMA chart was more sensitive to a systematic error. In case of dependent data, we can estimate that signal given by this chart is false, idle, because the chart with moving limits does not detect the limit violation. The variation was small, it is so unimportant and the process remains in the stable status. In the two cases data measured within one month were used. In the third case for the charts creation data measured within six months were used. The difference between various charts is higher in this particular case. While Shewhart´s x-individual and classical EWMA charts signal more frequent violation of the limits, the EWMA chart with moving limits signals the same only once.

Further it was discovered and compared, that data comming from the same process, but on different concentration levels of the measured analyte, have in the same time period different character. For this assessment data from one month

only were used, but tested twice a day, which meant doubled number of data compared to previous months. The higher the number of data was, the higher was the difference among usage of various control charts. The reason was that data change their character in time.

The performed analyses lead to conclusion that the usage of EWMA charts in clinical laboratories is possible, but it is not necessary for monitoring of the processes. In laboratories the values are recoded to the control charts once or twice a day, only rarely more frequently. The time period, which is important for an analyst, is maximally one month. With this volume of data there was found no significant difference among the compared control charts. The false signal about the limits violation comes out in a longer time period (4-6 months), but it is worthless information for the laboratory operation. The usage of EWMA charts, namely the chart with moving limits, is suitable for processes, where the test measuring is performed more frequently, apparently at production processes.

The alert to the incorrect use of the Shewhart´s control charts due to inappropriate data properties has not been confirmed in a clinical laboratory operation. The false signal moreover occures only in case when no deviation happened. The case, when all the points would be falsely within the control limits, has not occured. This means that any intervention to the process would be needless, not that the violation would not be detected. The number of false signals in a clinical laboratory is minimal, therefore also the needless interventions costs are minimal.

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Dana Trávníčková, achieved her secondary education as the clinical laboratorian and later won her master´s degree from the VŠB-Technical University Ostrava, in the field of quality management. For many years she has been working in clinical and analytical laboratories as the quality manager. With her capacity she prepared the laboratories for accreditation according to the standards EN ISO IEC 17025 and EN ISO 15189. She also prepares and lectures specialized courses for the educational centre Dům Techniky Ostrava. She actively participates at professional actions and publishes in conferences proceedings and journals.

BASIC INTERPRETATION OF INFLUENCE OF THE COMPANY PROCESSES' MANAGEMENT ON THE COMPANY'S FINANCIAL INDICES

DITA BEYROVÁ

1 INTRODUCTION

The basic and the simplest parameter of every company's success is profit. But there can be many reasons, why a company is prospering or not. Probably the main way how to review the (financial) health of the company is financial analysis. A lot was written and processed about the financial analysis. The goal of this article is not to bring detailed overview of all the possible methods of financial analysis and present trends or arguing about single approaches and indicators, but the purpose is to bring the basic view on the whole problem aimed for e.g. technically educated managers and lead workers.

The usual problem is that technical oriented managers don't use to be familiar with economical information (result of unilaterally profiled scientific education of technical schools' graduates) and results of economical and financial analysis are almost not used in their work. **The aim of this article is to explain selected indicators of financial analysis to these managers, so that the influence of internal processes on values of the single indicators is evident.**

Financial analysis allows economically evaluating the company, to diagnose the financial health and appraise the productivity of its assets. The financial health of the company is in fact analogous to human health - there isn't only one indicator "degree of health", according to which a doctor could have explicit result, but it is a collection of symptoms and conditions of some quantities (temperature, chemical structure...) [1]. In case of a company the financial health is as well meant as a complex quantity, being composed of many particular characteristics - quantifiable and qualitative. Financial health of the company expressed by the financial analysis is an objective evidence of sufficiency of the whole system concerned, including the **functionality of the quality management systems**. Because the quality is understood as level of fulfilled requirements (needs or expectations, which are determined, generally expected or biding), it can be in general claimed, that profit equals to the success with customers (and owners) and that profit is the rate of quality. The analysis of the economical indicators on the highest level means analysis of efficiency of quality management system as well, because it reports summarizing information if the company creates values and allows the validation accepted steps efficiency.

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2 METHODOLOGY

In the very beginning it is necessary to underline that only filling in the correct numbers to single formulas is not enough - without complex view on the company and knowledge of relevant facts the final conclusion will be most probably wrong and can lead to wrong decisions (e.g. it cannot be said, that high value of liquidity indicator is good or bad, because it can mean high liquidity or too high cash balance, what is wrong - that means deficiently productive asset).

Sources of financial analysis are [2]**:**

1) **Balance** - it gives us information about the condition of property at specific date *(assets - debts (debts)* = shareholder's capital*)*. Property is noted on the side of assets and sources, from which it is financed, are on the side of debts. So debts tell us, how are the assets financed and what does finance them. Certain restriction of using the balance for financial analysis is the fact that during evaluation of assets and debts original purchase price edited of depreciation is used. So in some cases it is preferable to use qualified presumption. If the balance is not constructed like this, then it should be edited before analysis, so that the items of assets are sorted according to their liquidity (length of period when it's possible to change it into cash) and debts are sorted according to their expiration. We value each item as realistically as possible and we should "clean" the disputed amounts.
2) **Report on income and loss** (Income report) - it gives us view of the structure of costs, profits and results of company management for fiscal period (income/loss) subdivided to financial, functional and unusual results, so that *income-loss=profit*. But we cannot forget that net profits doesn't equal to net cash balance produced by company in certain period (e.g. encashment payments from retail on credit from previous period is not included, costs doesn't have to be paid in time of its creation etc.). Before the analysis it is necessary to exclude the unusual items, because it's not a periodic and adequate source of financing.
3) **Supplement to financial statement** - here we can find basic information about the company, its proprietary and organizational structure, information about statutory authorities of the company, information about used accounting methods, write-offs and pricing processes, how are general accounting principles applied, specified information to balance and income statement and further analysis of cash-flow (compulsory for companies, that must have financial statement verified by auditor).
4) **Annual report** - for our purposes it is a more supplemental source, particularly of qualitative information (for financial analysis we need firstly quantitative data from above-mentioned statements). Annual report includes the 3 previous items and further deals with business development and financial situation of the company; development plans are important as well as subsequent changes in organization. Of course it s important to note also what the annual report avoids.

5) **Other sources of information** - stock exchange, press, Internet etc.

The ways of analysis are obviously different according to its purpose and target group:

- **shareholders and investors** – decide future investments, control how managers manage company resources; analyze the relation between future profits and cash-flow towards fixed debt;
- **company managers** – long-term and operational business management; feed-back between decision and effect;
- **creditors** – short-term (banks, supplies etc.); mainly interested in liquidity, analysis deals with quality and movement of short-term assets and debts, and time flow of financial paths; long-term (debenture holders etc.) - analysis focuses also on analysis of expect future of the company.

Methods of financial analysis:

- **method of implicit** (single items of accounting reports) and distance indicators (different of items);
- **method of proportion indicators** (percentage relation of items to specific base in time series). Proportion indicators are often compared in terms of one segment - so-called space alignment (the principle should be that companies should have similar parameters in activities character, quantity, etc.). Access to database with ordinary indicators in certain section is possible - fee for internet access.
- Another possibility of indicators evaluation is time comparing, when we watch progress of indicators for single period within the company. It' s also possible to watch functional relation of two items using regressive analysis e.g. progress of sales depending on GDP progress or number of disputes in production.
- **combination synthetic evaluation** – e.g. Altmans formula to characterize risk of failure of the company or Du Ponts resolution of profitability indicator represents relation between profits and assets return, including reciprocal influence of single indicators.
- Except this basic methods exists also more advanced methods, that are using mathematical statistics and supporting SW tools, usually used by financial and analytical companies.

2.1 Proceeding of working capital

Production cycle can be described as movement of capital through the company - capital is changing from one form to another - financial sources applies to buying

material, from material is produced product (product or service), that is, at the end, convert into financial source again (with profit). During this process comes up risk, that company won t get its invested coffers back. It is necessary to manage working capital according to aims of the company. **Usual solution is control and optimalization of holdings size, fast encashment of debts and cover of debts in terms of payment.**

Working capital cycle = *how long does it company takes to product financial sources* [4]

Tendency of the company is to make it at the shortest period, that s why is important to evaluate this indicator regularly, analyze reasons on the basis of alignment with subject standard and apply corrections. This indicator is for operative management useful as possibility of transmission with parallel period of process (period from induction of product to the process, until the end of the process). Long parallel period often leads to delayed delivery and displeased customers. It‘s often caused by high degree of completion (products and sources are hold inside production process). In in-process amounts is very often hidden wasting (store costs, more difficult planning systems etc.).

Net Working Capital = *gross short-term assets - gross short-terms debts* [4]

This indicator determinates level of smooth financing flow possibility of economical activities. Structure of short-term assets and its money change ability is important, it means that it is needed to subtract unenforceable debts, unmarketable holdings etc. and after that induct values to the formula. The later phase of the production process has not radical influence on indicators value in this case, because with assets growth are debts also growing, or only short-term assets structure is changing. From the financial flow perspective it is better if most of short-term assets are money, because it is asset with the highest liquidity. On this place is needed to mention, that so-called principle of time corresponding in financing should be significant, by another name short-term assets should by financed by short-term sources and long-term property by long-term sources.

2.2 The Liquidity Analysis

Liquidity is defined as ability of the company to obtain resources to cover debts and solvency as ability cover usual business debts at the moment of maturity. Indicators are always proportion of that how is debt provided and of that what is needed to provide (whereas possible money from fixed assets sale are not included). Before using indicator is needed to consider, which assets will be inducted to formula - some only improve balance e.g. unmarketable holdings. (unmarketable holding should be identified during the financial statement formation correctly and evaluated in market price value reduced by sale charges and in the case that it is really unmarketable should be assessment up to zero - this has to be validate before analysis.)

Immediate Liquidity (1st level liquidity) = *financial sources / short-term debts* [3].

It's very exact data about, how many a mature debt as per certain date is company able to cover by money resources in cash and accounts.

Available Liquidity (2nd level liquidity) = *(short-term assets – holdings – long-term debts)/ short-term debts*

Available liquidity eliminates influence of holdings to predicative ability about solvency of the company. Make indicator to be really able to describe rate of providing company costs, debts should be numerator (included in short-term property) in addition reduced by unenforceable or heavily enforceable debts.

Current Liquidity (3rd level liquidity) = *short-term assets / short-term debts* [3]

This indicator isn't too exact liquidity indicator, because if it comes out e.g. „2", the company may be insolvent, if most of short-term property is blocked in irredeemable debts, unused holdings and unmarketable products.

From the view of quality liquidity can be influenced by abridgement of continuous processing time, because in general it cuts money blocked in short-term assets. Relations with suppliers can also influence indicator. One of criterion should be date of maturity (the longer it is, the longer time are money disposable for company) and next running ability of supplier - ability to provide just in time, what means save the storage costs.

2.3 The Economic Effect Analysis

These indicators are in general give us information about how much crowns from profit falls on each invested crown. For calculation are used profit (from income statement) and capital (from balance). Used data can be as per 31.12. or as first and last day average in watched period.

Total Invested Sources Profitability (ROA) = *net profit + net interests / total assets* [4].

