

ISSN 1407-5806

**COMPUTER  
MODELLING  
AND  
NEW TECHNOLOGIES**

**Volume 11  
No 3**

**2007**



Transporta un sakaru institūts  
(Transport and Telecommunication Institute)

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# **Computer Modelling and New Technologies**

**Volume 11, No.3 – 2007**

**ISSN 1407-5806**  
**ISSN 1407-5814**  
(On-line: [www.tsi.lv](http://www.tsi.lv))

**Riga – 2007**

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**COMPUTER MODELLING AND NEW TECHNOLOGIES**, 2007, Vol. 11, No. 3

**ISSN 1407-5806, ISSN 1407-5814** (on-line: [www.tsi.lv](http://www.tsi.lv))

Scientific and research journal of Transport and Telecommunication Institute (Riga, Latvia)  
The journal is being published since 1996.

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## CONTENTS

<b>Editors' remarks</b>	5
<b>Transport technologies</b>	7
STATISTICAL MODELLING OF THE TRUCKS WORK ON THE INTERNATIONAL ROUTES AT VARIOUS STRATEGY RETURN LOADING ACCEPTANCE S. Azemsha	7
<b>Computer simulation</b>	16
IMITATION OF NATURAL STRATEGIC BEHAVIOR OF INTELLECTUAL AGENT IN LOGISTICAL NETWORK V. Gopeyenko, R. Muhamediyev	16
<b>Applied statistics</b>	21
INDICATORS OF BUSINESS CONFIDENCE IN SMALL BUSINESS OF LATVIA V. Gurov	21
<b>Information teaching technologies</b>	28
ANALYSIS AND COMPARISON OF LEARNING AND CONTROL TOOLS OF VIRTUAL LEARNING APPLICATIONS MOODLE 1.6.1 AND BLACKBOARD LEARNING SYSTEM CE 6.1 ENTERPRISE K. Ponomariov, S. Galdikiene, S. Goštautaitė	28
TYPES OF QUESTIONS FOR COMPUTER-AIDED TESTING OF STUDENTS' KNOWLEDGE N. I. Volkov, A. N. Alexeyev, A. N. Kochevsky	35
MULTI-LEVEL TEST CONTROL OF QUALITY OF KNOWLEDGE BY QUANTITATIVE PARAMETERS A. N. Alexeyev	43
TEACHERS IN INFORMATION ENVIRONMENT: USE OF INFORMATION TECHNOLOGIES IN THE STUDYING PROCESS – POSSIBILITIES AND TEACHERS' OPINIONS (PILOT-RESEARCH) S. Baigozina, T. Mezhis, E. Saveliev	46
<b>Authors' index</b>	53
<b>Personalia</b>	54
<b>Cumulative Index</b>	55
<b>Preparation of publications</b>	59



***Editors' Remarks***

**THE VOICE OF THE ANCIENT BARD**

Youth of delight, come hither,  
And see the opening morn,  
Image of truth new-born.  
Doubt is fled, and clouds of reason,  
Dark disputes and artful teasing.  
Folly is an endless maze,  
Tangled roots perplex her ways.  
How many have fallen there!  
They stumble all night over bones of the dead,  
And feel they know not what but care,  
And wish to lead others, when they should be led.

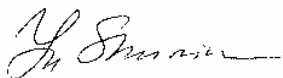
*Songs of Experience, William Blake, 1794*

This 11<sup>th</sup> volume No.3 points out an attention to some applied statistics problems, computer modelling problems, which are really actually for this day. There are some particular tasks in information teaching technologies discussed in the articles.

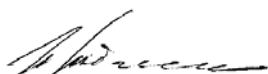
This means that our journal policy is directed on the fundamental and applied sciences researches, which is the basement of a full-scale modelling in practice.

This edition is the continuation of our publishing activities. We hope our journal will be interesting for research community, and we are open for collaboration both in research and publishing.

**EDITORS**



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# STATISTICAL MODELLING OF THE TRUCKS WORK ON THE INTERNATIONAL ROUTES AT VARIOUS STRATEGY RETURN LOADING ACCEPTANCE

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Characteristic feature of the international automobile cargoes transportations is the great value of vehicles run on a route. To evaluate efficiency of the given kind of transportations it is necessary to pay special attention to process of search and choice return loadings. The problem of cargoes in passing (the return passing) a direction is partially solved, that is connected with development of transport portals at Internet. However the problem of a choice rational transportation from set of alternative loadings variants remains urgent. The decision on acceptance of this or that cargo to transportation now is accepted by carriers managers on the basis of the intuitive conclusions based on personal practical experience. As a rule, such strategy of decision-making on a choice of rational return transportation are reduced to that the car transports that cargo which waiting time minimal.

In given article, are offered new, based on processing of the statistical information, strategy of decision-making on a choice of rational return transportation. The offered strategy of decision-making are based on the basis of the analysis more than 850 routes of trucks work on a direction Byelorussia–the Russian Federation. Statistical modelling cargo automobile work on each offered strategy and the subsequent economic estimation of the executed transportations allow to define optimum strategy of decision-making.

**Keywords:** *strategy of decision-making, modelling work of automobile vehicles, rational transportation, the law of distribution*

## 1. Introduction

The problem to increase the efficiency of automobile cargoes transportations has the high importance in the developed conditions of a rigid competition in the market of transport services. To increase effect from carried out transportation process it is obviously possible due to increase in a degree of use of run and carrying capacity of vehicles. The specialized information resources created in the Internet contain the information on cargoes purposed to transportation. It enables to solve a task in view – enables to prospect cargoes with the purpose of improvement of parameters of vehicles work. However the problem of a choice the optimum transportation from set of the cargoes offered to transportation remains actual. In practice the given problem is solved on the basis of acceptance of the intuitive decisions based on practical experience of activity auto carrier's managers. Thus it is accepted to minimize an idle time of a vehicle pending return loading, and as financial criterion of acceptance of this or that cargo to transportation the size of the rate of the freight acts for transportation not below average on the given direction. Such approach to maintenance and a choice of return loading is represented not always proved. For the decision of the stated problem it is necessary to develop and prove expediency application of various techniques of decision-making at the choice of rational transportation, and to choose from them optimum.

## 2. The Overall Performance Criterion of Trucks

As the criterion, allowing making the comparative analysis various variants of transportations, in the lead researches the specific profit [1] is offered. This parameter is defined as the attitude of the profit received by an automobile carrier from performance of this or that transportation, to time spent for its performance, and carrying capacity of a vehicle. The given parameter shows, what profit is brought with an automobile vehicle in unit of time on unit of the carrying capacity. In the developed kind expression of specific profit is the following:

$$P_s = \frac{V_t(L_{fr}(\beta \cdot d_s - S_{var}) + T_{it} \cdot d_{it})}{q(L_{fr} + \beta V_t(t_{lu} + t_c + T_{it} + T_e))} - \frac{S_{const}}{q}, \quad (1)$$



where

- $V_t$  – technical speed of movement of a vehicle;
- $L_{fr}$  – run of an automobile vehicle with a cargo, during job on a route;
- $\beta$  – operating ratio of run of an automobile vehicle;
- $d_s$  – specific proceeds for a unit of run. It depends on carrying capacity of an automobile vehicle demanded for transportation and can be approximated by linear dependence  $d_s = a_{0s} + a_{1s}q_d$ ;
- $S_{var}$  – variable expenses for a unit of run. These expenses depend on carrying capacity of a vehicle and its actual use and can be expressed as  $S_{var} = a_{0var} + a_{1var}q(1 + a_{2var}\beta\gamma_{st})$ ;
- $T_{it}$  – expected paid time of the above permitted standard idle time under cargo operations in fault of the customer;
- $d_{it}$  – payment for a time unit of the above permitted standard idle time under cargo operations in fault of the customer. It can be presented also by linear dependence on carrying capacity of a demanded automobile vehicle  $d_{it} = a_{0it} + a_{1it}q_d$ ;
- $t_{lu}$  – standard time of loading-unloading of an automobile vehicle;
- $t_c$  – expected duration of idle time at the control and documentary registration of transportation (at customs, etc.);
- $S_{const}$  – constant expenses for a time unit of job. These expenses depend basically on carrying capacity of an automobile vehicle  $S_{const} = a_{0const} + a_{1const}q$ ;
- $T_e$  – prospective duration of expectation of passing loading;
- $q_d$  – carrying capacity of the demanded (declared) automobile vehicle ( $q_d \leq q$ ).

It is established, that operated parameters in specific profit expression are full run, operating ratio of the run, demanded carrying capacity and a waiting time of return loading [2]. Besides it has been shown, that between operated parameters there is a statistical connection [3, 4]. It is caused by that with increase in a waiting time of return loading the quantity of the cargoes offered to transportation in the necessary direction extends. Having found dependence of length of the run with a cargo, operating ratio of run and demanded carrying capacity from a waiting time of return loading, and substituting them in expression of specific profit, after differentiation of expression (1), it is possible to receive, that an optimum waiting time of return loading is equally 15 hours [3].

### 3. The Strategy of Decision-Making on the Choice of Rational Return Transportation Development

As one of decision-making strategy on a choice of rational return transportation there will be a strategy based on occurrence expectation of a return cargo till 15 hours. In the lead researches connection between a waiting time of occurrence by a vehicle of the shipping request of a cargo which will allow reaching the maximal value of the accepted criterion of efficiency, from full run in a direct direction and intensity of occurrence of shipping requests in point of an unloading [3] has been established. The given dependence is as follows:

$$T_{w.opt.r} = \frac{12500 - 578\sqrt{L_{fr1}} + 7L_{fr1} - 99350N_{u,d}^2 + 23475N_{u,d} + 94750N_{u,d}^3}{578\sqrt{L_{fr1}} - 7L_{fr1} + 99350N_{u,d}^2 - 23475N_{u,d} - 94750N_{u,d}^3}, \quad (2)$$

where

- $L_{fr1}$  – distance of transportation of a cargo in a direct direction, km;
- $N_{u,d}$  – intensity of shipping requests occurrence of cargoes in the set direction in point of an unloading of a cargo transported by a straight line run (unit/hour).

At planning return loading chances when optimum return loading appears ahead of time the expectation received proceeding from expression (2). Therefore, it is possible to define what value of operating ratio of run is sufficient for acceptance of a cargo to transportation. For this purpose the hypothesis that value of sufficient operating ratio of the run, providing maximal specific profit, depends on length of full run in a direct direction has been put forward, i.e.  $\beta_{suf} = f(L_{fr1}, N_{u,d})$  carried out researches have allowed to define a kind of the given dependence [3]:

$$\beta_{suf} = 0,108408 \ln L_{fr1} - 0,0002216 L_{fr1} + 0,010837 \sqrt{L_{fr1}}. \quad (3)$$

Thus, it is possible to formulate the following possible strategy of decision-making on a choice rational return run. At the first strategy as possible loadings those cargoes which shipping requests have arrived in information system till the moment of a vehicle clearing from direct transportation are in the opposite direction considered. At this strategy from the created set of return loadings to transportation that cargo is accepted, the profit on which transportation on a route for a turnover will be the greatest.

At the second strategy as possible loadings in the opposite direction those cargoes which shipping requests have arrived in information system till the moment of a vehicle clearing from direct transportation also are considered. However at the given strategy from the created set of return loadings to transportation that cargo is accepted already, the specific profit on which transportation for a turnover will be the greatest.

At the third strategy as possible loadings those cargoes which shipping requests have arrived in information system during in advance set time after the moment of a vehicle clearing from direct transportation are in the opposite direction considered. At the given strategy from the created set of return loadings to transportation that cargo is accepted, the profit on which transportation on a route for a turnover will be the greatest.

At the fourth, also as well as at the third strategy as possible loadings those cargoes which shipping requests have arrived in information system during in advance set time after the moment of a vehicle clearing from direct transportation are in the opposite direction considered. At the given strategy from the created set of return loadings to transportation that cargo is accepted already, the specific profit on which transportation for a turnover will be the greatest.

At the fifth strategy as possible loadings those cargoes which shipping requests have arrived in information system during time counted of expression (2) are in the opposite direction considered. At the given strategy from the created set of return loadings to transportation that cargo is accepted, the specific profit on which transportation for a turnover will be the greatest.

At the sixth strategy of decision-making on a choice of return loading an automobile vehicle applications are considered serially, in the chronological order of receipt in information system all. For each considered variant the operating ratio of run is defined and compared to a sufficient degree of run use, certain by expression (3). To loading on the given strategy it is necessary to accept that cargo which transportation will give value of run operating ratio not less than its sufficient size. To define from the offered strategy of a choice the return transportation rational modelling work of vehicles will allow.

#### 4. The Plan of Modelled System Functioning

Process of vehicles functioning on the international routes can be presented in the form of the plan (Figure 1).

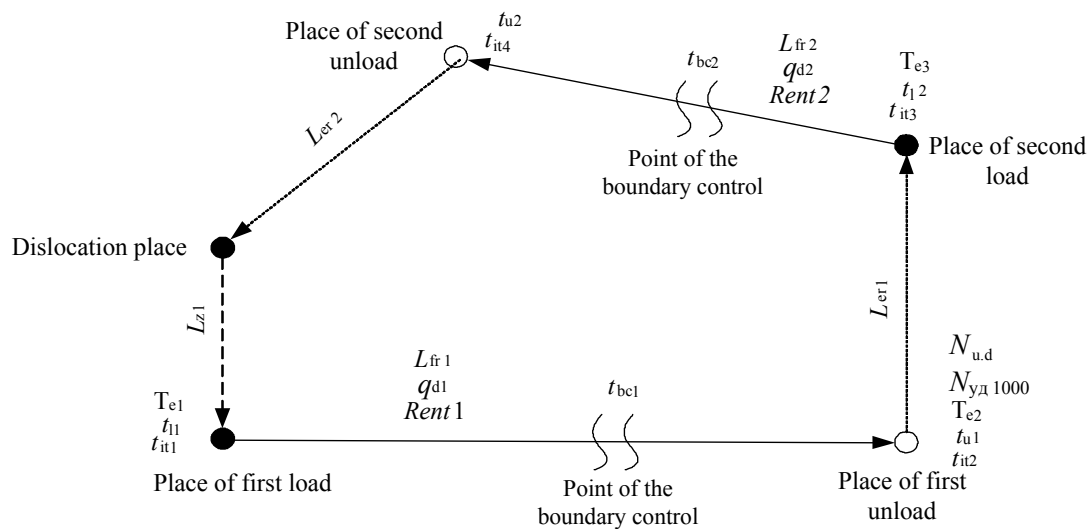


Figure 1. Plan of cargo vehicles work at the international routes

From the brought plan it is visible, that the car from a place of the constant disposition carries out zero run ( $L_{z1}$ ) to a place of the first loading. In the given point it can expect loading ( $T_{e1}$ ) because of arrival with anticipation, then stand idle pending loadings on fault of cargo sender ( $t_{i1}$ ), and then is under loading ( $t_{l1}$ ). Upon termination of loading the vehicle carries out full run in length  $L_{fr1}$ , profitability  $RENT1$ . In point of the boundary control the vehicle passes customs registration  $t_{bc1}$ . In point of the first unloading the vehicle is in a condition of expectation of an unloading on fault of the cargo owner ( $t_{i2}$ ), and then is under an unloading  $t_{u2}$ . After that if to make run for return loading in other point it is inexpedient, the vehicle can expect loading time ( $T_{e2}$ ).

If to make empty run expediently after an unloading the vehicle sends to point of return loading, making thus empty run ( $L_{er1}$ ). In the given point it can expect loading ( $T_{e3}$ ), then stand idle pending loadings on fault cargo sender ( $t_{i3}$ ), and then is under loading ( $t_{l2}$ ). Upon termination of loading the vehicle carries out full run in length ( $L_{fr2}$ ), profitability  $RENT2$ . In point of the boundary control the vehicle passes customs registration ( $t_{bc2}$ ). In point of the second unloading the vehicle can is in a condition of expectation of an unloading on fault of the cargo owner ( $t_{i4}$ ), and then is under an unloading ( $t_{u2}$ ). After that empty run to a place of a constant disposition ( $L_{er2}$ ) is carried out.

Proceeding from the brought plan of vehicles functioning follows, that for modelling trucks work on the international routes it is necessary to define distribution laws of the following sizes: the summary full run ( $L_{frs}$ ), the second full run ( $L_{fr2}$ ), the first and second empty run ( $L_{er1}$  and  $L_{er2}$ ), demanded carrying capacity ( $q_d$ ), an interval of time between occurrence of the application in information system and submission of a cargo for loading ( $I_1$ ), quantity of appearing applications depending on time of day ( $I_2$ ).

## 5. The Distribution Laws of Modelled Random Variables Definition

For an establishment the distribution laws of the given sizes sample of 858 possible routes of vehicles work proceeding from offers of a site [www.belcargo.com](http://www.belcargo.com) is processed.

For definition the distribution law of continuous random variable ( $L_{frs}$ ) we shall define quantity of splitting intervals at construction of the histogram of the given random variable. From known expression [5, p. 21], the given parameter will be equal 10. Thus, value an interval size of variational of some the investigated size [5, p. 21] it will be equal 271.

Let's define the statistics cores of an investigated random variable (Table 1).

**Table 1.** The basic statistical characteristics of length full run

Average	Median	Fashion	Minimum	Maximum	Average quadratic deviation
1861,27	1706	1504	1047,000	3865,000	498,3

Let's construct the histogram of distribution (Table 2, Figure 2). At selection of various distribution laws by means of software package *STATISTICA* it has been established, that most precisely this sample will describe lognormal distribution law.

**Table 2.** Frequencies of investigated random variable hit values in intervals

Intervals	Quantity of hits	Cumulative quantity of hits	Percent of hits	Cumulative percent of hits
$\leq 1328,80000$	26	26	3,03030	3,0303
1610,60000	327	353	38,11189	41,1422
1892,40000	215	568	25,05828	66,2005
2174,20000	102	670	11,88811	78,0886
2456,00000	88	758	10,25641	88,3450
2737,80000	36	794	4,19580	92,5408
3019,60000	32	826	3,72960	96,2704
3301,40000	17	843	1,98135	98,2517
3583,20000	8	851	0,93240	99,1841
< Infinity	7	858	0,81585	100,0000

However, the analysis of results shows, that the Hi-square more tabulated (217,5> 43,77), hence a hypothesis about lognormal distribution of an investigated random variable it is necessary to reject value of criterion. That is any, from distribution laws of casual continuous sizes does not describe the given sample.

