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CONTENTS

CRITERIA FOR EVALUATION OF DISSERTATION PAPERS

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Abstract: The author discusses methodological issues related to the most important used criteria for evaluation of dissertation paper. We proposed a classification of contributions and properties of scientific innovation as a result of comprehensive scientific research and dissertation papers.
The article makes possible to analyse effectively the received scientific facts and results and determines their contribution to solve current economic, technical and social problems.
Keywords: Dissertation Papers, Criteria for Evaluation, Scientific Contributions.

1. INTRODUCTION

Criteria for evaluation of dissertation papers should be met the following minimum features: the criteria should be objective (as far as possible) to allow an assessment of research parameter uniquely, to prevent controversial assessments of different experts; the criteria should be adequate, valid, i.e. to assess exactly that position the expert wants to assess; the criteria should be neutral with respect to the studied phenomena and the evaluation of the results obtained as a result of dissertation research.
The set of criteria should cover fully and adequately all of the evaluated results of the dissertation work and its author.

2. RESULTS AND DISCUSSION

2.1. General criteria

1. Compliance of dissertation research with the priority areas of the national economy: Compliance of the topic of the dissertation, as well as the goal and the objectives of the research with the priority areas and tasks of the economy; compliance with the methodology of the study of strategic areas of the national economy; facilitation the proposed science and developed practical recommendations to solving of the current problems of socio-economic development of the country; compliance with the priority areas and tasks of deepening economic reform, justifying of the important events to further development and increasing production efficiency in medium-term and long-term periods;
2. Relevance of dissertation research in one of the following requirements: solving the ъкииехш scientific issues of vital national-economic importance; * development of theoretical principles, the combination of which can be classified as a new big achievement in the development of the direction in the respective sector of economics; * new solution of current scientific tasks that have essential importance for the respective sector of economics;

3. Compliance of the structure of the study (chapters and paragraphs) and the content of the topic of the dissertation as well as the passport of the specialty. In Figure 1 are given the most commonly used criteria for evaluating the dissertation papers of young scientists.
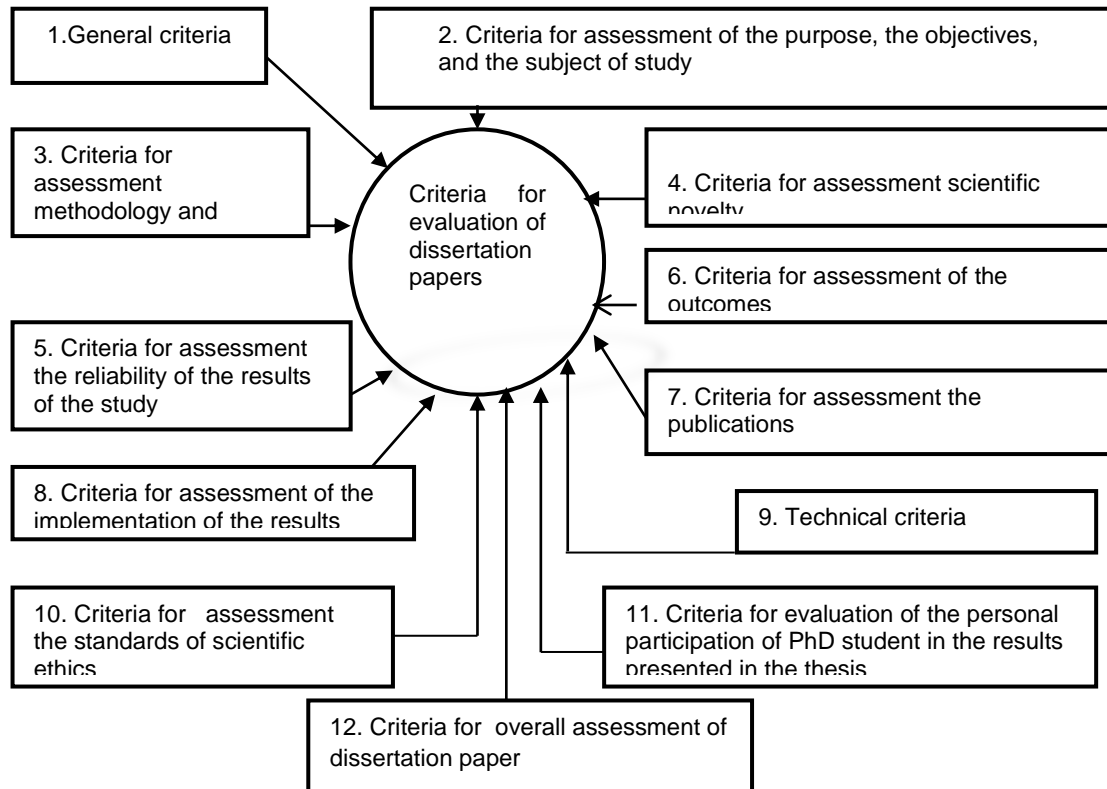
Figure 1. Criteria for evaluation of dissertation papers

2.2. Criteria for evaluation of the goal, the tasks, the object and the subject of study

1. Substantiation, theoretical and practical importance of the purpose of the study.
2. Compliance of the goal with the tasks of the study. Reasonableness and correctness. Completeness and degree of coverage of the tasks necessary to achieve the purpose of the study.
3. Degree of complexity of the problems, the ranking of the tasks of research, defining the conditions and restrictions according which they are solved.
4. Compliance and justification of the selected object and subject of research goal and objectives of the study. Clear limitation of the subject of the study in accordance to the purpose of the dissertation paper as well as the passport of the specialty.
5. Degree of scrutiny of the problems. Analysis, summary and systematization of scientific and other information that is directly relevant to the issues in the dissertation. Critical analysis and systematization of the latest scientific knowledge, practical development and other materials on the researched issues; the validity of the author's recommendations on their use in the process of dissertation research.

2.3. Criteria for assessment methodology and methods /general and particular/ of research

1. Methodological level of the dissertation. Justification of the principles of construction of the study. Compliance of the methodology of the study with the strategic directions of the development and reform of the national economy.
2. Presence of developed new methods for economic analysis of the development of the methodology of research in economics.*
3. Scientific and reasonable use of methodological approaches and methods of research in the paper. Evaluation of the correctness of their application, according to the complexity of the problem and the adequacy of the methods used for their solution, as well as the degree of complementarity of the methods of research. Application of scientifically based methods of sociological research.
4. Reliability and authenticity of the information basis. Usage of official statistics data base, reports, analysis and other materials. Usage of science-based results of official and original sociological research. Usage of probated results of monographic researches.
5. Authenticity, reliability and validity of the findings and results of dissertation research, and any inference in the conclusion. Evaluation of the results of the analysis and their logical inconsistency, assessment of the representation of the used statistical samples, the results of the test methods etc.

2.4. Criteria for assessing scientific novelty

1. Scientific novelty of the dissertation: presence of theoretical generalizations, concepts and development of the theory of scientific field *; new knowledge about the object of study that are set out in the form of completed research of a specific hypothesis, economic regularities, patterns of adjustment models of adjustment or reform of the national economy, alternative forecasts for the development of the study issue, results of the calculation experiment that contains as meaningful and formalized description; new methods to solve actual scientific problems and tasks; new or improved criteria and indicators; new formulations of known problems or tasks (adopted assumptions, adopted new conditions).
Scientific innovation should be evaluated in comparison with the methodology and methodological approaches and practical recommendations of other authors in solving the problem raised. Assessments the contribution of PhD students in the process of the particular section of the economy in the scientific and practical aspects.
2. Compliance of the main results obtained personally by the PhD students current tasks for the development of economic science and practice of national economy. The new research results can represent regularity, pattern, dependence, method of study, new technology, method of reasoning, and etc. These can be all new, partially new or those that contain a new set of known scientific results.
3. In justifying the new results in research it is necessarily to implement following requirements: completeness, consistency, compliance of the experimental data; verifiability; consistency in describing certain phenomena, ability to predict new phenomena.
4. Reliability of the results of the dissertation research should be justified by: rigorously proven and correctly used findings from basic and applied sciences; verification of the theoretical aspects and new solutions, ideas of experimental studies; metrological provide experimental studies; complex using of known practices with theoretical and practical research methods; developing by the author of theoretical issues in a specific task and comparing the new theoretical positions with the practice and experimental data of other authors; removing inconsistencies between theoretical principles, developed by PhD students and the known laws of evolution in science, technology, knowledge; checking out

the results using known procedures of design, methods of search solutions, as well as the methods of the physical and mathematical modeling; comparison of experiment results of the PhD student with known experimental data of other researchers in the same problem; publication of the main results of the thesis in peer-reviewed scientific journals; discussion of the research results at conferences and symposia and received reviews from leading researchers in the scientific specialty; usage the results in practice to evaluate the actual results of the implementation.

2.5. Criteria for evaluation of the results

1. Evaluation of the achievement of the goal and solving the tasks. Fullness and validity of the findings, scientific and practical suggestions and conclusions, as well as compliance with the objective of the study.
2. Approbation of the research results in the dissertation in national and international, scientific and practical conferences and symposia.

2.6. Criteria for evaluation of publications

1. Scientific level, completeness and number of published works: in the articles should be disclosed theoretical and methodological nature of dissertation.It should be analyzed, compared with last conceptions of development of the problem and discussed author's views with recommendations for proper application of the concept of national economy; the articles should contain objective and deep analysis of the current situation and also through the prospective requirements of the study area should be offered scientific, theoretical, methodological and practical solutions of the tasks; in the articles should be exposed conceptions and viewpoints, as well as practical recommendations that could have perspective in the future; in the articles should be published important points in each chapter of the dissertation, as well as results of sociological research, if they are conducted with the author's comments;
2. ** Required presence of two reviews in national publishers to publish a monograph.

2.7. Evaluation criteria for implementation of the results

1. Implementation of the research results in practice. Scientific results are considered to be implemented if they are utilized in the practice of national production which is confirmed by the acts or other documents of the body where they implemented the results of dissertation research.
2. Presence of recommendations and suggestions to help a new solution of current scientific problems and to make significant contribution to the development of the national economy *
3. *** Availability of actual or estimated economic impact of the implementation of scientific resultsi. In assessment they use indicators to quantify the economic evaluation of the implementation of scientific results, for example: increasing of labor productivity; reducing the costs of maintenance and cost of production; the date for redemption and the cost of development; increasing the efficiency of investment and investment grade; creating additional jobs; effect of developing efficient transport schemes; environmental impact; additional effect of the implementation of the results of the study, etc.
3. Implementation of scientific developments that have social impact, ie, the degree of impact of scientific result in achieving social objectives (preserving and improving the environment, improving the level and quality of life, etc.).
4. Implementation of scientific results in the field of intellectual property. The implemented are considered the following scientific results: textbooks and educational and methodological

tools used in the learning process; monographs, editions by decision of the scientific boards of the scientific organizations; patents and inventors' licensing agreements.

5. Implementation of scientific results in the form of specific management decisions by the management boards. Scientific results are considered to be implemented if they are used in the development of legislation, government regulations, programs and regulations acts, instructions, methodological guidelines, standards, norms and other management documents.

2.8. Technical criteria

1. Dissertation design in accordance to the requirements of the scientific organization.
2. Compliance of the Abstract content with the content of the dissertation.
3. Reasonableness, literacy and clarity of the statement of the thesis and the Abstract.
4. Keeping the technical requirements for design of the dissertation and the Abstract / text, figures, tables, formulas, applications, literature/.

2.9. Criteria for assessment the standards of scientific ethics

1. Norms governing the everyday research activity. In assessment of compliance this standard it should be assessed the following: strict keeping the rules for obtaining and selecting specific data research; reliable organization of the protection and conservation of the primary data, clear and full documentation of all important results; openness to doubt the accuracy of the data and analysis of the survey results; understanding of implied axiomatic assumptions and vigilant attitude towards attempts to adopt the desired results rather than actual data   inventing or falsifying research data, denial of undesirable outcomes; manipulating illustrations or images.

2.Norms governing the relationship between colleagues and collaborators. In assessment of compliance with this standard it should be pay attention on assessments of following activities of the PhD student: obligation not to impede scientific work of competitors; active support for the scientific advancement of young scientists; openness to criticism and doubt expressed by other scientists and working teams in the dissertation; misappropriation of research methods and ideas of others scientists without reference; falsification of the content of the research results, findings and conclusions; careful, objective and unbiased assessment of the work of colleagues.

3. Norms governing results publication. In assessment of compliance with this norm it is necessary to pay attention to the following points: to observe the principle of the universality of the results of the study; required to publish the results of dissertation research; respect the principle of recognition of errors in the interpretation of study results; to comply with the principle of recognition of merit and fair to assess the contributions of predecessors in research problem.

2.10. Criteria for assessment the standards of scientific ethics

1. Norms governing the everyday research activity. In assessment of compliance this standard it should be assessed the following: strict keeping the rules for obtaining and selecting specific data research; reliable organization of the protection and conservation of the primary data, clear and full documentation of all important results; openness to doubt the accuracy of the data and analysis of the survey results; understanding of implied axiomatic assumptions and vigilant attitude towards attempts to adopt the desired results rather than actual data   inventing or falsifying research data, denial of undesirable outcomes; manipulating illustrations or images.

2.Norms governing the relationship between colleagues and collaborators.

In assessment of compliance with this standard it should be pay attention on assessments of following activities of the PhD student: obligation not to impede scientific work of competitors; active support for the scientific advancement of young scientists; openness to criticism and doubt expressed by other scientists and working teams in the dissertation; misappropriation of research methods and ideas of others scientists without reference; falsification of the content of the research results, findings and conclusions; careful, objective and unbiased assessment of the work of colleagues.

3.Norms governing results publication. In assessment of compliance with this norm it is necessary to pay attention to the following points: to observe the principle of the universality of the results of the study; required to publish the results of dissertation research; respect the principle of recognition of errors in the interpretation of study results; to comply with the principle of recognition of merit and fair to assess the contributions of predecessors in research problem. Figure 2 is described classification of contributions and properties of scientific innovation in disertatsionata papers.
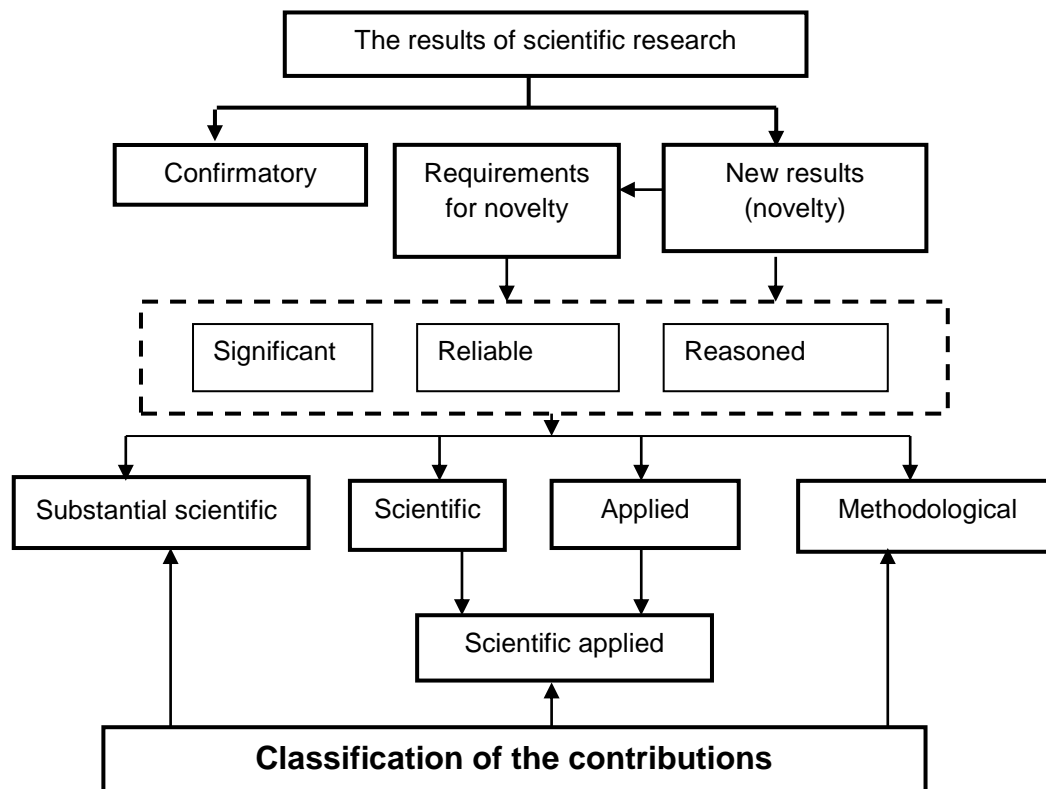
Figure 2. Correlation between the results of dissertation research and
contributions in dissertation research

2.11. Criteria for determination of the personal participation of PhD students in the results presented in the dissertation

1. The attribution of the scientific degree is based on an assessment of the dissertation, in which should be reflected the personal participation of PhD student and it is estimated by the contribution of the PhD student in: formulating the idea of the study; raised hypothesis;

experimental confirmation of the hypothesis of the study; the developed methodology of the experimental study; developed equipment for research; theoretical development; results; formulation of scientific contributions.

2.12. Criteria for overall assessment of the dissertation   Impact of the general assessment

1. Quality, content of the opening speech that reflects the essence of the basics of the work;
2. Freedom of use the basic theoretical concepts, terms, particularly in relevant to the topic of the study;
3. Knowledge of the main scientific sources, history of the matter, skills to respond to certain positions of scientists and justification of own position;
4. Evidences of outcomes and practical results of the study.