ROA predicate about how was property capitalized, no matter how it was finances. The higher is the indicator, the more prosperous it is. Using the net profit increased by interests, are profit and costs for foreign sources consolidated into one value and we can conduct alignment of single companies. We can often come across ROA in different variations - sometimes are gross interests in numerator, sometimes interest are missing (which is not very exact, because it excludes taking into account financing of the company as well by a loan).

The Actual Capital Profitability (ROE) = *net profit / own capital* [4].

It is indicator, from which we can infer, how effective company manages invested property. ROE decline can be caused by:

- decrease of profit making;

- increase of foreign capital interests;
- increase of own capital shares on foreign (if it is caused by accumulation of undistributed profit, it signalize wrong investment policy);
- combination of previous reasons.

Incomes Profitability (ROS) = *net profit / incomes* [4].

Calculation is changing regarding to profit formulation (gross or net profit – it's important when we compare one branch companies). Low level indicator documents wrong managing of the company, middle level shows good work of management and high level signalize problems with competition, which will try decrease price of similar product in the future (does not operate monopoly companies).

These indicators give us 3 different views to one thing – how is total property profitable, how invested money are profitable and ROS is more dynamical indicator, because it shows if productivity increase brings aliquot profit increase (e.g. if this happened at the price of disproportionate costs increase).

These indicators give us much information about how successful we are in managing our processes from the level of cost view. It's possible to connect indicator and process cycle effect, what means effect of the process based on added value amount regard to time that product spends in process. Any process with low cycle effect presents big opportunity to costs decrease – most of processing, business, evolution processes effect is lower then 10%. As a result are excess holdings, hidden expenses in production, reprocessing, waste, invested capital and unsatisfied customers as well.

2.4 Turnover Analysis

Top executives should reach their aims with optimal property values setting (i.e. stable and short-term assets). If the company owns too much assets, its charge of interests is too high (it depends on the proportion of foreign sources and own capital) and it compresses profit, conversely if the company owns few assets, it has to renounce a lot of opportunities. Turnover indicates how many times is bearer of costs value superior to certain asset items (depreciation property turnover is center of stable assets, in the case of short-term assets it is holdings and financial property turnover).

Stock Turnover Period= *holdings / (incomes/365)* [1].

It indicate existence period of capital in inventory form. The higher is indicator, the longer is average stock period and the more sources are hold in the stock. It 's necessary to mind if holdings are suitable valued and there are not obsolete holdings – its real value is lower. Holdings always represent considerably high size of financial sources. That's why it's necessary to watch range and manage effectively (in this branch exist number of conceptions e.g. just in time). Market

influences turnover, but there is possibility of active influence, what is again connected to work-in-process production.

Debts maturity average period = *debts / (incomes/365)* [1]

Result is the number of days during which is every day sale encashment hold in debts. It is useful to compare this value with common terms of payment when the company invoices products. It's important to determinate exact procedures of debts managing (conditions, terms, close contact with sales department to avoid insensitive procedures and disruption of relationships between company and customer).

In the case that the costs turnover period is lower than in liabilities, company markedly credits up its customers, what brings press to working capital. From the quality view, this indicator is more important from the customer relation managing view, what usually is business department matter.

Fixed assets turnover = *incomes / fixed assets* [1].

Fixed assets turnover shows how effectively company uses buildings and equipment. Very problematic is that asset price was given in the past (for calculation is used original purchase price and the inflation is not included – there are some methods how to include it, but usually not used). Supervisory management is interested in fixed assets real efficiency – it is quite easy to compare to company with same products. Assets real valuation is big problem and as well very important factors aren't included, e.g. know-how, mark, etc. That's why goodwill (good name, market position, people knowledge) includes to assets sometimes, but this is not coming out in the balance. Goodwill value can be specified in the supplement to financial statement, but the real value is checked only on sale.

Total assets turnover = *incomes / total assets* [1].

If is the indicators value comparing to others in the branch low, incomes should be increased or some assets should be sold, processes efficiency – decrease short-term assets.

2.5 Indebtedness analysis

These indicators inform about relation between foreign and own sources – the higher is value, the more indebted is company and can be problematic to pay loans and other debts, but as well interests from these debts. Then the company is in the closed cycle – to get money for installment, company tries to get foreign sources, banks are not gladly providing other sources, inspect the client situation, and if they afford sources it's of course more expensive. In this situation it's necessary to dissect the company situation and formulate disposals that can avert the end and after that negotiate with bank. On favorable condition can loan added to own property increase profitability (but it's necessary to save cost and increase incomes – so-called financial crow).

Creditor risk indicator = *total debts / total assets* [1]

This indicator determinates the high of company indebtedness. The higher is it, the more company depends on foreign financial sources and its financial stability is lower. It is necessary to point, that between the indebtedness scale and financial solvency of the company doesn't exist any continual proportion (less indebted company can make bad decision and get into trouble). But it is necessary to investigate within standards or actual situation in given branch and in time evolution. If unindebted company makes bad decision, it will survive better than indebted company.

3 CONCLUSION

Rarely happen, that one bad decision set up the company into troubles. Usually it's set of bad decisions and those can be, thanks to financial analysis, recognized before troubles attack and it's possible to avoid them. By financial indicators analysis can be defined future evolution of the company – easier cost estimation, with profit it's more complicated, because it's not possible to forecast unexpected affairs as well as future owners behaving. Based on analysis results it's necessary to recommend how to continue and if the company has really serious problem, insert analysis, production bases, manpower, market into it and determine healing steps.

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THE MARKETING MIX CONTRIBUTION IN IMPROVING THE NATIONAL MUSEUM OF ROMANIAN HISTORY STRATEGY

RUXANDRA IRINA POPESCU, RAZVAN-ANDREI CORBOS

1 INTRODUCTION

The National Museum of the Romanian History (NMRH) is the most important history and archeology museum of Romania, by both size (developed surface), and patrimony; it is also, one of the most important Romanian contemporary archeology actors and leader of the preventive archeology[1].

NMRH, as a public culture institution, in the job of the society, has the following objectives:

- research and collection of goods with historic and archaeological character, to build and complete the museum patrimony;
- organization of the management and scientific record of the cultural patrimony held in administration;
- constitution and organization of the documentary funds and the general archive;
- deposit, conservation and restoration of the held patrimony, according to the general European standards and the norms elaborated by the Ministry of Culture and Cults;
- capitalization of the cultural patrimony in its administration.

2 MARKETING MIX IN THE NATIONAL MUSEUM OF THE ROMANIAN HISTORY

2.1 Product policy

Generally it is considered that the most important component of the marketing mix is the product policy (Olteanu, 2003).

[1] Preventive archeology refers to the archeology diggings associated to investments, to prevent the history patrimony destruction.

The product policy of NMRH aims four distinctive spheres, although sometimes the boarders between them are hard to separate:

1) **basic offer** – the public exhibition and the associated programs (for example, the public conferences or the offer of the access to the museum's deposits);
2) **complementary offer** – products and services associated as interest sphere (temporary exhibitions, events, diverse programs based on the research activity of the museum) with the basic offer;
3) **educative offer** – services and programs offered with educative explicit and immediate purpose;
4) **supplementary offer** – services and products that mediate the access and the understanding of the basic or complementary offer (information services, guidance, confectionery, store etc.)

NMRH offers the visitors a live illustration of the Romanian history through the most valuable pieces of national patrimony, into a logic and harmonic display.

The collections contain 609.099 objects such as: archaeology – 79.289 objects, history – 191.114 objects, numismatics – 388.711, old books – 755 volumes, philately – 80.239 stamps. The museum's collections are growing permanently through donations, acquisitions and new archaeological findings.

According to the website www.mnir.ro, NMRH occupies 8000 m^2 and reunites in approximately 60 chambers very valuable exhibits. Crossing them, we can meet testimonies about the presence of the human on the Romanian territory still from the Paleolithic (600.000 years- 6.000 years B.C.), material and spiritual culture of the geto-dacians, the daco-romans wars and the transformation of Dacia into a Roman Empire province, the apparition and finalization of the power structure of the state in the medieval society, the Phanariot rules, the burgeous-democratic revolution from 1848, winning of the independence, the starting of the two world wars and the entrance of Romania under Russian influence.

The product policy adopted by NMRH shows the principal directions in which this can mobilize the resources to optimize its activity and materializes through the effective offer. Because the product policy must take into consideration more elements, it has more components (for example programs, supplementary services, experiences), it is also called ***product mix*** (Kotler, 2005). Through the product mix the modeling of the offer according to the demand on the market but also to the socio-cultural reasons is pursuit.

To accordingly capitalize the cultural patrimony in the custody of the museum, for the benefit of it, its the clients and the society in general, the following strategic options can be used (Zbuchea, 2005):

- **revitalization of the offer** – creation of new products and services, improvement of the public exhibition that will attract new visitors categories and determine the growth of the visiting frequency of the present ones;
- **diversification of the offer** – offering new products and services as interest sphere, that wants to attract new visitors categories;
- **innovation of the offer** – redevelopment or amplification of the public exhibition and the offered services;
- **adaptation of the offer** – limiting the offered products and services to those that attract the most visitors.

We must say that the situation of NMRH improved in the last years, through the capitalization of the cultural patrimony and the change of the way in which it is presented and offer diversification.

2.2 Price policy

A rather neglected component of the marketing mix in the case of NMRH is the practiced price. This fact is not justified at all, because the price policy, with the product one, assure both the social capitalization, and the economic one of the museum or of some product of cultural patrimony offered by it (Moldoveanu& Ioan-Franc, 1997).

NMRH confronts with for problems related to the procurement of the necessary funds:

- reduction of the public financing;
- growth of the competition for private funds;
- growth of the operative costs;
- reduction of the subsidies.

Still there are some favorable evolutions from the perspective of the financing possibilities, including:

- the development of the tourism;
- improvement of the legislation regarding sponsorship;
- the growing interest for sponsorship;
- the change of the population's mentality in the favor of the cultural, social and educative activities maintenance;

- the intensification of the marketing activity, in the direction of the finance procurement from diverse sources;
- diversification of the accepted practices of financial, material or human resources attraction.

These elements create the necessary premises to convince a large number of persons as possible to visit the museum and to donate sums of money for the conservation and development of the held patrimony or the vast capitalization of it. This desiderate will realize also through an according prices policy.

To obtain funds, NMRH can use:

1. The evaluation of the cultural patrimony

This is extremely difficult, because it must not be quantified only the value of the physical elements that are contained in a patrimonial good, but also its spiritual value. This process must be realized by specialists and it must be objective. According to the settled value by the specialists, the price on the cultural market of the patrimonial object also grows. If a museum or a collector decides to sell an object that is part of the cultural patrimony, this must be done by auction.

2. Settlement of an entrance price

This must not be considered as compulsory. The justification of a tax request is usually related to the financial needs of the museum and the development of the activity, respectively its offer. The decision to apply a level of price must be taken after a close analysis of the generated effects. The significant decline of some segment of visitors must be avoided, that would thus be debarred of an important cultural service.

Also, the museum should respect the principle of „accessibility". This means that all the interested ones, irrespective of their incomes, should have access to the museum's collections. As this principle is hard to respect by economic-financial reasons, but also by reasons related to the control of the visitors flux, there can be alternatives, such as allowing the free entrance sometimes or giving financial facilities to some categories of people.