For modelling values of an investigated random variable it is possible to use the following algorithm [7]:

1. We shall construct a cumulative distribution curve of a random variable, and on each interval it is replaced real function  $F_{ej}$  direct (Figure 3).
2. We generate a pseudo-random number  $r_b$ , in regular intervals distributed in an interval from 0 up to 1;
3. It is found in what an interval  $j$  gets  $r_b$ ;
4. It Is defined the generated casual value of a modelled random variable from expression:

$$L_{frs} = L_{fr1} + \frac{r_b - F_{ej-1}}{F_{ej} - F_{ej-1}}(L_{frj} - L_{frj-1}) . \quad (4)$$

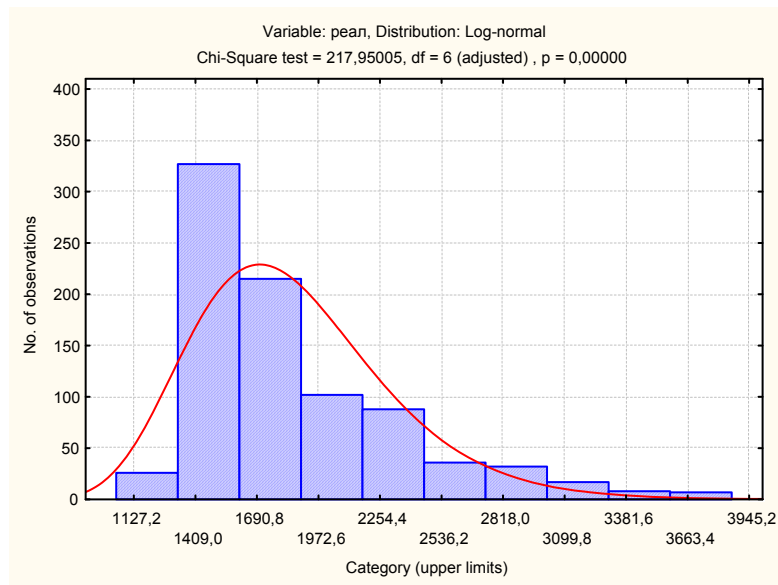


Figure 2. Check a hypothesis about lognormal law distribution of a random variable

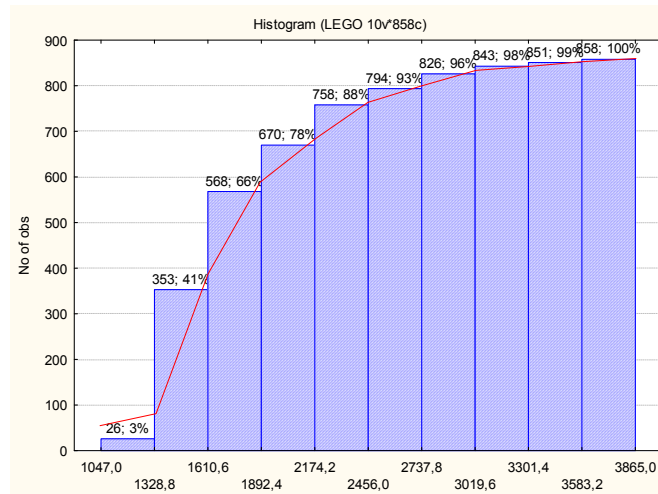


Figure 3. Cumulative curve of an investigated random variable



For example, let the random number  $r_b = 0,67$  is simulated. Then, on the basis of Figure 3 and expressions (4) it is received:  $L_{\text{firs}} = 1892,4 + \frac{0,67 - 0,66}{0,78 - 0,66} (2174,2 - 1892,4) = 1916$ .

To check up coordination between set of the real and simulated random variable values it is possible with use of criterion of the consent the  $\chi$ -square [5, p. 36]. For calculation of criterion the  $\chi$ -square it is necessary to construct the distribution histogram of the simulated values of a random variable by means of the generator of random numbers from 0 up to 1, expressions (4) and the distribution resulted in Figure 3. Results of modelling of the summary full run are presented in Table 3.

**Table 3.** Frequencies of the simulated values hit of an investigated random variable in intervals

Intervals	Quantity of hits	Cumulative quantity of hits	Percent of hits	Cumulative percent of hit
$\leq 1328,8000$	25	25	2,91375	2,9138
1610,6000	313	338	36,48019	39,3939
1892,4000	223	561	25,99068	65,3846
2174,2000	103	664	12,00466	77,3893
2456,0000	80	744	9,32401	86,7133
2737,8000	49	793	5,71096	92,4242
3019,6000	30	823	3,49650	95,9207
3301,4000	17	840	1,98135	97,9021
3583,2000	8	848	0,93240	98,8345
$< \text{Infinity}$	10	858	1,16550	100,0000

On the basis of Tables 2 and 3 it is possible to receive, that the settlement  $\chi$ -square is equal 7,78. Tabulated value  $\chi_{20,05; 8} = 15,51$  (where 8 – number of degrees of freedom, equal to a difference of quantity of intervals of splitting and number of the estimated statistical parameters [5 p. 36]. As tabulated value of criterion the  $\chi$ -square more settlement it is possible to draw a conclusion that divergences between the real and simulated values are insignificant.

Except for criterion the  $\chi$ -square for an estimation of a coordination of distributions it is possible to use Romanovskiy's criterion [6, p. 51] which value in this case for the real and simulated size will be equal 0,06. As the received value of Romanovskiy's criterion is less 3 it is possible to draw a conclusion that divergences between the real and simulated values are inessential.

Let's define the distribution law of occurrence time of the application in information system. The basic statistical characteristics of an investigated random variable are shown in Table 4.

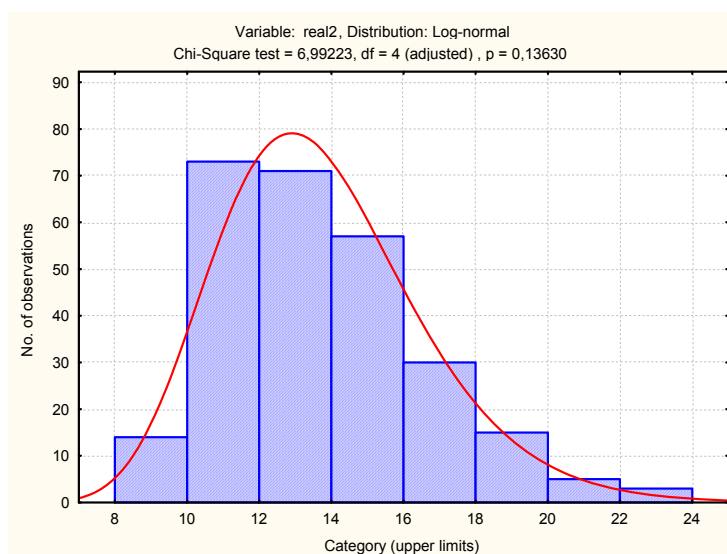
**Table 4.** The basic statistical characteristics of occurrence time of applications in information system

Average	Median	Fashion	Minimum	Maximum	Average quadratic deviation
13,74988	13,13333	15,20000	8,283333	23,96667	2,922023

The size of intervals variation of some will be equal 1,78. Then, quantity {amount} of intervals is 9. We shall construct the histogram of distribution (Table 5, Figure 4). We shall put forward a hypothesis about lognormal distribution of an investigated random variable. The analysis of results shows, that value of criterion the  $\chi$ -square equally 6,99, and tabulated – 14,07, hence, the hypothesis about lognormal distribution of an investigated random variable should be accepted. Thus, occurrence time of applications in information system is subordinated to the lognormal law with parameters 0,2056 and 2,5997. For modelling the continuous random variables subordinated to the lognormal distribution law, the corresponding formula [5, p. 123] is used.

**Table 5.** Frequencies of investigated random variable hit of values in intervals

Intervals	Quantity of hits	Cumulative quantity of hits	Percent of hits	Cumulative percent of hit
$\leq 10,00000$	14	14	5,22388	5,2239
12,00000	73	87	27,23881	32,4627
14,00000	71	158	26,49254	58,9552
16,00000	57	215	21,26866	80,2239
18,00000	30	245	11,19403	91,4179
20,00000	15	260	5,59701	97,0149
22,00000	5	265	1,86567	98,8806
< Infinity	3	268	1,11940	100,0000

*Figure 4.* Check a hypothesis about lognormal distribution of a random variable

Having made calculations it is possible to receive, that the  $\chi$ -square is equal 11,68. Tabulated value  $\chi_{20,05; 6} = 12,59$ . As tabulated value of criterion the  $\chi$ -square more settlement it is possible to draw a conclusion that divergences between the real and simulated values are insignificant. It is similarly possible to receive, that Romanovskiy's criterion will be equal 1,64. As the received value of Romanovskiy's criterion is less than 3 it is possible to draw a conclusion that divergences between the real and simulated values are inessential.

Modelling of other parameters of transportation process is made similarly to a technique accepted for summary full run as the given sizes are not described by well-known laws of distribution.

## 6. Modelling Algorithm of Random Variables

Let's consider a modelling technique of vehicles work at the offered strategy of decision-making on a choice of optimum return transportation. The first stage sets modelling quantity of days. After those modelling possible variants of cars return loading on set prospect is made. Then, value full run in a direct direction is modelled. Consequently, the search of optimum return loading on considered strategy of decision-making is made. At each strategy of decision-making on a choice rational return run, the alternative variants set of a return route joins those runs which are satisfied not only to conditions of each concrete strategy, but also with those on which loading the vehicle is in time. Modelling on each of the specified strategy is conducted until the days quantity of modelling will not exceed a preset value. For each turnover total profit value and the summary full run which increase with each subsequent turnaround flight pays off. The program of modelling is written in programming language Delphi 7.0.

## 7. The Analysis of the Modelling Results

Detailed results of automobile vehicles modelling work on the described algorithm and offered to six strategies, by transportation cargoes on the international routes on prospect in half a year borrow volume equivalent to 2,5 thousand pages of format A4. Final results of calculations on each strategy of modelling are resulted in Table 6.

**Table 6.** Results of the vehicle work modelling on the international routes

Number of strategy	Maximum quantity of hours of expectation of occurrence of the application, h	Profit, BYR	Summary run, km	Summary at one hour, h	Profit on 1 km of run, BYR/km	Profit at one hour, BYR/h
1	-	7038072	78116	4443,5	90,1	1583,9
2	-	7037577	78063	4443,5	90,2	1583,8
3	2	10327386	75806	4363,7	136,2	2366,7
	5	9787644	78253	4390,1	125,1	2229,5
	6	9831660	78097	4348,2	125,9	2261,1
	8	10067834	78836	4393,1	127,7	2291,7
	10	9540338	79267	4395,1	120,4	2170,7
	12	10576096	81449	4353,5	129,8	2429,3
	15	11183635	84718	4405,1	132,0	2538,8
	20	10517640	74748	4386,2	140,7	2397,9
	25	9808077	75105	4366,5	130,6	2246,2
4	2	10342863	76400	4362,6	135,4	2370,8
	5	9463542	76819	4341,5	123,2	2179,8
	6	10260885	78051	4391,1	131,5	2336,7
	8	9737650	78038	4344,5	124,8	2241,4
	10	9710435	78803	4324,5	123,2	2245,4
	12	9072803	79388	4345,4	114,3	2087,9
	15	8705019	79259	4371,5	109,8	1991,3
	20	7832445	75924	4405,1	103,2	1778,0
	25	6626094	74998	4338,3	88,4	1527,3
5	-	6998600	78063	4443,6	89,7	1575,0

Thus, if as the basic criterion of work to use total profit of an automobile carrier or a maximum of economic feedback at one hour it is necessary to recommend to expect occurrence of the shipping cargoes request in the opposite direction no more than 15 hours. If as the basic criterion of work to use a maximum of an economic gain from one kilometre of run it is recommended to expect occurrence of the shipping cargo request in the opposite direction no more than 20 hours.

By development of practical recommendations on decision-making on a choice of rational behaviour strategy at a choice of optimum return transportation it is necessary to consider, that at modelling work of vehicles did not take into consideration time of "urgency" of the application located in information system. Under time of "urgency" of the application we shall consider the period of time between occurrence of the application in information system and the moment of cargo offered acceptance to transportation by the given application. In existing information systems time of "urgency" is not reflected. Therefore, at modelling work of an automobile vehicle it was supposed, that time of "urgency" of applications is not limited. That is, at decision-making on strategy 1–5 applications considered a circle it was limited to only admissible waiting time of occurrence of the application in information system. Of the set of possible applications received by such restrictions got out optimum by the accepted criterion. However, in practice

while the carrier expects the expiration of an optimum waiting time of occurrence of the application, that cargo which transportation will give the maximal effect, can be already accepted to transportation by the competitor. Therefore, use in planning return transportations of strategy six which allows making a decision as much as possible quickly on acceptance of a cargo to transportation on the basis of sufficient value of run operating ratio will be expedient. Modelling of automobile vehicle work on the given strategy shows that the total profit for half a year of work of the car will be equal 9884390 roubles. Thus the profit on one kilometre of run will make 133,4 BYR/km, and at one hour – 2254,1 BYR/hour. Economic benefit in comparison with a variant of work on strategy 1 will make the order 5,6 mln. BYR per year from each vehicle.

## Conclusions

In the given work the actual problem of search and a choice optimum by return (passing return) loadings of an automobile vehicle working on the international routes is considered. The analysis of the literature has shown, that there are no the scientific techniques allowing prove to solve formulated problem. For the decision of the given problems there has been developed six strategies of behaviour at decision-making on a choice of return transportation. The lead statistical modelling automobile vehicles work on the international routes with size prospect equal half a year on each strategy and the detailed analysis of results of the given modelling has allowed to allocate optimum strategy. The essence of the given strategy consists that are considered serially, in the chronological order of receipt in information system all applications. For each considered variant the operating run ratio is defined and compared to a sufficient degree of use of cars run, certain of expression (3). To loading on the given strategy it is necessary to accept that cargo which transportation will give value of operating ratio of run not less than its sufficient size. Economic benefit of work on the given strategy in comparison with strategy put into practice now makes 2,3 thousand US dollars a year from each vehicle.

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Received on the 21<sup>st</sup> of June 2007



## IMITATION OF NATURAL STRATEGIC BEHAVIOR OF INTELLECTUAL AGENT IN LOGISTICAL NETWORK

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The concept of an intellectual agent in logistical network (IALN) for transformed circuits modelling is proposed. The ways of the IALN description by Petri nets are considered. Management of such agent is carried out on the basis of behaviour principles of the artificial alive essences-animates in particular self-training. To reduce the amount of possible model's initial markings, the algorithm of "appropriate" set of initial markings calculations is offered. The way to "logically" change the network by agent is also proposed.

**Keywords:** *logistical chain, logistical network, Petri nets, intellectual logistic net, animate, intellectual agents, natural strategy of training*

### 1. Introduction

Gradual withdrawal from MPR II methodology (focused on a large-lot production and as a rule long-life cycles of products) and transition to development of management techniques and technologies incorporated by term Supply Chain Management (SCM) is now being observed [1]. The purpose of the logistical chain management is to connect all participants in the uniform integrated system. The set of logistical chains forms more complex structure – a logistical network. That is why the task of logistical network optimisation is actually. The dynamical character of business processes make it necessary to construct the adaptive system, capable to be adjusted according to the changing conditions.

In essence, the question is if an intellectual agent of logistical network is capable to "adjust" for the current problem and to change "appropriately" according to the new conditions.

### 2. Logistic nets formalization by Petri nets

Petri nets are often used as formal model of logistic nets. Formal definition of a network can be found, for example, in [2]. In the same place some expansions of Petri nets are considered, allowing increasing their expressive capacity. Some examples of the Petri nets and their expansions applications for the business processes analysis are shown in [3, 4, 5].

Presence of different type peaks and corresponding rules of network work (transitions operation rules) allows dynamic parallel asynchronous processes analysing. There is a set of modifications (expansions) of classical Petri networks. For example, it is possible to apply time nets to estimate the time of transaction [6, 7]. In this case, time intervals are corresponded by transitions. Fuzzy Petri nets are based on the concepts of fuzzy logic entered by L. Zade. In [8] fuzzy Petri nets are used for hybrid system modelling. Other expansions – coloured nets [9], stochastic nets, predicate nets, etc. are also used.

Usually, the graph of achievable markings is applied to analyse the properties of nets. Imitation modelling is used to analyse the nets with the big expressive capacity.

There are no algorithms that correct the network structure in classical networks and their expansions. Hence, the classical nets are appropriate for static chains modelling. To optimize such networks the classical algorithms and the weak artificial intelligence algorithms [11] that optimise the network using the criterion of expenses and time reduction are used.

We shall name block of intellectual management in logistical network as an intellectual agent of logistical net. In difference from classical algorithms of optimisation, intellectual management assumes self-training and new strategy of behaviour development. If during the repeated passing through the chain the self-training process is basically possible, than the task of the new strategy development is more difficult. Obviously, it assumes not only the change of the network single chain elements but also the possible change of its structure. Usually, time and resources meant for this task solution are limited and the aim can be formulated unclear. In such way the behaviour strategy development task looks like a living organism or its model – animate. [12, 13].

Let's consider the models of logistical network elements (Fig. 1a, b, c, d). Elementary models with initial markings are shown in the top of the figure. The final markings achieved during transition are pointed in the bottom of the figure. We shall name the final markings as the "target markings" according to semantics of nets.

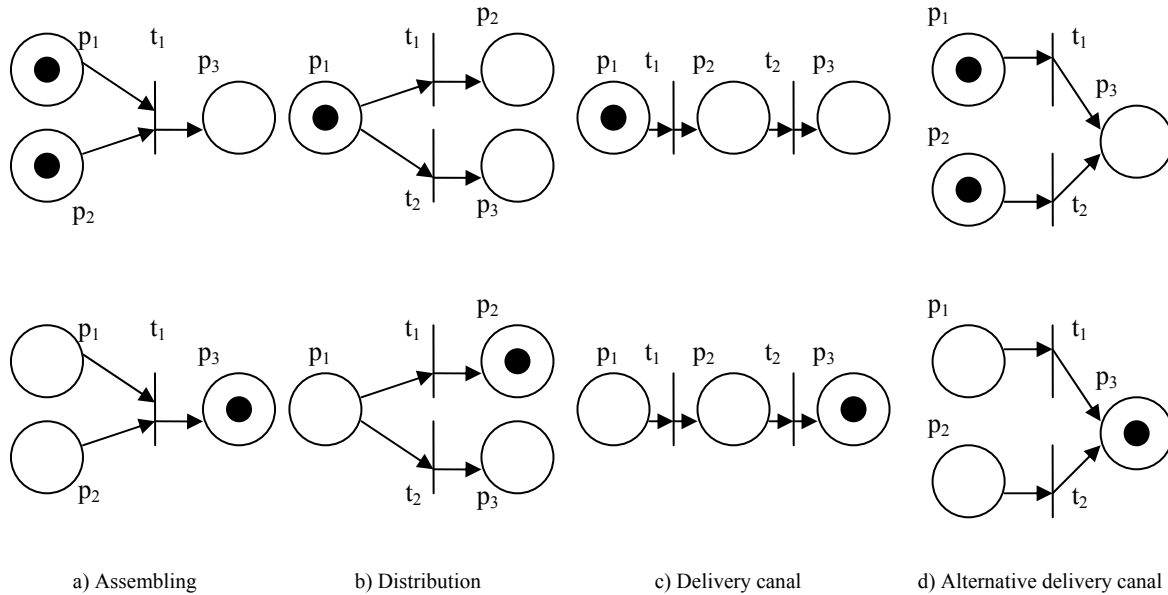


Figure. 1. Models of elements of logistical network

Peaks of the network can be interpreted as follows:

- a)  $p_1, p_2$  – warehouses,  $t_1$  – assembly process,  $p_3$  – warehouse of finished goods;
- b)  $p_1$  – production warehouse,  $t_1, t_2$  – delivery,  $p_2, p_3$  – consumer;
- c)  $p_1$  – warehouse,  $p_2$  – intermediary,  $p_3$  – consumer,  $t_1, t_2$  – delivery;
- d)  $p_1, p_2$  – warehouses,  $t_1, t_2$  – delivery,  $p_3$  – consumer.

In the most simple case, when the orders of network arches and/or time of transition operations are known the problem of optimisation is reduced to a task of token arrangement in such a way that there are more tokens where the weights are smaller.

What to do, if the order of arches or time (probabilities, weights) of transitions operations is unknown? One of decisions is to try various variants, choosing the best by the criterion of optimisation. Actually it means some kind of self-training strategy in the network. The self-training process can imitate the natural strategy of training which, according to [13], includes the following:

- Generating new tactics of behaviour;
- Correspondence of these tactics to physical laws of environment;
- The presence of non-linear oscillator;
- A predicative functioning;
- Work history consideration.

If the Petri nets are used as the formalism that describes the logistical circuits, the predicative functioning is provided by the rules of the transition operations.