3.   CONCLUSIONS

The results of the dissertation research are evaluated through the scientific significance of the research, the economic impact and its practical applicability.
The proposed systematic criteria for the evaluation of dissertation papers are in their completeness and comprehensiveness. They can be useful for PhD students, young scientists and their tutors.

Note:
*   Marked with these sign requirements are for dissertations for Doctor scientists;
** Marked with this sign requirements are for public - humanitarnite and economic sciences;
*** Marked with this sign requirements are for public - natural, technical and economic sciences.

COMPARATIVE ANALYSIS OF THE PROFESSIONAL SOCIALIZATION OF RUSSIAN AND BULGARIAN STUDENTS: CROSS-NATIONAL STUDY

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Abstract: *The article presents the results of a joint Russian-Bulgarian research project devoted to the problems of professional socialization of graduates of Russian and Bulgarian universities. The authors provide a comparative analysis of the factors and mechanisms of students' professional socialization. Particular attention is paid to the description of the distinguishing characteristics, as well as identifying universal trends of professional socialization of today's university students in the article.*
Keywords: *Professional Socialization, Students, Career Strategies, Motivation of the Professional Choices, Employment.*

1. INTRODUCTION

The globalization processes are increasingly manifested in various spheres of life in the contemporary society. One of the consequences of this is inevitably formation of some similar forms and mechanisms of functioning of various social, economic, socio-cultural processes. At the same time we can not deny the fact that in general similarity of these processes there is some specificity due to the national, cultural, ethnic, geopolitical factors and the desire of peoples to preserve the historical and cultural traditions that form and sustain national and ethnic identity. All this contributes to the scientific interest and updates both the theoretical and practical aspects of cross-national studies based on a comparative analysis. It allows identifying common features and special features of the social processes in different countries.

The results of one such study are presented in this article. In 2013-2014 in the framework of the cooperation agreement between Trakia University in Bulgaria (TRU) and Southern Federal University in Russia (SFU) conducted a joint research sociological project with the main aim to examine the major trends and mechanisms of professional socialization of today's university students in Russia and Bulgaria. The main research interest was to identify the similar (universal) trends of students' socialization in the field of professional activities, as well as definitions of specific features of this process.

Starting the study we proceeded from the understanding that the problems of professional identity and the search for effective mechanisms of students integration in the professional connections and relations. We consider they are relevant to any society and to every young person preparing for an active professional career. The selection of Russian and Bulgarian students as an object of comparative analysis is determined through historical proximity of the socio-cultural characteristics of our countries, due to the common Slavic roots, as well as belonging to the "system of socialist countries". All these led to a transition in the 90- years of the last century the socialist-type economic relations to market relations and, as a consequence, a certain similarity in the field of economic and social transformation.

The empirical base of this study are the results of a series of polls conducted using a common tool by scientists of Southern Federal University in Rostov on Don, Russia (SFU) [3] and lecturers of Trakia University Stara Zagora, Bulgaria (TRU). The survey was conducted at the Rostov State Medical University (Rostov on Don, Russia) also because it allowed receiving data about the students of medical science profile [4]. In total there were 350 students of 3, 4 and 5 courses of every university who were interviewed. 65% of them were boys and 35% - girls. The study involved students of engineering, natural sciences and humanities.

2. RESULTS

The structure of the questionnaire corresponds with the above defined goals of the study. It contains questions (except the personal data) that can be grouped into 3 main areas:
1) The students' attitude to their future professional activity and the chosen specialty;
2) The young people assessment of the quality of their professional knowledge;
3) The job placement problems of the university graduates.
In compiling the questionnaire the authors used the following forms of questions: open-ended questions followed by converting the response positions in the nominal scale; open-ended questions followed by converting the responses in the interval scale; open-ended questions followed by converting the response positions in the ordinal scale.

2.1. Attitude to the future professional activity

To determine the motivation of professional choices and students' attitude to their future professional activity the respondents were asked to answer the question about the role of work in their lives. (Table 1). It was found that both Russian and Bulgarian students view work as a mean of self-realization and self-development (63.2% and 62%, respectively). The second place took the answer "work as a source of livelihood" (47.3% and 59%). Third place was for option of answer "work is important in itself regardless of the payment" (19.4% and 10%). As you can see both the qualitative (by the distribution of points) and quantitative analysis of the results reveals a great similarity in attitude to the work as the value and for Russian and Bulgarian young people. Surprisingly the economic factor in the formation of attitude to the work is not determinative. The necessity of professional selfrealization is no less /but in a situation of Russians/ is even higher determiner of the professional choice. These results coincide with the earlier studies of the authors [2].

Table 1. What significance has the work to you in your life? (No more than two answers)

№	Variant of answer	Percentage, %	
		Russia	Bulgaria
1	The work is important in itself regardless of the payment.	19.4	10.0
2	The work is serious matter but there are things that occupy me much more.	18.6	5.0
3	The work is for me mainly a source of livelihood.	47.3	59.0
4	The work is unpleasant duty. If I could in general I would not worked.	3.5	1.0
5	The work is an opportunity to communicate.	5.8	0.0
6	The work is an opportunity to gain public support, to obtain endorsement.	5.8	0.0
7	The work is an opportunity for you to express yourself, to carry out your plans.	63.9	62.0

The more significant differences in the responses of Russian and Bulgarian students were revealed in the analysis of the responses to the question about the motives of choosing a future profession (Table 2). On the one hand with a large majority is the motive "satisfying their own interests, self-development and self-improvement" (56.8% for SFU and 68% for TRU). However for Bulgarian students in second place in importance appeared the place of the profession in the market demand (27%). But much more important for Russians was the prestige of the profession. Almost 40% of respondents chose this answer. The market demand for their future profession concerned only 12% of students and less than 8% focused on the level of remuneration. This indicator is significantly lower than the indicator of Bulgarians (27% and 18%, respectively). By the way, for Bulgarian students the prestige of the profession (19%) is quite closely related to the level of remuneration. Russians have the same idea of the prestige of the work. Obviously it is not due to economic, but rather to socio-cultural factors. It is no secret that in Russia there is a paradoxical situation where the prestige of the profession is not directly related to its profitableness.

Table 2. Why did you choose this profession, specialty? (No more than two answers)

№	Variant of answer	Percentage, %	
		Russia	Bulgaria
1	This profession is in high demand in the labor market.	30.1	27.0
2	This is a prestigious profession.	39.9	19.0
3	This is a highly paid profession.	35.7	18.0
4	To satisfy my own interests, skills development and self-improvement.	56.8	68.0
5	Upon the recommendation of my parents.	24.7	2.0
6	I sought to avoid military service.	3.0	0.0

We should also focus on the role of the parents in a professional choice of children (Table 2). As it turned out in the course of the study nearly one-third of Russians in are choosing a profession guided by the parents' opinions (30.1%). But the situation with the Bulgarian youth is fundamentally different because only 2% of respondents indicated this answer. Analyzing this position, we should take into account that the choice of profession is one of the most important decisions taken by the man in his life. There is a question about the reasons for such a low parental role in professional self-determination of children. This applies (although to a lesser extent) Russian youth. Whether this is the loss of continuity of socio-cultural values and norms or the transformation of forms of family relationships? In any case this fact in itself is unfavorable because of the indication of a certain alienation and too early autonomy of young people who are not always ready for independent decision-making.

Obviously the primary professional socialization at the level of professional self-determination takes place before entering the university. However in the course of study at the university this process does not stop and it enters the new phase. Continuing throughout the training it changes not only the accents but the grounds. In order to get a general idea of the nature of the ongoing transformations in the course of the study the students were asked to answer the question: "What would you do if you had to rechoose a specialty" (Table 3).

In general majority of students have not changed fundamentally their opinions on the chosen specialty. Only about 16% of Russians and 8% of Bulgarians are willing to consider options for change of the profession. At the same time the situation with Russian students is less favorable because more than 16% could not answer the question. That together with the above given data is 32% and this is a third part of the respondents.

Although answering the question: "To what extent do you like the chosen specialty", the absolute majority of both Russian and Bulgarian students evaluated positively the chosen specialty (86% of Russians and 97% of Bulgarians).

Table 3. What would you do if you had to choose a specialty again?

№	Variant of answer	Percentage, %	
		Russia	Bulgaria
1	I would choose again the same specialty at the same university.	44.2	87.0
2	I would choose the same specialty again but in another university.	23.3	1.0
3	I would choose another specialty but at the same university.	2.3	5.0
4	I would choose another specialty in another university.	14.3	3.0
5	It is difficult to answer.	16.3	4.0

2.2. Assessment of the professional training quality by the students

Analysis of the level of professional self-determination involves the comprehension of the students' training quality, provided by the university and their own efforts in the educational activity. We tried to identify these aspects, inviting students to answer the questions: "What kinds of knowledge do you think are not enough to learn the chosen specialty?" and "How do you assess your attitude to learning?"
On the first issue we note quite similar trends associated with a marked by majority of respondents lack of practical skills in their future professional activity (Table 4).
Russian and Bulgarian students demonstrate almost identical results (about 14%) to the theoretical training that, if assessed by the obtained results, satisfies most of the students.
The other positions are not as fundamental, considering the overall low number of answers.

Table 4. What kinds of knowledge did you received thas are not enough for mastering the chosen specialty? (No more than two answers)

№	Variant of answer	Percentage, %	
		Russia	Bulgaria
1	Practical and organizational skills in the specialty.	66.3	50.4
2	Knowledge in the field of business relationships, social communication, management.	8.2	16.0
3	Knowledge in the field of theoretical foundations the specialty.	14.3	13.0
4	The skills in all areas I have received are enough.	9.7	16.6
5	Knowledge is not sufficient in all areas.	16.7	1.0
6	It is difficult to answer.	5.8	4.0

But in assessing their own contribution to the future professional competence Russians are more critical compared with Bulgarian students.
Only 22.2% of all Russian students think that they learn to spare no effort, while 66% of Bulgarian students chose this answer (Table 5).
Completely opposite pattern is observed in answering "I study, no lazing around but without much exertion of effort" - respectively 67.5% of Russians and 29% of Bulgarians. However, in general the students are convinced that they relate to learning enough in good faith.

Table 5. How do you generally assess your attitude to learning?

№	Variant of answer	Percentage, %	
		Russia	Bulgaria
1	I believe that I study with full dedication my strength and abilities.	22.2	66.0
2	I study not lazing around but without much exertion of effort.	67.5	29.0
3	I rather do not study, only for "show", not to be expelled.	7.2	0.0
4	I am inactive; I have other applications of my own strength.	2.8	2.0
5	Another.	0.3	3.0

2.3. Problems of graduates employment

A separate group of questions of the questionnaire was devoted to the employment of college graduates. This is one of the most difficult challenges facing university graduates. The cancellation of the system of compulsory assignment of graduates is the factor that made the employment process spontaneous and almost unmanageable. The universities respond to the market demand with a delay and applicants are focused more on their own interests than the situation on the labor market (as it can be seen in Table 2). In addition, within 4-6 years of students' study at the university the demand for those or other professions and trades can vary greatly. In the current situation it is very important to study the factors, mechanisms, and also the most common ways of employment from the viewpoint of graduate students as the most active subjects in the process.

For this purpose we asked all students to answer the following question "How are you able to find a job after graduation?" (Table 6). It turned out that for Russian students the most preferred channel is the Internet. Russian and Bulgarian students consider a variant "the help of parents and friends" with a small distinction (25% and 22%, respectively). Almost half of the Bulgarian respondents intend to take advantage of personal acquaintances. It is appropriate to recall that when choosing a profession the opinion of the parents are taken into account only 2% of Bulgarian students. There is a clear contradiction when on the primary stage of professional self-decision the decision is taken by themselves and the responsibility for taking this decision is shifted to the "older colleagues". But 34% (one third) of respondents plan to solve the problem of employment independently. For Russians the situation is more clear: the main hopes about the choice of profession and employment are connected with the older generation (24% and 22%, respectively). Only 4% of the respondents expects to on their own strength. We should also pay attention to the low percentage of selecting channels such as the university (13% of Russians and 19% of Bulgarians) and Employment Service (8% of Russians and 7% of Bulgarians). This is an indicator of poor performance of appropriate structures whose main function (and especially, the Employment Service) - to assist in finding employment for students.

Table 6. The main channels of employment

№	Variant of answer	Percentage, %	
		Russia	Bulgaria
1	Through the Internet.	25.0	21.0
2	With the help of parents, friends, acquaintances.	22.0	49.0
3	With the help of the university.	13.0	19.0
4	The Employment Service	8.0	7.0
5	The media.	7.0	13.0
6	Independently.	4.0	34.0

Among the most significant factors affecting employment both Russian and Bulgarian students unanimously distinguished 3 basic factors: work experience, the availability of the necessary connections and higher education.

We observe practically complete identity of both the trends and the quantitative distribution of answers here. Incidentally this coincides with the findings of scientists who research working students [1].

One of the main factors is not only the need for additional income but also the opportunity to obtain professional experience in the period of study at the university.

Table 7. To what extent the successful job placement is influenced by:

Russia				
Factors	It significantly affects, %	It does not significantly affect, %	It does not affect, %	It is difficult to answer, %
1. Higher Education	82.3	8.0	1.9	1.6
2. Age	30.6	47.2	10.9	5.0
3. Work experience	83.7	8.0	2.3	1.2
4. The time spent on the job search	30.6	24.8	32.6	14.8
5. Availability of relevant friends	83.0	31.0	0.8	3.9
Bulgaria				
Factors	It significantly affects, %	It does not significantly affect, %	It does not affect, %	It is difficult to answer, %
1. Higher Education	78.0	15.0	2.0	5.0
2. Age	64.0	30.0	3.0	3.0
3. Work experience	79.0	8.0	9.0	4.0
4. The time spent on the job search	45.0	36.0	10.0	9.0
5. Availability of relevant friends	77.0	16.0	2.0	5.0

In assessing the personal qualities contributing to successful employment, Russian and Bulgarian students unanimously put in the first place the "responsibility" (64% of Russians and 63% of Bulgarians) and as the leading quality they marked "communicability" (46% of Bulgarians and 36.8% of Russians) (Table 8).

The opinions differed on the third position. Russian respondents chose "the ability to learn quickly" (29.9%) and Bulgarian respondents noted "teamwork" (58%). It is interesting that "the desire to improve own professional level" was noted by only 9% of Bulgarian students. Russians have selected higher percentage (24%) but it is not too high.

Taking into account the socio-economic situation and the opinion of employers, it is the quality of the specialist that is one of the leading. It provides the experts' mobility and competitiveness in the professional community.

Table 8. Key personal characteristics that can help students successfully find job (No more than three variants)

№	Variant of answer	Percentage, %	
		Russia	Bulgaria
1	Communicability	36.8	46.0
2	Team work ability	20.2	58.0
3	Responsibility	64.5	63.0
4	Insistence in achieving the goals	33.0	40.0
5	Punctuality	16.0	7.0
6	Ability to learn quickly	29.9	10.0
7	Abilities for creative approach to task solution	8.1	9.0
8	Activity	8.5	2.0
9	Efficiency	21.7	6.0
10	Sense of initiative	5.0	20.0
11	Non-conflict	10.5	2.0
12	Self Confidence	11.0	7.0
13	Analytical abilities	6.2	1.0
14	organizational skills	6.6	6.0
15	Stress resistance	8.5	8.0
16	The desire to increase the professional level	24.0	9.0
17	Honesty	19.0	5.0
18	Independence	5.8	3.0

In conclusion, to assess the overall social well-being of students, they were asked the question "What kind of mood you have, looking at the future" (Table 9).
Responding to it both Russian and Bulgarian students showed almost unanimous opinion. The absolute majority of them chose the option "with hope and optimism".
Calm but with no illusions about the future are little less a third of respondents. Thus, in general, more than 80% of the respondents showed a positive attitude to their future.

Table 9. What kind of mood you have, looking at the future?

№	Variant of answer	Percentage, %	
		Russia	Bulgaria
1	With hope and optimism.	57,4	58
2	Calmly without hopes and illusions.	24,6	29
3	With anxiety and uncertainty.	11,5	9
4	With fear and despair.	4,5	1
5	It is difficult to answer.	2	3

3. CONCLUSIONS

The above analysis is primary and it needs of further, more depth study of problems of university students' professional socialization.
However, we are able to identify a number of problems and contradictions, that are typical for Russia and Bulgaria, based on the data, in particular:
1. The low level of orientation students on the labor market situation in the choice of profession;
2. The weak influence of parents on the process of professional choice of their children on the background of high degree of their participation in the finding a job;
3. Dissatisfaction with the level of students' practical training at universities;

4. Insufficient efficiency of higher education system and employment services in solving the problems of the employment of university graduates.

5. The low motivation of students at improving of professional skills clearly contradicts the situation with the choice of profession. The motif of self-development in the professional field should be leading.

In conclusion, we note that in the future we plan a deeper analysis of the cause and effect connections and identified contradictions in the article. The work in this area will be continued and the results will be incorporated into subsequent publications of the authors.

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NANOSTRUCTURES IN NATURAL OBJECTS

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Abstract: The study of natural materials, a creating of their similarities from the point of view constructions, structures and materials is relative new and a perspective field connecting results of scientific research of biologists, chemists, physicists, material engineering, constructors and designers. A lot of these results have been already transferred in to the industry application. Through scanning electron microscopy we have possibility to get inside to other world of interesting structures where structures, processes and technologies are encrypted in the genetic information, raw materials are not treated at high temperature and pressure but they are created from biogenic elements.
A hierarchical structure of natural materials is created by the nanotechnology process that is very important fact. Material structures and surfaces were modified and optimised for millions of years. If we want to get more information about nanomaterials and nanotechnologies we should study natural materials at first.
Key words*: Hierarchical Structure, Nanostucture, Microstructure, Natural Materials.*

1. INTRODUCTION

Plants and animals have undergone great developmental changes during their many millions years lasting evolution. The evolution of the species associated with living conditions changes has been the basic reason of these changes. Plant and animal species have adapted to climatic changes and to living conditions in order to fulfill the basic programmed algorithm – an own reproduction. Hundreds of optimized designs, structures, chemical compositions, security features, communication devices and sensors were created as the result of this development. Now we are able to study above mentioned parameters using the most modern technical equipment and inspire ourselves for a long time optimized materials, designs, structures and technologies [1].