NRHM settled as standard prices of entrance to exhibitions the following:

1) permanent exhibitions:
   - adults: 7 RON;
   - pupils, students, pensioners: 2 RON;
   - possessors of EURO 26 card: 3,5 RON.
2) temporary exhibitions:
   - adults: 5 RON;
   - pupils, students, pensioners: 2 RON;

3. Acquisitions and donations

During 2008, the patrimony of NMRH grew with a number of 2.400 purchased objects, in total value of over 275.000 RON. From these purchased pieces, a very valuable object is remarked – from historic perspective – a medieval crossbow (XV century) of „deer foot" type. It is interesting that in Romania, like in all Europe, the existence of such pieces is very low, numerically speaking.

Also in 2008 a number of 44 pieces were donated to the museum. Through the most significant are: 12 gold medals from the Romanian Treasure in Moscow; a number of 8 medals, from 1971; a medal „Account Court" – Romania (issued after the entrance of Romania in the European Union); 16 soviet banknotes (dated 1961).

To develop an adequate price policy, NMRH must fix realistic objectives. If these are not fixed and understood, than the museum can not practice the most proper prices. These objective (Kotler& Kotler, 1998) must refer to:

- maximization of the number of visitors;
- maximization of the financial benefits;
- costs coverage;
- attraction of visitors in the detriment of the competition, including the entertainment one.

Irrespective of approach and objectives, the prices must justify in front of the visitor public through the benefits generated to it. It must always be taken into consideration the needs and wills of the visitors, the cost of it – financial or no – related to the participation at the activities proposed by the museum.

2.3 The distribution policy

Distribution refers to spreading the right to access culture for all market segments (Moldoveanu & Ioan-Franc, 1997). Although some offers are addressed to some specific categories of public, a lot of them being even elitist, the distribution process must be designed in such a way that the product becomes accessible, at least a portion of it, to other segments.

The NMRH's mission is the inventory, conservation, restoration and capitalization of the heritage that it manages. The last mission's last component is the source of the museum's very intense public activity. There are organized permanently and simultaneously more temporary exhibitions, of various scale. Also, the educational programs have developed very much.

For suggesting the amplitude of public activity and ways of making the owned patronage known, for educating the public and for distributing thus, cultural values, one must make a shortlist of temporary exhibitions (2008):

- **New values in the NMRH patronage – acquisitions, donations and recent archeological findings** (16th – 28th of February) – the exhibition's main objective was to exhibit the most valuable and most significant cultural goods that have been added to the NMRH's collections during 2007;
- **Romania's cities. The late XIXth century – the early XXth century** (17th of April – 31st of May) – presenting images and objects regarding the cities' life, including all aspects of utilities and administrative organization – buildings, markets, parks, public and cultural monuments, theaters, schools and universities;
- **The 1848 Revolution** (June - September) – the exhibition material was extremely diverse, including documents and official printings that had been issued during the revolution, photographs and illustrated postcards, flags and weapons;
- **Aspects regarding the personality cult in communism** (August) – the exhibition included homage albums received on different occasions (birthdays, congresses, official visits etc.) by Gheorghiu-Dej and Nicolae Ceauşescu;
- **Prague – 40** (August – September) – dedicated to commemorating 40 years from the soviet troops' invasion into the Czechoslovakia's capital, the exhibition comprised of 40 original photographs taken right into the events action;
- **„8", o magic figure in Slovakia's history** *(September – October) – this photo-documentary exhibition was organized to mark the 40th anniversary of the armed intervention into* Czechoslovakia of the Warsaw Pact's troops, at 21st of August 1968;
- **68/89. From the Prague Spring to the Velvet Revolution** (October) – the black and white photos depicted the important moments that modeled the history's course from '68 until '89;
- **The Masters of the Romanian lyric and dramatic stage** (October) – this exhibition presented the glorious tradition of the Romanian lyric and dramatic art by using original photographs of the bands and theater companies, personal objects that belonged to the first directors of the National Theater in Iaşi and of the National Theater in Bucharest;
- **The embroidery's evolution in the Romanian countries. Centuries XIIIth – XVIIth** (9th of October) – the exhibition presented silver pots and ornaments discovered outside the Romania's Carpathian Arch;

- **90 years from the Great Union** (27th of November 2008 – 12th of January 2009) – the exhibition dedicated to this event illustrated through the use of valuable heritage objects, the important moments that led to this historical act.

- In 2008 the museum's staff tried to organize more **educational programs**:

  a) **„The Museums' Night"** – NMRH was one of the 2.000 European museums that participated to the fourth edition of the „Museums' Night" program, a project initiated by the French Ministry of Culture and Communications and placed under the Council of Europe high patronage. In the night of 17-18th of May, within a joint program in which took part 12 large museums from Bucharest, NMRH was open to the public between 16:00 p.m. and 4:00 a.m. 13.000 visitors crossed the threshold of this museum, attracted by the exceptional value of the exhibited pieces within the "Treasury History" and the "Lapidarium", but also by the diverse theatrical representations put into scene by students, especially for this event.

  b) **Workshops** – their purpose is to contribute – on the long-term – to attracting children towards history and its universal values, so that children would perceive the museum space as interactive as possible, a space in which they can both learn and play. Combining in an attractive manner the sending of theoretical knowledge and the forming of practical abilities, the workshops have been organized by the Museum Education and Public Relations sections together with specialists from "Restoration - Investigations" and "Numismatic and Treasury" sections. During these workshops children familiarized themselves with a series of measures and basic techniques for the restoration of ceramics coming from archeological digs, techniques that they then practiced using contemporary handicrafts. They also learnt how to order their own coin collections.

  c) **History lectureships** – comprised of various themes linked to some of the NMRH's exhibitions (permanent or temporary organized during 2008). This is the case of the lecture sustained during the exhibition "Romania's cities. The late XIXth century – the early XXth century" and the series of lectures sustained under the slogan "Traian's Column – A history in stone". Also an interactive lesson on the theme "The History Museum – Space and support for teaching history notions to primary education level" was organized, that emphasized on identifying written and unwritten sources regarding the Getae–Dacians and Roman wars, starting from the Column's reliefs. Children were organized into workgroups (linguists, historians, mathematicians, geographers, artists and photographers).

  d) **A communication session for students** – was held during the celebration of 90 years of the Great Union. At this event took part

pupils from several schools in Bucharest, the communications presentation was followed by an artistic program supported by pupils from the Children's Club in District 1. The program was organized in partnership with the School Inspectorate of Bucharest.

e) **The pedagogical project** „The ancestors from the Column" – held in three separate stages, addressed themes regarding culture and ancient civilization and was based on the excellent educational support that Traian's Column represents. In the first stage, under the slogan „Let's decipher the story from the stone", the children familiarized themselves with the dacian wars' history just like it is depicted on the ancient monument's bas. In the second stage, „Traian's Column in the like artists' vision", the participants made drawings based on the casts exhibited, as well as on some lectures and stories. The last stage, named „We honor heroes", comprised of a spectacle put into scene by pupils and the opening of a mini-exhibition housing the works made by them.

f) **The program „The Little Chevaliers School"** – this program, that had its official opening in December 2008 was developed by NMRH in collaboration with the Medieval company. The project is comprised of courses that take place in the NMRH building, every week-end starting from 31st of January 2009, at 12 o'clock. The courses are meant for those who wish familiarize with the glorious world of the medieval knights.

g) An important matter which the museum should address is the way in which it can achieve its mission and make accessible the heritage owned and the specific offer outside the physical location. For this the museum has at least three different channels (Zbuchea, 2005):

- **other museums** – both museums from Bucharest and outside it, from within the country or from abroad, the objects from the museum's collections can be exhibited as part of other exhibitions or there can even be organized independent exhibitions;
- **the educational system** – wether through collaboration programs or independently, NMRH can get involved in the pupils education using diverse means, directly in schools. Also, through the educational system can be sold tickets to different events held by the museum, or just for visiting;
- **travel agencies** – in the West there is a well known practice for the travel agencies or hotels to include in their products' prices the entry to different museums.

Another point that needs a better management by the museum is the ***distribution of publications*** also in other locations (libraries, but also in souvenir shops).

Also, it could have a tighter collaboration with researchers from outside the museum through which to make valuable albums, that would be edited under the museum's name.

2.4 The promoting policy

Often people understand marketing as product promotion, but promoting a product is the last step of the marketing strategy. Before promoting its products, cultural institutions must first understand the institution's external environment and the way in which it affects the selling of the product (Kolb, 2005).

The promoting policy is comprised of complex activities aiming to inform the targeted public regarding the cultural products and services offered. Also known as the promotional mix, promotional activities seek to rise the public awareness regarding the new offer, to attract new market segments, to gain the trust in different works, but also to construct the identity of new services. The success of promotional activities consists in the capability of the bidder to focus on the main reason that convinces potential consumers to become real clients (Moldoveanu & Ioan- Frânc, 1997).

The specific activities undertaken for the purpose of making the exhibitions known, the museum's events and projects focused on using efficient means of communication and, at the same time, involving costs as low as possible.

All the events undertaken under the NMRH logo were announced in the press through specialized services for the transmission of press releases and the museum's media partners: TVR, the daily newspaper *România Liberă,* the periodicals *Şapte Seri, Descoperă România, Historia* magazine, *Revista 22*, *Radio România Cultural, On-Line Gallery*, *Zoom TV* network, *Smart FM* and the dedicated websites www.comunicatedepresa.ro, www.stirievenimente.ro, www.comunicatemedia.ro, www.ghidulpresei.ro.

One must remember the existent partnership with Onlinegallery.ro – a prestigious website for cultural information and entertainment – where the events organized by the museum were highly promoted, as well as the collaboration with the website www.comunicatedeoresă.ro, where the museum of offered for free the Professional subscription, NMRH benefiting of the priority distribution of its press releases, which can be accessed – in maximum an hour from publishing – by over 1.400 journalists and approximately 13.000 people that use this modern information service.

The collaboration with the diplomatic representatives of other countries represents a constant for the NMRH activity (NMRH 2008 Annual Report). A series of exhibitions were hosted and promoted in collaboration with institutions like the Polish Center from Bucharest, the Czech Center and the Czech Republic Embassy in Romania, Slovak Republic Embassy in Bucharest, Ministry of

Foreign Affairs of the Slovak Republic, Public Diplomacy Division of the North Atlantic Treaty Organization.

The NMRH website (www.mnir.ro) was redesigned in a new, more dynamic version. The new format is intended to better respond to the need for faster updates, given the large volume of information and ability to change graphics without costly interventions. It creates the preconditions for museum professionals to become editors of the site, directly, without the intervention of a web programmer. Similarly, authorized translators – that collaborate with NMRH – will have direct access to the online forms, thus shortening the reaction time for publishing news. Also on this basis, it becomes possible to devise an online search engine, part of the institution's heritage, an instrument that will be created in 2010. During 2007 the website of NMRH recorded a number of 74.936 visitors. All major cultural events organized by NMRH in 2008, had dedicated websites hosted on the museum's server. In this context were made micro-sites for presentation of exhibitions.

3 CONCLUSION

The marketing mix implementation for the market development of the National Museum of Romanian History is difficult to achieve because of the low level funding available. At the present moment the auto financing for the National Museum of Romanian History remains a desideratum.