### 3. An approach to taking into account the “physical” laws of the environment

Taking into account of physical laws of environment means that from all of set of variants of behaviour are excluded obviously unsuitable (it is impossible to deliver faster the plane speed, it is impossible to have an unlimited source of the finance, etc.)

In our case, the "physical" environment for work of the agent is the subset of Petri nets (time nets). Hence, it is necessary to consider only "appropriate" markings that provide the set of target markings from all sets of initial markings. There is no necessity to consider obviously impasses.

If  $x$  is any positive integer and  $0, w$  is positive and is greater than  $0$ ;  $m(p_i)$  – markings of the place  $p_i$ , on any step during the work of the net; then the set of markings  $m(p_1) = x, m(p_2) = x, m(p_3) = w$  are the target markings of the subnet on Fig. 1a or in the vector form  $g_a = (xxw)$ . The target markings of the subnets are resulted in Table 1.

**Table 1.** Target markings of elementary subnets (Fig. 1)

Subnet on Fig. 1	Vector of target markings set (g)
a	xxw
b	xww
c	xxw
d	xxw

**Definition 1.** We shall name the initial marking of the net  $m_0$  as "appropriate" if one of the target markings  $g$  can be achieved from  $m_0$  at the defined operation rule. For example, for the net in Figure 2a the "appropriate" markings are (110), (120)..., (ww0). The task of marking approachability corresponds to the NP-full [14]. Therefore, the algorithm or a method is necessary for the calculation of the "appropriate" markings set.

Let's define net  $R$  as "reverse" of the net  $N$  if the places and transitions of these networks coincide, however, the directions of the network  $N$  arches are changed to the opposite directions in comparison to the network  $M$ .

Formally,  $M(X)$  is a rectangular matrix of connections of net  $X$ , in which element

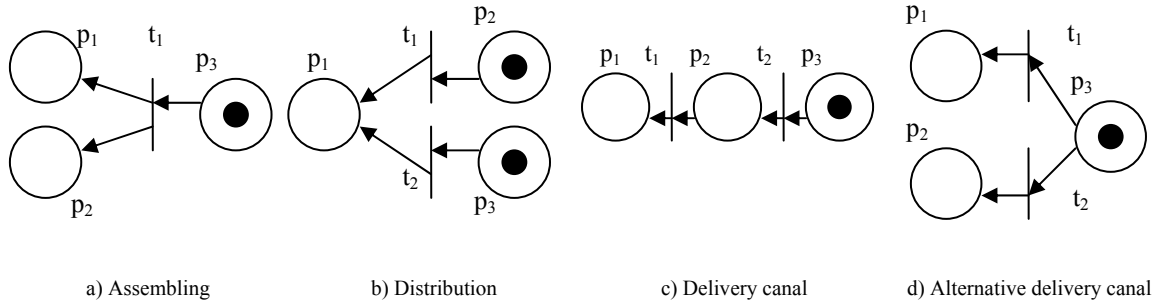
$x_{ij} = 1$  if the arch goes from the place  $p_i$  to  $t_j$ ;

$x_{ij} = -1$  if the arch goes from  $t_j$  transition to the place  $p_i$ ;

$x_{ij} = 0$  if the place  $p_i$  is not connected to the transition  $t_j$ .

$E(X)$  is the set of "appropriate" markings of the net  $X$ .

**Definition 2.** We shall name the net  $R = (P_r, T_r, M(R))$  reversed  $N = (P_n, T_n, M_n(N))$  net, if  $P_r = P_n, T_r = T_n$ , and  $M(R) = j * M(N)$ , where the scalar  $j = -1$ . It is enough to calculate set of markings of net  $R$  to calculate the set  $E(N)$ . Elementary nets that are reversed for the nets in Fig. 1 are represented in Fig. 2. It is evident that after transition operations the network markings in Fig. 2 and in Fig. 1(top) will coincide.



**Figure 2.** Reverse nets

Let's consider an example to illustrate the described approach. We have the nets  $N_1$  and  $R_1$  (Fig.3a, b). The Table 2 represents the connection matrix for the net  $N_1 - M(N_1)$ . To calculate the reversed net connections matrix it is necessary to solve the following expression:  $M(R_1) = -1 * M(N_1)$ . The result is represented in Table 2.

**Table 2.** Connection matrix for  $N_1$

$p \backslash t$	1	2	3
1	1	0	0
2	1	0	0
3	0	1	0
4	-1	-1	1
5	0	0	1
6	0	0	-1

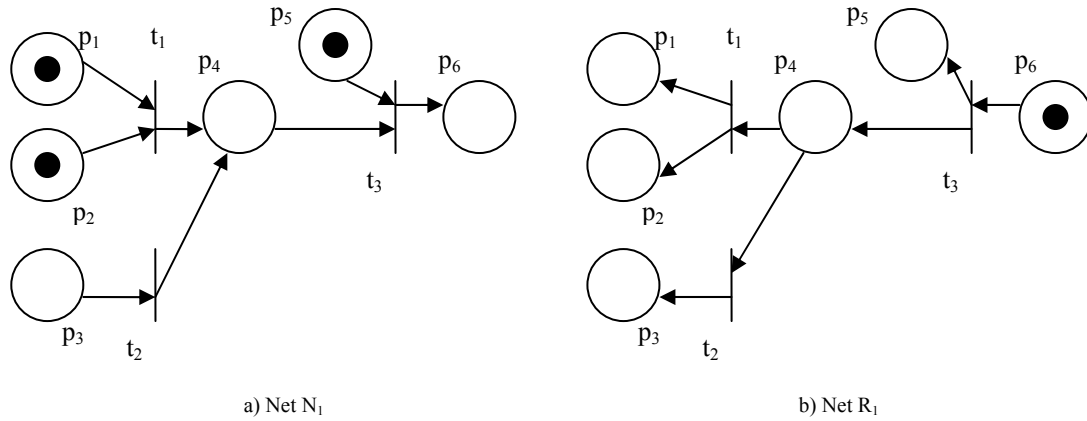
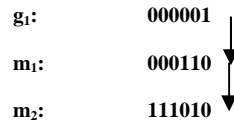


Figure 3. "Direct" and "reverse" nets

**Table 3.** Connection matrix for  $R_1$ 

p \ t	1	2	3
1	-1	0	0
2	-1	0	0
3	0	-1	0
4	1	1	-1
5	0	0	-1
6	0	0	1

To calculate the set of "appropriate" markings of net –  $E(N_1)$ , it is enough to calculate the graph of achievable markings (GAM) of  $R_1$ . For one of the target marks sets  $g_1(N_1) = 000001$ , GAM of the net is represented in Fig. 4.

Figure 4. GAM of net  $N_1$ 

The set  $E(N_1)$  includes  $m_1$  and  $m_2$ . It is obvious that the mark  $m_1$  for the net  $N_1$  is intermediate. It means, that  $m_1$  always can be founded from  $m_2$ . Calculation of all  $E$  sets in any network can represent a difficult task. Let's introduce concept of the final marking.

**Definition 3.** The set of reverse net's  $F(R)$  final marking of will consist of such  $f_i \in E(R)$  marks that any transition cannot work or that does not vary during any transition operation (probably also, that these are zero marks). In other words, the final marking includes the set of deadlock markings of the net and the set of markings that do not vary during any transition operation. It is obvious, that  $|F(R)| \leq |E(N)|$ . Though it is possible to believe, that generally algorithmic complexity of the sets  $F(R)$  and  $E(N)$  calculation is equivalent, nevertheless, in many cases the elements quantity in  $F(R)$  is lower than in  $E(N)$ , this allows lowering the requirements for memory during the network analysis. In particular, in an example,  $E(N_1) = (m_1, m_2)$ , and  $F(R_1) = (m_2)$ .

#### 4. The new tactics of behaviour generation

Until now we have considered nets with steady structure. So the quantity of places, transitions, arches and connections between the peaks of the net is fixed. New knowledge in our model is an occurrence of the new peaks and connections. Obviously, that first of all it is necessary to subject transformations of those net parts that influence the optimised parameters (time, cost) most of all. Similarly to the PERT diagrams we shall name the given parts of the network as critical. The concept of the critical part of the net follows from the semantics of the processes simulated by the model.

Generally, amount of possible net modifications can't be restricted. Nevertheless, it is possible to offer the following sequence of net modification steps from the common principles:



- ❖ Revealing the critical nodes and ways.
- ❖ Critical nodes optimisation using "logical" network modification. In other words, addition or removal of the peaks and arches with an answer to the question – "What will be if...? ". In the case of the logistical network this is, for example, the finding of the new channels of deliveries or commodity markets. Thus, "logical" modification consists in the change of the critical nodes and ways, calculation of the "appropriate" markings and the analysis of the received result to reveal the optimal modification.
- ❖ Network modification.
- ❖ Go to the step 1 if the parameters (time or transactions costs) are changed.
- ❖ Go to the step 1 "spontaneously" even without the net parameters change after casual interval of time  $dT$
- ❖ Note, that the efficient system of modification should reveal contradictions during net modification, and also should take into account the previous experience of changes and carry out selection of  $dT$  size.

## Conclusions

The ways of the logistical circuits by Petri nets description are considered. Various expansions of Petri nets are applied to the description of the logistical networks. Generally, evident models can be used to calculate some parameters and optimise static logistical chains. The logistical net can be transformed depending on the business process aims in the real environment. For changeable circuits modelling the concept of the intellectual agent of the logistical network is offered. The behaviour of such an agent is carried out on the basis of the principles of the artificial alive essences-animates, in particular self-training. The goal of the agent is to change the net accordingly to the change of the conditions. For example, it must change in the case of single transactions cost change or change of the critical ways. The way to simulate natural strategy of agent training is proposed.

In some cases the speed of net change and transformation variants checking limitations can be critical. To reduce the amount of possible model's initial markings, the algorithm of "appropriate" set of initial markings calculations is offered. It allows reducing the amount of "logical" network change variants and steps.

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Received on the 21<sup>st</sup> of June 2007

## INDICATORS OF BUSINESS CONFIDENCE IN SMALL BUSINESS OF LATVIA

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The central notion of the indicators-based system of management and planning is an index – an integral indicator that characterizes by-quantity the qualitative features of socio-economic processes. The methods to examine business climate developed by the European Commission were adopted to serve the basis of the indicators. In years 2005–2006 the research laboratory of the Baltic International Academy (BIA) conducted a monitoring of business confidence indicators in micro- and small business in Latvia. The monitoring involved 5.3% economically active enterprises.

**Keywords:** *indicators, business climate, territorial marketing, small business in Latvia*

### 1. General

In building territorial marketing systems, in addition to the basic components or parameters of the marketing-oriented economic and social model, a concept of by-indicator management employing the indicators-indices is of great importance. By-indicator planning is viewed as a process of forming and subsequent achieving of a system of parameters (indicators), which characterize the state and development of the country's economic environment. By-indicator management determines certain “corridors” where the selected indicators should be found. If an indicator extends beyond the scope of the set corridor, this serves as a signal for taking corrective managerial measures, applied both to the economy on the whole and to the subsystem of economy where the mentioned indicator belongs [1, 2].

Thus, by-indicator management is built on an aggregate of parameters (indices) in economic management, the values that the indicators should reach, or the corridors, within which the indicators should be present in order for the economy to develop according to the objectives set, as well as the mechanisms to influence the indicators.

By-indicator management can also be defined as a mechanism of coordination of interests and activities of governmental and non-governmental entities of economic management. It entails determining of nationwide priorities, defining objectives, and forecasting, budgeting, programming, contracting and other procedures on all the levels of national economic management.

The key notion of the system of the by-index management and planning is **the indicator** – an integral index, which quantifies the qualitative characteristics of social and economic processes. Indicators are determined as the parameters of boundaries, within which the system comprising organizational mechanisms, technological linkages, material and financial flows can function and develop steadily. Unlike an index providing only a quantitative statement, the indicator has a vector-type, directed nature. Indicators have threshold limit (minimum and maximum) levels of profitability, tax rates and modes of multi-resource systems development.

Special attention is paid to determining and using threshold values of the indicators, which are meant for signalling the approach of a critical state of the object of management and the necessity to change the strategy of the development of the object, i.e. the activation of regulators. Indicators play a major part for the entrepreneurs and investors as far as understanding of the trends in business environment is concerned, and help to comprehend economic and social phenomena occurring in the society. The laboratory of the Baltic International Academy (BIA) is developing indicators of business confidence in micro-business and small business in Latvia. These indices cover such sectors as:

- a) industry;
- b) retail and wholesale trade;
- c) construction;
- d) services.

The indicators are based on the adapted methods of research in business climate developed by the European Commission and OECD. Unlike the EU indicators, these indicators cover only micro- and small companies in Latvia and help to reveal the current trends in Latvia's business and opinions for the economically active entrepreneurs.

MBA laboratory specializing in research of the issues of entrepreneurship and management sets an objective to monitor 2500–3000 companies in micro- and small business in Latvia. The monitoring involves more than 5.3% of the total number of economically active companies entered in the National Register. Selection of 5.3% of the total amount is sufficient to perform the monitoring and create the indicators of business confidence in micro- and small business regarding the following sectors:

- |   |   |   |
|---|---|---|
| ➤ Industrial sector                       | – | monitoring of over 350 companies, amounting to 5.3% of all companies involved in the industrial sector. |
| ➤ Construction (civil engineering) sector | – | over 200 companies (or 5.5% of all companies in this sector).   |
| ➤ Trade sector                            | – | over 1050 companies (or 5% of all companies in this sector).  |
| ➤ Tertiary (services) sector              | – | over 840 companies (or 5% of all companies in this sector).   |

BIA laboratory has been performing a regular quarterly monitoring of the above companies, starting from the fourth quarter of 2005. Approbation of the indicators of business confidence was successfully carried out at the international conference "Science and Innovation in Development of Zemgale" in Jelgava on the 17<sup>th</sup> February, 2006 and in April 2006. By the start of the fourth quarter of 2006, sufficient data was collected to create indicators of confidence according to the sectors.

Indicators of confidence are defined as an arithmetical mean of answers to the list of questions developed for each sector. The questions are organized into questionnaires and the respondents give answers in writing. Companies mainly receive the questionnaires from the Bachelor and Master students of BIA, by fax and e-mail. After that, random test checks are performed on telephone.

After determining the weighted values across the positive and negative answer, balance in percentage points is calculated using the following formula:

$$B = P - M, \quad (1)$$

where B is a balance, P is a positive answer, M is a negative answer.

This formula is used when there are only three options of answers (better – neutral – worse). If there are six options of answers, the balance is calculated according to average weighted values using the following formula:

$$B = (PP + 1/2P) - (1/2M + MM). \quad (2)$$

If all respondents select the negative answer, the value will be lower than 100. If all respondents select the positive answer, the level of the indicator will be higher than 100. Data on the indicators of confidence are also corrected by seasons, and linked to annually recurring events such as: Easter, Christmas, etc. These recurring events also tend to have an impact on the indicators of confidence.

BIA laboratory has already received initial data for the four quarters from each region of Latvia and regarding the country in general. The results of the survey of economic and business situation in four sectors of micro- and small business in Latvia have revealed the following main trends:

- on the whole, positivism and optimism prevail in the business situation of micro- and small business in Latvia;
- positive financial situation prevails;
- positive situation in crediting of micro- and small business in Latvia is evident.

## 2. Industrial Sector for the Third Quarter of 2006

Industrial sector accounts for about 10% of GDP in Latvia. The questionnaire for the companies engaged in the industrial sector consists of 16 questions. The responses to the question: "How has your production changed in the last three months?" were distributed as follows:

54% – has not changed;  
33% – has increased;  
13% – has decreased.

33% of the companies surveyed in this sector mentioned increase in production in the last three months of 2006. 54% reported on no increase and 13% reported on decrease in growth rate.

67% of the surveyed companies claimed that their current full orders were sufficient, 13% mentioned that the orders were more than sufficient and 20% reported insufficient orders.

At the same time, 67% of the companies said that their production would neither grow nor decrease in the coming three months. Only 13% of the companies reported that increase of production is expected in the coming three months, while the remaining 20% claimed that the production would decrease. The Figure 1 below shows main factors hindering production in the third quarter of 2006.

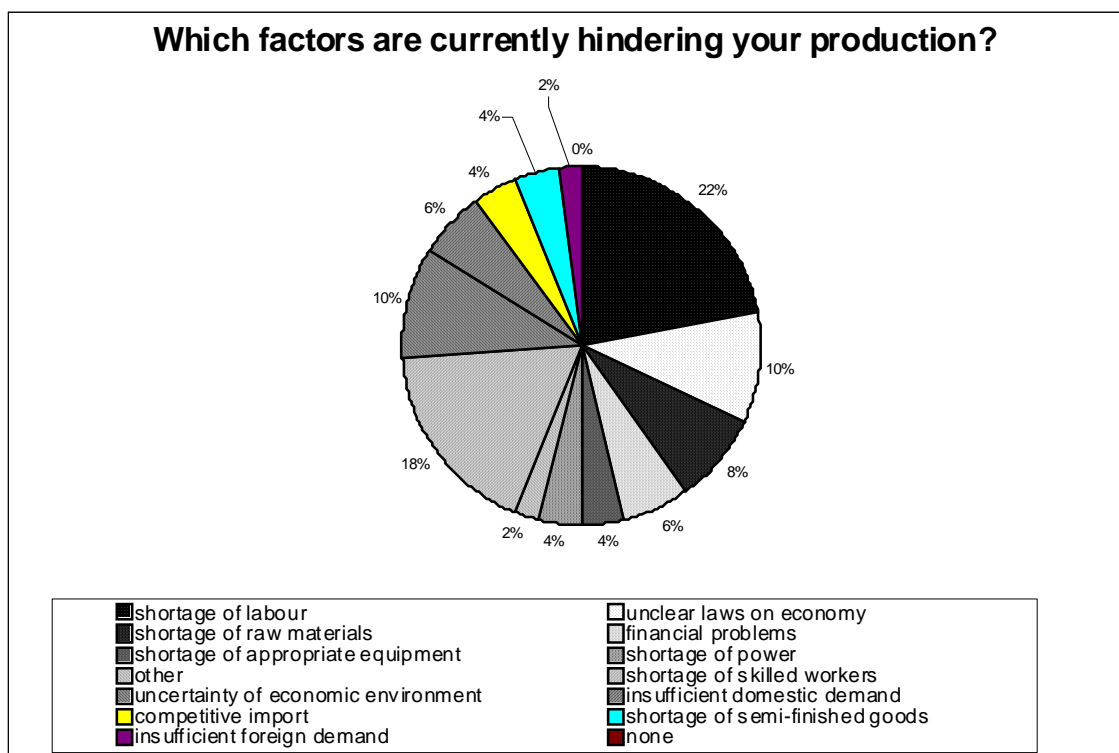


Figure 1. Main factors hindering production in the third quarter of 2006

Overall, the indicator of business confidence in Latvia's industrial sector for the last four quarters is shown on Figure 2.