Over the past decades nanotechnologies have been rapidly developed. We are to prepare nanoparticles, nanofibers, material products with special nanostructured surfaces. Prepared nanomaterials are generally expensive and are usually manufactured in small quantities. Compared to this development we can get a lot of inventions from flora and fauna that evolved considerably longer. Nature is using sophisticated technology, biogenic elements, self-assembly and self-healing processes, biodegradation and has no other energy requirements than sunshine. Perfect parameters associate with the chemical composition and material structures had been achieved in nature [1, 2, 3].

Structures in natural materials usually exhibit more degrees. Their formation begins at the molecular level, progressing through the level of nanostructures and microstructures with the combination of multiple materials that coexist together in order to create perfect architectural object. The hierarchy of structures is evident in a number of natural objects whether plant or animal. Samples of natural objects have been monitored by scanning electron microscope. The samples that were selected to cover the basic concept of structures are commonly found in nature and well known to everybody [2, 3].

2. METHODS

Fully developed natural samples were selected for the investigation. Plant samples were dried in the air and sample surfaces were sputtered by thin layer of Au-Pd alloy to reduce charging effect. Studies of the structures of natural objects were performed on scanning electron microscope TESCAN VEGAII at magnifications in the range of 200 to 100 000 × at 10 to 30 kV accelerating voltage. Energy dispersive chemical analysis was done by Bruker XFlash.

3. EXAMPLES OF HIERARCHICAL STRUCTURES IN NATURAL OBJECTS

Different types of plant and animal objects were selected as examples of hierarchical structures. An attention of microscopy observation were concentrate to an inner and an outer structure of biology objects in order to show their optimise structures.

3.1. Nanostructure fibres in cell walls

The basic building block of all plant materials is the cell. This is a very complicated system that ensures the growth and other functions of living plants. The shape of plant cells is different and it depends on the type of plants, on the cell place in the plant body and its function.
Each plant cell is surrounded by a cell wall that has more than one function. Cell walls give to cells their shape and prevent them before swelling during water ingress. The interior of cells is filled with protoplasm. According to the current view of the material structure the cell wall can be described as a hierarchical composite system composed mainly of cellulose fibers and lignin.
The formation and extension of the basic cellulose macromolecular chain occurs during the process of photosynthesis. Macromolecular chains of cellulose form very fine filaments called microfibrils that gradually clump together into larger units called macrofibrils and then fibrils. They are the basic building material of the cell walls of plants and the resulting fibrous structure is hierarchical.
The cell wall is composed of several layers called lamellas. We can find there the middle lamella, primary lamella, secondary cell wall side (secondary lamella) and tertiary lamella that differ in a thickness and a content and an arrangement of cellulose fibers. The total thickness of cell wall is not only related to its functions in the plant but it depends on a plant age. Macromolecules of cellulose are the simplest building blocks of the hierarchical fibers structure that are the basic reinforcing component of plant cell walls and ensure their strength and integrity. The cellulose content varies by type of plant cell depending on a plant species and a season. Cellulose reinforcing fibers are accompanied by other biopolymers - hemicellulose, lignin and pectin that are in a function of glue to cellulose fibers Middle lamella is created during cell dividing process and it is associated with the cell walls of other cells. Middle lamella thickness is variable and ranges between tenths to units of micrometers. The primary lamella (thickness is around 0.5 nm) follows-up to middle lamella.
Secondary cell wall (secondary lamella) occupied the largest space of the cell wall. This layer grows up on the inside part of the primary lamella. Microfibrils of cellulose as a reinforcing material are placed in an amorphous matrix of hemicellulose and lignin. Secondary cell wall is completed by the tertiary lamella. Due to the high concentration of lignin is resistant to the enzyme action. A lumen follows the tertiary lamella [1].
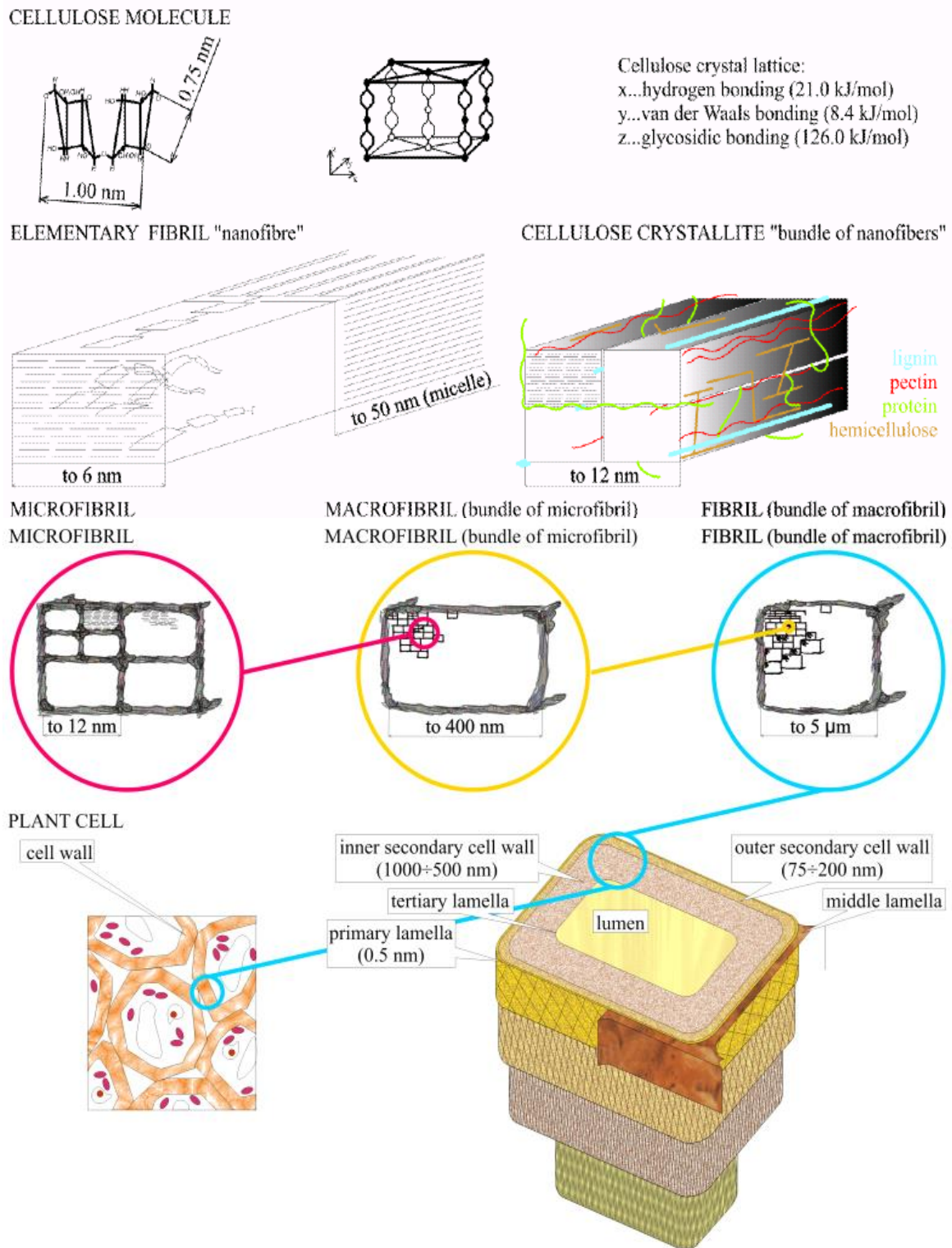
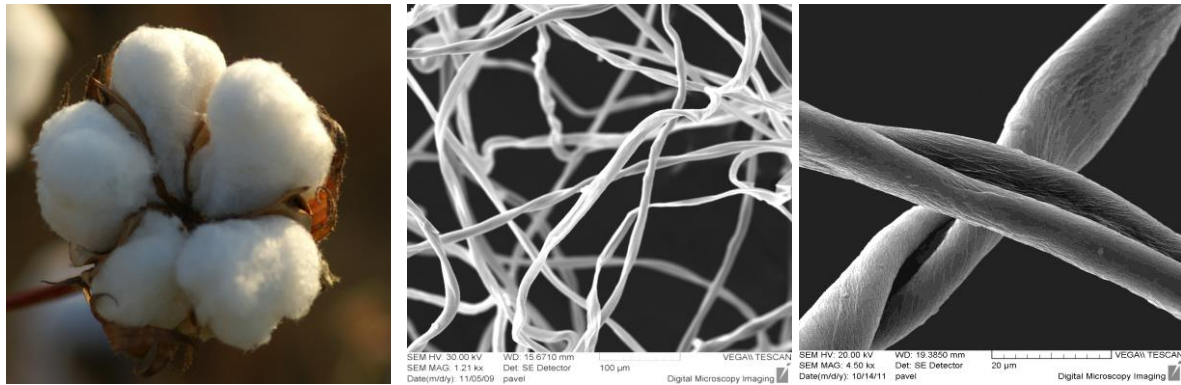Figure 1. A plant cell wall hierarchical structure model [4]

Figure 2. Cotton fibres. Cotton fibres cover and protect cotton seeds inside.
The detailed micrographs of cotton fibres shape and surface

3.2. Microstructure and nanostructure of beatle wing case

Ground beetle *(Carabus arcensis)* belongs to the order of beetles. Beetles could response to changes during million year evolution and were able to perfectly adapt to different environments. The specific composite structure of beetle wing case can be easy identified by electron microscope. Developed composite system consists of reinforcing chitin fibers of rectangular or square cross-section that are embedded in a protein matrix. The advantage of a rectangular reinforcing fiber cross-section is improved arrangement of fibers in the matrix thus minimizing its volume. The length of the fiber edges is within the range 5 up to 10 microns depending on the location of the fibers in beetle wing case. The fibers are built up into layers with layers alternating with each other at an angle of 90o. Submicron fibers connect layers together [5]. In the detail of the figure 6 - left side - special structured surface protecting and covering the beetle wing case can be seen in the thickness about 20 microns. In the same figure – right side it is possible to see beetle wing case inner part with small tiny hairs. This hairy structure is important for opening of wing case.
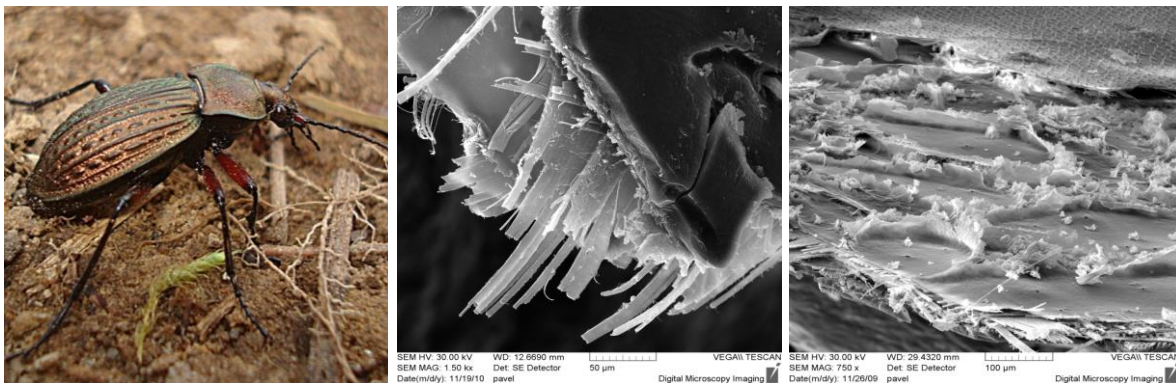

Figure 3. Ground beetle. The detailed micrograph of the beetle wing case fracture surface shows the rectangular shape of reinforcing chitin fibres. In the right part of left figure the compact surface layer can be seen. In the upper part of right figure it is possible to see the hairy cover of beetle wing case inner part

3.3. Nanostructure plant surfaces shapes

Horsetail *(Equisetum arvense)* commonly belongs to the oldest plants of the Earth and their species can be found in the lowlands and in mountainous areas too. The surfaces of horsetails are formed hierarchically. Precipitated different formations of silicon dioxide are clearly visible under the electron microscope and have been detected by EDX analysis too. Dimensions of the plant surface silica particles are in a range from 2 to 20 micrometers. This inorganic structure is covered by very fine plate-like structure that was identified at higher magnification. A length of these plate-like shapes changes in the range from 200 up to 500 nanometers and a thickness from 50 up to 100 nanometers. Silica particles strengthens the construction of the plant body, it helps the plant's own thermoregulation, it has a bacteriostatic effect and ultimately discourages herbivores from eating plants, as it negatively affects their tooth enamel [6, 7, 8].
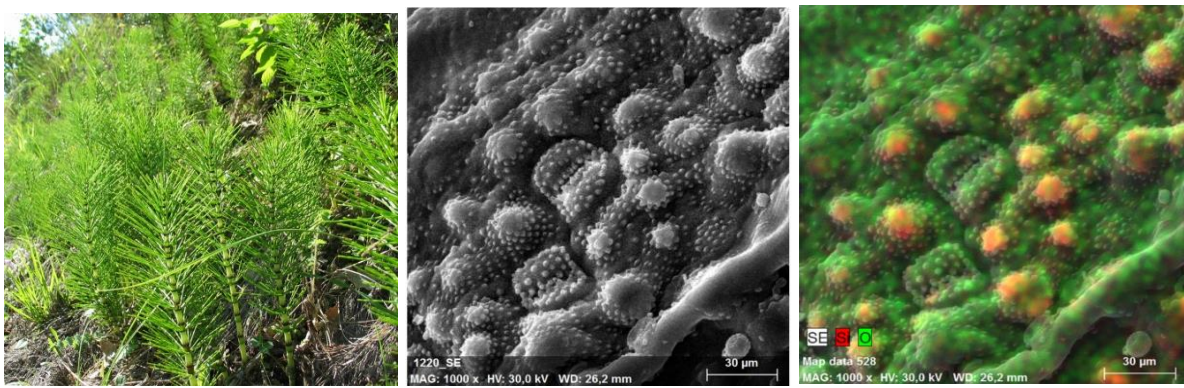

Figure 4.Horsetail. The detailed micrograph of the horsetail surface part with precipitated spiral formations of silicon dioxide.
Micrograph of the Si and O elements distribution. SEM – EDX analysis
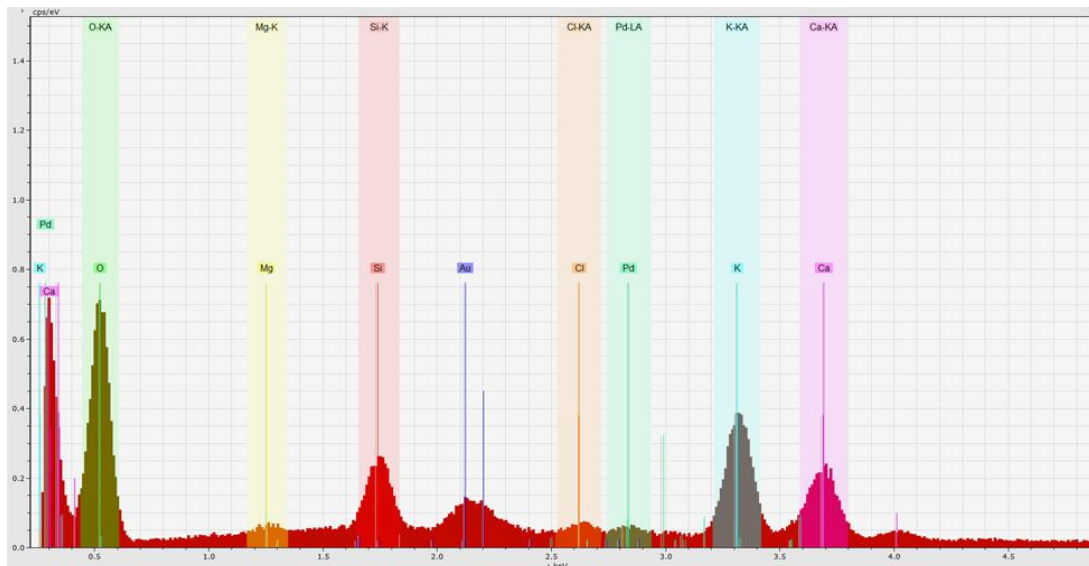
Figure 5. The energy-dispersive spectrum (Equisetum arvense). SEM – EDX analysis
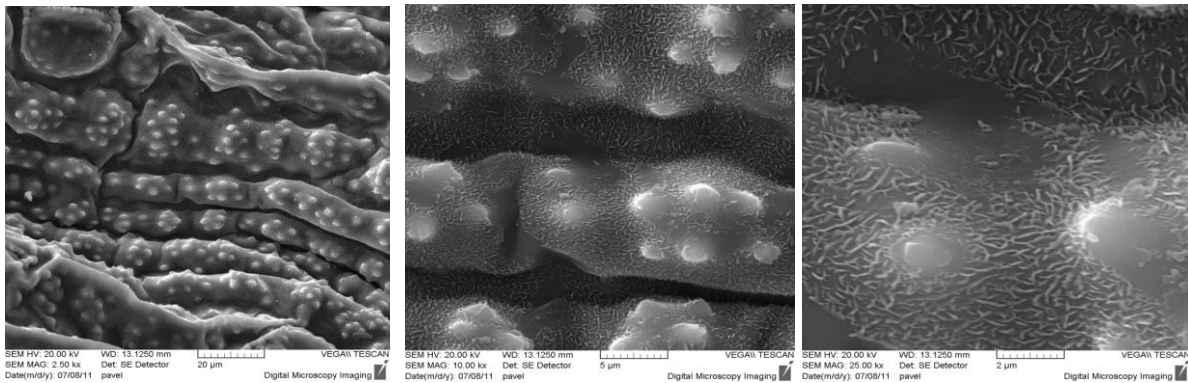
Figure 6. The detailed micrograph of the surface part with precipitated formations of silicon dioxide. In the right figure it is possible to see tiny surface waxy structure