The museum would achieve a successful marketing implementation by formulating clear objectives, by an efficient management of the funds, by attracting new sponsors, collaborators and by attracting as many visitors as possible.

Four factors (Kotler & Kotler, 1998) have determined the search for applying the marketing principles and practices in the museum:

- The museum's sector development, the promoting of the Romanian cultural heritage;
- The problems regarding the financing problems;
- Multiplying the offer for spending the free time of the clients-visitors;
- The need for better visitor knowledge.

The NMRH's management sees marketing more and more as a very useful tool for reaching in optimum conditions the objectives proposed. The efficient application of the modern marketing methods depends not only on the management of the respective organizations, but also on its employees. They must understand the role that the marketing policy plays, the importance of improving the work and the services that they provide. Unfortunately, the

National Museum of Romanian History makes no exception at this chapter, being, like most museums in Romania, poor in this area.

Marketing would contribute to the elimination of the numerous problems that the museum is facing with, like the following: the fairly reduced number of visitors, the insufficient funds for the corresponding management of the heritage and the collections' development, the lack in popularity of its specific cultural products.

A solution for the National Museum of Romanian History was the transformation of clients from simple visitors into active users and discussion partners. Also, other persons and businesses from the museum's external environment should become active partners.

This thing is not very easy because there are some factors that limit the projection and the appliance of marketing strategies in this museum. Some negative aspects were found, such as:

- Inadequate knowledge of marketing theory and practice;
- Insufficient experience;
- The inadequate quantity and quality of market information;
- Considering the products and services offered as addressing to a any person, not to a specific segment;
- The offer's rigidity;
- The fear of radical changes;
- The lack of motivation.

A frequent wrong approach and extremely harmful is the equivalence of marketing with promotion (Kotler & Armstrong, 2004). Also, it is extremely difficult to measure the efficiency of the marketing activity performed. This is due to the fact that mostly, the objectives pursued are of socio-cultural and not financial nature.

Others factors often met are the resilience of employees, the ethical and moral problems regarding a too „commercial" approach of the offer, the fencing of access for some visitors categories etc.

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THE QUALITY OF HARDNESS TESTER CALIBRATION

JOZEF PETRIK, PAVOL PALFY

1 INTRODUCTION

The Vickers test is the standard method for measuring the hardness of metals, particularly those with extremely hard surfaces: the surface is subjected to a standard pressure for a standard length of time by means of a pyramid-shaped diamond with vertex angle 136°. The diagonal of the resulting indention is measured under a microscope. The Vickers testing method is the most accurate and sensitive hardness test method. It is unsuitable for inhomogeneous and coarse-grained materials. Thoroughly prepared surface before test is required. The Vickers test does not deteriorate the surface of final product as much as Brinell test.

Like in any test of mechanical properties, there is obvious requirement for reliability of measurement results, which is unthinkable without sufficient quality of measurement process.

Metrological confirmation shall be designed and implemented to ensure that the metrological characteristics of the measuring equipment satisfy the metrological requirements for the measurement process. Metrological confirmation comprises measuring equipment calibration and measuring equipment verification [1].

The indirect calibration of the hardness tester is checking of a measuring instrument against an accurate CRM (certified reference material, standard) to determine any deviation and correct for errors [2]. The direct calibration includes verification of test force, indenter dimensions (deviation of the angle between opposite faces of the pyramid α), measuring microscope (device for measuring of indentations) and the testing cycle (speed of penetration speed of the indenter, application time and force duration) [3].

The perfect measurement cannot be performed because the values are, by nature, indeterminable. In fact, says the International Organization for Standardization (ISO), it is impossible to fully describe the measured value without an infinite amount of information. In other words, the final corrected result of a measurement is, at best, an estimate of the true value of the quantity that someone intended to measure. The measurement uncertainty is a parameter that characterizes the dispersion of the values that could reasonably be attributed to the measured value [4].

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A calibration laboratory, or a testing laboratory performing its own calibrations, shall have and shall apply a procedure to estimate the uncertainty of measurement for all calibrations and types of calibrations. Testing laboratories shall have and shall apply procedures for estimating uncertainty of measurement or calibration. When estimating the uncertainty of measurement, all uncertainty components which are of importance in the given situation, shall be taken into account using appropriate methods of analysis [5].

For indirect calibration of hardness tester against CRM according to the respective standard usually there is not a problem to keep the requirements for repeatability r_{rel} and maximum relative error E_{rel} of the tester. The problem arises after the determination of the maximum permissible deviation of the tester including its measurement uncertainty, which is equivalent to relative expanded uncertainty of calibration U_{rel}, whereas it is frequently higher than the value permitted by the standard. In such case, the measuring device is nonconforming and shall be removed from service.

Table 1 – The results of indirect calibration

No.	Appraiser A						Appraiser B					
	$\overline{H}$ (HV10)	s_H (HV10)	r_{rel} (%)	E_{rel} (%)	u_{ms} (HV10)	U_{rel} (%)	$\overline{H}$ (HV10)	s_H (HV10)	r_{rel} (%)	E_{rel} (%)	u_{ms} (HV10)	U_{rel} (%)
1	506	2.91	0.65	7.16	0.764	8.66	502	7.34	1.69	6.28	0.755	8.34
2	502	5.58	1.30	6.22	0.754	8.08	506	3.86	0.91	7.05	0.763	8.63
3	500	4.53	1.17	5.89	0.751	7.69	504	4.56	1.04	6.72	0.760	8.41
4	500	3.31	0.91	5.94	0.751	7.64	504	2.45	0.65	6.77	0.760	8.30
5	493	6.98	1.80	4.31	0.734	6.57	506	6.32	1.31	7.06	0.763	8.88
6	503	11.75	2.86	6.42	0.756	9.09	499	3.72	0.78	5.56	0.747	7.33
7	493	3.95	0.90	4.26	0.734	6.19	494	1.89	0.52	4.62	0.738	6.40
8	490	3.44	0.90	3.77	0.728	5.72	494	2.29	0.65	4.63	0.738	6.42
9	490	3.62	0.77	3.67	0.727	5.63	495	5,05	1.41	4.85	0.740	6.82
10	490	1.91	0.51	3.67	0.727	5.53	500	4.67	1.17	5.89	0.751	7.70

2 METHODOLOGY

The calibration was realized by two alternating approximately equally skilled appraisers (A, B). The measurement points were along the diameter (rim to rim) of the CRM in equidistant intervals. Appraiser A performed a calibration (5 indentations) followed by appraiser B. The indentations of both appraisers were evenly distributed around the center of the filed of view complying with the standard's requirement for the minimal spacing between the adjacent indentations (3 × the average indentation diagonal) [6]. The force application time was 10 seconds. The values of average hardness and standard deviation s_H for individual calibrations are in tab. 1.

The hardness tester is not legal measuring equipment (Slovak regulation No. 210/2000) and metrological confirmation is limited only to calibration according to standard [3]. Calibrated tester HPO 250 was made by VEB Werkstoffprüfmaschinen „Fritz Heckert“ (East Germany) in 1982. The magnification of measuring device is $140\times$.

Table 2 – The sensitivity coefficients

appraiser	A			B		
No.	A_F mm^{-2}	A_A $Nmm^2/°$	A_d Nmm^{-3}	A_F mm^{-2}	A_A $Nmm^2/°$	A_d Nmm^{-3}
1	5.17232	102.2656	5289.815	5.129913	101.4271	5224.604
2	5.12696	101.3688	5220.241	5.167001	102.1604	5281.611
3	5.11088	101.0507	5195.754	5.150926	101.8426	5256.945
4	5.11341	101.1009	5199.683	5.15343	101.8921	5260.872
5	5.03512	99.55295	5080.485	5.167307	102.1664	5281.925
6	5.13626	101.5526	5233.794	5.094907	100.735	5171.462
7	5.03211	99.49343	5064.395	5.050165	99.85033	5103.553
8	5.00881	99.03271	5040.943	5.050185	99.85073	5103.574
9	5.00377	98.93126	5033.191	5.06088	100.0622	5119.668
10	5.00356	98.92891	5033.072	5.110889	101.0509	5195.766

The test force/load F = 98.07 N (10 kg). According the direct calibration (VI/08) the deviation for test force 98.07 N is -0.2 % and the deviation of the measurement device is -0.2 % for 0.1 mm and -0.2 % for 0.2 mm. The certified reference material (CRM) in form of hardness reference block with specified hardness H_c = 472.4 HV 10 and expanded uncertainty U_{CRM} = ± 9.448 HV 10 (coverage factor k = 2) was used as a standard. The ambient temperature was 20°C, relative humidity 48 %.

Table 3 – The values of standard uncertainty for deviations of vertex angle α

α (°)	0	0.086	0.0925	0.099	0.1	0.2	0.3	0.4	0.5
u_A (°)	0	0.049652	0.053405	0.057158	0.057735	0.11547	0.173205	0.23094	0.288675

The first step of analysis is to estimate whether the discrimination (effective resolution) d*- the value in HV 10 of the smallest scale division (graduation) of measurement equipment is sufficient. A general rule of thumb is that the discrimination ought to be at least one - tenth the process variation (standard deviation s_H in tab. 1). The discrimination d* = 2.72 HV10 is not sufficient [7].

Grubbs' test (with significance level $\alpha = 0.05$) detected one outlier (appraiser A, calibration No. 6). The statistical outliers would indicate that the process is suffering from special disturbances and is out of statistical control.

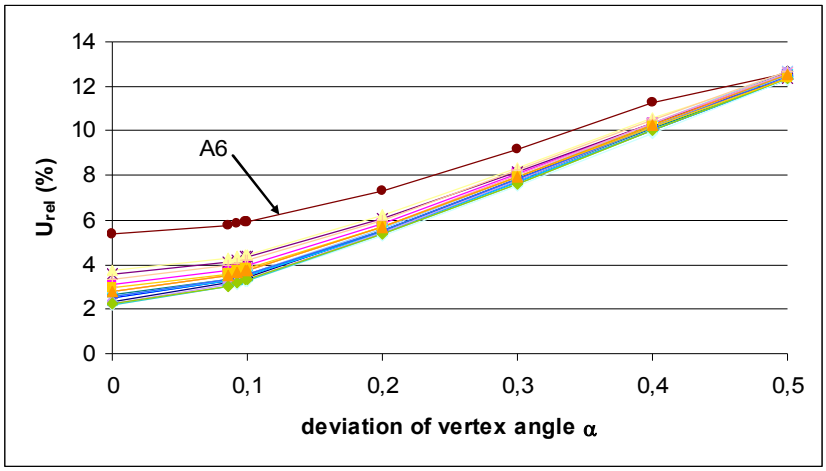

Figure 1 – The influence of vertex angle deviation α on U_{rel} for individual calibrations (ΔF = - 0.2 %, u_{CRM} = 4.724 HV10)

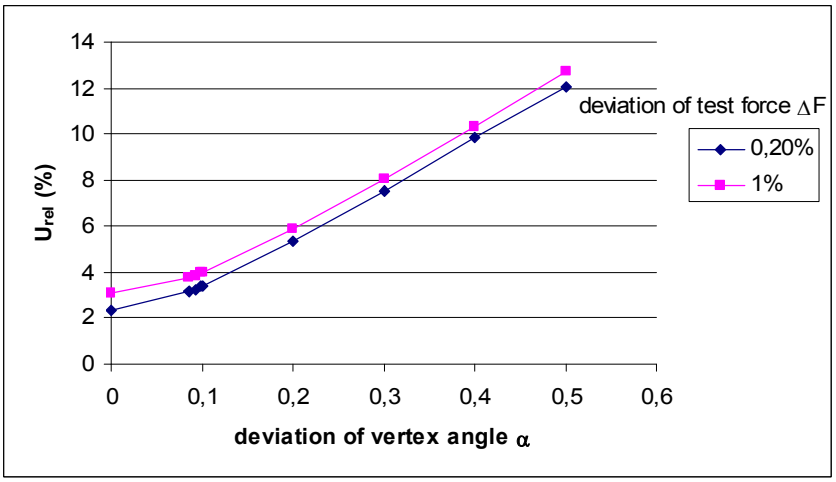

Figure 2 – The influence of vertex angle deviation α and test force deviation ΔF on mean values of U_{rel} (u_{CRM} = 4.724 HV10)

2.1 The indirect calibration

The repeatability of tester $$r_{rel} = 100 \times \frac{d_5 - d_1}{\overline{d}} \%$$ (1)

$\overline{d}$ is the mean, d_5 is the maximum and d_1 is minimum value of indentations diagonals.