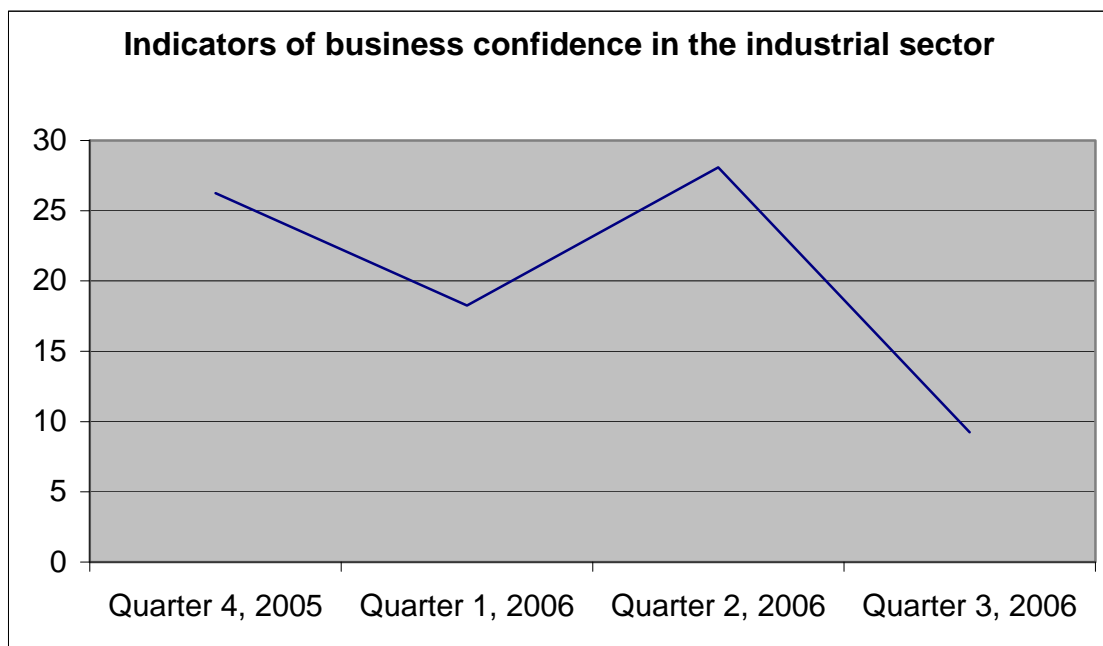


Figure 2. The indicator of business confidence in Latvia's industrial sector for the last four quarters

### 3. Construction Sector for the Third Quarter of 2006

Construction sector accounts for a little over than 5% of GDP in the country. The questionnaire for the companies engaged in construction sector consists of 11 questions. In reply to the question regarding the development of construction business in the last three months, 87% of the companies surveyed reported on growth. The Figure 3 shows that the main factor, hindering the companies' activities in the third quarter of 2006, was shortage of skilled workers and cost of labour.

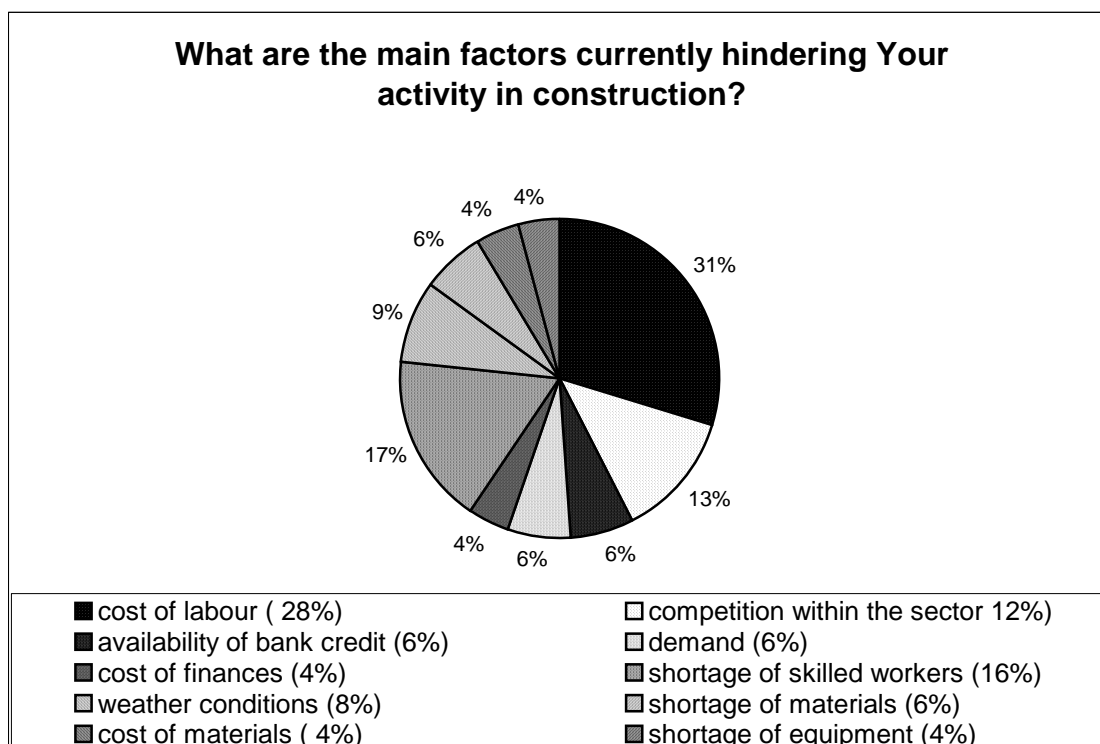


Figure 3. The main factor, hindering the companies' activities in the third quarter of 2006

Overall, the indicator of business confidence in construction sector for the 2005–2006 quarters is shown on Figure 4.

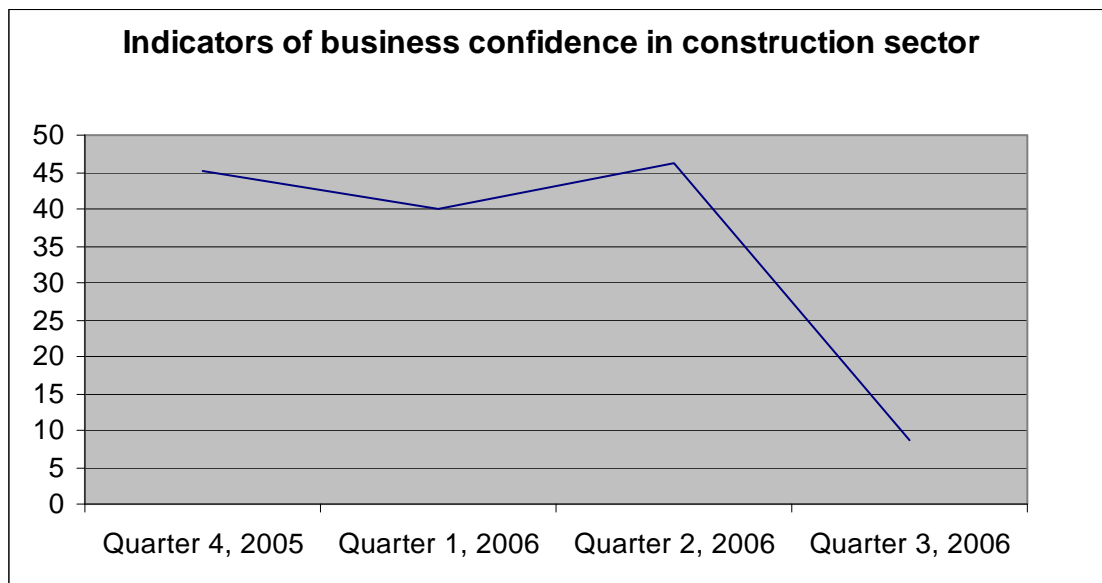


Figure 4. The indicator of business confidence in construction sector for the 2005–2006 quarters

#### 4. Tertiary (Service) Sector for the Third Quarter of 2006

Tertiary (service) sector accounts for about 64% of GDP in Latvia. The questionnaire for the companies engaged in tertiary sector consists of 10 questions. In reply to the question regarding the development of the tertiary (service) sector in the last three months, 54% of the companies' surveyed reported on growth in their business and only 13% reported on decline. 60% of the companies expect growth in their business in the coming three months. The Figure 5 shows that the cost of labour was the main factor, hindering the growth in business.

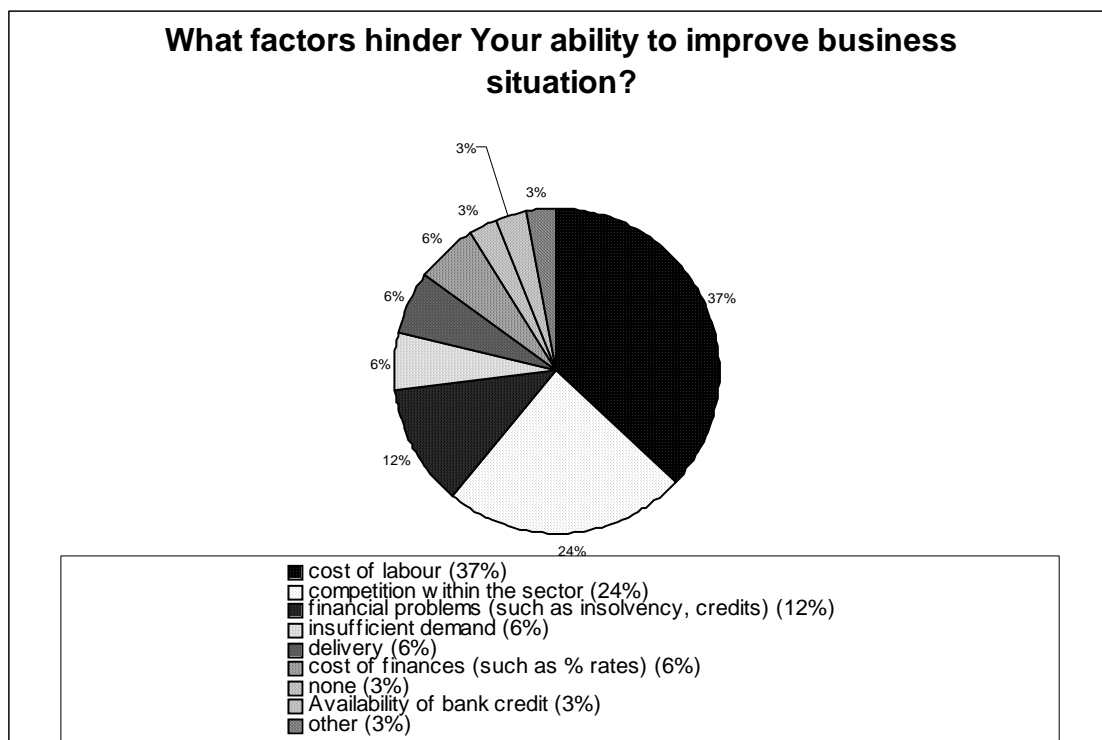


Figure 5. The cost of labour as the main factor, hindering the growth in business

Overall, the indicator of business confidence in the tertiary (services) sector for the 2005–2006 quarters is shown on Figure 6.

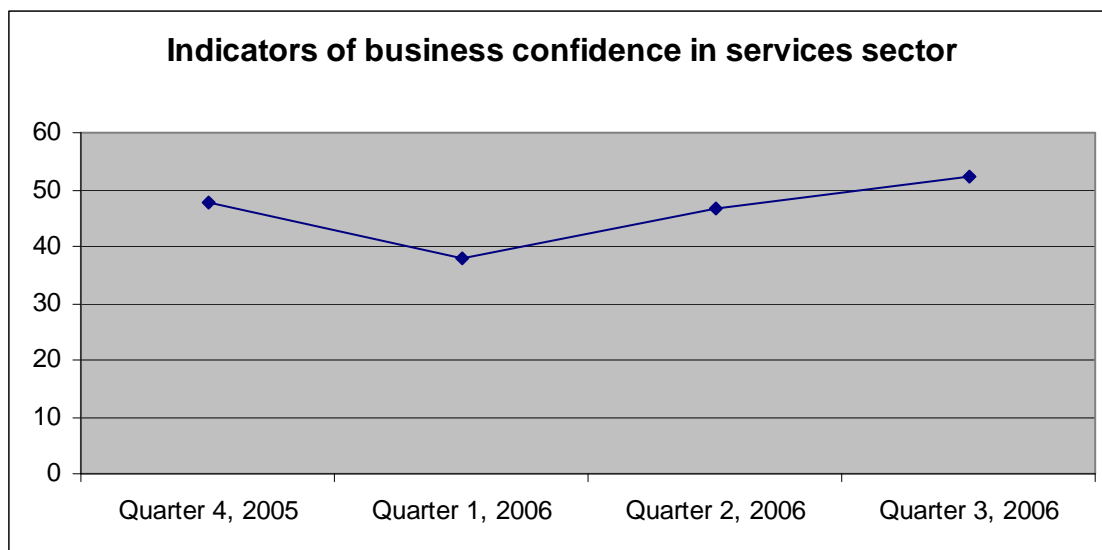


Figure 6. The indicator of business confidence in the tertiary (services) sector for the 2005–2006 quarters

## 5. Trade Sector for the Third Quarter of 2006

Trade sector accounts for a little over than 21% of GDP in Latvia. The questionnaire for the companies engaged in trade sector consists of 14 questions. In reply to the question regarding the development of business in the last three months, 93% of the surveyed companies reported on improvement in business activities. Replying to the question about the companies' expectations in the next three months, 60% reported on growth in their sales.

The Figure 7 shows that the cost of labour was the main factor hindering growth in business activities in trade sector in the third quarter of 2006.

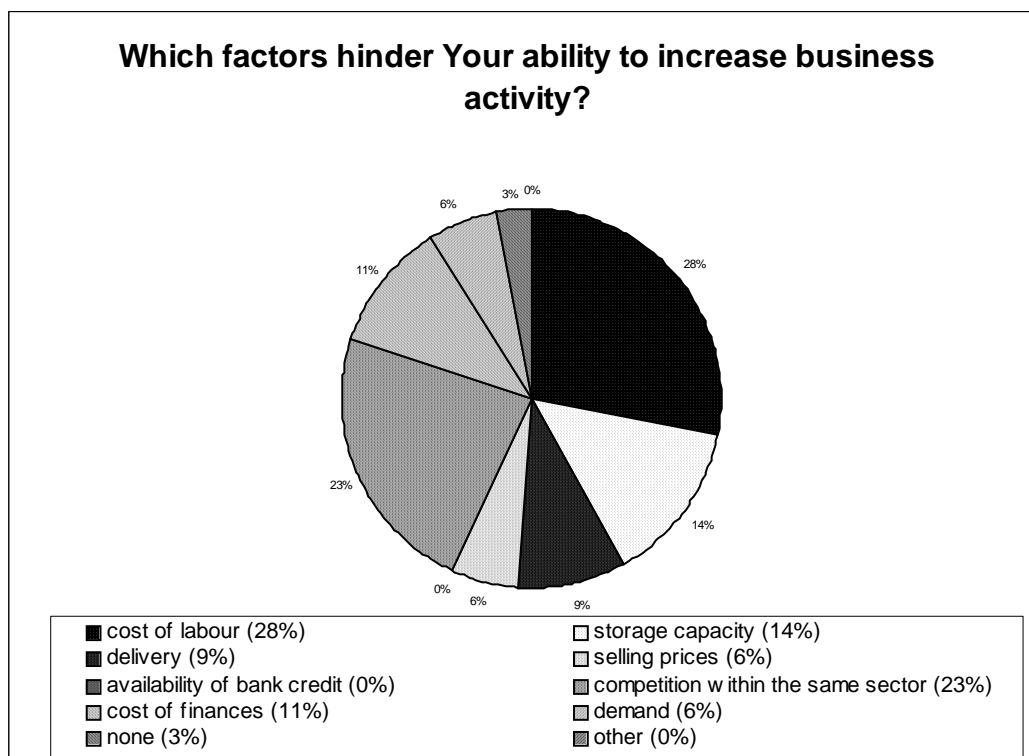


Figure 7. The cost of labour as the main factor, hindering growth in business activities in trade sector in the third quarter of 2006

## **Conclusions**

The BIA researches obtained first data for 2005–2006 quarters on each region of Latvia and on Latvia in general demonstrate the main tendencies of small business development. The survey results concerning economic and business situation across four sectors of micro- and small business in Latvia have revealed the following basic trends:

- a) in general positive and optimistic attitudes are prevailing in the business situation in micro, small and medium business in Latvia;
- b) positive financial situation is prevailing;
- c) positive situation with business credit in micro, small and medium business in Latvia could be observed.

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*Received on the 1<sup>st</sup> of May 2007*

# ANALYSIS AND COMPARISON OF LEARNING AND CONTROL TOOLS OF VIRTUAL LEARNING APPLICATIONS MOODLE 1.6.1 AND BLACKBOARD LEARNING SYSTEM CE 6.1 ENTERPRISE

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The article analyses two distance learning environments – **Moodle** 1.6.1 and **Blackboard** Learning System CE 6.1 Enterprise. **Moodle** is the leading open source program while Blackboard is a leading commercial product. The article will analyse the properties and tools of these programs.

**Keywords:** *student, instructor, technologies, virtual learning*

## Abbreviations

WebDAV is the abbreviation for Web-based Distributed Authoring and Versioning. It is an addition to the HTTP protocol that allows the users to simultaneously edit the files uploaded to the server, LDAP (light weight directory access protocol) is a protocol for creating and editing of large directory services, WYSIWYG is the abbreviation for What You See Is What You Get. It is a type of editor that enables to create text and images that will not change their appearance when printed or viewed through a different browser, VLA is a virtual learning application, MathML – Mathematical Markup Language, IP – Internet protocol address, URL – Uniform Resource Locator.

## 1. Introduction

The establishment of information society is determined by the fast development of informational and communication technologies that provide the new possibilities in the development of social, cultural, economic and educational areas of life. Using the opportunities provided by the informational and communication technologies to improve the process of general education in colleges and universities is crucial. The technologies can be used in professional development, extramural studies and especially the development of distance learning. Several different virtual learner environments can be used in distance learning.

## 2. Analysis of the Tools of Virtual Learning Applications *Moodle* and *Blackboard*

Virtual learning applications (abbr. VLA) for the first time appeared in institutions of higher education. Later they were also introduced in secondary schools. In colleges and Universities VLAs are used mostly when the instructor and the student cannot meet on a regular basis.

**Moodle** and **Blackboard** are two of the most popular VLAs in Lithuania. **Moodle** was created by Martin Dougiamas from Australia. The application is used by Vilnius Pedagogical University, Klaipeda University, Business College of West Lithuania, some secondary schools and other academic institutions of Lithuania. In December 2006 there were over 150 000 users of Moodle in 160 countries. The application is now available in 75 languages (**Moodle** VLA see on Fig. 2.1).

Blackboard Inc. Worldwide Headquarters is located in Washington, DC. The company also has offices in Asia, Australia, and Europe. The company claims to be the worldwide leading provider of enterprise software applications and related services to the education industry. It is a traditional VLA with a main focus on the educational materials and testing. This application is currently used by Kaunas University of Technology (Lithuania), Vilnius University (Lithuania), and other educational institutions (colleges and secondary schools). In 2006 the user community of **Blackboard** was spread in over 75 countries. (**Blackboard** VLA, see on Fig. 2.2).