Similar surface plate-like formation can be observed on different but well-known plant surfaces as a white clover, ficus benjamina, common types of grasses and passionflower. Plate - like surface waxy structure is important for hydrophobic behaviour of plant stems, leaves or flowers.
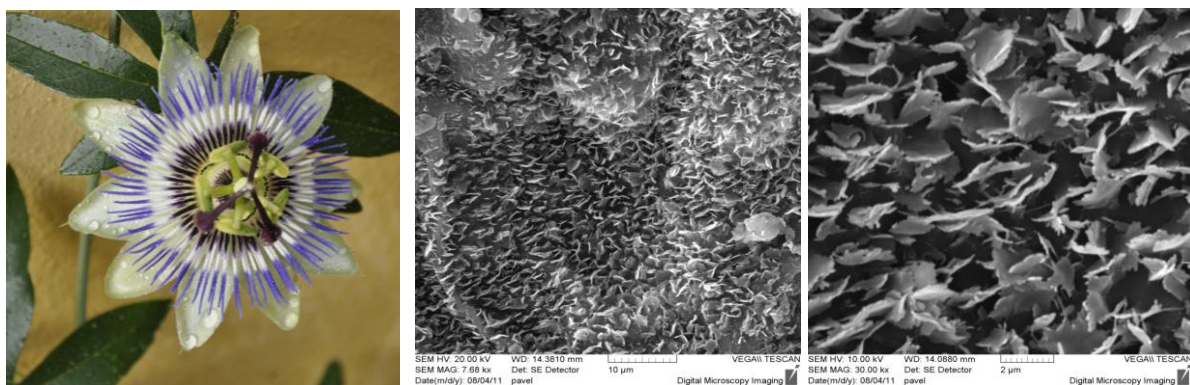
Figure 7. Passionflower (Passiflora cearulea). The micrograph of surface part.Tiny surface waxy structure is created by fine plate-like formation

3.4. Nanostructure protective surfaces

Teeth (dens) generally reveal a high stiffness and a high compressive strength. Every tooth is covered by the dental enamel in thickness up to 2.5 millimeter that is hard, abrasion resistant and tough. Dental enamel mechanical parameters that are admired by specialists rests in its special structure that is created by the hydroxylapatite fibrous crystals (consisting from hydroxylapatite particles) orientated perpendicularly to the tooth surface and embedded in a protein matrix. Moreover tiny pores between these fibres are filled with water and are important for absorbing of mechanical energy during biting. Dental enamel is composed of 96% mineral phase the rest is water and the organic protein phases - amelogenin and enamelin that are important for the growth of hydroxylapatite crystals and their orientation but the complex function of these proteins is not yet fully understood [1].
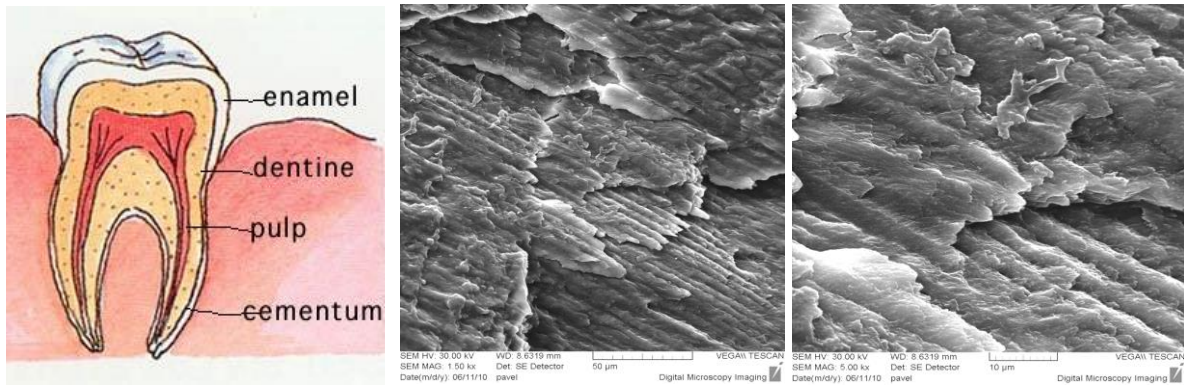
Figure 8. A tooth model [10]. The detailed micrograph of the dental enamel layer - left. The specific structure of fibrous crystals. SEM

Nacre is an organic-inorganic composite material that is produced by some mollusks as their inner layer. It is strong, resilient and iridescent material with the special structure. The structure is built up from hexagonal platelets of aragonite as a form of calcium carbonate in range of 5 to 20 micrometers in width and about 1 micrometer thick that are embedded in organic biopolymer matrix. The composition of brittle ceramic like platelets in organic phase makes the material strong and resilient due to specific structure that inhibits transverse crack propagation. Nacre formation and growth is controlled by organic matrix consisting of chitin, lustrin and silk-like protein. Nacre differs from fibrous aragonite – a brittle material of the same chemical composition and the form – in that the growth in c-axis (perpendicular to the shell in nacre) is slow in nacre but fast in fibrous aragonite form. [11]
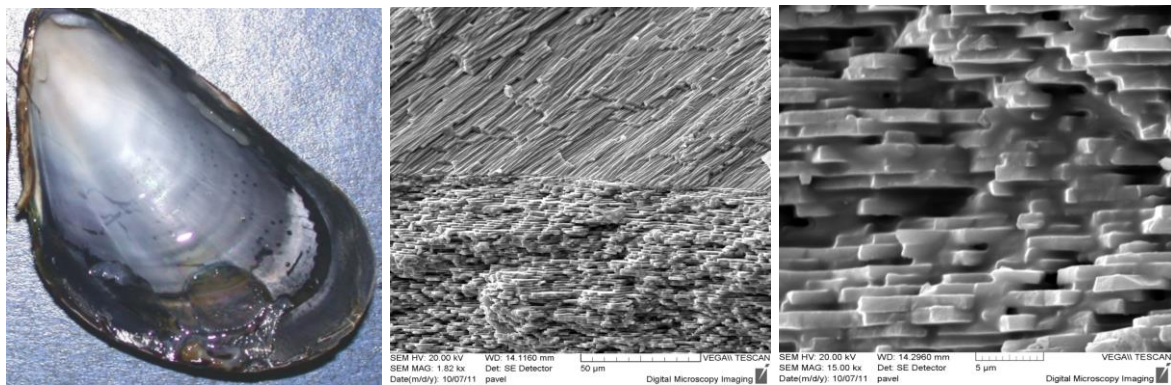
Figure 9. Nacre in abalone shell *(Blue Mussel)*. The detailed micrograph of the structure of aragonite crystals - left. Tiny structure of shell is joined to aragonite platelets - right

4. RESULTS AND DISCUSSION

Fibrous micro-and nano-structures are used very often in natural objects. Nanostructures usually create larger units showing different degree of hierarchy.
Macromolecules of cellulose create bigger cellulose fibre formations – nanofibrils and macrofibrils that forming larger units used as composite reinforcing elements of natural systems - plant cell walls.

A similar system is used by beetles. Beetle cases are composite system where rectangular chitin fibres are used as reinforcing elements and protein matrix is a glue connecting threads together.

Nanostructure shapes occurring on the surface of natural plant are used to pre-specified functions associated with photosynthesis and reproduction. The most common surface parameter is the hydrophobic behaviour of leaves and blossoms in order to avoid wetting of surfaces. Other parameters are a protective function related to the bacteriostatic effects and a reinforcing of the body plant.

The system of fibrous structure is used in the case of teeth that are long-term mechanical stressed. This structure is created by combining individual nearly spherical nanoparticles forming microscopic fibrous formations. These units are also stored in the protein matrix. Some similarity is possible to find in the structures of shells.

5. CONCLUSIONS

Following conclusions based on the monitoring of selected structures of plant and animal objects were formulated:

- different structural hierarchy associated with a different type of mechanical stress, transports and protective functions were found during the study of natural objects,
- microstructure and nanostructure plant surface shapes show generally organic origin with waxy character depending on natural conditions but special formations consisting of inorganic-organic compounds are possible too,
- microstructure and nanostructure objects occurring in the animal kingdom are organic-inorganic origin, there are composite systems consisting of inorganic particles located in the organic phase where the inorganic particles provide a system hardness, strength and abrasion resistance while the organic phase allows their connection and provides toughness system as a whole, proteins of these organic phase control an inorganic phase organizing into the crystalline structures of different shapes.

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X-RAY DIFFRACTION ANALYSIS OF RESIDUAL STERSSES AFTER MILLING OF SUPER-ALLOYS

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Abstract: Nickel super-alloys are widely used in aerospace as material for turbine blades. Unfortunately, their machining is difficult since mechanical hardening and, consequently, extreme tool wear occur. Casting can no longer meet the requirements for precision, hence, the castings are being ground or milled. In this contribution, a quality check of the milled surface by several surface integrity parameters is proposed with respect to the surface structural inhomogeneities caused by mutual effect of plastic deformations and thermal fields during the cutting process. Castings from Inconel 738LC were milled with cutting conditions chosen by Design-Of-Experiments method and the resulting surfaces were assessed by non-destructive X-ray diffraction methods in several areas corresponding to various cutter orientation and work-piece angle. Surface integrity was described by macroscopic residual stresses, microstrains, grain sizes and phase composition. Mostly, favourable compressive surface residual stresses were observed in the cutting direction, grain sizes were distinctively smaller when the tool axis was perpendicular to the machined surface.

Keywords: Residual Stresses, Milling, Geometrical Product Specification, Nickel Super-alloys, Turbine Blades.

1. INTRODUCTION

Cooperation between industry and research institutes can often broaden the production lines and even help to find new markets. This is exactly the case of the present contribution which is aimed at extension of the technological possibilities enabling to machine castings from nickel super-alloy. In particular, since the castings themselves can no longer meet the stringent requirement for precision and the hitherto used grinding has not delivered the coveted results, we are concentrating on the use of milling as a final operation in producing turbine blades form Inconel 738LC for aerospace industry. The goal is to find such milling parameters that would be not only efficient in respect to the machining time, but would also lead to a high quality surface necessary for components' reliability and a long service life. In order to do the quality inspection, the milled surface is described by several surface integrity parameters obtainable by non-destructive X-ray diffraction technique. This approach is based on assumption [1] that structure and microstructure of the surface layer, residual stresses, microstrains and dislocation density directly affect the durability, and hence, the service life of components that are under dynamic loads.

The very use of nickel super-alloys in aerospace industry is based on their favourable properties stemming from complicated microstructure and the real structure of individual crystalline phases that is distinguished by a complex character of grain boundaries, presence of defects such as vacations, dislocations, stacking faults and residual stresses. Moreover, from this point of view the grinding is not a very considerate processing of the material since it in can trigger off local melting resulting in presence of usually undesirable white layer and cracks [2]. On the other hand, the enormous evolution in the material of tools for milling has

facilitated substantial reduction in costs due to increase of cutting speed, e.g. up to ten times faster machining with whisker reinforced corundum [3] when compared with traditional cermet WC-Co tool tips. The use of ceramic materials in tool tips represents another bonanza to the milling process as their high melting temperature limits the thermally activated tool wear and favours the less harsh abrasive mechanism.

In this study, we present an investigation of *macroscopic residual stresses, microstrains, grain sizes and phase composition* of milled turbine blades with special attention to the effect of *tool feed, tool wear and the cutter orientation or work-piece angle*.

2. SAMPLES UNDER INVESTIGATION

The analysed bodies were casted from Inconel 738LC super-alloy and subsequently machined by 3 axis milling. The choice of milling parameters was done according to Design-Of-Experiments (DOE) method in such a manner that will enable to ascertain their effect on the selected surface integrity parameters. The machining conditions, which are briefly summarized in Tab. 1, were set according to DOE to compare *(i)* tool wear while keeping the other machining parameters constant. Furthermore, we are able to assess from the diffraction measurements *(ii)* the influence of cutter orientation and work-piece angle and *(iii)* the effect of tool feed. As the castings were not exactly the same from the geometrical point of view, they were coarse milled in order to ensure the constant cutting depth during the final milling. The very reproducibility of both the diffraction measurements and the milling process was verified on three blades that were machined under exactly the same conditions. The assessment of the *(ii)* parameter was possible because three areas corresponding to three different places with the cutter orientation and the work-piece angle as seen in Fig. 1.
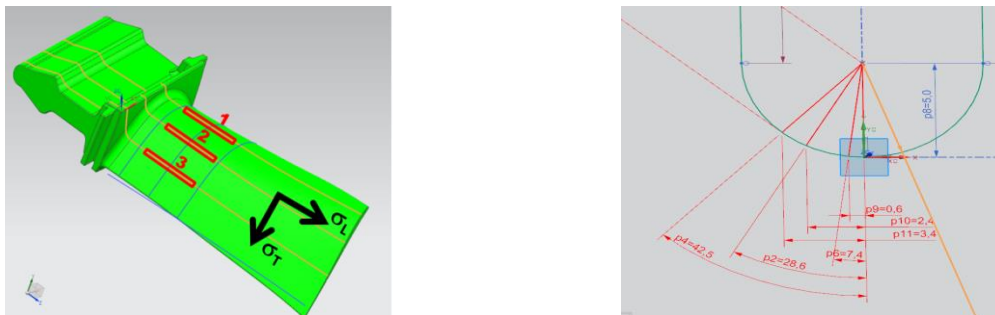
Figure 1. Scheme of the measured surface on samples with marked directions of stress determination σ_L, σ_T and the measured areas *1, 2* and *3* (left) and corresponding average values of the tool tilt in respect to the work-piece (right)

Table 1. Working and cutting conditions used in the experiments

Sample	1	3	4	5	6	7	8	9	10	11	14
Tool diameter [mm]	10/R5										
Character of tool feed	parallel milling with pushed tool										
Cooling	flooding by cooling liquid										
Axial depth a_p [mm]	2 x 0.5										
Number of teeth [-]	4										
Cutting feed [mm]	534	534	696	567	534	534	534	643	534	378	626
Cutting speed [m/min]	42	42	42	37	42	42	42	42	42	37	49
Tool's run	1st	1st	2nd	1st	2nd	1st	1st	2nd	3rd	1st	1st

3. EXPERIMENTAL TECHNIQUES

The measurements were performed on a *θ/θ* goniometer *X´Pert PRO MPD*. Positioning of the blade to the desired areas was done by in-house system with 6 degree of freedom, namely x,y,z translation, rotation and two tilts; with control of the surface position having 5µm accuracy employing laser triangulation system [4]. MnKα radiation was used for diffraction measurements aiming at residual stresses calculations, CrKα radiation for microstrains and grain size computation and CoKα radiation for phase composition determination. Unfortunately, it is not within the powers of X-ray diffraction to distinguish between the two in nickel super-alloys most commonly occurring phases of γ and γ'. Both crystalize in f.c.c. with γ having the austenitic structure and γ' being the main precipitation phase, moreover, their lattice parameters a_γ, $a_{\gamma'}$ are very similar [5] with the lattice mismatch $\delta = 2(a_\gamma - a_{\gamma'})/(a_\gamma + a_{\gamma'})$ in the order of 0.x % resulting in almost perfect overlapping of diffraction profiles.

The diffraction line *{311}* of γ and γ' phases was measured in order to obtain macroscopic residual stresses. Values of macroscopic residual stresses σ_L and σ_T, see Fig. 1, were calculated from lattice deformations determined from $2\theta^{311}(\sin^2\psi)$ plots following Winholtz-Cohen algorithm [6] and using the X-ray elastic constants $\frac{1}{2}s_2 = 6.57.10^{-6}$ MPa^{-1}, $s_1 = -1.56.10^{-6}$ MPa^{-1} computed according to Eshelby-Kröner approach [7]. Diffraction angle $2\theta^{311}$ was taken as a centre of gravity of the *{311}* diffraction doublet MnKα.

Single-line Voigt function method [8] was applied for calculations of microstrains and average grain sizes using *{111}* diffraction line of γ and γ' phases. Both parameters were determined from all three areas *1, 2, 3* oriented in two directions given by stresses σ_L and σ_T).

4. RESULTS

The values of macroscopic residual stresses in both measured directions are summarized in Tab. 2 in such a manner that would enable to consider the effect of tool wear. Microstrains *e* and grain sizes *D* averaged over all values in areas *1, 2, 3* and both directions are in Tab. 3. The impact of tool feed can be seen from Tab. 4 where residual stresses obtained in the direction of tool feed σ_T and perpendicularly to it σ_L are shown for all three investigated areas. Eventually the example of phase analysis is in Fig. 2.