The error at specific conditions of calibration $$E = \overline{H} - H_c$$ (2)

$\overline{H}$ is the average hardness of CRM

Relative maximum error $$E_{rel} = 100 \times \frac{\overline{H} - H_c}{H_c} \%$$ (3)

The present calculations supposed, that the result of calibration equals to its ideal (or real) value. But, as it results from the uncertainty definition: "Uncertainty is a parameter associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measured value" and for this fact must be made provision [8]. The uncertainty of indirect calibration:

$$u_{HTM} = \sqrt{u_{CRM}^2 + u_{CRM-D}^2 + u_H^2 + u_{ms}^2}$$ (4)

The standard uncertainty of used CRM u_{CRM} = 4.724 HV10. The uncertainty resulted drift of CRM u_{CRM-D} was ignored (used CRM was calibrated only once, XI/2005).

Standard uncertainty of hardness tester $$u_H = \frac{t \times s_H}{\sqrt{n}}$$ (5)

s_H is standard deviation of the results of calibration, Student's factor t = 1.15 for n = 5 (number of trials in one calibration) and significance level α = 0.317 [3].

Another source of uncertainty is measuring device.

$$u_{ms} = \frac{2\overline{H}}{d} \frac{\delta_{ms}}{2\sqrt{3}}$$ (6)

δ_{ms} = 0.0005 mm is the sensitivity of indentations measuring device at used magnification 140× (the unit of abovementioned discrimination d* is HV0.05!).

$$d = \sqrt{0.1891 \times \frac{F}{\overline{H}}}$$ (7)

F = test force (N)

The error of calibration $$\overline{b} = \overline{H} - H_c = E$$ (8)

The maximum permissible error of the tester including the measurement expanded uncertainty U_{HTM} (coverage factor k = 2):

$$U_{HTM} = k \times u_{HTM} \tag{9}$$

$$\Delta H_{HTM\,max} = U_{HTM} + |\bar{b}| \tag{10}$$

Relative maximum permissible error of the tester (relative expanded uncertainty):

$$U_{rel} \quad \frac{\Delta H_{HTM\,max}}{\overline{H}} \times 100\% \tag{11}$$

The values $r_{rel} \leq 2\%$, E_{rel} and $U_{rel} \leq \pm 3$ % for satisfactory tester and used CRM [3]. The values of r_{rel} , s_H and E_{rel} are in the tab. 1. It is possible that high value of uncertainty of calibration is a result of low capability (high value of %GRR) [9] and low resolution of the tester. The tester is not satisfactory for all calibrations and all appraisers with respect to its U_{rel}. The two factor ANOVA with replication was used for evaluation of hardness values. The influences of appraiser (p = 0.000303) and calibration's place (p = 3.16 E-9) are both statistically significant.

Table 4 – The values of average diagonals of indentations d and their standard devitation $\bar{d}_{SD}$

	Appraiser	1	2	3	4	5	6	7	8	9	10
d (mm)	A	0.1914	0.19225	0.19225	0.1925	0.1940	0.1921	0.19405	0.1945	0.1946	0.1946
	B	0.1922	0.1915	0.1918	0.19175	0.1915	0.19285	0.1937	0.1937	0.1935	0.19255
$\bar{d}_{SD}$ ($\times 10^{-4}$ mm)	A	5.48	10.61	8.73	6.37	13.81	22.26	7.79	6.85	7.20	3.79
	B	14.09	7.29	8.73	4.68	11.99	7.20	3.71	4.47	9.84	8.91

2.2 The direct calibration

The standard [5] defines Vickers hardness as a function of the measured value of test force F [N], the vertex angle of diamond α (136°) and the indentation diagonal length d [mm]. The measured values of $\overline{H}$ (tab. 1) = H in the formulas (12) – (15). The sources of uncertainty z and sensitivity coefficients A were identified and calculated according to [10][11][12].

$$HV = 0{,}102 \times \frac{2F \sin\left(\frac{\alpha}{2}\right)}{d^2} \tag{12}$$

The values of sensitivity coefficients for test force A_F, vertex angle of diamond A_A and mean diagonal of indentation A_d are:

$$A_F = \frac{\partial HV}{\partial F} = \frac{HV}{F} \tag{13}$$

$$A_A = \frac{\partial HV}{\partial \alpha} = \frac{HV}{2\tan\left(\frac{\alpha}{2}\right)} \tag{14}$$

$$A_d = \frac{\partial HV}{\partial d} = -2 \times \frac{HV}{d} \tag{15}$$

The values of sensitivity coefficients are in table 2.

The uncertainty of specific source was calculated according to formula u = $\frac{z}{\chi}$ z = the source of uncertainty, χ is the value associated with the relative probability distribution [13].

$$u^2 = A_F^2 u_F^2 + A_A^2 u_A^2 + A_d^2 u_d^2 + u_{CRM}^2 \tag{16}$$

1. The test force meets standard tolerance if maximal permissible error (deviation) ΔF = ± 1 % is not exceeded [6] (i.e. z = 2.942 N). The force deviation of tester ΔF = -0.2 %. $\chi = \sqrt{3}$ for assumed rectangular distribution. The values of uncertainty u_F are 0.113242 N (ΔF = -0.2 %) and 0.566208 N (ΔF = ± 1 %).

Table 5 – The values U_{rel} of indirect calibration

	1	2	3	4	5	6	7	8	9	10
A	3.08	3.62	3.40	3.17	4.06	5.45	3.31	3.23	3.26	3.01
B	4.10	3.24	3.40	3.03	3.80	3.24	2.99	3.04	3.53	3.42

2. The vertex angle of pyramid shaped diamond is 136° ± 0.5° according to standard [6]. The source of uncertainty z_A= 0.0925° for average angle deviation α of used diamond (+0.099° for axis x and +0.086° for axis y, measured by TSK C1700 SD2 contourograph, Department of Biomedical Engineering, Automation and Measurement, Faculty of mechanical engineering, Technical University Košice). Rectangular distribution was assumed, $\chi = \sqrt{3}$. The values of uncertainty for deviations of vertex angle α are in tab. 3.

3. The standard deviation of individual diagonals d ($\overline{d}_{SD}$, tab. 4) for individual appraiser is source of uncertainty z_d. Because normal distribution was assumed, $\chi = 1$ and therefore $u_d = \overline{d}_{SD}$ [13, pp. 23].

4. The uncertainty u_{CRM} = 0, 1, 2, 3 and 4.724 HV10 was regarded as the fourth source of uncertainty. No other potential sources of uncertainty (the test force application time, test force duration time, tip radius and length of the line of junction, measuring device (microscope) [12]) were not regarded.

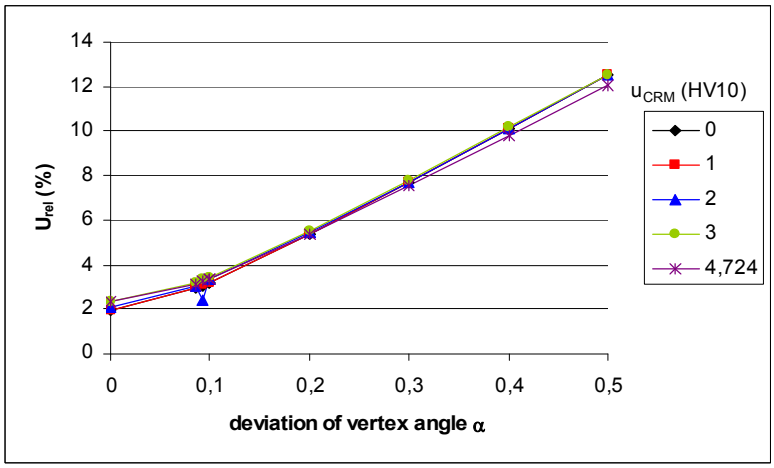

Figure 3 – The influence of vertex angle deviation α and u_{CRM} on mean values of U_{rel} (ΔF = 0.2 %)

The relative maximum permissible error of the tester (relative expanded uncertainty U_{rel}) was calculated using formulas (9) and (11), the coverage coefficient k = 2. The values of U_{rel} for ΔF = -0.2%, α = 0.0925°, individual $\overline{d}_{SD}$ and u_{CRM} = 4.724 HV10 are in tab. 5.

2.3 The discusion

Resulting from tab. 5, all but one results of direct calibrations do not satisfy the requirements of standard. The values of relative expanded uncertainty, calculated according to standard [3] overvalue those obtained by direct calibration. It is result of number with error of calibration E (formulas (2), (8), (10)) in the case of direct calibration**.** The influence of the vertex angle deviation α on uncertainty is more significant than the influence of test force deviation ΔF, fig. 1 and fig. 2. Increased values of uncertainties were obtained at calibration No. 6, appraiser A. As can be seen on the fig. 3, the influence of u_{CRM} on final U_{rel} is obscure. The higher values of uncertainties in direct calibration published in [14] result from regarded extreme values of test force deviation and first off the vertex angle deviation.

3 CONCLUSION

1. The hardness tester is not conforming for all repeated calibrations using indirect method. Only one calibration (appraiser B) is conform in direct method.
2. The uncertainty obtained by indirect calibration is more significant as it of direct calibration.
3. The influence of the vertex angle deviation on uncertainty is more significant as the influence of test force deviation.
4. With regard to the identified insuficient resolution it is recommended to use larger magnification for the calibration.

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SWARM-BASED OPTIMISATION

LENKA RAUDENSKÁ

1 INTRODUCTION

Swarm intelligence is based on nature-inspired behaviour and is successfully applied to optimisation problems in a variety of fields. The goal of optimisation is to find the optimum in the smallest possible amount of iterations, where optimum means the best from all possibilities chosen from a particular point of view (so-called: criterion).

2 SWARM-BASED INTELLIGENCE

Swarm-based intelligence is artificial intelligence technique based on the study of collective behaviour in self-organizing systems.

Swarm-based systems are usually composed from population of individual, which takes effect between each other and environment. Individual could communicate directly or through impacting in surroundings [1].