Figure 2.1. Moodle course environment

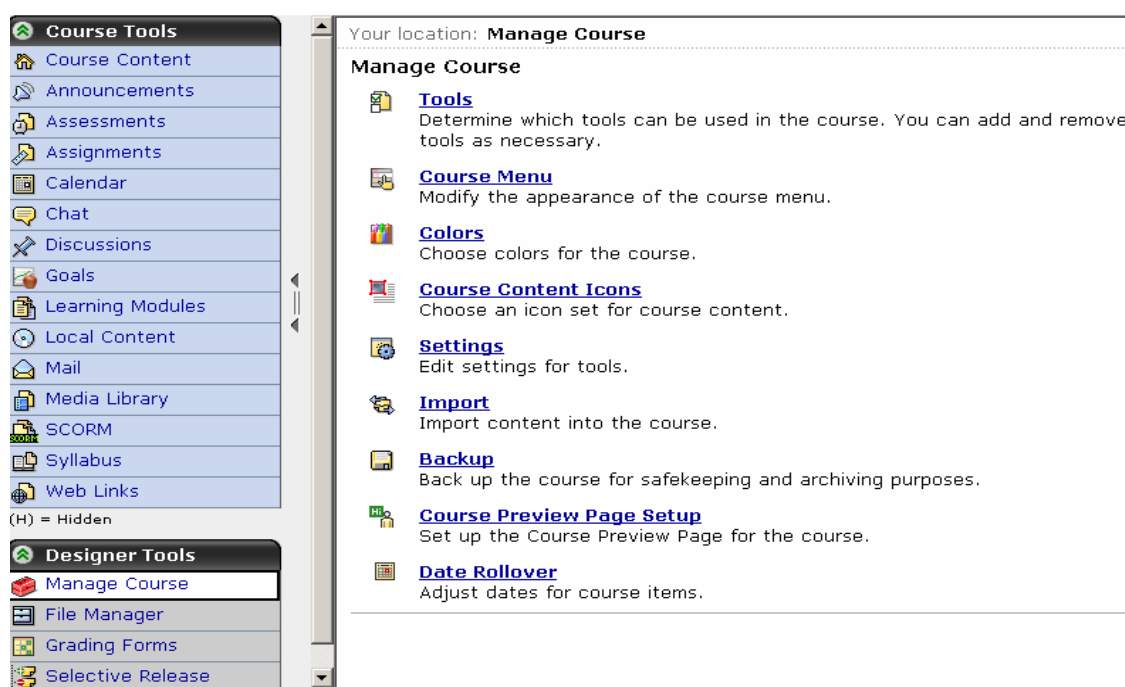


Figure 2.2. Blackboard course environment

### 2.1. Learning Tools

*Discussion forum.* Moodle discussion forum advances collaboration and critical thinking and promotes social constructionist pedagogy. Discussions can be sorted by date, subject, or author. The instructor can expand a topic into sub-topics. The instructor can set (limit) the level of participation (reading, posting or private messaging) for the students. The application allows uploading mail attachments, video and audio materials, PowerPoint slides and URL addresses. When posting to the forum the students can use the user-friendly text editor that is also equipped with a spellchecker. Students can sign up for discussions. Students can also subscribe to receive the posts by e-mail. Students can choose to review posts as daily digests of subject lines or as whole posts.

**Blackboard** allows sorting the discussions by date, type, topic, and author. The instructor can determine the level of students' involvement to reading, posting or private messaging. The instructor can create special environments for small-group discussions. File attachments, URL addresses, and HTML formatting can be included into the posts. A formatting text editor is available for more effective posting. The threads can be expanded or collapsed to enable viewing a topic in one screen. The selected discussion can be saved and printed for further reference.

*File Exchange (Upload).* In **Moodle** students can submit files using drop boxes. With **Blackboard** students can use the drop boxes or upload a file to a sharing folder.

*Internal E-mail (used within the VLA).* **Moodle.** Students can use the internal e-mail to communicate with other users. They can attach and archive catalogues and forward the messages to external e-mail accounts. The internal e-mail inbox is searchable. Several search criteria can be used. The outgoing messages can be spell-checked. **Blackboard.** Students can use the internal e-mail to communicate with other users. They can attach and archive catalogues and forward the messages to external e-mail accounts. The internal e-mail inbox is searchable. Several search criterions can be used. The outgoing messages can be spell-checked.

*Real-time Chat.* **Moodle** chat allows image upload. The system generates an archive for all chat rooms. The instructor can check the archive logs for all chat rooms. The chat time can be restricted by the instructor. Students can see what users are also participating in the chat. **Blackboard** chat is powered by Java. It allows personal messaging and creation of private chat rooms. The registration log is generated for all chat rooms. Simultaneous participation in several chat rooms is possible.

*Online Journal/ Notes.* **Moodle.** Students can add notes using the WYSIWYG editor or the regular textbox. Notes can be added to the personal journal or shared with the instructor.

**Blackboard.** Students can add notes to any page. Notes can be added to the course material to create a personalized printable study guide.

*Whiteboard.* **Moodle.** The whiteboard is not available. **Blackboard.** The software allows the instructor to create and control the whiteboard. The whiteboard supports image and PowerPoint uploading. The whiteboard sessions can be recorded and archived for future viewing.

*Video Services.* **Moodle** – none. **Blackboard** – none. Productivity Tools. Calendar/Progress Review. **Moodle.** Students can see the assignments and the progress report of completed tasks. The progress report includes grades on completed assignments, total points possible, and the course grade. **Blackboard.** The instructor as well as the students can post events in the online course calendar. Students can see their progress report and the course grades. Each student has a personal home page that lists all courses in which the student is enrolled. It also shows if there is new mail as well as all course and system-wide events from their personal calendar.

*Orientation/Help (tools that help students to learn how to use the course management system).* **Moodle.** The context sensitive help tool – that has not yet been translated into Lithuanian. **Blackboard.** The context sensitive help tool is available in Lithuanian.

*Searching Within the Course.* **Moodle.** The course content, discussions and e-mail are searchable. **Blackboard.** The course content, discussions and e-mail are searchable.

*Working Offline/Synchronization.* **Moodle.** Working offline is possible if **Moodle** applications are installed on the computer and the necessary course has been downloaded. **Blackboard.** The instructor can create a downloadable CD-ROM for offline viewing.

*Group work.* **Moodle.** The instructor can divide students into groups. Groups can be defined by course level, assignments, or level of involvement and individual participation. **Blackboard.** The instructor can either assign groups manually or allow the system to randomly create groups of a certain size. Each group can have a discussion forum, chat or whiteboard.

*Student Portfolio.* **Moodle.** Every student can have a homepage. The page may include the lists of all the student's posts, a student's photo and personal information. **Blackboard.** A student can have a homepage for every course he/she is registered for. The student can use the homepage to display the course work. Students can export their homepage information.

## 2.2. Control Tools

*Translation Tools.* **Moodle.** This tool allows translating certain modules of the learning environment into most languages or improving the existing module translations. **Blackboard** learner environment does not have such a tool therefore Kaunas Technological University (Lithuania) uses different technologies for translating their **Blackboard** Learning System CE 6.1 Enterprise version into Lithuanian.



*Authentication. Moodle.* The system uses the main username and password for user authentication. The system can verify the existing user against an external database. *Blackboard.* The administrator can secure individual courses by requesting username and password. Connection can also be limited by IP address. The system is equipped with a password reminder function. The login information can be secured with SSL. The system can authenticate against the external LDAP server. The administrator can create authentication against a secondary source (e.g. the system's own database) in the event that the primary source (e.g. LDAP server) fails.

*Course Authorization. Moodle.* The software provides the administrator with the tools to assign roles to different user groups: administrators, instructors, students and guests. The exclusive rights of a group can also be assigned to a subgroup. Students and instructors can have different roles in different courses. The system has access to information stored in external catalogues including the paid services. *Blackboard.* The administrator can set different levels of system and course material access based on the set roles such as instructor, student, designer, associate instructor, and system administrator. Students and instructors can have different roles in different courses.

*Hosted Services. Moodle* has the following systems: software installation management, multi level operations in a safe UNICS server, wide span of control, 10 GB bandwidth with a night-time backup, allowing unlimited usage of the course materials. *Blackboard.* The product is accompanied by a host system that includes service agreements with guaranteed system efficiency. The network is capable to service massive amounts of users without breakdowns. The product has a modern security system with non-stop monitoring, a direct T3 connection with a second redundant connection and daily external backups. Users can access the courses and the system from any computer that has Internet connectivity and a web browser. The system can also be accessed from Emбанet that provides daily sites, selected programs, and system block for a limited number of users.

*Registration Integration. Moodle.* The instructors can add students to the course or the students can register themselves. The software supports integration with external information systems through its own program interface. *Blackboard.* The administrator can add a list of students to a system using a delimited text file. The instructor can then add students to courses himself or herself or he/she can also allow the students to register themselves. The administrator can import and export student information to and from the system using IMS Enterprise Specification v1.1 XML files via web services.

*Automated Testing and Test Management. Moodle.* The instructors can do the following:

- create self-assessment tests with true/false, multiple choice, short answer questions, the questions can include images, video and links to every answer;
- create mathematical equations;
- create specific or general tests for a certain course or for general use in the system;
- include questions from other databases. The system can automatically select questions and create alternatives for multiple choice question answers;
- require students to enter a special password and set a time when the tests are to be accessed;
- set a time limit for completion of a test; limit access from certain IP addresses;
- differentiate between easy and the more difficult questions and create rules for grading;
- allow students to re-take tests and enable the display of results; discard the automatically calculated points; add necessary questions.

The system provides test materials for every part of the course. *Blackboard.*

The instructor can enable the system to automatically score multiple choice, true/false, and short answer type questions; select the most relevant questions from existing test banks; set a time limit for completion of a test; choose to use the MathML editor that would allow students to include mathematical formulas in their answers; limit access from certain IP addresses. The system also allows observing (proctoring) tests.

*Course Management. Moodle.* The instructor can set the materials and discussions to appear on certain dates. The system can synchronize course dates set on the course calendar. *Blackboard.* The instructor can provide guidelines on how to use specific resources that are available for group members set the overall course schedule as well as assign individual tasks to students. The instructors can upload specific assignment to check if the students know the course content. The assignments may include filling in the missing terms. The instructors can create additional course materials to make the course less complicated and be more applicable for self-studies.

*Online Grade book. Moodle.* The instructor can disable the automated scoring. The instructor can also give partial credit for certain answers. The student can review individual grade books or the combined group grade book. The grades can be exported to an external spreadsheet. The grades can be recorded as percentages using decimal points. Instructors can have a two-way communication in all course communication tools.

**Blackboard.** The instructor can add grades for assignments that were completed offline. The instructor can indicate key words based on which the program will determine if the answer in the fill-in field is correct. The instructor can add additional columns to the grade book to account for the assignments that were completed offline so that the grade in the online grade book is the actual course grade. The instructors can export the grade book to external spreadsheets. The instructors can review the grade book and edit all grade book entries. The instructor can be responsible for the evaluation of offline assignments. The instructor can create custom columns to add additional information to the grade book. When the instructor adds an assignment to the course, it automatically appears in the grade book.

**Student Tracking. Moodle.** Instructors can receive messages that show how often every student accessed the system. It shows on what particular dates and from what IP address the student connected. The instructor can make notes about every student. The instructor can also receive messages on individual student activity. The instructor can control the students that are registering for his/her course. **Blackboard.** The instructor can receive a report on how an individual student, a group of students or all students used the course materials, specific topics and discussion forums, when and how often they accessed it and for how long. The instructor can see how much time a particular student spent on a particular task. The instructor can share these observations with the students.

**Course Templates. Moodle** supports 10 course templates: activities arranged by week, activities sorted by topic, and a social discussion format. The instructor can create a new course on the basis of an existing course or use a course content template. The instructor can then use the templates for discussions, links, course content and resources. All the templates are created using WYSIWYG editor that is also equipped with a spellchecker. **Blackboard** offers to create new courses using the existing templates. The templates are created using WYSIWYG editor. The instructor can use templates to create the courses, course descriptions, topics, discussion forums, list the infrequent words, calendars, chat rooms and other resources. The system provides the course project with a step-by-step tutorial on how to create a course homepage, outline the schedule, discussions, set up e-mail, calendar and the chat room. The instructor can divide the course content into course topics, discussion forums, programs, types, resources and infrequent words. The course content can be uploaded by using a form or through WebDAV. It is possible to export the course content for students that enter the course later.

**Curriculum management. Moodle.** The instructor can identify difficult tasks across different course levels or course functions. **Blackboard.** The instructor can identify difficult tasks across different course levels or course functions.

**Instructional Standards Compliance.** Performing to standards to enable using course materials in different VLAs (these standards include features that make it easy to transfer the course between different applications). **Moodle** supports SCORM 1.2 and SCORM 1.3 standards. **Blackboard** supports IMS Content Packaging 1.1.3, IMS QTI 1.2.1, Microsoft LRN, and SCORM 1.2.

**Teaching Tools. Moodle.** The instructor can arrange the topics in either linear or non-linear sequence by using the library. The instructor can have series of lectures. The software provides constructive ways to solve the main problems and improve the learning experience. The instructors can include the context to accompany the educational projects and advance the interactive learning environment. The instructor can link the regular assignments with the tests and use it as a model for future lessons. **Blackboard.** The instructors can expand the courses. They can create additional study objects and course materials that would benefit the quality of the course. The instructor can upload the documents to the system through WebDAV. The instructors can create grade books for specific courses.

### 3. Additional Moodle Features

When analysing **Moodle** I have noticed that it has additional management and teaching modules that are not included in the main package. These modules need to be installed separately. The installation is rather simple: once you copy the file to the designated catalogue the program activates it automatically. There are over 100 modules and plug-ins that can be used to adjust the system to the individual needs.

#### 3.1. Main Extra Moodle Learning and Control Tools

**Certificate Creation Module** can be used to create professional looking certificates for students, who successfully complete the course. The certificates can be issued online within the learning environment.

**Gallery Module** allows the students to create an album by uploading photos to the homepage (Fig. 3.1).



Figure 3.1. Moodle Gallery Module

*Advanced Grade book* enables every student to have a custom grade book (see Fig. 3.2).

[Collab Home](#)
[Demo101 Home Page](#)
[Control Panel](#)
[Gradebook](#)

Welcome Admin
[Logout](#)

collab » Demo101 » Grades » Edit Grades

[View Grades](#)
[Edit Grades](#)
[Set Preferences](#)

[Save Grade Changes](#)

Editable grades are displayed in green. Click Save Grade Changes to view the results of any edits you have made to student grades.

Edit Grades - Uncategorized

Student Sort by Lastname Sort by Firstname	Test Assignment	Test Peer Review	test	Quiz 1	Second Quiz	Field Journal	Quiz 3	Midterm One	Quiz 5	Terms Quiz	Review for Final	Extra Credit Quiz	Total Stats	Student Sort by Lastname Sort by Firstname
	100	100	6	10	10	10	10	10	10	10	10	10	296	
Bonapart, Cory	89	0	-	10	10	-	10	10	10	10	10	10	169	Bonapart, Cory
Boton, Kathy	-	0	-	-	-	-	-	-	-	-	-	-	0	Boton, Kathy
Diderot,														Diderot,

Figure 3.2. Moodle Advanced Grade book

*Internal Mail Module* allows for electronic mail exchange within the system. This module has all features typical to any electronic mail system. One can send, receive, delete letters, and attach files. There is also an address book with the contact list of students enrolled in the same course.

*Java Molecule Editor* allows the instructor to create visualized chemical molecule systems for testing purposes (see Fig. 3.3).

*Jmol Filter Module* allows the instructor to create interactive 3D molecule structures (see Fig. 3.4).

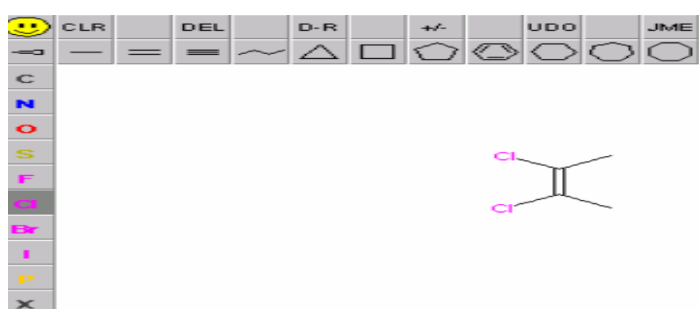


Figure 3.3. Java Molecule Editor

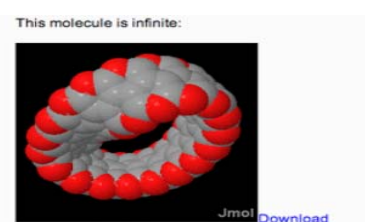


Figure 3.4. Jmol Filter Module

*Questionnaire Module* provides an essential tool for testing. It can be used creatively in a variety of situations. For example, to test students' knowledge about the course material before the course starts, to see how fast students are learning, or to check their motivation, computer proficiency, etc. The questionnaire format is flexible. The instructor can set the desired number of questions with a certain type of answers. The answer types could be one out of many, more than one out of many, other, or a blank field where the student could enter the correct answer. A drawing field can also be selected. The module collects and analyses the responses and scores them.

*Registration Module* enables the students to register for exams.

**Table 1.** *Moodle* and *Blackboard* Feature Comparison

Learning Tools	<i>Moodle</i> 1.6.1	<i>Blackboard</i> Learning System CE 6.1 Enterprise	Control Tools	<i>Moodle</i> 1.6.1	<i>Blackboard</i> Learning System CE 6.1 Enterprise
Discussion Forum	+	+	Authentication	+	+
File Exchange (Upload)	+	+	Course Authorization	+	+
Internal E-mail	+	+	Course Management	+	+
Online Journal/ Notes	+	+	User Registration	+	+
Real-time Chat	+	+	Automated Testing and Scoring	+	+
Whiteboard	–	+	Curriculum Management	+	+
Video Services	–	–			
Bookmarks – (allows the students to emphasize the important information that they can come back to late)	–	+	Teaching Tools	+	+
Calendar/ Progress Review	+	+	Grade book	+	+
Orientation/ Help	+	+	Student Tracking	+	+
Searching Within the Course	+	+	Course Templates	+	+
Working Offline/ Synchronization	+	+	User Tracking	+	+
Group work	+	+	Themes	+	+
Student Portfolio	+	+	Certificate Creation	+	+
Questionnaire Module	+	–			
Registration Module	+	–	Instructional Standards Compliance	+	–
			Translation Tool	+	–

## Conclusions

Two virtual learning applications *Moodle* and *Blackboard* are analysed. Both of them are similar in many ways. *Blackboard* is a commercial product while *Moodle* is distributed free of charge. These remote programs have a wide spectrum of services: Discussion Forums, File Exchange, Internal E-mail, Online Journal/Notes, Real-time Chat, Video Services, Bookmarks, Calendar/Progress Review, Orientation/Help, Searching within Course, Group work, Self-assessment, Student Portfolios and other functions mentioned in Table 1. Its architecture can be integrated into the structure of a portal. The authors believe that it is very important for the institutions that would choose VLA *Moodle* to have the methodology that would provide the instructors and students with the guidelines on how to use this particular environment.

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Received on the 1<sup>st</sup> of June 2007

## TYPES OF QUESTIONS FOR COMPUTER-AIDED TESTING OF STUDENTS' KNOWLEDGE

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The paper describes the types of questions for computer-aided testing of knowledge as implemented in the software tool *SSUquestionnaire* developed by the authors. Some of these types are commonly used; some other types are suggested by authors. The types described in the paper are as follows: Composition of terms and definitions, Classification of terms, Input of text and/or numbers, Positioning of a figure, Confirmation of correctness of a suggested statement, Selection of the correct answer, Substitution of missing words or expressions, Composition of a sequence of prescribed words, Keywords, Correction of numbers or text, Sequence of actions. The examples of test questions of each type are given.

**Keywords:** *computer-aided testing, types of questions, SSUquestionnaire*

### 1. Introduction

In the system of higher education, the problem of evaluation of quality of knowledge is always of primary importance and is the complex interaction process between a teacher and a student [1, 2]. The computer-aided testing of knowledge becomes very popular nowadays, firstly, because it saves the working time of a teacher, relieves him from routine work and allows for securing impartial evaluation of knowledge, the results of which do not depend on subjective opinion of different teachers. In computer-aided testing, each question should be formulated in such a way that answers would be written in any of the typical forms and, thus, application of special software for evaluation of knowledge would be possible [3].