Table 2. Surface macroscopic residual stresses σ_L and σ_T, MPa; analysis of tool wear effect

Sample	1, 3, 7 and 8		6		10	
Tool's run	new – 1st		used – 2nd run		used – 3rd run	
Area	$\langle\sigma_L\rangle$	$\langle\sigma_T\rangle$	σ_L	σ_T	σ_L	σ_T
1	7 ± 23	-298 ± 20	-225 ± 29	-455 ± 16	-104 ± 14	-492 ± 21
2	187 ± 19	-195 ± 22	141 ± 35	-194 ± 35	44 ± 35	-379 ± 47
3	159 ± 26	-189 ± 22	214 ± 24	2 ± 32	226 ± 25	-271 ± 23

Table 3. Microstrains *e* and grain sizes *D* averaged over all values in areas *1*, *2*, *3* and both directions

	Area *1*	Area *2*	Area *3*	direction *L*	direction *T*
$\langle D \rangle$, nm	39	48	50	48	43
$\langle e \rangle$, 10^{-4}	61	61	57	62	58

Table 4. Surface macroscopic residual stresses σ_T and σ_L, MPa; analysis of the tool feed effect
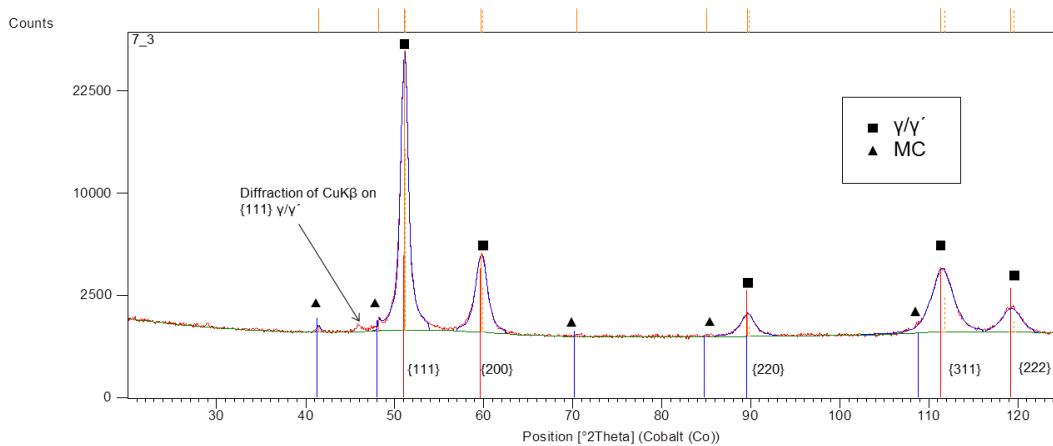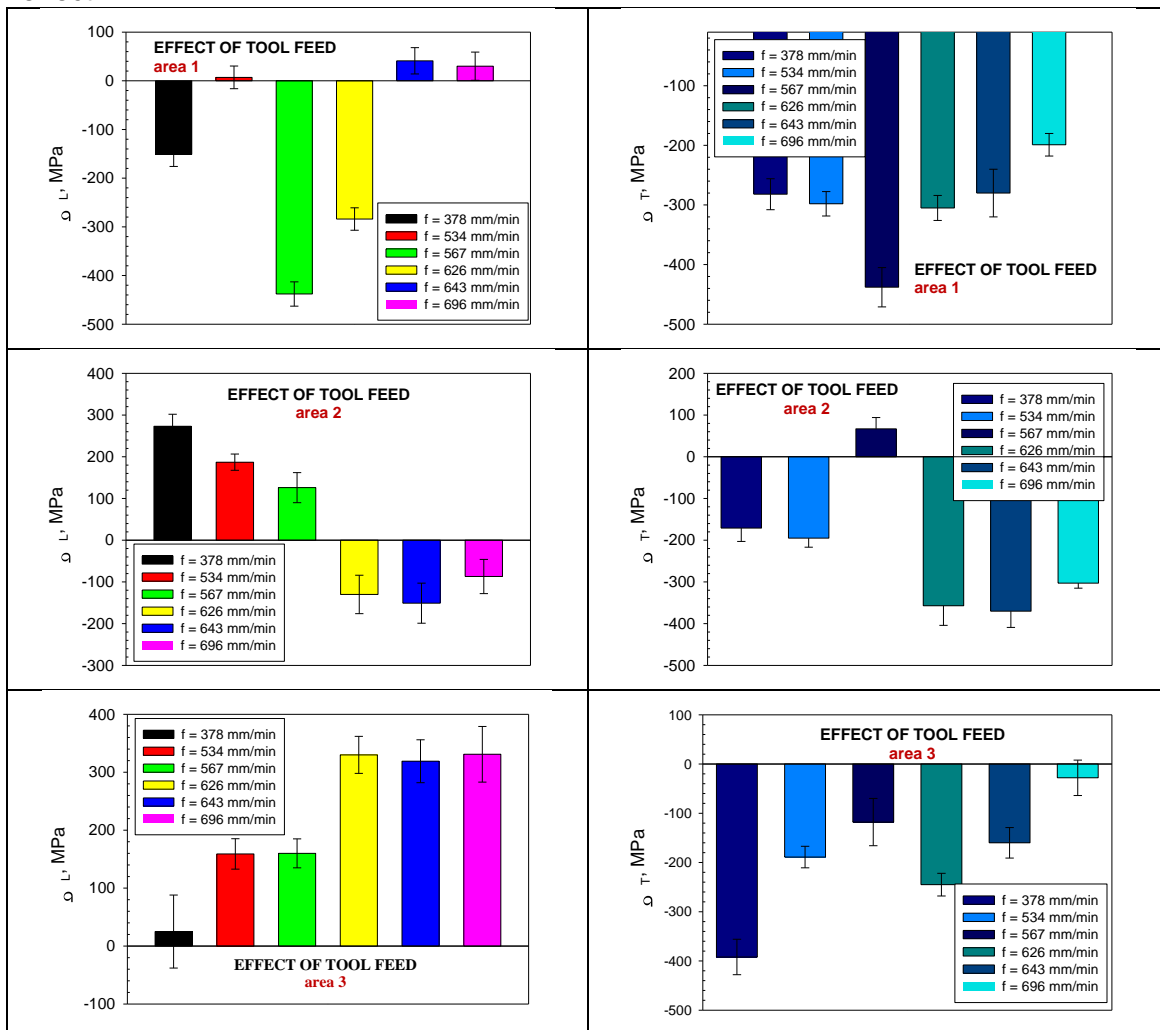

Figure 2. Phase analysis of selected diffraction pattern from area *3* on blade *7*. Phase ID revealed presence of *γ, γ´* and a univalent Metal Carbide (*MC*) phase

5. DISCUSSION

Nickel super-alloys belong to difficult-to-machine materials and are generally prone to mechanical hardening during machining. Mechanical hardening is causing significantly heterogeneous behaviour with manifestations of unstable chip formation or vibrations. Ultimately, the quality of the machined surface is poor which is reflected in shorter service life. Analyses of several surface integrity parameters are only one important step in the process of finding the right machining parameters. Once this is combined with cutting forces measurements and economic feasibility check, a solid ground for new manufacturing process is laid. Here, we present such analyses of initial research stage aiming at 3 axis milling; the other stages will include 4 and 5 axis milling.

X-ray diffraction can significantly contribute to this process by non-destructive assessment of relevant parameters of surface quality. First of all, it offers comparatively fast check of the presence of unwanted phases such as tetragonal σ phase as seen in Fig. 2. Secondly, it is capable of giving information about residual stresses that can be directly related to the surface quality. The results in the chapter above amply illustrate this.

Microstrains and grain sizes are seldom studied in the case of nickel super-alloys machining, even though microstrain strongly correlates with microhardness [9]. Although debatable and problematic, the average values of microstrains and grain sizes reflect the essence of the individual results which is that no significant differences in both measured directions were observed and that area *1* had distinctly lower values of grain sizes.

6. DISCUSSION

- There is no indication in any diffraction pattern of amorphous material presence in the surface layer and only crystalline phases of γ and $\gamma´$ and a univalent Metal Carbide (*MC*) phase were found. Neither the M_6C or $M_{23}C_6$ or the detrimental tetragonal σ phase were present in the surface. Therefore, it has been verified that no precipitation of undesirable phases on the surface after the milling with selected parameters was observed.
- The average grain size (Tab. 3) is the smallest in area *1* and it rises with increasing tool tilt, i. e. in the areas *2* and *3*. This effect of crystallite crushing is caused by the squeezing of the material by the tool that has the smallest tilt in the area *1* of 7°, see Fig. 1 (right), the effective diameter of the tool is here only 1.3 mm with effective cutting speed of 5 m/min. Area *1* is also distinguished by higher cutting temperature.
- Neither monotonous rise nor monotonous decline of *D* and *e* was observed with increasing tool feed, but systematically lower values were recorded when feed reached 534 mm/min. Machining with new tool always led to lower values of *D* and *e* when compared with the worn tool which is caused by more effective cutter edge.
- Macroscopic residual stresses σ_T are in the absolute majority of measured areas, with only two exceptions, compressive. Yet, the stresses in the direction perpendicular to the tool feed, i.e. σ_L are mostly tensile. The notable exceptions are the σ_L in area *1* which are always compressive which is most probably the effect of chip squeezing resulting in much larger tool wear and changes in torque and power values of milling process.
- Tool wear has appreciable effect on the values of residual stresses in both analysed directions. Most likely due to the cutting edge blunting, the values are moving to the tensile stresses, i.e. growing. Only the area *3* in the *L* direction has different character, where the stresses are decreasing towards more pronounced compression. In this area, the cutter tilt is the largest exceeding 42° as seen in Fig. 2 (right) and the mesh is of another kind especially in respect to the geometry of chip formation and overall energetic balance.

- Values of residual stress are sensitive to the tool feed in all three areas *1*, *2* and *3*, but do not follow monotonous dependence.
- The area *3* appears to be problematic, since only unfavourable tensile residual stresses are observed in the *L* direction, see Tab. 4. This issue can be eliminated in the following stage of 4 axis milling. Stresses in the *T* direction are with only one exception always compressive, we therefore suggest to avoid the f = 567 mm/min.
- The residual stresses σ_L have quite oscillatory character on the tool feed value in the area *1*, the surface roughness in this area was beyond the limits of tolerance.
- Considering the area *2*, values of tool feed exceeding 600 m/min seem to be the most appropriate since they result only in compressive residual stresses.

Based on the performed analyses, the following recommendation can be made. For the upcoming stage of 4 axis milling it would be most convenient to use tool feed exceeding 600 m/min and have a similar cutter orientation and work-piece angle as in the area 2.

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INVESTIGATION POSSIBILITIES FOR THE USE OF FREE SOFTWARE FOR DATA PROCESSING USED FOR ACCURATE MEASUREMENT DETAILS THROUGH PHOTOGRAMMETRY

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Abstract: In this report examined the possibilities of using free software for photo processing, through which one can obtain an accurate measurement of the dimensions of machine parts, which typically is used in other areas of science. This study may indicate ways to implement the relatively cheap and sufficiently accurate methods to accurately measure the size of the details that will help reduce the cost of monitoring the accuracy and quality of machine parts.
Keywords: Measurement Accuracy, Industrial Photogrammetry, Stere Photography, Free Software.

1. INTRODUCTION

The problem of controlling the dimensional accuracy of the machine parts stands always in the focus of research since its significance in terms of guaranteeing the quality of the final products is essential, and the time required to perform control operations is about 90% of the time for production.

Using traditional contact measurement methods leads to significant measurement uncertainty, which is mainly due to the wear of the contact surfaces of the measuring instruments, errors in reading of errors from temperature deformation, etc.

In the non-contact measurement methods this type of error is minimal or even missing a precision measurement and significantly higher. Usually measuring instruments for non-contact methods work on the principle of optical transformation of information or laser scanning, the price of these devices is high, and the requirements for the environment in which they work are essential.

Using the principles of photogrammetry in technical measurements and to determine the accuracy of the dimensions of machine parts is still in its early stages worldwide [1]. This principle is widely applied in the field of cartography, architecture and more. The basis of the method stands the use of photographs taken on the preliminary plan and coordinate pre-orientation that are processed with specialized software. During this process, define a reference point against which to calculate the coordinates of multiple points from the object so as to obtain a spatial image. Many companies develop and market software for such treatment [5]. Some of the programs are free for non-commercial purposes.

The aim of this study is to identify opportunities for the use of free software designed for handling photographs, through which it is possible to obtain a three-dimensional image of parts that has the appropriate quality for subsequent measurement of its size with sufficient accuracy.

2. PROBLEMS USING PHOTOGRAMMETRY FOR IMAGING CONTROLLED OBJECT

The main method in the display of machine elements in mechanical design is orthogonal, in which the received image (projection) of the object is uniform in shape and size to the object. However, measuring surfaces of the projection can be deduced for their accuracy.

Photography, in its broadest sense is a process that converts three-dimensional world in a two-dimensional image. The camera is a device that makes the transformation or mapping from three in two sizes. Unfortunately we are unable to present fully three-dimensional world in a two-dimensional plane, so part of the information is lost (usually depth /height). In photography, the principle of design is a perspective in which the image on the picture is a different size, depending both on the distance between the camera and the object, and the size of the object [2].

In order for a single image of the object to determine the size of a geometric an amount necessary to ensure the availability of a number of factors:

- To the subject of the photo is a second object that has at least one known exact size. As objects-standards commonly used Linear measures trailer;
- The camera and the subject to lie on a straight line. This requirement is related to obtaining distortion as a result of the method used;
- Be provided with required lighting level. In case of insufficient light dark spots appear that blur the contours of the objects, and in artificial lighting is shadow. This hamper reporting dimensions;
- To comply with the focal length of the lens. Vague contours lead to inaccuracy in determining the size of the dimensions.

Research in this field has been published in [3], where are formulated conclusions that although limited information which gives using single image of an object can be determined with sufficient accuracy the size of an object in two axes (in a plane). It is forthcoming conducting further research to establish the impact of the above mentioned factors over the quality and accuracy of the image of the object.

Photogrammetry, in its broadest sense, is the reverse process of photography. It converts two-dimensional image back into a real three-dimensional image. The principle of triangulation is widely used in photogrammetry, wherein the intersecting lines in the space are used to calculate the position of the point in the three directions.

Sometimes, due to the loss of information in the process of photographing the reconstruction of the object cannot be done from a single photograph. As a minimum, is required at least two different images - then the method is called stereofotogrametriya. In this way works, for example, the software "StereoScan" [4] of the Russian company Agisoft. It uses two images of the same object taken at a certain angle, one is assumed to be left (fig.1.a) and the other - for the right (fig.1.b). After processing the input data with the program receives partial spatial object model (fig.1.c).

From the shown example it is obvious that the received result does not contain the full geometric volume information of the object, and that it depends on the size of the angle at which the two images are made. This angle is limited by the requirement to obtain the necessary minimum number of pairs of reference marks for recognition and reconstruction of the image. The images are partially due to the small volume of an input. The software works with stereo images.

a)

b)

c)
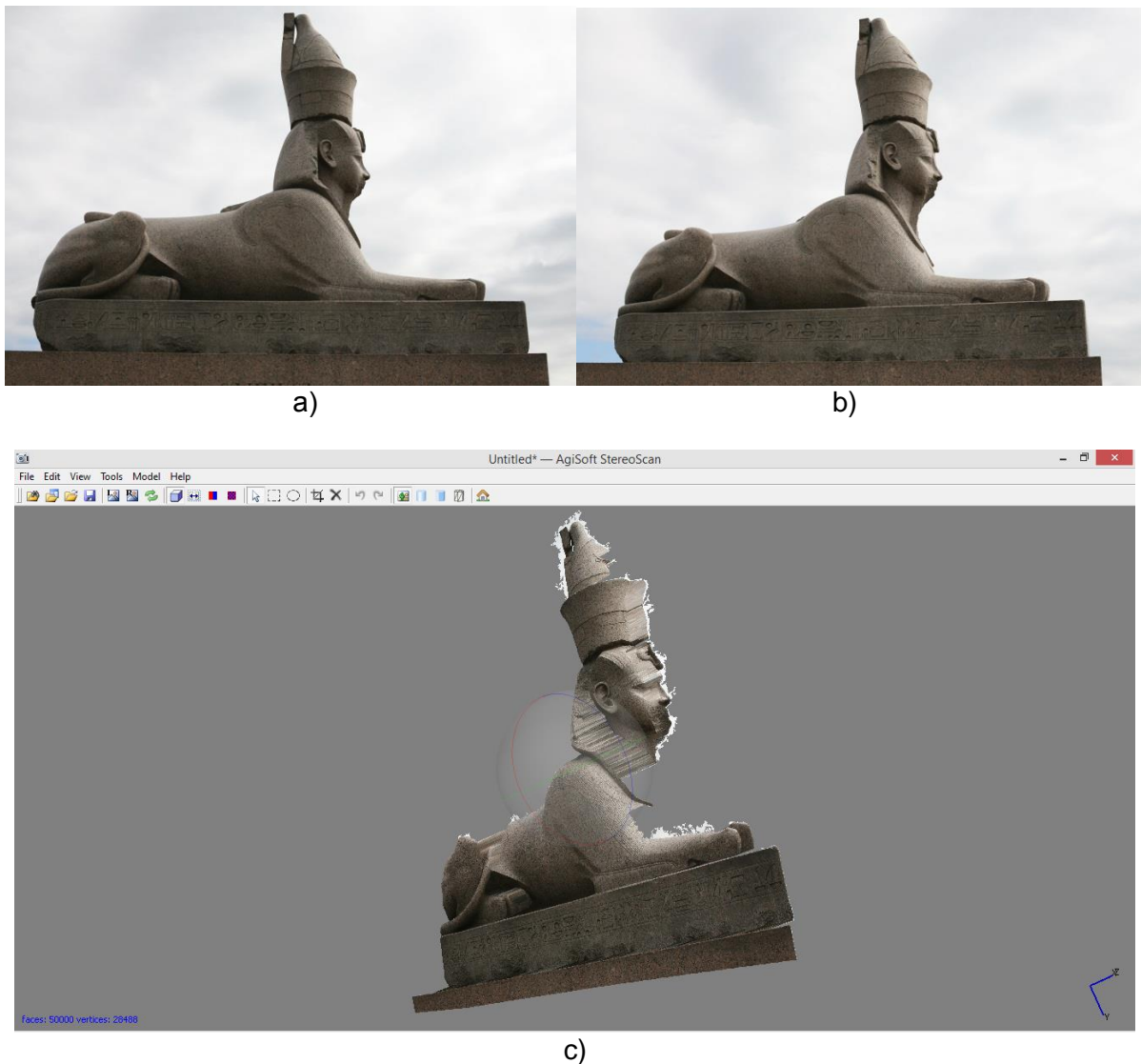
Figure 1. Receiving stereo image using StereoScan:
a) and b) – single photos; c) stereo image

The foregoing is substantiates the necessity of using more than two photographs to improve the quality and accuracy of the reconstructed volumetric model. Used photos, addition to meet the above requirements must be made prior plan so as to obtain a certain overlapping of images, which is a requirement of processing and identification of selected reference marks in the reconstruction model. Mathematical calculations are performed by software programs which with the principle of triangulation calculated coordinates in three-dimensional space of the reference points. The different software have different restrictions with regard to required number of photographs. This is one of the directions in the development of modern photogrammetry - the use of a less expensive and of lower quality photographic equipment is compensated by an increased number of photographs from which to extract the input information.