Although this systems do not have any central control of the individual behaviour, interaction between individuals and simple behaviour between them usually lead to detection of aggregate behaviour, which is typical for whole colony.

This could by observe by ants, bees, birds or bacteria in the nature. By inspiration of these colonies were develop algorithms called Swarm-based intelligence and are successfully apply for solving complicate optimisation problems [3].

2.1 Genetic algorithm (GA)

Genetic algorithm is search based on the natural evolutionary process and is a stochastic search technique which works on the process of natural selection.

GA begins with an initial population (i.e. the first generation), which is usually generated randomly. This population evolves the next generation, which expectantly contains better solutions (fitness) [10].

There are use three fundamental operators: selection, recombination (also called crossover) and mutation.

Value of fitness determines how good the candidate is. The selection operator presents natural selection, it means that bigger chance to be selected is for candidate with higher fitness. The best selected candidates create the next generation using the recombination operator. The recombination is applied on pairs (called parents) and is producing two children solutions (for each pair). Each new child contains a part of both parents. Practically it is usually arithmetical mean.

The mutation operator randomly chose a few candidates from the generation and changes its value in chromosome and product is children solutions. In practice it is based on adding random vector to chromosome.

Both of the operators (recombination and mutation) should by conform to make solution of new generation even better compared to old one. New generated population of children become for next generation parent [3].

The basic steps of a GA:

1) Random generate the initial population.
2) Evaluate the fitness for all candidates.
3) Repeating of the following steps until a satisfactory solution is reached:
    a) Select parents from the population according to fitness value.
    b) Create children from selected parents using a recombination operator.
    c) Mutate operator use on candidate with a smaller fitness value.
    d) Create the next generation with the children.
    e) Evaluate the fitness of all candidates in the new population.

Termination of the algorithm is reaching the satisfactory solution or after given number of repetitions.

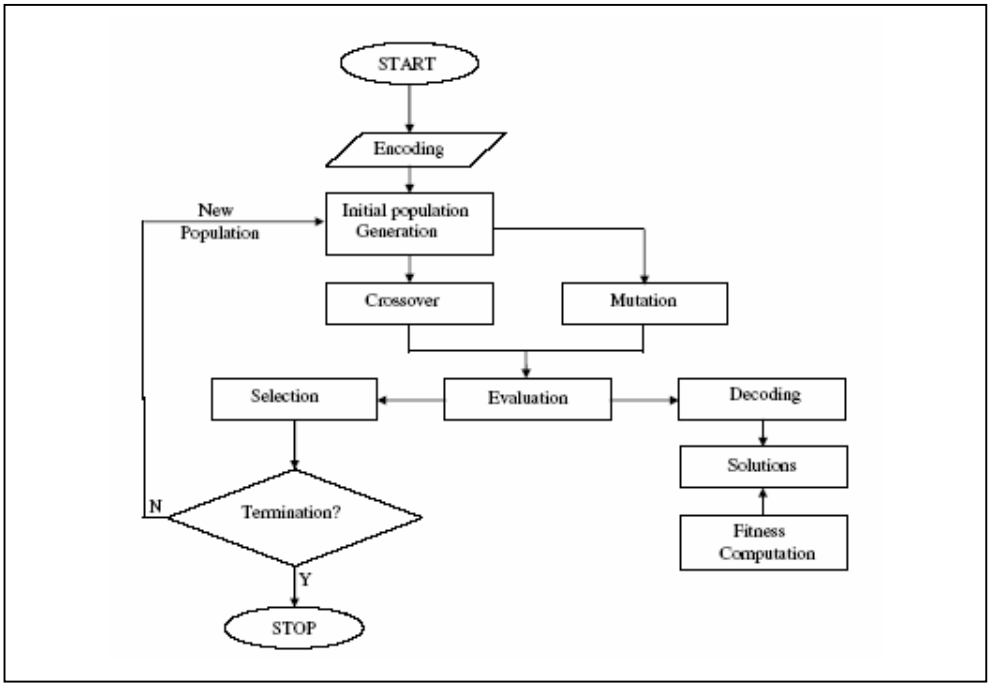

Figure 1 - Flow-process diagram of a simple genetic algorithm.

2.2 Ant Colony Optimization (ACO)

The basic principle is based on finding the shortest path from food source to anthill by smelling pheromones (chemical substances they leave on the ground during walk).

System of obtaining food in ant colony is managed by hundreds of individuals and covered thousands of square meters. In process of collecting food if there are two possible paths to reach a food source, as shown in Fig. 1, and they have no clue about which direction to choose, they choose it randomly. It is assumed that half of them choose the first direction and the rest choose the other one. Suggesting that all ants have same walking speed, the shorter way will receive a greater amount of pheromone per time. Next time when they will choose the shortest way by smelling more pheromone on the shorter path than the longer one. Other ants make use of pheromone concentration to determination of the shortest way, which give them the possibility to collect food quicker [8].

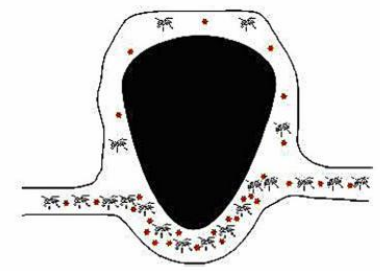

Figure 2 - The pheromone deposition of ants (red dots).

2.3 Particle swarm optimization (PSO)

Particle swarm optimization is one of the latest evolutionary optimization techniques with a stochastic population based optimization approach.

PSO is inspirited by interaction and communication in a flock of birds or shoal of fishes. In these groups, there is a leader (individual with the best value of fitness) who guides the movement of the whole swarm. The movement an individual is based on the leader and on its own knowledge. Generally could by said that the model PSO presuppose that the behaviour of each individual is a compromise between its own and collective knowledge.

The basic steps of a PSO:

1) Setting of population block data with random value of a position (i.e. a solution) and a velocity (i.e. change pattern of the solution).
2) Every individual knows its position and the value of the objective function for that position. It also remembers its own best previous position and its corresponding objective function value.
3) Evaluate the fitness of all individuals.
4) Comparing the current fitness of each individual with its own historical best position, and if its own historical best position is smaller then it is replaced with the current fitness.
5) Comparing the best current position of all individuals with the historical best position of the whole swarm, if the historical best position of the whole swarm is smaller then it is replaced with the best current position of all individuals.
6) Refreshing the positions and velocities of all individuals according to the following equations:

$$v_{i,t+1} = c_1 v_{i,t} + c_2 (p_{i,t} - x_{i,t}) + c_3 (p_{\psi i,t} + x_{i,t})$$

$$x_{i,t+1} = x_{i,t} + v_{i,t+1}$$

Variables:

xi,t ... position of individual in iteration (equivalent to the one problem solution)

vi,t ... velocity of individual in iteration (equivalent to the change pattern of the solution)

pi,t ... the best previous position among all the individuals in iteration (memorized by each individual)

7) Termination of the algorithm is reaching the satisfactory solution or after given number of repetitions.

2.4 The Bees Algorithm

Bees Algorithm is inspired by the natural behaviour of honey bees during collecting pollen.

The process begins by sending scout to search round for promising sites. Scout bees move randomly during the searching. When they return to the hive, they express by dancing three pieces of information about found site: the direction in which it is situated, its distance from the hive and its quality. This information helps the colony to evaluate the amount of energy needed to harvest it and after it they can send its bees to the most promising place directly.

Each individual's knowledge of the outside environment comes only from this dance. After dancing more follower bees are sent to more promising patches. This allows the colony to harvest pollen quickly and efficiently.

1) Random generate the initial population.
2) Evaluate the fitness for all candidates.
3) Repeating of the following steps until a satisfactory solution is reached:
   a) Select sites for circumambience search.
   b) Send out bees to selected sites (more bees for better sites) and evaluate its fitness.
   c) Select bees with the highest fitness from each patch.
   d) Assign remaining bees to search randomly and evaluate their fitness.

On the end of each iteration has swarm two parts of population – individuals from selected sides and scout bees designate for searching.

Termination of the algorithm is reaching the satisfactory solution or after given number of repetitions.

2.5 Comparison of Swarm-based optimisation algorithms

Optimization algorithms above were compared by eight following benchmark functions with hundred independent measurements.

Table 1: Methods comparison

Function	GA		ACO		Bees Algorithm	
	Number of iterations	Success [%]	Number of iterations	Success [%]	Number of iterations	Sucess [%]
De Jong	10160	100	6000	100	49	100
Goldstein & Price	5662	100	5330	100	999	100
Branin	7325	100	1936	100	1657	100
Martin & Gaddy	2844	100	1688	100	526	100
Rosenblock	10212	100	6842	100	898	100
Hyper sphere	15468	100	22050	100	7113	100
Griewangk	200000	100	50000	100	1847	100

The first function De Jong's figured out, that the Bees Algorithm reached the optimum 207 faster than GA and 120 times faster than ACO, with a success of 100%. For the next function Goldstein & Price, the Bees Algorithm could find the optimum almost 5 times faster than GA and ACO, again with 100% success. With Branin's function, there was for Bees Algorithm a 15% improvement compared with ACO and 77% improvement compared with GA, also with 100% success. Rosenbrock's function in two-dimensions has with the Bees Algorithm at least twice fewer evaluations than the other methods also with 100% success. Four-dimensions Rosenbrock's function, where ACO could reach the optimum 3,5 times faster than the Bees Algorithm with success rate 100%. In Hyper Sphere model of six dimensions, the Bees Algorithm needed half of function evaluations compared with GA and one third compared with ACO. Last but not least Griewangk function is ten-dimensional and the Bees Algorithm found the optimum with 100% success and 10 times faster than GA and 25 times faster than ACO [7].

3 CONCLUSION

This paper has presented methods of Swarm-based intelligence. From comparison above follows that the Bees Algorithm gives the results in the biggest number of function in the shortest time with 100% success rate in all cases. The Bees Algorithm is the youngest from this and is still in its beginning – it is still developing. Future work for this algorithm should turn to the reduction of parameters and incorporation of better learning mechanisms or combination with some other earlier mentioned algorithm.

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ADJUSTMENT OF SIX SIGMA TOOLS FOR A BETTER CONTROL OF PROCESS TIME

FILIP TOŠENOVSKÝ

1 INTRODUCTION

The article discusses an appropriate adjustment of standard statistical tools used by Six Sigma methodology to limit problems that occur in organization processes. The adjustment is specifically related to the problem of process time control the unique characteristics of which require a modification of some of the standard statistical methods generally used in Six Sigma.

2 STANDARD SIX SIGMA APPROACH

If processes in a company last too long, there is a good reason to make an effort at curtailing the time because the more time it takes to run the process, the costlier it usually becomes, let alone the fact that customers awaiting the process output become impatient and later dissatisfied too. There are several ways how to approach the problem with process time. Given the current trend, however, it is quite likely that companies facing such a problem will choose Six Sigma as a solution.