The state standard for higher education of Ukraine devoted for evaluation of quality of knowledge [4] presents the following qualification for types of questions for testing knowledge:

1. Test questions of closed form, i.e., when several variants of the answer are suggested, one of which is correct and should be selected.
2. Test questions where reconstruction of correspondence is required, i.e., where correspondence of suggested definitions or characteristics to relevant terms should be indicated.
3. Test questions where reconstruction of correct sequence is required – such questions are useful for testing of knowledge of correct sequence of actions, definitions of terms, etc.
4. Test questions of open form, i.e., questions without suggested variants of answers – such questions are useful for evaluation of knowledge of terms, definitions, notions, etc.
5. Situation test – set of test assignments designed for solution of problematic situations typical for future professional activity of trainees.

The document [4] presents also more detailed classification for each of these types of questions.

Figure 1 presents the main types of questions suggested to use for computer-aided testing by the authors of this paper. Some of them are commonly used for testing of knowledge, e.g., selection of one or several correct answers among the list of suggested variants of answers [4]. Other types of questions are used rarely (e.g., sequence of keywords or prescribed words) or suggested by the authors for the first time (e.g., positioning of a figure).

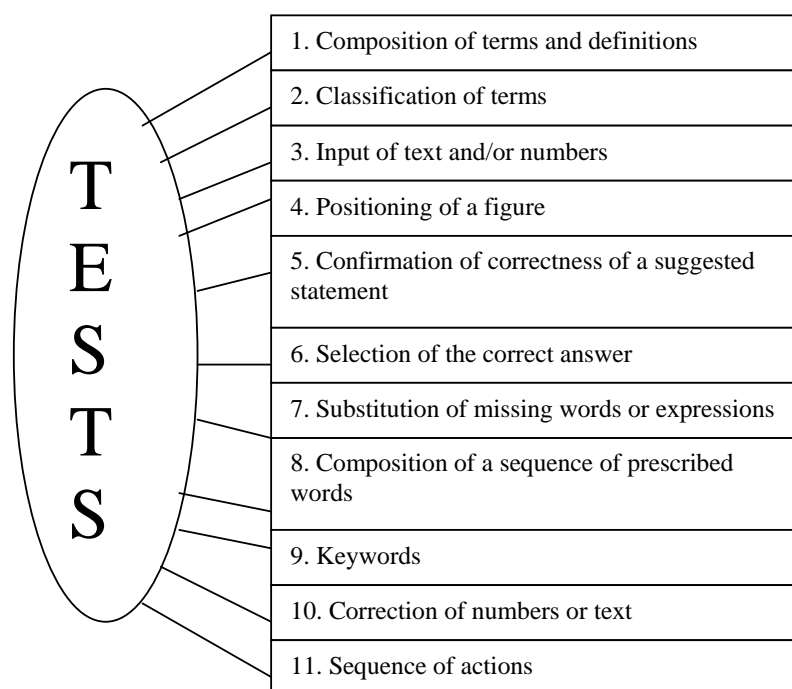


Figure 1. Main types of test questions

## 2. Description of Separate Types of Questions

### 2.1. Composition of Terms and Definitions

This type of question requires finding correspondence between terms and their description or notation. This type of question corresponds to the 2nd type of classification presented in the document [4].

*Form of presentation of a question*

Topic to which the question belongs	
Contents of the question	
Terms	Description of terms
List of terms	List of descriptions of terms that corresponds to the correct answer

*Sample question*

Main notions of the measuring technique	
Indicate what for each of these measuring tools are used	
Name	Destination
Slide gauge	Marking, external and internal measurements; scale interval is 0.1 – 0.05 mm
Shifting gauge	Marking, measurements of height; scale interval is 0.1 – 0.05 mm
Depth gauge	Marking, measurements of height, depth; scale interval is 0.1 – 0.05 mm
Micrometer	External measurements; scale interval is 0.001 mm

## 2.2. Classification of Terms

This type of question requires fulfilment of classification of terms, according to the suggested criteria of classification. This type of question corresponds to the 2<sup>nd</sup> type of classification presented in [4].

*Form of presentation of a question*

Topic to which the question belongs
Contents of the question
The first criterion of classification
List of descriptions of terms that corresponds to the first criterion of classification
The second criterion of classification
List of descriptions of terms that corresponds to the second criterion of classification
The third criterion of classification
List of descriptions of terms that corresponds to the third criterion of classification
...
List of descriptions of terms that corresponds to the N-th criterion of classification

*Sample question*

Main notions of the measuring technique	
Classify the listed parameters according to the following criteria of classification	
Geometrical parameters	Physical&mechanical parameters
Surface roughness	Strength
Surface corrugation	Thermal conductivity
Dimensional accuracy	Wear resistance
	Hardness

## 2.3. Input of Text and/or Numbers

This type of question requires input of a number (several numbers) and/or a word (several words) that unambiguously determine the answer. This type of question corresponds to the 4<sup>th</sup> type of classification presented in [4].

*Form of presentation of a question*

Topic to which the question belongs		
Contents of the question	Numerical or textual value of the answer	Range of controlled symbols

*Sample question*

Main notions of the measuring technique		
Indicate the numerical value for the scale interval of the micrometer	0.01	4 symbols

## 2.4. Positioning of a Figure

This type of question requires shifting of a figure to the correct position. This type of question corresponds to the 4<sup>th</sup> type of classification presented in [4], but just this sort of question may be considered new. The questions requiring positioning of a figure assist in mastering of the topic due to use of visual aids.

*Form of presentation of a question*

Topic to which the question belongs
Contents of the question
Source position
Possible ways of shifting
Position of the figure that corresponds to the correct answer
Description of the correct position



Sample question

Tolerances of smooth cylindrical joints		
Indicate the mutual position of tolerance ranges for orifice and shaft that corresponds to the interference fit		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shifting of both left and right images in vertical direction		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The right image is above the left image		

## 2.5. Confirmation of Correctness of a Suggested Statement

This type of question contains a statement that should be confirmed or rejected. This type of question corresponds to the 1<sup>st</sup> type of classification presented in [4].

Form of presentation of a question

Topic to which the question belongs	
Contents of the question	
The suggested statement	False or true

Sample question

Main notions of the measuring techniques	
Indicate whether this statement is correct	
Complete inter changeability is the inter changeability concerning values of optimal performance parameters	False

## 2.6. Selection of the Correct Answer

When answering a question of this type, one or several correct answers among suggested list of answers should be selected. This type of question corresponds to the 1st type of classification [4].

Form of presentation of a question

Topic to which the question belongs		
Contents of the question	The first possible answer	False or true
	The second possible answer	False or true
	...	
	N-th possible answer	False or true

Sample question

Main notions of the measuring technique		
What is the complex of measuring tools for reproduction of a meter via the of light wave length	An example of standard unit of physical magnitude	True
	An example of working measuring instrument	False
	An example of "in situ" method	False

## 2.7. Substitution of Missing Words or Expressions

When answering a question of this type, one or several missing words or expressions should be inserted. This type of question corresponds to the 4th type of classification [4].

*Form of presentation of a question*

Topic to which the question belongs
Contents of the question
The first fragment of the text
Missing words and their synonyms, with marked controlled parts of the words
The second fragment of the text
Missing words and their synonyms, with marked controlled parts of the words
...
N-th fragment of the text
Missing words and their synonyms, with marked controlled parts of the words

*Sample question*

Main notions of the measuring technique
In the presented definition of the working measuring instruments, add the missing words
The working measuring instruments are the measures, facilities and
DEVICES (CONSTRUCTIONS, PLANTS, APPLIANCES)
used for measurements,
not RELATED (CONNECTED)
to expression of the unit
of a physical magnitude

## 2.8. Composition of a Sequence of Prescribed Words

This type of question assumes construction of a phrase (sequence of prescribed words) that forms the correct answer. This type of question corresponds to the 3<sup>rd</sup> type of classification [4].

*Form of presentation of a question*

Topic to which the question belongs
Contents of the question
Sequence of words that forms the correct answer

*Sample question*

Main notions of the measuring technique
Compose the correct sequence of actions when measuring using a microscope
shift the rod, fix the holder, count the scale marks

## 2.9. Keywords

This type of question assumes construction of a phrase that includes the keywords by which the correctness of the answer is checked. This type of question corresponds to the 3<sup>rd</sup> type of classification [4].

*Form of presentation of a question*

Topic to which the question belongs		
Contents of the question		
Keywords and their synonyms, with marked controlled parts of the words	Allowed (required)	
	Word	Negation
Possible variant of the answer		

Sample question

Main notions of the measuring technique		
What is the metrology		
Keywords and their synonyms	Allowed (required)	
	Word	Negation
SCIENCE	Obligatory	Not allowed
MEASUREments	Obligatory	Not allowed
PHYSICal, (MATERIAL, REAL)	Obligatory	Not allowed
MAGNITUDEs (VALUEs, PARAMETERs)	Obligatory	Not allowed
SIZEs (DIMENSIONs)	Not allowed	Not allowed
METHODs (MEANs, WAYs)	Obligatory	Not allowed
Science about measurements of physical magnitudes, methods, means for their fulfilment		

## 2.10. Correction of Numbers or Text

When answering a question of this type, one should check and, when necessary, modify the number, word or phrase written as a variant of answer. This type of question corresponds to the 4<sup>th</sup> type of classification [4].

Form of presentation of a question

Topic to which the question belongs					
Contents of the question					
Fragment of the text (before)	Word (phrase)		Fragment of the text (after)	Control	
	Reference answer	Spelling in the question		Punctuation marks	Register
Possible variant of the answer					

Sample question

Main notions of the measuring technique					
Correct the errors (if available) in the spelling of names of measuring tools					
Fragment of the text (before)	Word (phrase)		Fragment of the text (after)	Control	
	Reference answer	Spelling in the question		Punctuation marks	Register
-	Slide gauge	Slide-gauge	-	No	No
-	Hole-gauge	Hole gauge	-	No	No
-	Micrometer	Millimetre	-	No	No
SLIDE GAUGE / HOLE-GAUGE / MICROMETER					

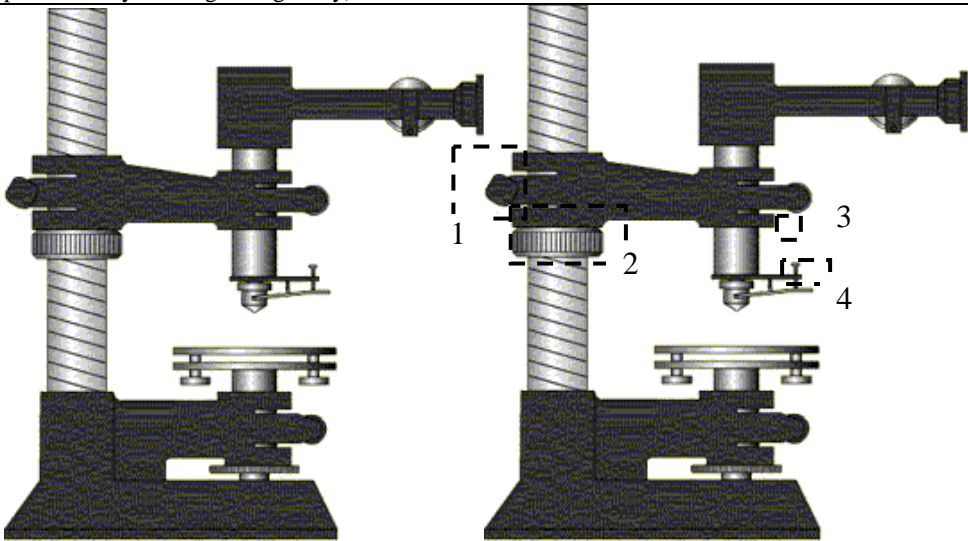
## 2.11. Sequence of actions

This type of question assumes control of correctness of actions performed by manipulations with the mouse (shifting of a pointer and clicking the left or right keys) and by pressing alphanumeric keys together with the keys Alt, Shift, Ctrl or without them. This type of question corresponds to the 3<sup>rd</sup> type of classification [4], but just this sort of question may be considered new. The questions requiring positioning of a figure assist in mastering of the topic due to use of visual aids.

*Form of presentation of a question*

<b>Topic to which the question belongs</b>
<b>Contents of the question</b>
The figure placed to the display screen in full-scale
The figure placed to the display screen in full-scale, with specification of rectangular bounds for the mouse pointer and, when necessary, their numeration in the sequence that corresponds to the correct answer
Sequence of clicking of the mouse keys and pressing of alphanumeric keys together with the keys Alt, Shift, Ctrl or without them

*Sample question*

<b>Main notions of the measuring technique</b>
Indicate the controls of the opt-meter in the sequence in which one should use them in order to set the stack of gauge blocks (place the mouse pointer inside the bounds of the image of the corresponding control and confirm your selection by clicking the left key; refusal of selection is performed by clicking the right key)

<p>1 – Left mouse key – selection, Right mouse key – refusal</p> <p>2 – Left mouse key – selection, Right mouse key – refusal</p> <p>3 – Left mouse key – selection, Right mouse key – refusal</p> <p>4 – Left mouse key – selection, Right mouse key – refusal</p>

**Conclusion**

The authors have developed the software tool *SSUquestionnaire* (copyright protected, [5]) that allows for preparation of test questions and conduction of testing using any of the suggested below types of questions. Description of this software tool and the algorithms for evaluation of knowledge implemented in it is presented in the previous papers of the authors [6, 7]. The demo-version of this software tool may be freely downloaded at the site <http://dl.sumdu.edu.ua/ssuquest.html>. A user can freely switch between the English, Russian and Ukrainian language of interface.

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*Received on the 1<sup>st</sup> of June 2007*

## MULTI-LEVEL TEST CONTROL OF QUALITY OF KNOWLEDGE BY QUANTITATIVE PARAMETERS

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In this paper, the author suggests to introduce the multi-level computer-aided testing control for evaluation of knowledge of students. This approach may be used in cases when a student gets the number of points that is intermediate between neighbouring grades. In these cases, the student will be asked additional questions, and his final grade will depend on whether he will answer these questions successfully.

**Keywords:** computer-aided testing, multi-level test control

### 1. Introduction

One of the most important ways for reforming of education in Ukraine is perfecting of testing and control and controlling of education quality. A traditional system of education has large experience in the field of control of learning results but is essentially of subjective nature. Due to its organizational and technological features, it can not satisfy the needs in objective information concerning the learning achievements of students. Though, the new technologies of study often also have some disadvantages. Analysis and elimination of these disadvantages will promote their wider implementation in the pedagogical practice.

Test control of knowledge, as a part of modern quickly developing fields of learning technologies, increases significantly the objectivity of grades. The fact of exclusion of a human, being the source of subjectivity, from the testing process, will certainly improve the objectivity of results in evaluation of knowledge of students being tested.

Disadvantage of removal of a teacher from the process of evaluation of knowledge is some rigidity of conclusions that are drawn as a result of testing. The matter is the test control that is not able to take into account the nuances familiar to experienced teachers that a student may know the answer but fail to give detailed explanation at the moment due to some reasons. Often students are able to demonstrate their knowledge only after additional discussion, additional leading questions, etc.

In order to alleviate this disadvantage of test control of knowledge, we suggest supplementing it with multi-level statistical control by quantitative parameters. Figure 1 presents a flowchart of two-level test control, as the most acceptable

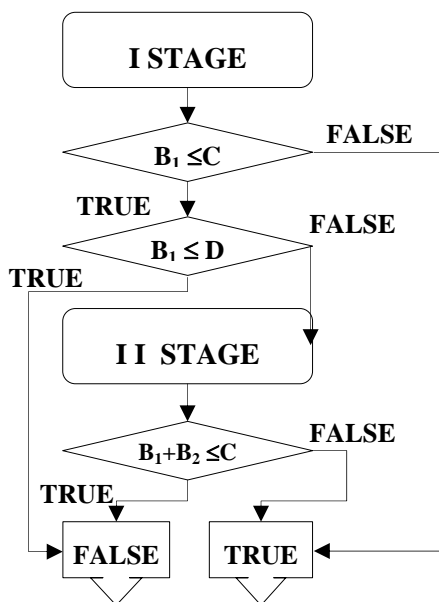


Figure 1. Flowchart of the procedure of two-level test control of knowledge

variant due to simplicity of its implementation. When it is necessary to improve the reliability of results of two-level testing procedure, the technique for its conduction may be extended to the multi-level variant.

## 2. General

The first stage of control is performed by traditional scheme of test control of knowledge or using the elements of fuzzy logic [1]. With this purpose, a test assignment is composed that includes a certain set of questions. Each question is accompanied with the number that specifies the complexity of the question. After conducting the test, a student is graded in dependence of how much his answer is correct and how high is the complexity of question. The total number of points obtained by the student for all the questions in the set is considered to be the measure of knowledge of this student.

In order to make a decision concerning the level of knowledge of a student, nowadays is a one-level procedure of testing control that is usually used. I.e., the number of points obtained by the student is compared with the prescribed threshold values, and if this number is larger than the required one then it is concluded that the student comprehends the material. Otherwise, the conclusion is drawn that the student does not get to the bottom of the material.

However, this conclusion is right only when the received number of points is much higher or lower than the required one. E.g., if the threshold value is 100 points, and a student obtains 10 points, then it is clear that his knowledge is unsatisfactory. Similarly, if the student gets 200 points, it is clear that his knowledge is acceptable. However, if the student gets 99 or 101 points, the subsequent conclusion about his level of knowledge is not so clear. According to the traditional procedure, in this case the student gets what he gets. At the same time, if a teacher in person would test the student, the teacher would pose him in this case some additional questions and grade him taking into account his answer for these questions.

Computer-aided test control of knowledge may be performed the same way. We suggest specifying the criterion values that encircle the range of indefinite situation. If a student gets the number of points that belongs to these ranges, additional control sessions should be conducted. The number of questions in each additional session for each level should be specified. Such algorithm of multi-level test control will eliminate subjectivity in evaluation of knowledge and preserve the advantages peculiar to traditional non-computer control of knowledge, by increase of reliability of results due to inclusion of additional questions that determine more exactly the actual level of knowledge of students.

In order to determine the criterion values, we suggest applying mathematics used in development of plans for evaluation of quality of industrial production and widely applied in practice of acceptance inspection [2, 3]. Here, it is necessary to solve the following problem of probability theory that specifies the level of quality using the values of sample estimates of total population.

As a result of determination of quality of knowledge graded in points  $X_1, X_2, \dots, X_N$ , from the normal population of grades with the average value  $X_{CP}$  and dispersion  $\sigma$ , it is necessary to determine the probability that a random value  $X$  of this total population will be higher or lower than some prescribed boundary values. Then the upper and lower bounds of the controlled parameter can be expressed by dependencies

$$q_U = \frac{1}{\sqrt{2\pi}\sigma} \int_U^{\infty} e^{-\frac{(x-x_{cp})^2}{2\sigma^2}} dx, \quad (1)$$

$$q_L = \frac{1}{\sqrt{2\pi}\sigma} \int_{-\infty}^L e^{-\frac{(x-x_{cp})^2}{2\sigma^2}} dx. \quad (2)$$

Having conducted prior experiments that are enough for reliable determination of grades  $X_{CP}$  and  $\sigma$  and having performed the necessary computations, it is possible to determine the theoretically precise criterion values, by comparing the acceptance value  $C$  with the upper criterion value  $q_U$ , and rejection value  $D$  with the lower criterion value  $q_L$ .

For practice of test control it is allowed, with 5% probability of erroneous decision, to specify the acceptance value  $C$  to be 95% of the maximal number of points a student can get for the test. In order to avoid necessity to conduct long-term research for each test assignment where the conditions differ in a number of questions and kind of learning material, we suggest using the rejection value  $D$  as the option of strictness of the teacher. In this case, for repeatability of results of testing, the accepted value of  $D$  should be unified.



### Conclusions

Thus, the procedure for two-level test control of quality of knowledge will look as follows.