As a result of the processing is obtained "cloud" of points that describe the geometry of the object. Depending on the software, the visualization of the model can be different. With this reconstructed object is obtained with a comparatively more accurate shape that could be used to measure dimensions of the object.

3. EXPERIMENTAL STUDY OPPORTUNITIES FOR USING OF FREE SOFTWARE FOR PROCESSING DIMENSIONAL INFORMATION OBTAINED THROUGH PHOTOGRAMMETRY

The purpose of this work is to explore the possibilities of using free software for processing photographs series, so as to obtain a three-dimensional model by which can determine the dimensions of the physical object. In practice there are a number of expensive programs that are specialized in different fields - architecture, construction, mapping, etc. but in technical measurements there is no. As a result of this work, it is expected to provide a relatively inexpensive and uncomplicated process for the use of photogrammetry to determine the accuracy of the dimensions and shape of the articles.

There were studied different programs available on the market, such as. Russian software company "Agisoft" - "StereoScan" (Figure 1), "SURE" - Photogrammetric Surface Reconstruction from Imagery - software developed by the Institute of Photogrammetry, University of Stuttgart, "MY STUDIO" - an online platform for creating three-dimensional models and such others, but in the end studies were concentrated mainly on the products offered by the American company "Autodesk Inc. ", which produces a relatively wide range software and some of them are free, and for frequently used programs in practice there are free student and university licenses.

For initial processing of a set of 70 images was used software "Autodesk 123D Catch" [8]. Figure 2 shows a visualization of the image, generated by a cloud of reference marks, obtained after processing which is performed in real time via an online platform. After registration it is possible to work with 3D web browser or the program can be downloaded and installed on a local computer. In both cases the mathematical treatment of the data is performed on-line by the method of cloud computing, which is not burden the computer hardware configuration. Through compulsory registration the user has access to his gallery, generated from earlier models or models developed by other users.

The software limits the number of images - from 20 to 70, which must be positioned at different angles while preserving the stationary state of the object, it is necessary to cover the object as many possible angles.

Besides the above mentioned requirements regarding the quality of the images is needed the captured objects to possess a sufficient number of reference marks to serve in processing. If the object is into one color nuance as usually machine parts are, it is necessary to use a background that adds the required number of points of comparison. In Figure 2 are used as the basis elements with contrasting colors to obtain relatively high-quality image. With the preview of the received image is able to trace and the location of the camera while shooting.

If the processing of images software fails to find a pair of reference marks in the adjacent images, they are marked with a yellow triangle then it needs to manually specify the position of these points on at least three photos.

The thus obtained image consisting of a plurality of points with known coordinates is not yet a solid model of the object. The next step is the receipt of a mesh model for which may use a plurality of software products. This study was carried out by treatment program "Autodesk Meshmixer" [6]. This is also free software developed by the company "Autodesk Inc.", which is designed to create objects for 3D printing by creating models. This can be obtained by using three-dimensional primitives or generated "clouds" of points, as in the present study. The result of the processing is shown in Fig.3.
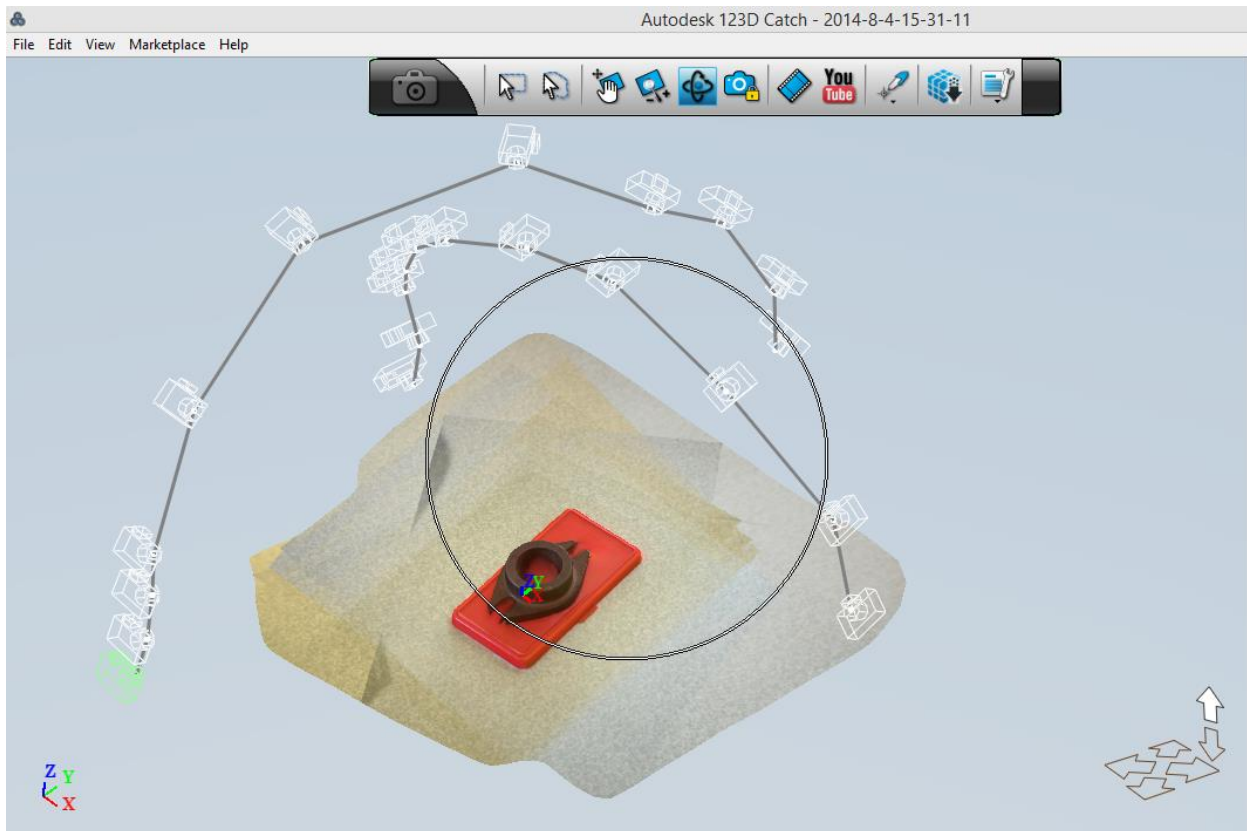
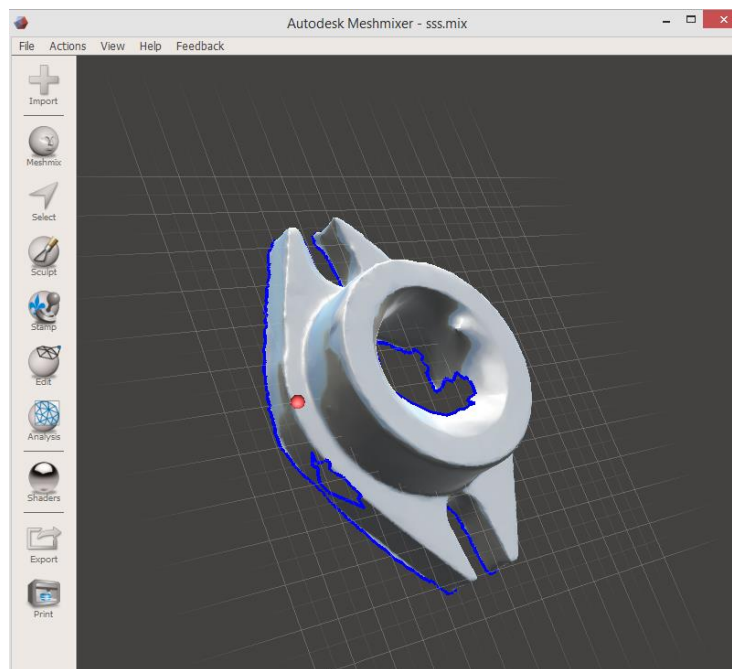Figure 2. Visualization of the reconstructed model using "Autodesk 123D Catch"

Figure 3. Mesh model of the object obtained by treatment with "Autodesk Meshmixer"

With this software can correct some defects in the surface of the object, to perform some analysis in terms of continuity and thickness of the walls, strength calculations and mechanical characteristics, can be edited grid by setting a desired density, to define the type of the material and etc. Here, however, there is no possible to measure the lengths of individual elements of the model.

The next step was to the received model to be imported into the "Autocad" [7], where has possibilities the mesh model to be transformed into a surface or solid object, then using sizing commands to assess the accuracy the obtained model. For this purpose it was necessary to use a converter to change the file format from "obj" in a format known to "Autocad". This was done with "Autodesk FBX Converter x64 2013" [9] creating files with extensions ".FBX".

Figure 4 shows the image that was obtained by importing a mesh model of the object in the "Autocad" as a block that allows its handling. Here we clearly see that the model lacks parts of the surface due to poor recognition of pictures with "Autodesk 123D Catch" - some of them were of poor quality, insufficiently illuminated and insufficient focus.

The next step is the transformation of the mesh model, and "AutoCAD" offers the possibility to convert into a surface model or solid body. In both cases, after that, using the commands for dimensioning it is possible to visualize the size of the regenerated model. The result of the transformation of the mesh model in the solid body by the command "Convert to Solid" is shown in Figure 5, and the resulting model is enlarged in proportion to the actual detail. That is possible to calculate the scaling factor by which the model be adjusted and to obtain a precise, in dimensions, image identical to the current physical detail.
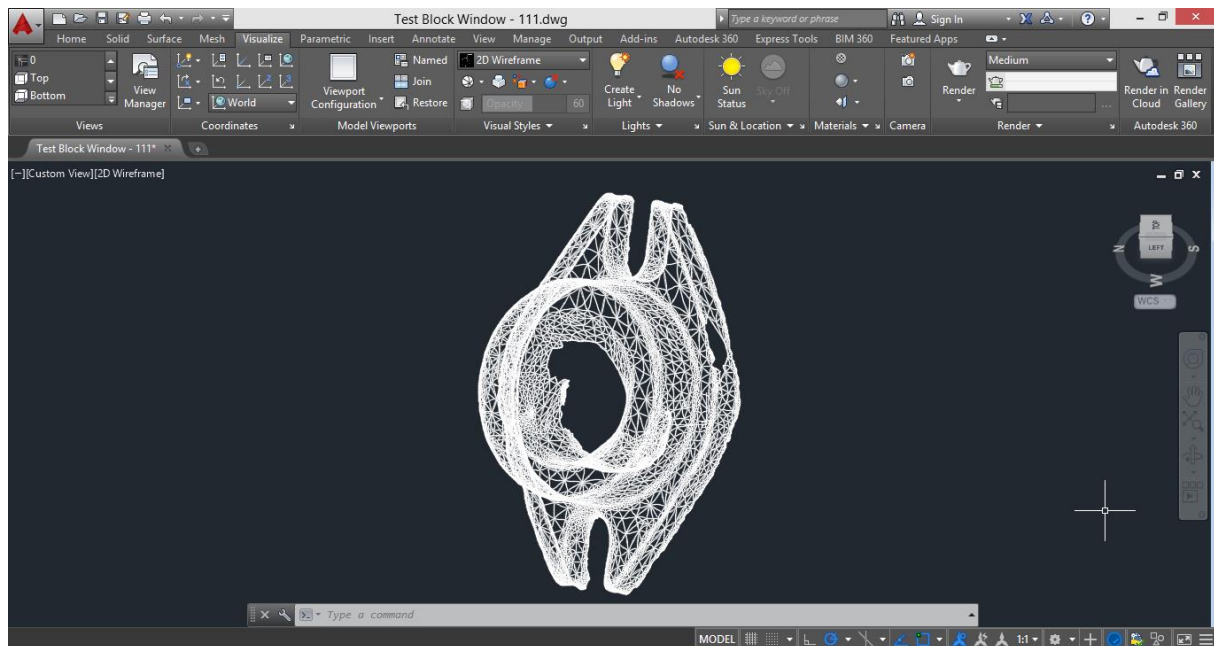
Figure 4. Importing of the mesh model of the object in "Autocad"
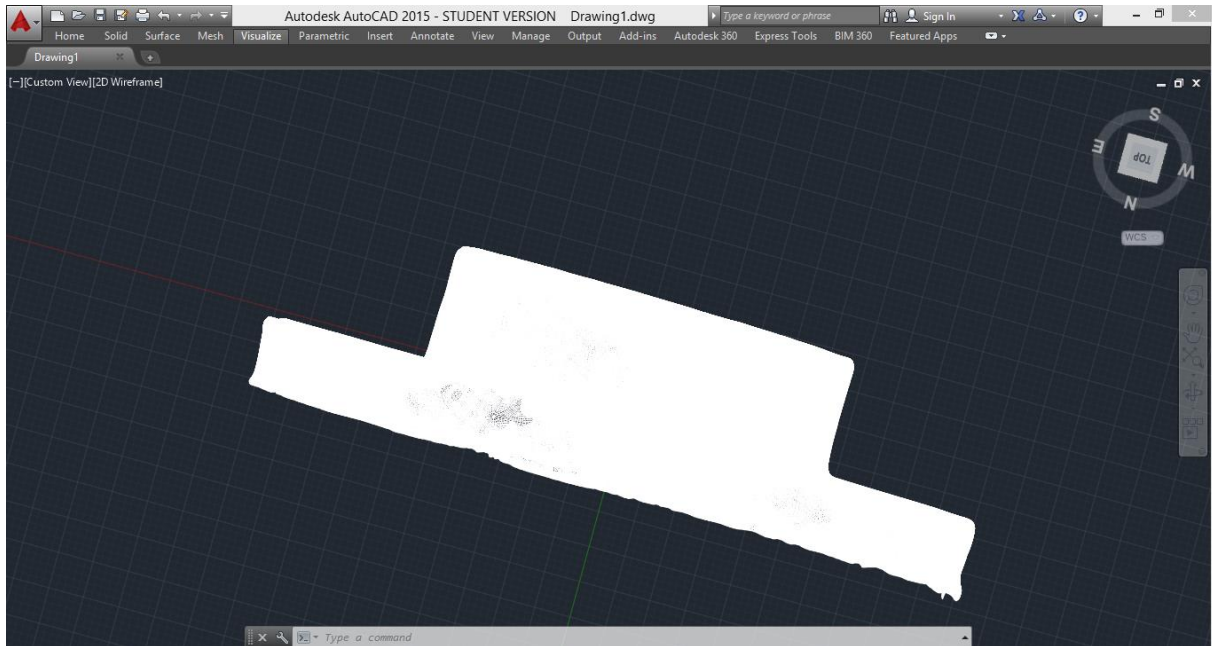
Figure 5. Regenerated solid model of the object in the "Autocad"

4. CONCLUSIONS

As a result of this study, was established that it is possible by using free software from the set images to regenerate the three-dimensional model of an object from which to obtain dimensional information with sufficient accuracy. Thereby it is providing an inexpensive and quick method for performing metrological control the size and quality of the machine parts with relatively small sizes.

In the working process was identified a number of problems whose solution identifies the following research tasks:

- It is necessary to prepare a preliminary plan for accurate capture of the object so as to obtain consistency and continuity in the sequence of photographs, which will ease the process of reading;

- It is necessary to solve the problem of the illumination, so that the surface of the parts to not produce bright spots and to avoid a "shadow". The solution can be sought in two directions: to seek a solution with respect to the light source or to conduct experiments with different shooting modes - aperture setting, flash, exposure and etc.;

- In conducted study on the final stage of processing model was obtained a file with a large volume, which impedes its treatment – it must study the causes and propose a suitable solution.