Six Sigma relies heavily on the define, measure, analyse, improve and control methodology known as the DMAIC cycle. The cycle is a step-by-step procedure to reveal major causes of problems occuring in a process, and to eliminate the causes. After a Six Sigma project is defined from the organizational point of view (phase D of the cycle), data from the problematic process are gathered and checked for their accuracy, stability of the process is determined based on the data and the actual performance of the process is estimated (M phase). If the data are correct and reflect the process in question, i.e. the process is stable and its behaviour is not contaminated by unplanned and unexpected external events, the analytical phase A follows, trying to detect the mechanisms by which problems in the process arise. The A phase states as its result a group of major factors that create the problems in the process, and also a relation that expresses the problem as a function of the behaviour of the major factors. Based on the known relation or relations, a favourable configuration of the factors is proposed so that the pre-set behaviour of the factors caused as few problems in the process as possible (I phase). In the final C phase of the DMAIC cycle, a surveillance over the improved process is designed to make sure the improvements really take place and the process stays improved for a longer period of time.

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The measure and analyse phases are the key to solving the problem in the process as they gather information on the process and decide what and how causes the problems. Statistical tools that are often used in the two phases involve control charts to determine the stability of the process and regression or correlation analysis to define the relations between factors and the problem they create in the process.

3 THE STANDARD APPROACH AND THE PROBLEM OF PROCESS TIME

Effective elimination of problems in processes requires effective implementation of the measure and analyse phases of the DMAIC cycle. In order for this to happen, right conditions must be met so that control charts and regression worked properly in the two phases.

In order for control charts to give a valuable and trustworthy result, data collected from the process should be at least approximately normally distributed and their collection should have the form of a random sampling, i.e. the data ought to be statistically independent. Although some say too much of the probability theory is put into control charts, and the charts are rather an intuitive tool, the above-mentioned conditions were in place when control charts were invented and successfully tried out, so the conditions are justified. None the less, the truth probably lies somewhere between the two intellectual streams.

When a process lasts too long, and its time is therefore the focus of a Six Sigma project, it may easily happen that none of the two conditions is met and control charts will then be a too rough tool for making a judgement on the stability of the process – on the stability of time as an observed process characteristic. Situations when queueing occurs is an example. Process time as a random variable is typically modelled by Gamma distribution which not even remotedly resembles the normal distribution. Moreover, process time t_n may depend on the previous process time t_{n-1} when queueing takes place. The time it takes to serve a customer in the bank, for instance, depends on the time it took to serve a previous customer if the two customers joined in the same queue. We may also add that the fact the data on process time are not independent in such cases is more inappropriate than the fact that time is not normally distributed as independence might in many cases ensure at least approximate normality thanks to the central limit theorem provided the data samples gathered about the process time are large enough. If the independence is not in place, the theorem doesn't apply.

Success of regression modelling also largely depends on the situation, of course. The standard approach works mainly with linear modelling, which gives good results if the modelled variable – the variable that represents the problem in the process – is normally distributed and the coefficients of the model are estimated via the least squares method. Under normality and least squares, linear model is the best for the description of such variable. The word „best" means that the

analytical form of the model is the right one (Anděl 1984), and if we had a chance to get an infinite number of series of data samples on the process, we would – in average - estimate the unknown theoretical coefficients in the model precisely, that is we would get unbiased estimates. In addition to that, if we don't estimate the coefficients precisely with an individual data sample, the imprecision is the smallest we can achieve. Unfortunately, this is not the case with process time which is not normally distributed. A different approach must then be considered.

4 PROCESS TIME AND SIX SIGMA TOOLS ADJUSTMENT

If process time is the problem and the data on process times indicate the condition of their independence is not met, control charts might be an inappropriate tool to assess the process stability in terms of the process characteristic observed. However, since the process times are necessarily recorded at a certain point in time, they can be represented as a time series, and the fact that a dependence exists among the data then starts to be conversely an advantageous feature of the data. It is advantageous because the Box-Jenkins representation of time series, which is based on an existing dependence among the data, allows us to analyse such series properly (Box, Jenkins 1969). What is even more important is that the definition of the so called „stationarity of a process", as presented in the theory of time series analysis, may be considered a synonymum for the term „stability of a process", as presented in the theory of control charts. Thus, if control charts are not available due to existing dependence in the data on process times, we may check the stability of the process by forming a time series of process times and validating stationarity of the series according to Box and Jenkins theory.

As regards regression, there is more than one way how to handle non-normally distributed variables like process time that we want to model as a function of major factors involved. We may stay with linear regression model, benefiting from the simplicity of the model, but the full appropriateness of the model for the given situation will not be guaranteed. Or we may also try to find a model that suits the situation, utilizing Box-Cox transformation, for instance. The transformation can bring the variable in question, e.g. the process time in our case, closer to normality, for which we know how the good model looks like – it is linear. Thus, the following procedure may lead to a good, generally nonlinear, regression model describing the behaviour of process time as a function of several conceivable factors:

1) Find a transformation T that brings the modelled process time y closer to normality.
2) Model the average behaviour of T(y) with the best model, i.e. with linear model:

$$E[T(y)] = \beta_0 + \beta_1 x_1 + \ldots + \beta_\kappa x_k,$$

where the operator E stands for expected value (average), β_i, i=1,…,k, are coefficients in the model to be estimated by least squares and x_i, i=1,…,k, are major factors influencing the process time.

3) Some transformations have the property $E[T(y)] \cong T[E(y)]$, for instance the logarithmic transformation, which turns out to be in many cases a good transformation in step one (McCullagh, Nelder 1990). If this is the case, then $T[E(y)] \cong E[T(y)] = \beta_0 + \beta_1 x_1 + \ldots + \beta_\kappa x_k$, in other words $E(y) \cong T^{-1}(\beta_0 + \beta_1 x_1 + \ldots + \beta_\kappa x_k)$ provided the inverse function T^{-1} is also available.

This way, it is possible to get a regression model $E(y) \cong T^{-1}(\beta_0 + \beta_1 x_1 + \ldots + \beta_\kappa x_k)$ which suits the situation better than a linear model.

5 CONCLUSION

Six Sigma has proven to be a good approach to solving problems in organization processes. However, while the DMAIC cycle Six Sigma consists of methodologically is fine-tuned, statistical tools used to analyse the data gathered from the process must be selected ad hoc, depending on the nature of the problem occuring in the process. Problems of specific nature show up when it is the process time that must be shortened by Six Sigma. The specific nature of process time requires us to alter some of the standardly used Six Sigma statistical methods, particularly those with a major influence on the result of a Six Sigma project. Those are control charts used in the M phase of the DMAIC cycle, and the modelling of relations among variables used in the A phase of the cycle. Box-Jenkins theory on time series enables to check stability of a process when control charts are insufficient due to dependence in analysed data, while the Box-Cox transformation can lead to a nonlinear regression model which describes relations in the data better than linear model if the modelled variable does not follow normal distribution.

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ENVIRONMENTAL EDIFICATION AT UNIVERSITIES AS A PART OF SLOVAKIA SUSTAINABLE DEVELOPMENT

KATARÍNA KORÁLOVÁ, ALENA PAULIKOVÁ

1 INTRODUCTION

The Czechoslovak republic was the country with relatively high concentration of production. Heavy industry and production of semi-products were concentrated predominately in area of Slovakia whereas consumer industry was in Bohemia. Industrial manufacture development, which was represented the wide range of vehicle production as well as constantly threatening risk of ecological crisis situations, required to deal with restriction of influences for activities, technologies and processes in environment. However, there was not done in the past and that is why very low or none environmental consciousness was „underwritten" below environmental debts of our society.

2 HISTORY OF ENVIRONMENTAL PROTECTION AND GENERATION IN SLOVAKIA

Several Czech and Slovak ecologists and environmentalists were identified with this opinion. One of the principal authors, who has comprehended "ecology" as a science discipline, was A. DICHTL *(Animal Ecology, Brno, 1924)*.

Further, the importance of environmental protection was also emphasized even in the works A. ZLATNÍK *(Fundamentals of Ecology, Prague, 1973)* and P. FARB *(Ecology, Prague, 1977)*. Besides conception "ecology" as well as the terms "life environs" and "environment" have begun to be applied.

From Slovak authors who adopted just this terminology, it is necessary to name for example the work of E. MAZÚR and J. HUŠŤÁK *(Making More Effective A Science Application - Integrated between Science Solution of Problems With Environment, 1978)*. In generally Slovak authors E. MAZÚR J. DRDOŠ J. URBÁNEK *(Landscape Synthesis and Their Role For Creation of 3D Environmental Structures, 1980)* dealt with landscape ecology.

In Slovakia M. LISICKÝ founded nature protection in the framework of ecological base. After all that works expressed one common idea. They highlighted a need of environmental conscious human, who would be motivated oneself to behave in consideration to environment, [1].

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Environmental developed countries' pressure was a stimulator of new approaches to the environmental development and protection. That is why the majority of available environmental knowledge and documents were in foreign languages. There were predominately English, French and German languages.

3 LEGISLATIVE SUPPORT

The necessity for integrating approach in solution of given problems was a support and an international unification of legislative. In ČSSR (the Czechoslovak Socialist Republic) there were existed over 350 juridical standards concerning the partial questions of environmental conservation. For the first time there were the terms "ecology" and "ecological edification" put into the practice by means of *Conception of State Development Of Nature Protection in the SSR (the Slovak Socialist Republic)*, adopted with the resolution of previous government No. 113/1987, [1].

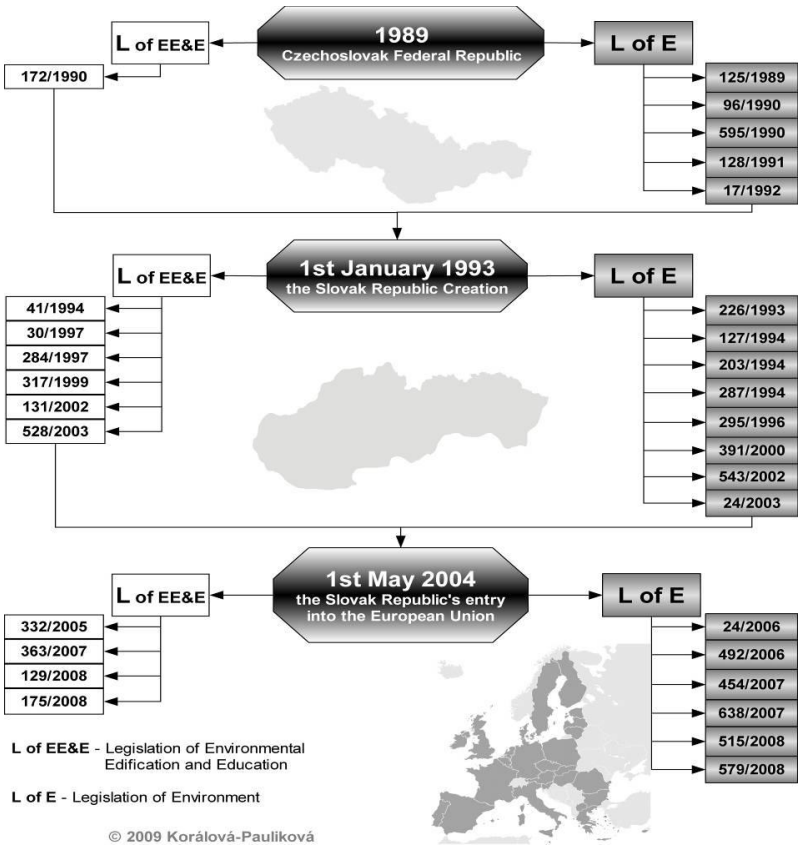


Figure 1 - Development of environmental legislation from point of edification and education in Slovakia

On 14th June 1991, during the negotiations of previous Slovak Commission for Environment there was introduced a term "environment" for the first time. Under

a political development and an outer pressure from environmental developed countries there were created, cancelled or novelised laws and regulations concerning to environmental protection. The main point of environmental legislative development was to achieve the independency of the Slovak Republic in 1993. The next very important year is 2004, when the Slovak Republic entered into the European Union's structures and it was beginning of an extensive rebuilding of regulations as a consequence of approximation to the laws and edicts towards European legislation.