- The acceptance value C and the rejection value D are calculated or specified.
- Test control is performed; the results are compared with the specified values of C and D.
- If the number of points received by student is higher than the acceptance value C, the conclusion is drawn that the student comprehends the material, and the control is stopped.
- If the student receives the number of points below the rejection value, the conclusion is drawn that the student does not know the material, and the control is also stopped.
- If the student receives the number of points below the acceptance value but above the rejection value, the conclusion is drawn that it is not possible to determine the actual knowledge of the student and, thus, an additional test session is conducted.
- The test control of the second level is conducted, the results of which are compared with the specified acceptance value C.
- If the student receives for the first and second test session in total more points than the acceptance value C specified by the maximal possible sum of points for both sessions, a conclusion is drawn that the student knows the material. Otherwise, it is concluded, that the student does not get to the bottom of the material. The test control is stopped and the student is graded. (In case of multi-level control, additional control sessions are conducted, according to similar procedures).

In order to increase the reliability of results of control and their comparability with the results obtained for several topics or disciplines, the suggested procedure may be supplemented with specification of the number of questions that should include the test assignment at each of the control level. This problem can be solved by the method of calculation of the number of questions in the test assignment using the criteria of cumulative significance and difficulty of the material being controlled [4].

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*Received on the 1<sup>st</sup> of June 2007*

## TEACHERS IN INFORMATION ENVIRONMENT: USE OF INFORMATION TECHNOLOGIES IN THE STUDYING PROCESS – POSSIBILITIES AND TEACHERS' OPINIONS (PILOT-RESEARCH)

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Introduction of information technologies to the educational and studying processes in schools; teachers of Riga schools and computer education; evaluation of the problems and the current situation from the point of view of teachers in Riga and Latvia; conclusions and offers for rising the effectiveness of introduction to information technologies (IT) in the studying process.

**Keywords:** *information technologies, educational process*

### 1. Project Realization on E-Education in Latvia: Summary on Directions, Aims and Purposes of the Project as the Main Process of Pilot-Research

The project on e-education has been realized in Latvia from 1997 – LIIS (Latvian Education Information System) project, you can find information about them visiting the following address: [www.liis.lv](http://www.liis.lv). Shortly about the project: it consists of several directions including material and technical provision, education of teachers and pupils. The article reviews some aspects of teachers' training, connected with them problems and possible solutions. One of the main aims of the project is the achievement of the appropriate demands in mastering the computer as one of the important means of search, processing and analysis of information. The set of skills, abilities and knowledge, methods and forms of checking knowledge and skill level is worked out in the materials of ECDL – European Computer Driving License; the further details are on site [www.ecdl.com](http://www.ecdl.com). The basic system of knowledge and skills and ECDL test Exam consist of 7 modules: BCIT – Basic Concept of Information Technologies, UCMF – Using Computer and Managing Files, WP – Word Processing, S – Spreadsheets, DB – Databases, P – Presentation, IC – Information & Communication. The process of e-education in general proceeds successfully thought there can be made one supposition: in the result of the uneven directions in the project, the realization of it is slowing down noticeably.

Statistical data on one of the project direction: Teacher's training program (direction of the investigated process), the analysis of the present situation.

Let us examine a teachers' training direction RIIS TTP (Teacher's Training Program). In 147 Riga Schools (109 – Secondary, 38 – Basic and Primary) 8282 teachers worked in 2004, their age is indicated in Figure 1.

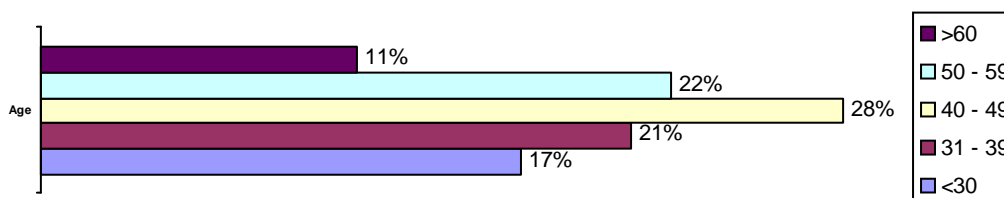


Figure 1. Riga School Teachers Age 2004

The statistical data were collected for the analysis of teachers' computer competency. They concern the organized and conducted courses by RIIS TTP for teachers in Riga from 1999 to 2004. The results are shown in Figure 2.

## Information teaching technologies

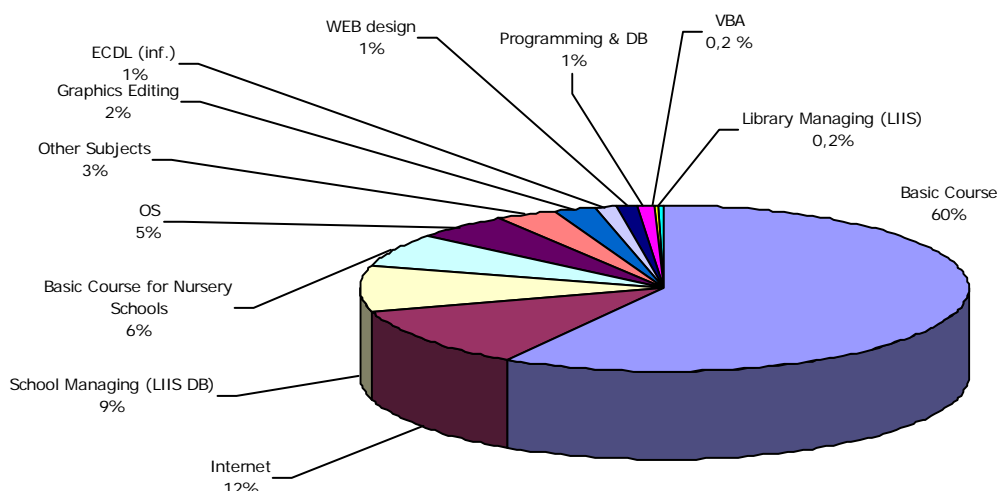


Figure 2. Themes of Computer Courses 1999–2007 in Riga

The total number of the teachers who finished the courses in Riga from 1999 is 8324. 667 groups were organized and 27968 academic hours (40 min) were conducted. 60% time for school teachers and 6% for nursery school teachers and 12% for both – it is 78% – the basic course that included the work with files, word processing, spreadsheets, presentations, Internet and e-mail. Taking into account the numbers, the level of the courses is quite high. Then in decreasing order are courses for information science teachers, librarians or those who work with a special computer program of LIIS “School Administration Program” – 9% for working with e-documentation within the school administrative system – LIIS Lotus Notes Database and 0,2% – subsystem of school library administration. Then there are courses for information science teachers, school head-masters or administrator of school nets (5%+2%+1%+1%+1%+0,3%=10,3%) – 10,3% thematically there are Operating Systems, Graphic Processors, web-design, training for ECDL Exam, programming and work with databases, programming on VBA. Then 3% of courses are for mathematics, music, physics, astronomy, foreign languages, history, geography, handicrafts and primary school teachers. By finishing courses the teachers take the exam that is more close to ECDL demands.

## 2. Review of the Object of Research: the Analysis of Two Groups of Teachers-Respondents, Who Were Selected to Evaluate the Situation

The amount of the work carried out is well known now. The gained level of knowledge, abilities and skills in the information environment are supported in case of their constant use in the real life. *The real usual life of the teachers – is a studying process, the real usual life of the pupil – are lessons. If there is no possibility to create conditions for regular use of knowledge in practice simultaneously with the studying, the whole process of e-education beginning with **primary** schools and finishing with the **high** schools and Universities would impede noticeably, that can be observed in the nearest future.* Very often the problem is not in the technical part and not in the children who are able and ready to accept the information environment and skills to work in it, but the *problem is in practical application of knowledge and skills the teachers could offer to the pupils in the sphere of information technologies and in the studying process.* There are various reasons, including those that do not depend on the teachers themselves. **Thus, the problem is deceleration of the information and communicative technologies introduction process into the basic and secondary education.**

The possible reason – is insufficient attention to the specific problems of schools and teachers from the part of the LIIS project makers. For the evaluation of the work quality on teachers' training, results at the moment and the future, as the base of the investigation was selected one of the largest Riga Secondary schools, where 114 teachers work and 1331 children study – Riga Zolitude Grammar School (RZGS). Owing to the fact that there is a special development program, the principal Svetlana Semenko and the head of information science Vladimir Trasko, there is a good material and technical base, including the class with 30 multimedia computers (Media Centre), where the lessons on other subject have been conducted for the second year – German, English, Russian, Latvian, History, Maths, Astronomy and History of Culture – see Table 1.

**Table 1.** Lessons in Computer Class in Riga Zolitude Grammar School

<i>RZGS</i>	<i>1st and 2nd Term of 2004–2005</i>	<i>1st Term of 2005–2006</i>
<i>English</i>	211	63
<i>Russian</i>	23	11
<i>Latvian</i>	14	2
<i>German</i>	42	23
<i>Culture&amp;Estetics</i>	74	30
<i>Social</i>	44	24
<i>Math</i>	36	25
<i>Nature</i>	8	0
	452	178

Pupils study programming within the limits of the school program and additional lessons. As a result, the school annually takes places in district, republic and international Olympiads and contests on applied programs and programming. The additional lessons have been conducted for forms 3–4 of primary school for the last 9 years. As the object of the investigation the teachers of different subjects were chosen, 27 people, from them 4% men. The Latvian Conference of Mathematics Teachers Association (LMTA) was held at school in January 2005. That is why the second group of respondents are Mathematicians of different schools in Latvia. The respondents from participants of the conference were 25 people, from them 8% men. It was interesting to compare two different groups. The age of the first group (RZGS) and the second (LMTA) is viewed in Figures 3 and 4, on the average – Figure 5. The distribution of the respondents according to their pedagogical experience for grammar school teachers, for the participants of the conference and on the average are shown in Charts 6, 7 and 8. On the whole the age of the ¾ of respondents are from 40 years old and older, from them 42% are older than 50 years old. According to the work experience the members of LMTA are more experienced than the teachers of the grammar school, but on the average 78% respondents have the work experience at school from 25 years and more.

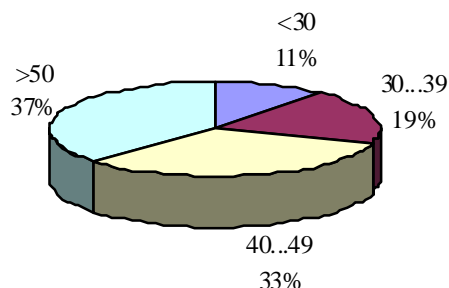


Figure 3. Grammar School Teachers Age

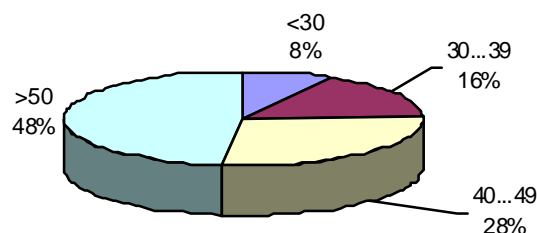


Figure 4. The Participants of the LMTA Conference Age

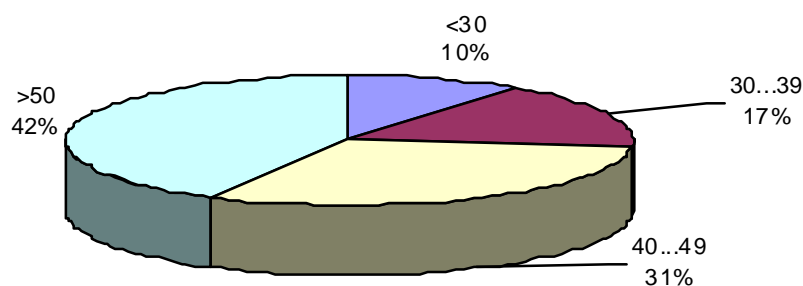


Figure 5. All Respondents Age

## Information teaching technologies

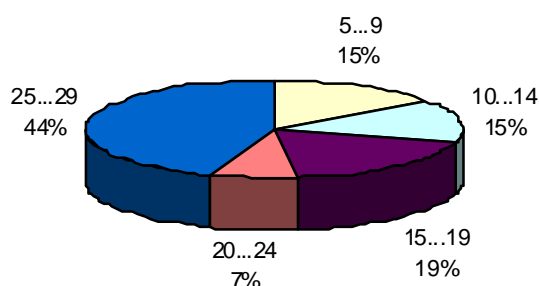


Figure 6. Pedagogical Experience of the Grammar School Teachers

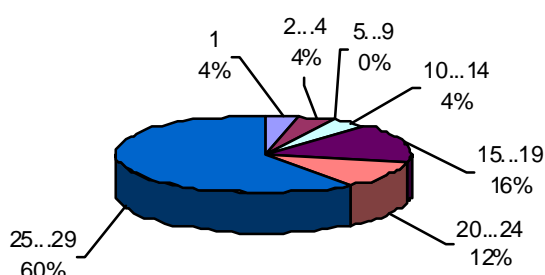


Figure 7. Pedagogical Experience of the Participants of the LMTA Conference

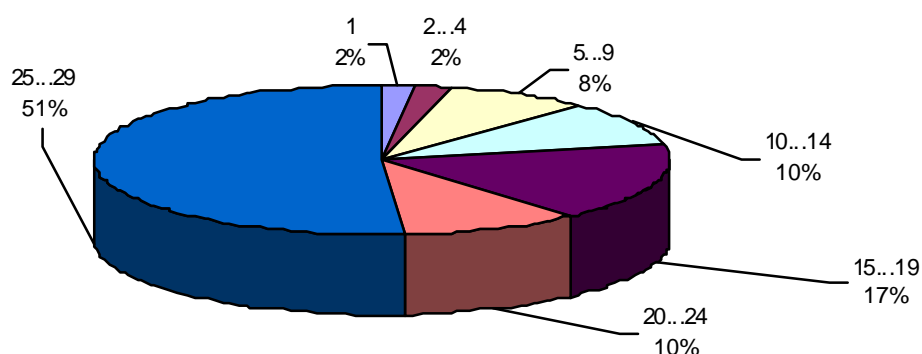


Figure 8. Pedagogical Experience of all Respondents

### 3. The Results of the Pilot-Research, Content-Analysis of the Respondents Answers

Let's begin the analysis with question 7: **“How often do you use the computer classroom for your classes?”** where the situation on IT usage is observed. The results are in the Figure 1. 11% schoolteachers and 8% of mathematicians regularly conduct lessons in the computer classroom. 19% teachers and 12% mathematicians in Latvia – conduct the lessons several times a term, and 26% of teachers and 44% mathematicians just tried this practice in their pedagogical experience – only once or twice a term. In the questionnaire of two different groups we didn't expect that results would be thus much equal – this is the index of the present level usage of IT at school. It is typical for the secondary schools to the beginning of 2006 (see Figure 9). The variant of the answer “wish it were more often” marked also the teachers who do not use the computer classroom for their classes (37% of teachers, 32% mathematicians) – it can be supposed as a wish to START the work. In the questionnaire the answer “do not use” was not deliberately provided.

## Information teaching technologies

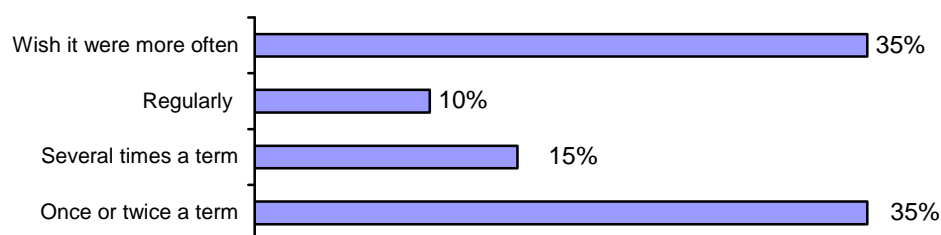


Figure 9

We have learnt about the experience of the respondents. Let us examine the results of the answer to Question 1: **“Do you consider the classes with IT usage to rise the effectiveness of the studying process?”** The participants of the conference more sceptically regarded the effectiveness with IT usage. 16% LMTA gave the negative answer but they more rarely apply IT on the whole, and 7% at all gave the negative answer that are not sure in the rise of the effectiveness. On the average 88% agree, 12% do not agree with the possibility to raise the effectiveness of the studying process (see Figure 10). It is necessary to carry out the additional long-time research (investigation) for the reliable answer, though; our aim is to exam the already existing teacher’s point of view.

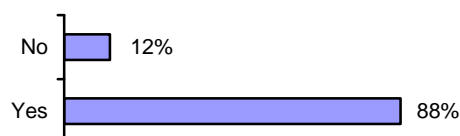


Figure 10

The result of the answers to Question 2: **“Would you like to teach within the usage of IT?”** The negative answers gave 12% participants of the conference; the grammar school teachers gave 100% positive answer, probably owing to the possibilities (computer classroom for 30 pupils) and conditions in the Riga Zolitude Grammar School (see Figure 11).

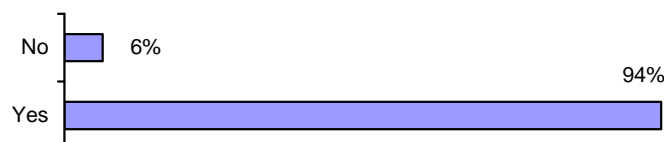


Figure 11

Question 3: **“Do you consider yourself to be ready for active work within the usage of IT in the studying process?”** The answers are in Figure 12. This is the proof of the work done for training the teachers. For sure, answered “Yes” accordingly 44%, 40%, on the average – 42%. It can be stated that for different groups the results are quite close to each other. Probably, it objectively reflects the situation.

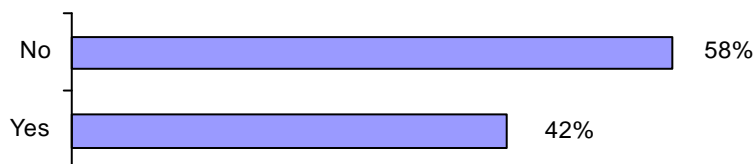


Figure 12

The Question 5 the teachers were to choose the courses to attend for raising the level of their skills. For comparison Figure 13 shows: the first place – 79% – take modern method of teaching within the usage of IT, the second place – 67% – take seminars on new studying IT programs with practical training, and the third place – 56% – takes training of usage of interactive methods for teaching.

## Information teaching technologies

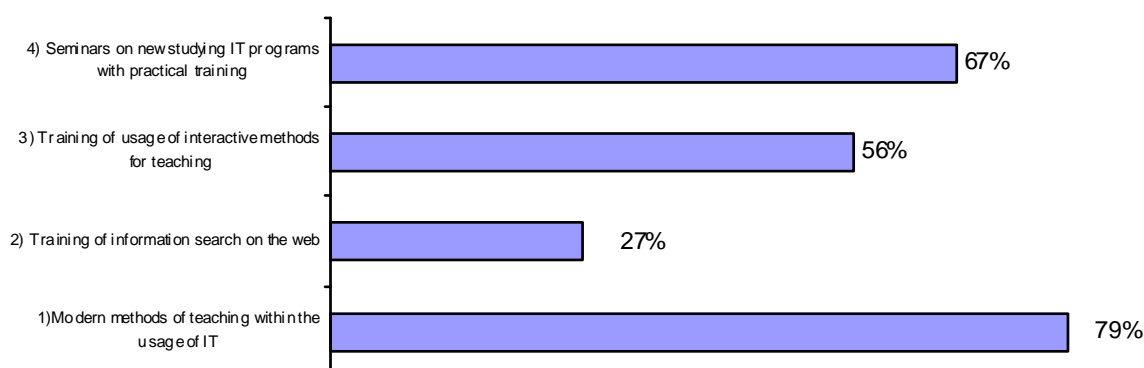


Figure 13

In the last closed Question 6 the teachers were asked to tick the most important skills for the studying process within the usage of IT. Table 2 demonstrates it.