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ARCHITECTURAL FASHION AS A HERALD OF NEW TECHNOLOGIES AND INNOVATIONS OF THE FUTURE. GEOMETRY, COLLABORATION AND INTERDISCIPLINARY APPROACH IN FASHION DESIGN IN THE XXI CENTURY

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Abstract: *The phenomenon architectural fashion exists in different forms in the world fashion design. Ever since the appearance of the Japanese deconstructionists the influence of architecture on fashion has emphasized technologically the innovation and unique technique of the clothing construction.*
In contemporary fashion and the reality of the XXI century the so-called "architectural garment" is composed of plenty of specific components as well as from the point of view of composition in fashion and in purely technical aspect and execution in material.
Architectural fashion has turned into a herald of the latest technologies and innovative intelligent textiles from the future which enable designers to experiment and collaborate with specialists in different disciplines of science and art and to achieve as an ultimate result ultra modern and futuristic designs.
This would be unconceivable if interdisciplinary approach, free collaboration and creative experiment didn't exist as a trend, without which architectural fashion wouldn't have this impact on the younger generation of designers.
No doubt they expose their preference for minimalism, geometry and the experimental methods of construction such as the moulage, free assembling and sculpturing the shape and silhouette.
Fashion awareness as a three-dimensional art object brings about transcending of practices from architecture designing to fashion and vice versa, which can be defined as parallel and mutual devices.
The effect of architecture and three-D can be attained in every possible way but mostly by experimenting and looking for a new technological way of execution of the design project which very often is an author's development and a result of collaboration among several experts.
In this report the attention will be drawn to selected designers from different generations and ethnic groups, culture and background whose work would be identified as architectural fashion with interdisciplinary origins.
Keywords: *Aarchitectural Fashion, Three Dimensional Art Object, Collaboration, Experiment, Interdisciplinary Approach, Sculpturing, Moulage, Geometry.*

1. INTRODUCTION

1.1. Architectural fashion as a herald of new technologies and innovations from future

Since designers and other practitioners have been transforming traditions from the past into a new inspiration for the present moment of modern times they have put a new symbolic role and direction of the fashion of future.

Surfaces from industry for the production of robots, microelectronic circuits, conductor fibres and elastic sensors sound like symbolic materials for Computer Studies, but in the hands of designers and technologists they turn into a raw material for some of the most state-of-the-

art garments produced nowadays. When these materials are combined with high-performance fabrics they can be transformed into keyboards of cloth and wearable computer systems which define the fashion of future.

Architectural fashion plays a significant role in this cultural discourse, although interactive technologies and devices for communication have been represented in the form of mobile devices and built structures, several fashion labels integrated in their products communication technologies and microelectronic systems which made fashion interactive.

Many designers have collaborated with technologists to integrate electronic parts in the clothes they design while others are creating a new synergy between the garment and the wearer through interdisciplinary methods.

The new generation of designers reorganize the forms, silhouettes, materials of the future transforming clothes from passive to active technological instruments.

Radical reinterpretations of fashion design set up groundbreaking silhouettes with surfaces which contain a potential for a new creative expression and have new functions close to the characteristics of architecture and three-dimensional art object.

Technologies with shape-shifting functions integrate new silhouette lines and change the way the wearer responds in a particular environment. As a result today the garment forms a microenvironment around the body. The new dialogue between the body and the garment is developing in contemporaneity driving fashion and its potential to function as an electronic device designed in collaboration with the necessary specialists.

Although today clothes are perceived as individual structures, the technological interfaces characterizing them will make them parts of global systems.

2. METHODS AND EXPERIMENTAL PART

2.1. Geometrical silhouettes and structures producing an architectural effect in the garment

The newest fashion trends link contemporary science and technologies calling forth collaborations between physicists and mathematicians.

The physical characteristics of fashion are easily defined through the three dimensions: length, width and depth, but fashion also resonates and echoes in the fourth dimension – time as well. These factors create the sensation for fashion as experience and event situated in time and space, which, coming into appearance exceeds their limits.

Issey Miyake has proved himself to be a fashion innovator who is continuously provoking the existing explanations of it and thus opening new horizons. The Japanese designer has a fresh look on the meaning of clothing and a new way of thinking and perception of fashion. Miyake pays attention to the moment when the garment is worn and to the effect it produces on the observer. This is the moment when fashion 'comes to life' and he describes this experience as part of the fifth dimension which hypothetically exists in physics. Thinking about fashion this way he takes us to the idea that fashion cannot be perceived isolated from time and space. Myake's concept about the fifth dimension is immediately expressed in his work. He collaborates with a Japanese computer specialist who creates a software program which constructs three-dimensional geometric forms from a piece of paper. The project is called '132 5' and its name reflects the idea of different dimensions in the way fashion exists nowadays. The first dimension is the flat piece of cloth, the third dimension is the three-dimensional form it turns into .Reducing it to a two-dimensional geometric form obtained by pressing we go back to the perception of the second dimension, and the fifth dimension is the moment of unfolding and wearing this complex three-dimensional figure. The 3-D forms of the clothes made for the project '132 5' are mathematically translated into two-dimensional geometry from which a pattern can be created. By a slight unfolding a complex construction

with architectural character and sculptural effects is displayed. For the 2012 collection Issey Miyake uses recycled materials, fabrics and fibres which add a more alternative look to the fashion objects.

In '132 5' project Issey Miyake is focused on the innovative aspect of fashion achieved through scientific research, inspiration from the environment and the mathematical precision in nature. With the ultra modern ideas in fashion the label was presented with the award for design of 2012. The latest spring/summer 2014 collection is a composition of explorations emphasizing the new fabric structures of the square, the grid and the frame putting them together and the final result is composing around the concept of the word 'union'. The base of inspiration forms is developed together with the architecture of MDRDV and the products of Ronan and Erwan Bouroullec. The movement of newly launched fabrics such as the new jacquard, produced from recycled polyester gives the original spirit of the line revealing the complexity of each garment. The line '132 5' adopts a new image and development in the new 2014 collection increasingly articulating associations with architecture and urban environment.

The surface structure of a fashion object also can evoke parallel with architecture and the surroundings. Apart from that it can be perceived as a peculiar shelter of the body and a mini-built environment. In his book "Fashion Futures" Bradley Quinn analyses this phenomenon in terms of development of technologies and the so called 'wearable technique'.

If a garment is an extension of the body, then its surface is an extension of the skin. Fashioned skins whether made of leather, fur, natural fibres, metal fibres or synthetic materials, are surfaces loaded with meaning. Fashion surfaces can be multilayered and multidimensional, and be designed to invite the gaze or to deflect it…

… With the advent of wearable technology, fashion surfaces are revealing their potential to do more than simply decorate the clothing they cover. They are becoming information hubs capable of gathering data from the environment around them, and able to exchange data with other technological systems. [1]

Another interesting parallel between architecture and fashion is caused by the phenomenon 'shifting silhouettes' characteristic of Iris Van Herpen and architectural fashion. The complex constructions made of 3-D printed elements configure complicated architectural forms or advanced figures which appear different depending on the point of view. Multielement constructions forming new silhouettes around human body with different proportions from its natural architecture.

Some fashions disguise the body altogether using rigid materials to redefine it radically, or to cocoon the body in garments with architecture-like proportions.

…In recent year, leading designers have revived interest in form-fitting styles and dramatic silhouettes.

…New lightweight materials are introducing the notion of weightless volume. Fabrics that are stiff yet flexible make it possible to create large silhouettes without compromising wearability or manufacturing techniques.

…New computer-aided design tools, algorithmic modeling and mathematical software scripts make it easier to design layered structures, to fold flat planes and to create unusual angles that craft strikingly geometric silhouettes generating fragmented shapes that create angular surfaces and bold lines around the body. [2]

An example of architecturally manipulated silhouettes with a display of structural fragments organized around the anatomy of the human body is the work of Irina Shaposhnikova and her "Crystallographica" collection (2009). The garments are executed in cotton, wool and silk organza fused with synthetic materials that highlight the body outlines. Irina Shaposhnikova configures again the contours from conventional fashion in rigid geometric forms which remind us of architectural environment or architectural surfaces.

A beautiful play with geometry, sculptural effects and asymmetrical silhouettes are a precise definition of the 2010 collection of the designer Amila Hrustic. She studies in great depth the potential of the geometric silhouette following the natural body lines with three-dimensional geometric figures closely arranged next to each other. They get involved in the silhouette formation and the building of a multi-dimensional surface of the garment. As a result a field of 3D forms enabling the wearer to find himself in an unexpectedly powerful geometric silhouette is obtained. Geometry here also creates the feeling for a certain environment formed by the body architecture.

The Balkan designer Alice Zixxheddu has drawn inspiration from the geometry of nature creating a fashion collection called 'Living clothes'. These are conveyed refractive nature forms which she has observed in mineral crystals and glaciers. Zixxheddu uses a 3D software to translate these forms in the clothes enlarging and twisting geometry to achieve dramatic textures and volumes, and incorporating in the garments light sensors which cause changes in the form of the surfaces. Zones from the surface combined with memory materials activated by wireless technology are folded and flattened as a response to light shaping the silhouette of the clothes.

Based on the idea of 'hybridity' – hybrid clothes for a hybrid body – the architecturally designed clothes define a new aesthetic. In addition she has incorporated technology into the clothes such as light sensors that allow 'memory' textiles to pop up and collapse, changing silhouette in response to light.

Another example of the 'shifting silhouettes' effect as part of architectural fashion is the work of the based in Australia designer Eunjeong Jeon who introduces natural fibres in technology – work related to her PhD thesis – to create transforming kinetic clothes shaping new silhouettes. Sensor monitor detects the muscle movement, breathing, heartbeat and temperature of the body aiming to intersect when the wearer feels discomfort. The collection is called 'Trans – for –M- otion'. The clothes respond automatically closing around the wearer to foster a greater sense of security. As a result the form of the silhouette depends directly on the wearer's sense of wellbeing virtually enabling him' to wear his heart on his sleeve'.

Working with wool felt, her garments replicate three-dimensional geometric shapes to create a design that hopes to elicit an emotional response from the wearer. The philosophy of her work is anchored in an understanding of applied emotional aesthetics to cognitive image processing of human interaction, associated movement and response. [4]

One more example of architectural silhouette and high technologies implementation are the objects of Iris Van Herpen.

Dutch designer Iris Van Herpen, who is known for her sculptural silhouettes and pioneering use of digital technology, started her own label in 2007 following a stint at Alexander McQueen. Her work proposes fresh directions for fashion, combining traditional tailoring techniques with new materials and innovative construction processes. Van Herpen used 3D printing technology to design and fabricate her Escapism collection (Autumn/Winter 2011-2012). [5]

In the interview given specially for Bradley Quinn's book 'Fashion Futures' in 2012 she talks about the technology of creating her collection, the use of industrial materials and generally the new tendencies in the work of the new generation of designers. Her answer to the question how the new materials influence the direction of the fashion development is:

Exploring new processes and new materials enables fashion to move forward. For example, my Escapism collection emerged as the result of seeing what the possibilities of using 3D printing within fashion would be. The 3D printed dresses I designed were not intended for everyday wear, simply because the material they are made from is fragile. 3D printing technology has advanced since then, making it possible to print clothing in flexible thin rubbers. I think it is only a matter of time before it will be possible to 3D- print washable fabrics, and after that there will be a huge shift in fashion.

Iris Van Herpen reveals more of the process of creating her collections furthermore in terms of technologies and their influence on designing.

Technology creates new design possibilities and innovative materials. It brings me the opportunity to collaborate with architects and other design companies.

…When I experimented with 3D printing, my ways of designing changed radically. The drawings of the 3D printed dresses had to be translated into milimetre details in the computer, forcing me to use a technologised process that is the opposite of drawing and pattern-cutting freehand.

Curiously, her works are extremely light and fragile in spite of the big and complicated volumes. Van Herpen's spring/summer collection 'Crystalyzation' is the first in which she shows clothes made in 3D-printing technology, for which she collaborates with architect Daniel Widrig and digital manufacturer MGX. She continues working with them in her collection 'Escapism' for autumn/winter 2011- 2012. In spite of their volumes and mass the separate objects are extremely light and their exact symmetry shows the precision with which the 3D-printed dresses can be produced.

Architectural fashion can be also defined as such by the highly technological materials used for their creation. The so-called 'intelligent' fabrics and ' high-performance' fibres combined with conductive materials can transform clothes into interactive devices which are wirelessly connected to other systems assembled with active materials which have the possibility to communicate and react, to change colour, texture or shape.

The high-technologies materials give clothes a list of new opportunities expanding their functionality and appearance. Exciting colours and surface patterns can be made of fabrics which are computer-woven with optical fibres or light-responding diodes which can be programmed to reconfigure, to pulsate or to illuminate.

Textiles engineered by scientists and micro-biologists can respond more to the question about being than perform their function of fashionable cloth, they can even cover the body as a second skin produced by a certain bacterium.

These crossover materials mark a specific moment in fashion in which clothes begin to be characterized by hybrid forms and themselves to connect as a complex of multi-facet hybrids technologically. This derives from the multi-functional nature of contemporary experimental fashion and defines it again as synthetic art and production of multi-cultural and multi-media character.

Volumes and silhouettes can be created from shape-shifting materials but could be designed by simply folding the cloth using the principles of origami as well to convey a sculptural architecture effect. A good example of such technological processes and concept is the work of Diana Eng, who uses low-tech methods such as the working out of the Japanese astrophysicist Koryo Miura. The line they create with Miura is inspired by biomimetics. Diana Eng uses also high-tech processes like laser-cutting for a series of tops and T-shirts.

The laser offered the perfect solution to creating precision lace patterns.

…I created the shirt designs around the quality and look of the T-shirt fabric after it went through the laser distressing process. I noticed that the fabric patterns became stretched out and sometimes looked completely different from the original laser cuts. So I looked at floral anatomy and botanical cells for design inspiration. [6]

An interesting technical experiment in Diana Eng's work is the use of so-called deployable structures which she incorporates in some of the fashion objects from the 'Fairytale' collection. Close to origami but inspired from biomimetics they give an architectural sculpture effect as details of clothes.

In terms of technologies and the topic of map-making and introducing in the form of scheme the contours of human body by using laser-cutting the latest working out belongs to 'Skin Graph'.

Skin Graph's technology uses motion capture and thermal scanning processes to create 3D representations of the body. A parametric modeling program then converts the 3D model into a topographical diagram, which maps out the wearer's contours much as a cartographer would chart a landscape and portray it on paper. The resulting template draws the human body mathematically, representing it as lines, cones, circles and spheres that form the basis of a dress pattern. The pattern is subsequently 'cut' from leather or cloth by lasers, and the pieces can then be stitched or bonded to create a uniquely individual garment. The clothing that results fits the wearer as well as any bespoke garment, moving with the body as though it were a second skin. [7]

The cartographed and captured as a scheme in a mathematical way human body and the converted into cut-pattern laser contours give architectural sound as well as stern individuality to the clothes. Not only because of the architectural principles of designing but also as a mathematically developed proportioning which is in harmony with body architecture, these clothes possess architectural character. The use of laser-cutting and proportioning are techniques borrowed from architectural designing, but here they are implemented creatively in the mini-structure of the dress.

3. RESULTS AND CONCLUSIONS

3.1. Conclusions drawn from the analysis of the selected authors, considered as examples of architectural fashion with an interdisciplinary approach

All these examples of designers' work and formations of a new generation of collaborations between different specialists are proof of interdisciplinary approach which was imposed in the first decade of the XXI century and of the innovative place conquered by architectural fashion on the fashion podium. The combination of different media and technologies in the execution in material of a particular conceptual platform in the specialized aspect of architectural fashion leads to the fusing of different disciplines with the art of fashion, designing and spheres of science, which reflects on the synthetic nature of fashion and its self-determination and status.

The search of innovation not only in the vision by some authors but in terms of technology in the choice of materials and innovation in construction with radically new methods and technologies creates the new face of fashion design of the XXI century. The new generation of designers also forms the contemporary history of the high-tech multi-functional garment as well as the nature of fashion, inspired by architectural environment, construction and surfaces.

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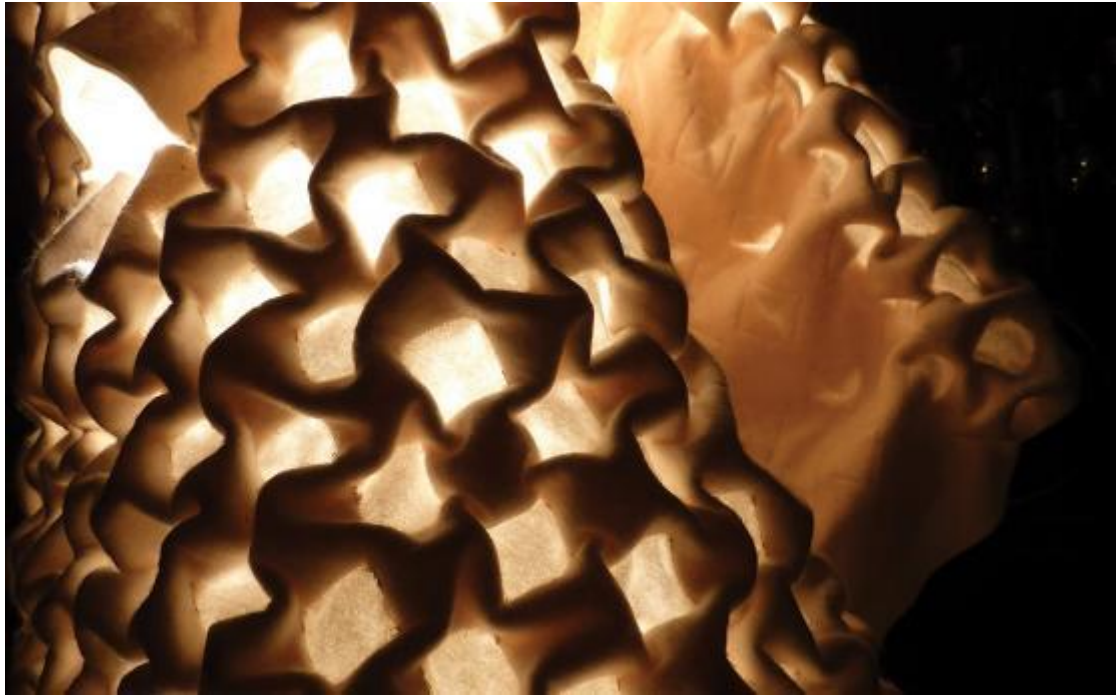Issey Miyake – "132 5"

Irina Shaposhnikova "Crystalographica"

Amila Hrustic

Alice Zikedu

Eunjeong Jeon

Iris Van Herpen

Diana Eng

Skin Graph

FIBONACCI ROSE IN FASHION DESIGN

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Abstract: The papers presents design of ladies' dresses using the Fibonacci series tiling with triangles named Fibonacci rose. As a result of the use of Fibonacci rose for designing of aesthetic, beautiful and harmonic clothing, it can be concluded that in fashion design Fibonacci rose can be used in different ways of colour combinations, proportions toward the clothing sizes, and as a frame of creations of design elements.
Keywords: Fashion Design, Fibonacci Sequence, Fibonacci Series Tiling, Fibonacci Rose.