In Fig. 1 there is schematically illustrated legislative development of laws, public notices and rules concerning to environmental edification and education in the framework of environmental legislative.

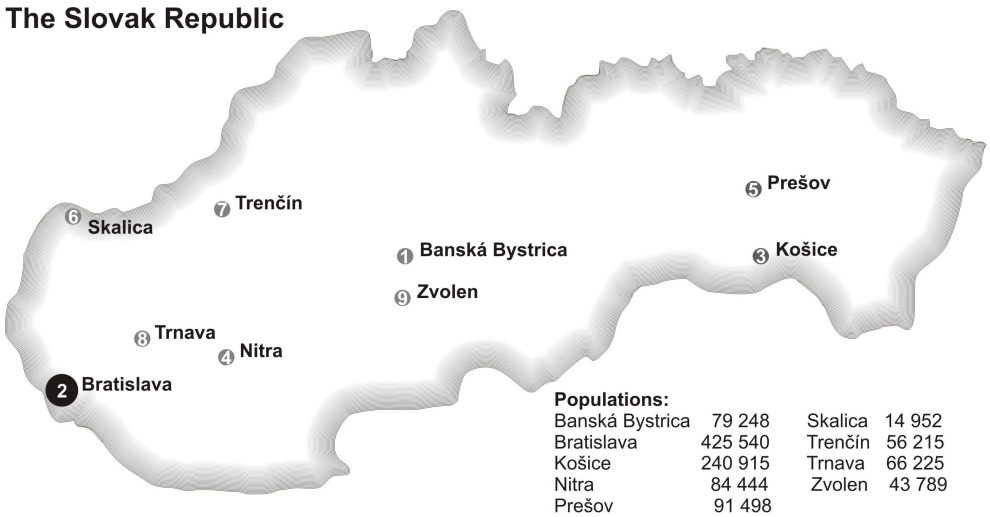
The environmental care, which is done with the national institutions and it is represented with environmental policy and legislative standards, would not satisfied an expected aim. It was necessary to transform specified standards together with actual environmental knowledge into not only citizens' minds but also into managers' minds in all regions and all sectors of economic activities.

The first "environmental" points came into existence at the sections of BOZP (Safety and Protection of Health at Work). In firms there were safety technicians often substituted; eventually they were at work in cumulative positions as "environmental conservators". There was a need of environmental educated people, who would take the new places of "company ecologist" in the system of industrial, manufactural and assembled operations and services. In general environmental activities are conditioned of environmental consciousness. It means that the change from consciousness toward to behaviour is often very long.

4 ENVIRONMENTAL EDIFICATION AND EDUCATION AT TECHNICAL UNIVERSITIES IN THE SLOVAK REPUBLIC

Environmental consciousness, itself is received mainly environmental edification and education in a family as well as in educational system from nursery, basic school to universities. If we went out above-mentioned information it was necessary to coordinate edification and education in such a way that people not only understood environmental problems but also they were able to solve them from point of causes and consequences. Also there was very important to understand where their place is in this process. However, academic education was under the highest pressure because universities were cradles of environmental edification later this new system was transferred to lower levels of education. At basic and secondary schools there was environmental edification integrated into curriculum in low-coordinated way. Till this time environmental studies were understood like a broad issue rather than an intersection of ecology, biology, geography and chemistry. In curriculum there were environmental studies only like small parts of the main study subjects.

Since 2000 at universities the coordinated integration of environmental aspects for edification and education at universities has already evident and intercepted in new environmental curriculum even with technical study fields. The specialised places with environmental orientation – departments as well as faculties have come into existence. They were developing and reorganizing during previous years.



Legends:

1. Matej Bel University in Banská Bystrica
• Department of Environmental Management
• Department of Biology and Ecology
• Department of Geography and Landscape Ecology

2a. Slovak University of technology in Bratislava
• Institute of Chemical and Environmental Engineering
• Institute of Safety and Environmental Engineering
• Institute of Manufacturing Systems, Environmental Technology and Quality Management
• Institute of Ecological and Experimental Architecture
• Department of Sanitary and Environmental Engineering

2b.Slovak Academy of Science in Bratislava
• Institute of Landscape Ecology

3. The Technical University of Košice
• Department of Environmental Studies and Process Management
• Faculty of Mining, Ecology, Process Control and

4. Constantine the Philosopher University in Nitra
• Department of Ecology and Environmental Sciences

5. University of Prešov in Prešov
• Department of Ecology

6. University of Central Europe in Skalica
• Institute of Environment and Regional Development

7. University of Trenčín A. Dubčeka in Trenčín
• Department of Chemical Technology and Environment

8. Trnava University in Trnava
• The Department of Administrative Law, Environmental Law and Financial Law

9.Technical University in Zvolen
• Department of Biology and General Ecology
• Department of Applied Ecology
• Department of Environmental Engineering
• UNESCO Department
• Department of Environmental Technology

Figure 2 - The allocation of universities providing specialized environmental edification and education, [3]

The actual allocation of Slovak universities, which provide environmental education and edification, is illustrated with a survey map in Fig.2. In the framework of the Slovak republic there is the allocation of environmental

departments and faculties balanced. The representation of schools with technical orientation is a most significant fact.

5 DEPARTMENT OF ENVIRONMENTAL STUDIES AND PROCESS MANAGEMENT

The department of Environmental Studies and Process Management, Mechanical Engineering Faculty at Technical University in Košice is considerable for mechanical engineering industry. It came into existence in the year 1998 and during ten years it was extensively transformed. At present this department has got an important position not only in Slovakia but also abroad. It cooperates with many industrial companies and technical universities (Badger Meter Europa, GmbH, Beuren (Germany); Netzsch Filtrationstechnik GmbH, Selb (Germany); SE, a.s., Bratislava; Siemens, a.s. Michalovce; Whirlpool, a.s. Poprad; SCP, a.s. Ružomberok; MobilStar, s.r.o. Košice; TU Vienna (Austria); BUGH Wuppertal (Germany); TU Maribor (Slovenia); TU Novi Sad (Serbia); TU Cluj-Napoca (Ro); TU Budapest (Hungary); STANKIN Moscow (Russia); Zakarpatska State University Uzhhorod (Ukraine) and Institut Neftechim Moscow (Russia), [2].

By means of such co-operation the department of Environmental Studies and Process Management is able flexibly and fast to accommodate trend and contains of individual study subjects for practical needs of mechanical engineering industry. The department curriculum was an inspiration for foreign universities (TU Novi Sad in Sebia, Kokshetau University in Kazakhstan)**.** The department has got accredited two educational programmes in the framework study fields: Environmental Engineering (EI) and Environmental Management (EM), which include environmental edification and education for sustainable development as a complex in.

The profiled study subjects of educational programmes in the frame of study fields are illustrated in Fig. 3.

The study programme Environmental Protection Technology in the framework Environmental Engineering study field deals with machines, instruments and technologies for mechanical engineering production. The study programme Environmental Management in the framework Environmental Management study field deals with management and regulation outdoor and indoor environment.

The interest in the study of environmental engineering and management is evident from the number of applied student every year. In 1998, when the department was established, the total number of M.Sc. study: in regular and external types and B.Sc. study: in regular type were 35 students per an academic year. At present there is this number increased to 250 applicants for the study with environmental orientation. Very important year was especially an academic year 2005/2006, when the number of students double-increased from 110 students to approximately 225 ones. We can suppose that interest will be

accelerated henceforward for B.Sc; M.Sc. and Ph.D. study. It is satisfied that the high proportion of applied students finish their study as well.

More and more new skills are needed. The conscious students should be to have "environmental skills" because they can integrate into their future work process in a more successful way. It is necessary to make out a new plan for development of individual study programmes and subjects. This way there will be filled up the incurred gaps from point of new knowledge and progress of environmental protection. There is one possibility to make-to-measure "environmental education". It means the education for individual technical operations e.g. automotive industry, sorting and recycling operation plants, electric power plants, municipal and dangerous waste incineration plants with and without energy utilisation, municipal and industrial water treatment plants and other industrial, production and assembled operation plants. In this way the graduated students should be ready for a practice in industrial operations, where they would be able to solve effectively old as well as new-developing environmental aspects, impacts, hazards and loadings. There are solutions of all these problems regarding to avoid them without potential consequences in future, [4].

6 THE NEW STUDY PROGRAMME – ENVIRONMENTAL DYNAMICS

Environmental Dynamics (ED) as a new study programme is a new challenge for environmental education. The programme would be focussed into processes by means of long -term and short-term aspects and would be developed present study fields in the above-mentioned department. This vision is also included in Fig. 3.

By developing of the new study programme it will prevent a frequent diffusion of study subjects in the frame of accredited study programmes: "Environmental Protection Technology" and "Environmental Management" and students will be organized better and more specifically. This way the department would educate students with more flexibly and variably orientation of their knowledge and skills.

In Fig.3 there are individual subjects of Environmental Management, which are oriented in the areas:

- Activity impacts assessment on environment according to the law of No. 24/2006 Collection of Laws;
- Environmental oriented regulation and audit;
- Systems of environmental and integrated management and accreditation and certification of these systems by means of standards ISO 14001;
- Registration Eco-Management and Audit Scheme (EMAS), etc.

Figure 3 - Sustainable development in environmental education as integration of engineering, management and dynamics

The study programme: Environmental Protection Technology, in the study field: Environmental Engineering deals with:

- Industrial production from point of environmentalism;
- Industrial production from point of consumption;
- Industrial production from point of production and assembly processes.

The study programme: Environmental Dynamics, in the study field: Environmental Engineering would deal with:

- Diagnostics of environmental factors;
- Objectification of environmental factors;
- Computer Aided Simulations (Stella, Vensim, PowerSim).

The individual subjects will be created by means of above-mentioned divisions. All of the programmes have got one role to keep sustainable development in mechanical engineering industry and in our society.

CONCLUSION

At present ecologisation and sustainable development are developing trends and strategies in industries. Sustainable development is understood like very good balanced social-economic-environmental development. However it is not separated from environmental consciousness, feeling and knowledge. It is pleased that there is progress in environmental edification and education in Slovakia. The interest in environmental education still increases and influences the sustainable development strategy and environmental policy of the Slovak Republic. It is necessary to realise that Slovakia has got the biggest environmental debts in comparison with the other European states, [2]. That is why it is needed to pay attention for these problems. Knowledge of the areas Environmental Protection and Generation must be still developed and enlarged for benefit of future generations. It is expected that there are introduced the new environmental study fields, programmes, forms and subjects for all school levels and for system of life-long education. Only qualitative environmental edification and education can be regarded as "initiator" and "engine" for changes of human attitudes and behaviours.

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