**Table 2.** The most important skills for the studying process within the usage of IT

<i>What is the most important for the studying process applying IT?</i>	<i>RZGS</i>	<i>LMTA</i>	<i>ALL</i>
<i>Training computer programs on definite topics</i>	74%	68%	71%
<i>Studying materials and interactive models on CD</i>	59%	80%	69%
<i>Form tests or on-line tests for checking the students' level</i>	70%	64%	67%
<i>Methodical aids by other teachers from the WEB</i>	48%	64%	56%
<i>Interactive classes or interactive models on the WEB</i>	37%	76%	56%
<i>Lessons plans on the WEB</i>	30%	64%	46%
<i>Information about new books or methodical and studying aids on the WEB</i>	30%	64%	46%
<i>List of thematic resources and web-sites on your subject with short description</i>	56%	32%	44%
<i>Programmer services</i>	33%	24%	29%
<i>Encyclopaedias and dictionaries on CD</i>	30%	24%	27%
<i>Information of electronic methodical and studying aids on the WEB</i>	22%	28%	25%
<i>Information in the web about the latest achievements in your subject on the WEB</i>	26%	20%	23%
<i>Encyclopaedias and dictionaries ON-LINE</i>	26%	16%	21%

In the questionnaire open questions also were supposed. Let us examine the answers to the four open questions. Question 4: **“In your opinion what are the necessary skills to obtain or develop aimed to use IT effectively at your classes?”** In the answers two subgroups can be made: a) answers connected with knowledge and b) answers connected with abilities and skills.

In the subgroup KNOWLEDGE more often the ignorance is mentioned, how to prepare tasks or tests or lessons from the materials (14%), then comes lack of knowledge how to work with the studying programs (13%), then the lack of computer knowledge (12%), and at last the lack of knowledge in work methods (8%).

In the subgroup ABILITIES AND SKILLS more often the absence of skills to work on computer is mentioned (14%). It means that not every teacher uses the computer in the work every day (or even every week). It is also stated that some teachers cannot work with the studying programs (2%) and Internet (2%). In the analysis of the answers the situation became clear: in more answers (in 12 answers from 52–24%) the difficulties and proposals to arrange classes appeared. These offers (Question 10) and difficulties (Question 8) are summed up with the answers for the next Questions 8 and 10.

Question 8 **“What were the difficulties you came across during the planning and conducting classes within the usage of IT?”** The question was supposed for those who had the proper experience. In the answers there are 2 subgroups of difficulties: a) OBJECTIVE, that do not depend on the teachers efforts and b) SUBJECTIVE – that depend on the teachers. On the whole objective difficulties were mentioned in 48% answers, subjective difficulties – in 40% answers. It is evident that there are more objective than subjective difficulties. Then in the brackets after + there is the answer from the other question (number 4, 9 or 10) according to the theme.

## Information teaching technologies

In OBJECTIVE difficulties more often technical problems are mentioned (24% + 4%) – the classroom for 15 pupils, not for 30, old computer equipment, not enough computers, and the printer is necessary. Then – absence of the studying programs, tests and information about them (10% + 4%), difficulties to plan the computer class (10% + 2%), absence of the methods (10%), in teachers' opinion not all the pupils can use the computer (6%) and lack of information about others' experience (2%).

In the subgroup SUBJECTIVE difficulties again we can observe the answers about lack of knowledge and skills, thus, they can be summered (united) with answers to Question 4. Here among the subjective difficulties is the lack of time to prepare the lesson (16% + 4% + 2%), lack of computer knowledge (10%), ability to use the computer (4%), ignorance of Internet (4% + 2%), absence of the own experience (2% + 4%), lack of ability to work with teaching programs (2%) and passiveness (2%).

Among 52 answers there were 3 proposals, which are shown in the analysis of the proposals of Question 10.

Question 9: **“In your opinion how to overcome these difficulties?”** and Question 10 **“Your proposals to arrange the classes using IT more effectively?”** The analysis of two questions can be united, because the answer of both is coinciding or very close. The answers are divided into two subgroups: a) what I can do myself (INTERNALITY) and b) necessary help of others (EXTERNALITY) – at schools, in the districts, or somewhere else.

In the subgroup “What I can do myself” (INTERNALITY) – Question 9, 10 the teachers' wish is that they should work more often with the computer (20%), they have perspectives to overcome the psychological difficulties (10% + 4%) – not to be afraid of IT usage, be more persistent and enterprising, attend courses, rise the personal motivation, be more interested in IT usage and decide, if they need it or not.

In the subgroup “help of others” (EXTERNALITY) the proposals are the following: organization and conducting courses (40%), technical equipment of the computer classroom or the computer extra room or increase the amount of computers or modernize computers (18%), help of colleagues, information science teachers or specialists (10%), have ready studying computer programs for subjects (8%), catalogues with teaching materials, popularisation and informing the administration and the teachers about the existing programs (6%), form division into two groups or payment to two teachers for 1 lesson (6%), teach children the ability to work with the computer during the computer classes (4%), share the experience of other teachers on the subject (4%), find the additional time for preparing to the lesson in the computer class (2%), enlargement and advertisement of the studying programs base (2%).

## Conclusions

From the mentioned above the following conclusion can be made. The final aim – is the ECDL Exam for school-leavers of secondary and basic schools and for teachers.

*The first precondition:* for mastering the computer at ECDL level it is necessary to apply the information technologies in the usual studying process, it is not enough to have 1–2 information science lessons at week.

*The second precondition:* for mastering modern information technologies the teachers have to use IT in their everyday activity, in planning, organizing and conducting the studying process.

Therefore, at the moment the special governmental program is necessary that can provide the introduction and further constant assistance within the usage of information and communication technologies in the studying process in primary, basic and secondary Riga schools.

*Received on the 1<sup>st</sup> of June 2007*



## **Authors' index**

Alexeyev A. N.	<b>35, 43</b>
Azemsha S.	<b>7</b>
Baigozina S.	<b>46</b>
Galdikiene S.	<b>28</b>
Gopeyenko V.	<b>16</b>
Goštautaitė S.	<b>28</b>
Gurov V.	<b>21</b>
Kochevsky A. N.	<b>35</b>
Mezhis T.	<b>46</b>
Muhamediyeu R.	<b>16</b>
Ponomariov K.	<b>28</b>
Saveliev E.	<b>46</b>
Volkov N. I.	<b>35</b>



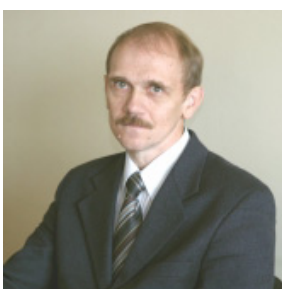
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## CUMULATIVE INDEX

### COMPUTER MODELLING and NEW TECHNOLOGIES, volume 11, No. 3, 2007 (Abstracts)

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**S. Azemsha.** Statistical Modelling of the Trucks Work on the International Routes at Various Strategy Return Loading Acceptance, *Computer Modelling and New Technologies*, vol. 11, No 3, 2007, pp. 7–15.

Characteristic feature of the international automobile cargoes transportations is the great value of vehicles run on a route. To evaluate efficiency of the given kind of transportations it is necessary to pay special attention to process of search and choice return loadings. The problem of cargoes in passing (the return passing) a direction is partially solved, that is connected with development of transport portals at Internet. However the problem of a choice rational transportation from set of alternative loadings variants remains urgent. The decision on acceptance of this or that cargo to transportation now is accepted by carriers managers on the basis of the intuitive conclusions based on personal practical experience. As a rule, such strategy of decision-making on a choice of rational return transportation are reduced to that the car transports that cargo which waiting time minimal.

In given article, are offered new, based on processing of the statistical information, strategy of decision-making on a choice of rational return transportation. The offered strategy of decision-making are based on the basis of the analysis more than 850 routes of trucks work on a direction Byelorussia–the Russian Federation. Statistical modelling cargo automobile work on each offered strategy and the subsequent economic estimation of the executed transportations allow to define optimum strategy of decision-making.

**Keywords:** strategy of decision-making, modelling work of automobile vehicles, rational transportation, the law of distribution

**V. Gopeyenko, R. Muhamediyev.** Imitation of natural strategic behavior of intellectual agent in logistical network, *Computer Modelling and New Technologies*, vol. 11, No 3, 2007, pp. 16–20.

The concept of an intellectual agent in logistical network (IALN) for transformed circuits modelling is proposed. The ways of the IALN description by Petri nets are considered. Management of such agent is carried out on the basis of behaviour principles of the artificial alive essences-animates in particular self-training. To reduce the amount of possible model's initial markings, the algorithm of "appropriate" set of initial markings calculations is offered. The way to "logically" change the network by agent is also proposed.

**Keywords:** logistical chain, logistical network, Petri nets, intellectual logistic net, animate, intellectual agents, natural strategy of training

**V. Gurov.** Indicators of Business Confidence in Small Business of Latvia, *Computer Modelling and New Technologies*, vol. 11, No 3, 2007, pp. 21–27.

The central notion of the indicators-based system of management and planning is an index – an integral indicator that characterizes by-quantity the qualitative features of socio-economic processes. The methods to examine business climate developed by the European Commission were adopted to serve the basis of the indicators. In years 2005–2006 the research laboratory of the Baltic International Academy (BIA) conducted a monitoring of business confidence indicators in micro- and small business in Latvia. The monitoring involved 5.3% economically active enterprises.

**Keywords:** indicators, business climate, territorial marketing, small business in Latvia

**K. Ponomariov, S. Galdikiene, S. Goštautaitė.** Analysis and Comparison of Learning and Control Tools of Virtual Learning Applications Moodle 1.6.1 and Blackboard Learning System Ce 6.1 Enterprise, *Computer Modelling and New Technologies*, vol. 11, No 3, 2007, pp. 28–34.

The article analyses two distance learning environments – **Moodle** 1.6.1 and **Blackboard** Learning System CE 6.1 Enterprise. **Moodle** is the leading open source program while Blackboard is a leading commercial product. The article will analyse the properties and tools of these programs.

**Keywords:** student, instructor, technologies, virtual learning

**N. I. Volkov, A. N. Alexeyev, A. N. Kochevsky.** Types of Questions for Computer-Aided Testing of Students' Knowledge, *Computer Modelling and New Technologies*, vol. 11, No 3, 2007, pp. 35–42.

The paper describes the types of questions for computer-aided testing of knowledge as implemented in the software tool *SSUquestionnaire* developed by the authors. Some of these types are commonly used; some other types are suggested by authors. The types described in the paper are as follows: Composition of terms and definitions, Classification of terms, Input of text and/or numbers, Positioning of a figure, Confirmation of correctness of a suggested statement, Selection of the correct answer, Substitution of missing words or expressions, Composition of a sequence of prescribed words, Keywords, Correction of numbers or text, Sequence of actions. The examples of test questions of each type are given.

**Keywords:** computer-aided testing, types of questions, *SSUquestionnaire*

**A. N. Alexeyev.** Multi-Level Test Control of Quality of Knowledge by Quantitative Parameters, *Computer Modelling and New Technologies*, vol. 11, No 3, 2007, pp. 43–45.

In this paper, the author suggests to introduce the multi-level computer-aided testing control for evaluation of knowledge of students. This approach may be used in cases when a student gets the number of points that is intermediate between neighbouring grades. In these cases, the student will be asked additional questions, and his final grade will depend on whether he will answer these questions successfully.

**Keywords:** computer-aided testing, multi-level test control

**S. Baigozina, T. Mezhis, E. Saveliev.** Teachers in Information Environment: Use of Information Technologies in the Studying Process – Possibilities and Teachers' Opinions (Pilot-Research), *Computer Modelling and New Technologies*, vol. 11, No 3, 2007, pp. 46–52.

Introduction of information technologies to the educational and studying processes in schools; teachers of Riga schools and computer education; evaluation of the problems and the current situation from the point of view of teachers in Riga and Latvia; conclusions and offers for rising the effectiveness of introduction to information technologies (IT) in the studying process.

**Keywords:** information technologies, educational process

**COMPUTER MODELLING and NEW TECHNOLOGIES, 11.sējums, Nr.3, 2007**

**(Anotācijas)**

**S. Azemša.** Kravas mašīnu darba statistiskā modelēšana starptautiskajos maršrutos pie dažādu atgriežamo kravu pieņemšanas, *Computer Modelling and New Technologies*, 11.sēj., Nr.3, 2007, 7.–15. lpp.

Starptautisko automobiļu kravu transportēšanas raksturīgākā iezīme ir transportlīdzekļa noskrējiena dotajā maršrutā. Lai izvērtētu dotā transportēšanas veida efektivitāti ir nepieciešams pievērst īpašu uzmanību meklējumu procesam un atgriežamo kravu izvēlei. Kravas problēma, veicot atgriežamās kravas sūtīšanu, ir atrisināta tikai daļēji, tas ir saistīts ar Interneta portālu attīstību. Lēmumu pieņemšanas stratēģija atgriežamo kravu racionālā transportēšanā ir tā, ka kravu transportēšana reducējas uz atgriežamo kravu, kuras transportēšanas laiks ir minimāls.

Dotajā rakstā tiek piedāvāta jauna lēmumu pieņemšanas stratēģija, kas pamatota uz statistisko informāciju. Piedāvātā lēmumu pieņemšanas stratēģija ir pārbaudīta vairāk nekā 850 kravas mašīnu maršrutos Baltkrievija–Krievijas Federācija.

**Atslēgvārdi:** lēmumu pieņemšanas stratēģija, automobiļu transporta līdzekļu darba modelēšana, racionāla transportēšana, sadales likums

**V. Gopejenko, R. Muhamedijevs.** Intelektuālā aģenta dabīgās stratēģiskās uzvedības imitācija loģistikā tīklā, *Computer Modelling and New Technologies*, 11.sēj., Nr.3, 2007, 16.–20. lpp.

Rakstā tiek izskatīts intelektuālā aģenta koncepts loģistikajā tīklā, kas paredzēts pārveidota riņķojuma modelēšanai. Intelektuālā aģenta loģistikajā tīklā apraksta veidi ar Petri tīkliem tiek izskatīti konkrētajā rakstā. Šādu aģentu vadība tiek veikta, pamatojoties uz mākslīgi dzīvu būtnu animāciju uzvedības principiem, konkrētajā pašmācībā. Lai samazinātu modeļa sākotnējo atzīmju daudzumu, rakstā tiek piedāvāts iespējamo sākotnējo atzīmju rindas aprēķinu algoritms. Veids, kā „loģiski” izmainīt tīklu ar aģenta palīdzību, arī tiek izskatīts.

**Atslēgvārdi:** loģistiska ķēde, loģistisks tīkls, Petri tīkli, intelektuāls aģents, apmācības dabīgā stratēģija

**V. Gurovs.** Biznesa palāvības rādītāji mazajā biznesā Latvijā, *Computer Modelling and New Technologies*, 11.sēj., Nr.3, 2007, 21.–27. lpp.

Vadības un plānošanas rādītāju-bāzētas sistēmas galvenais jeb centrālais viedoklis ir indekss – integrālais indikators, kas raksturo līdz-kvantitātes sociāli ekonomisko procesu kvalitatīvās īpašības. Biznesa vides izvērtēšanas metodes, kas ir izstrādātas Eiropas Komisijā, tika pieņemtas, lai kalpotu indikatoru pamatu labā. Baltijas starptautiskās akadēmijas pētījumu laboratorija 2005.–2006. gadā izstrādāja biznesa palāvības indikatoru monitoringu mikro- un mazajam biznesam Latvijā. Monitorings ietvēra 5.3% no ekonomiski aktīviem uzņēmumiem.

**Atslēgvārdi:** indikatori, biznesa klimats jeb vide, teritoriāls mārketing, mazais biznes Latvijā

**K. Ponomarjovs, S. Galdikiene, S. Goštautaite.** Analīze un kontroles instrumentu izpētes salīdzinājums virtuālās apmācības pielietojumam Moodle 1.6.1. un tāfeles mācīšanas sistēmas CE 6.1. pasākums, *Computer Modelling and New Technologies*, 11.sēj., Nr.3, 2007, 28.–34. lpp.

Rakstā autori analizē divus tālmācības paņēmienus – Moodle 1.6.1. un tāfeles mācīšanas sistēmas CE 6.1. pasākums. Moodle ir vadoša atvērtā avota programma, kamēr Tāfeles jeb Blackboard programma ir vadošais komerciālais produkts. Rakstā tiks analizēti šīs programmas īpašības un līdzekļi.

**Atslēgvārdi:** students, instruktors, tehnoloģijas, virtuālā apmācība

**N. Volkovs, A. Aleksejevs, A. Kočevskis.** Jautājumu tipi studentu zināšanu testēšanai ar datora palīdzību, *Computer Modelling and New Technologies*, 11.sēj., Nr.3, 2007, 35.–42. lpp.

Rakstā tiek izskatīti jautājumu tipi zināšanu pārbaudei ar datora palīdzību pēc autoru izstrādātā programmnodrošinājuma SSUquestionnaire. Daži no šiem minētajiem jautājumu tipiem tiek vispārīgi lietoti, bet daži no tiem ir autoru izstrādātie. Rakstā iztirzātie tipi ir šādi: Terminu un definīciju kompozīcija. Terminu klasifikācija. Teksta un/vai ciparu ievietošana. Attēla pozicionēšana. Piedāvātās varianta pareizības apstiprinājums. Iztrūkstošo vārdu vai izteicienu aizstāšana, u.c.

**Atslēgvārdi:** testēšana ar datora palīdzību, jautājumu tipi, SSUquestionnaire

**A. Aleksejevs.** Zināšanu kvalitātes daudzpakāpju testa kontrole ar kvantitatīviem parametriem, *Computer Modelling and New Technologies*, 11.sēj., Nr.3, 2007, 43.–45. lpp.

Autors rakstā piedāvā ieviest daudzpakāpju datortestēšanas kontroli, lai izvērtētu studentu zināšanas. Šī pieeja var būt lietota gadījumos, kad students saņem punktu skaitu, kas ir starp blakusesošajām atzīmēm. Šajos gadījumos, studentam tiks uzdoti papildu jautājumi, bet viņa atbilžu pēdējā atzīme būs atkarīga no tā, vai viņš sekmīgi atbildēs uz šiem jautājumiem.

**Atslēgvārdi:** testēšana ar datora palīdzību jeb datortestēšana, daudzpakāpju testa kontrole

**S. Baigozina, T. Mežis, E. Saveljevs.** Skolotāji informācijas vidē: informācijas tehnoloģiju lietošana studiju procesā – iespējas un skolotāju viedokļi (pilotpētījums), *Computer Modelling and New Technologies*, 11.sēj., Nr.3, 2007, 46.–52. lpp.

Autori rakstā risina šādus jautājumus: informācijas tehnoloģiju ieviešana mācību procesā skolā; Rīgas skolu skolotāji un datorizglītība; problēmu izvērtēšana un pašreizējā situācija Rīgas skolās pēc skolotāju viedokļiem; secinājumi un priekšlikumi efektivitātes uzlabošanā informācijas tehnoloģiju ieviešanā mācību procesā.

**Atslēgvārdi:** informācijas tehnoloģijas, izglītošanas process

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- semiconductor electronics and semiconductor technologies
- aviation and aerospace technologies
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## **Computer Modelling & New Technologies \* Preparation of publication**

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**COMPUTER MODELLING AND NEW TECHNOLOGIES**, 2007, Vol. 11, No.3

Scientific and research journal of Transport and Telecommunication Institute (Riga, Latvia)  
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Text	Text	Text

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### 19. **Authors Index**

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### 20. **Acknowledgements**

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