1. FIBONACCI SERIES TILING WITH TRIANGLES – FIBONACCI ROSE

The proportions of Golden ratio and Fibonacci sequence associate harmony and beauty and by this reason they are used in design.
The Fibonacci numbers are the sequence of numbers $\{F_n\}_{n=1}^{\infty}$ defined by the linear recurrence equation

$$F_n = F_{n-1} + F_{n-2} \tag{1}$$

with $F_1 = F_2 = 1$. As a result of the definition (1), it is conventional to define $F_0 = 0$.
The Fibonacci numbers for n = 1, 2, ... are 1, 1, 2, 3, 5, 8, 13, 21, ... [2]
Fibonacci sequence is used in the creation of geometric objects. There are some versions of Fibonacci series tiling, which are constructed with equilateral geometrical figures – squares or triangles, as the sides' lengths are equal to the numbers of the Fibonacci series, or the lengths of the sides of the squares or equilateral triangles are each to other in proportions, which are equal to Fibonacci sequence. The version which uses equilateral triangles to form a double-spiral is shown in figure 1. [1] This tiling version is named Fibonacci rose.
The papers presents design of ladies' dresses using the Fibonacci series tiling with triangles or Fibonacci rose.
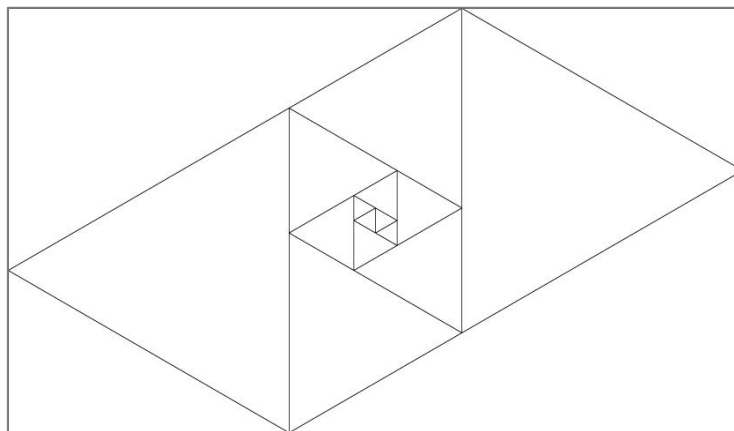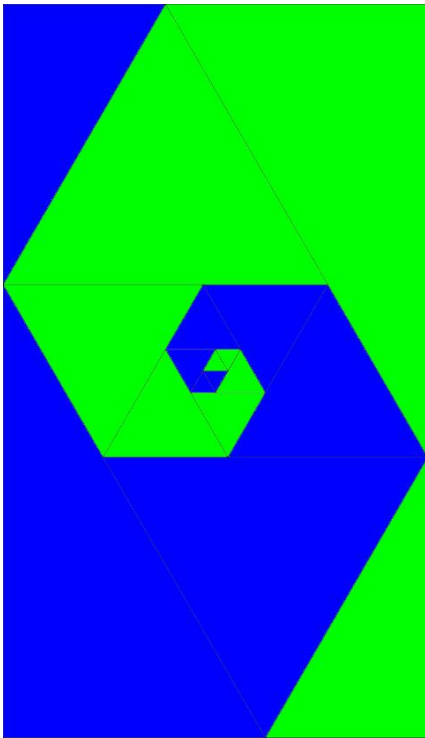

Figure 1. Fibonacci rose

Figure 2. Fibonacci rose with different coloring of the both spiral forms
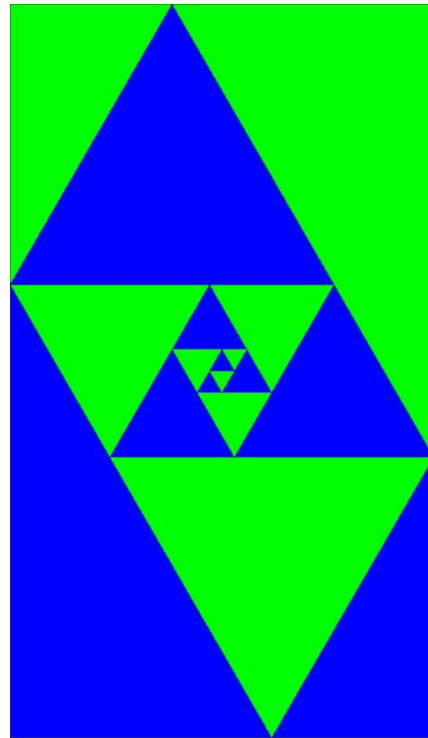

Figure 3. Fibonacci rose with difference of coloring of triangles in the both directions
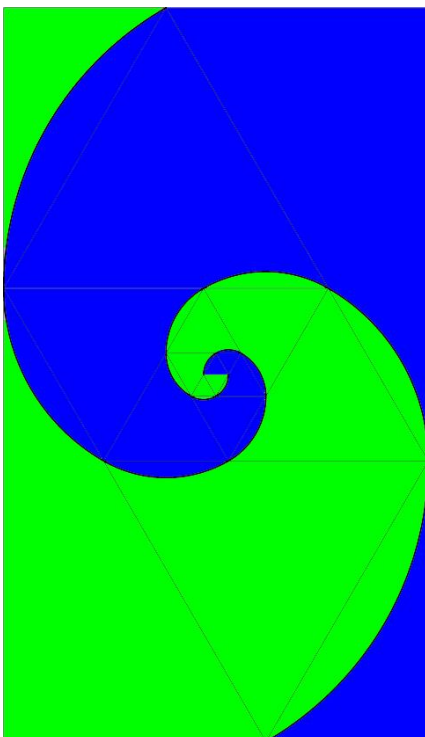

Figure 4. Double spirals formed with curved lines around the both Fibonacci rose spirals
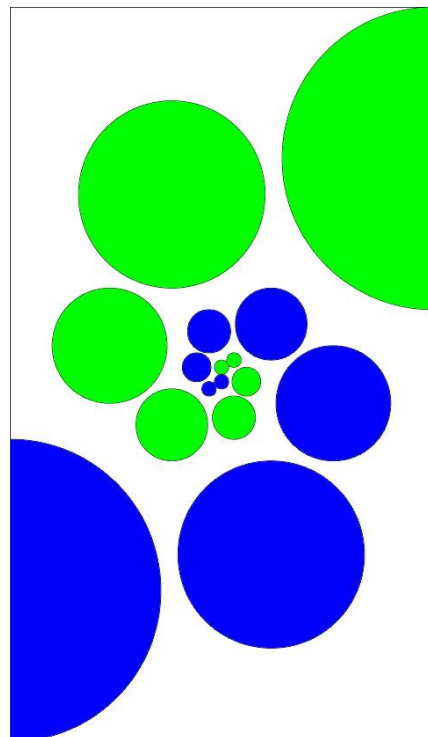

Figure 5. Double spirals formed by circles which are entered in Fibonacci rose triangles

2. FIBONACCI SERIES TILING WITH TRIANGLES OR FIBONACCI ROSE IN FASHION DESIGN

Figures 2-5 show different pattern designs which are created on the base of Fibonacci series tiling with triangles Fibonacci rose. These designs are directly used in creation of new models of ladies' dresses.

Figures 2 and 3 present the both variants of double coloring of Fibonacci rose.

In the variant which is shown in figure 2 the both spirals of Fibonacci rose are colored in different colors.

In the second variant which is presented in figure 3 the triangles in the both directions are colored in different colors.

The design of the lady's dress presented in figure 6 uses the model of coloring, shown in figure 2, in which the both spirals of the tiling are colored in different colors.

The creation of the lady's dress presented in figure 7 uses the second model of double coloring, shown in figure 3, in which the triangle in the both directions are colored in different colors.

Figure 4 presented a use of Fibonacci rose as a frame. The double spiral, which is designed with curved lines, is formed around the double spiral of triangles in Fibonacci rose. This model is colored in two colors too.

The model shown in figure 4 with a double curved spiral around the spiral of triangles in Fibonacci rose is directly used in the creation of the lady's dress which is presented in figure 8.

The design of the lady's dress presented in figure 9 uses only the double spiral designed with curved lines without the frame of Fibonacci rose.

The model shown in figure 5 is formed by a double spiral from circles. These circles are in proportions of Fibonacci sequence and they form a double spiral because they are got as entered ones in the frame of Fibonacci rose.

Figure 10 presents a model of a lady's dress which is designed with a double spiral from circles, but the design uses not only the double circles' spiral but the frame of Fibonacci rose too. The dress is designed in double color model. The triangles and circles are colored in different colors. In each of the both spirals the triangles use the color of the circles of the other spiral.

Figure 11 presents a model of a lady's dress with design in which the model in figure 5 is directly used. In this dress the double circles' spiral is used without the frame of Fibonacci rose and three colors model is used.

In the models of ladies' dresses presented in figures 6-11 the start of Fibonacci rose is orientated in the center of the waist, but it can be situated in different clothing and body areas according of the design.
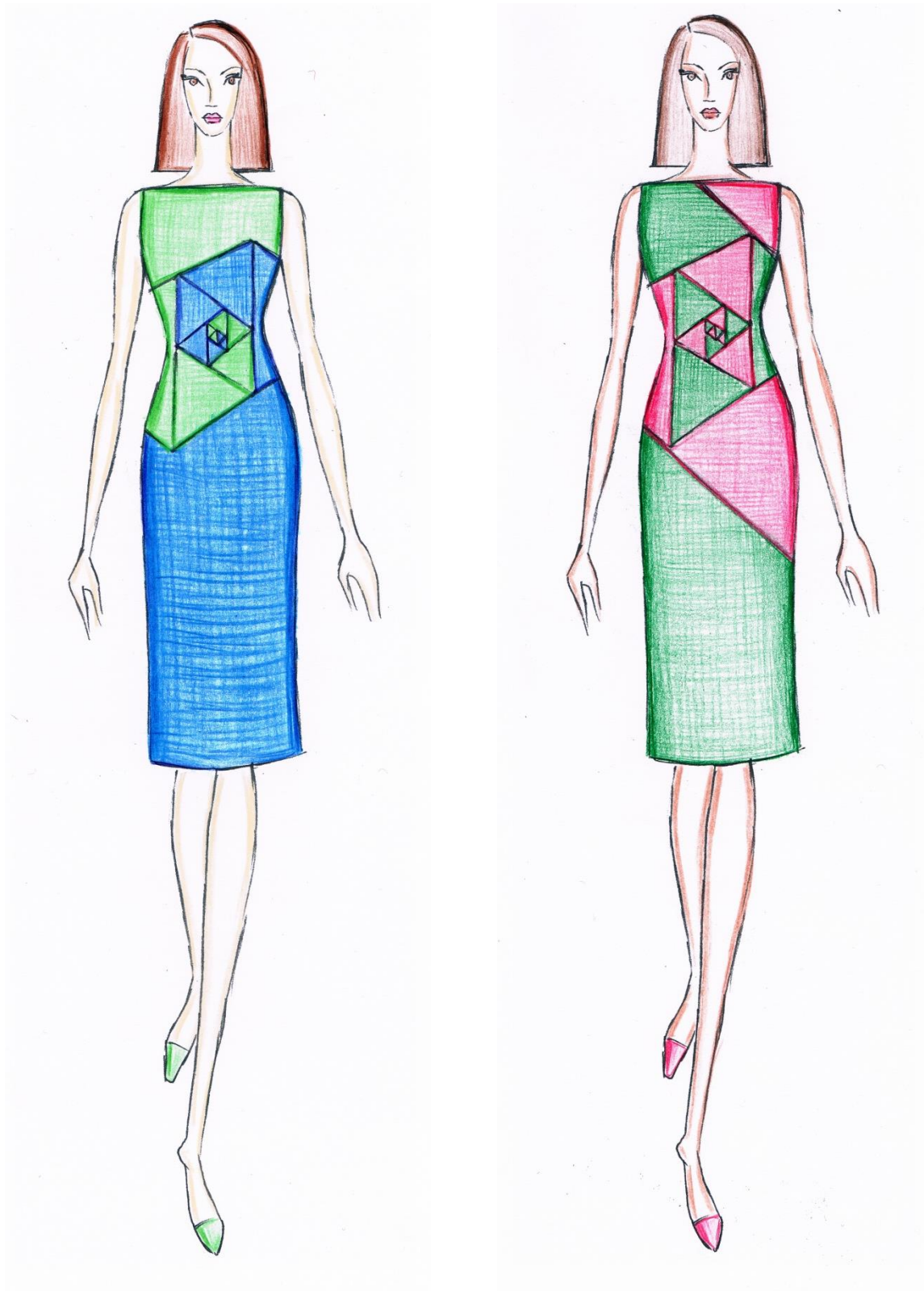
Figures 6 and 7.
Design of ladies' dresses using Fibonacci rose in both models of double coloring
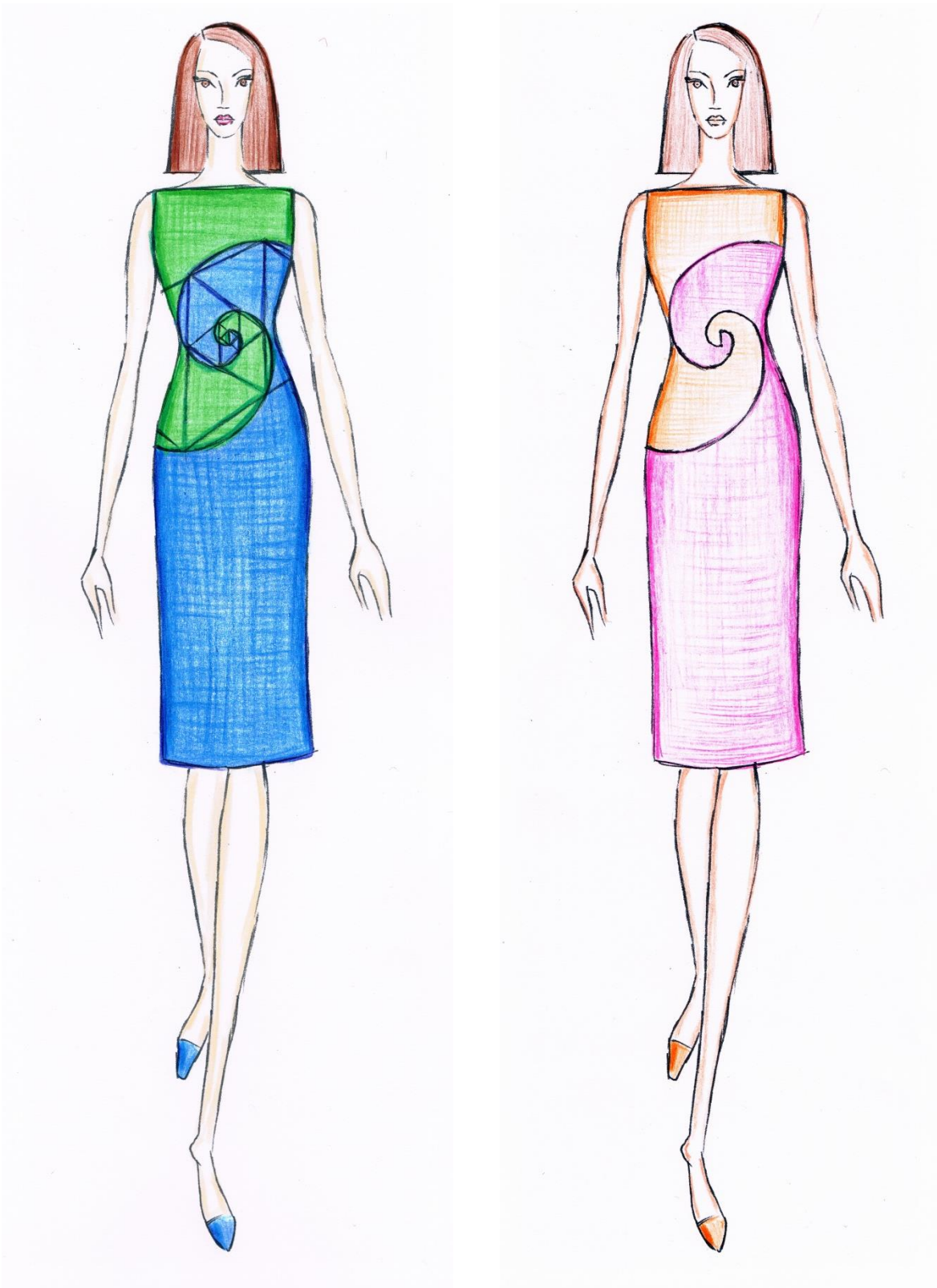
Figures 8 and 9. Design of ladies' dresses using the double curved spiral which is formed around Fibonacci rose
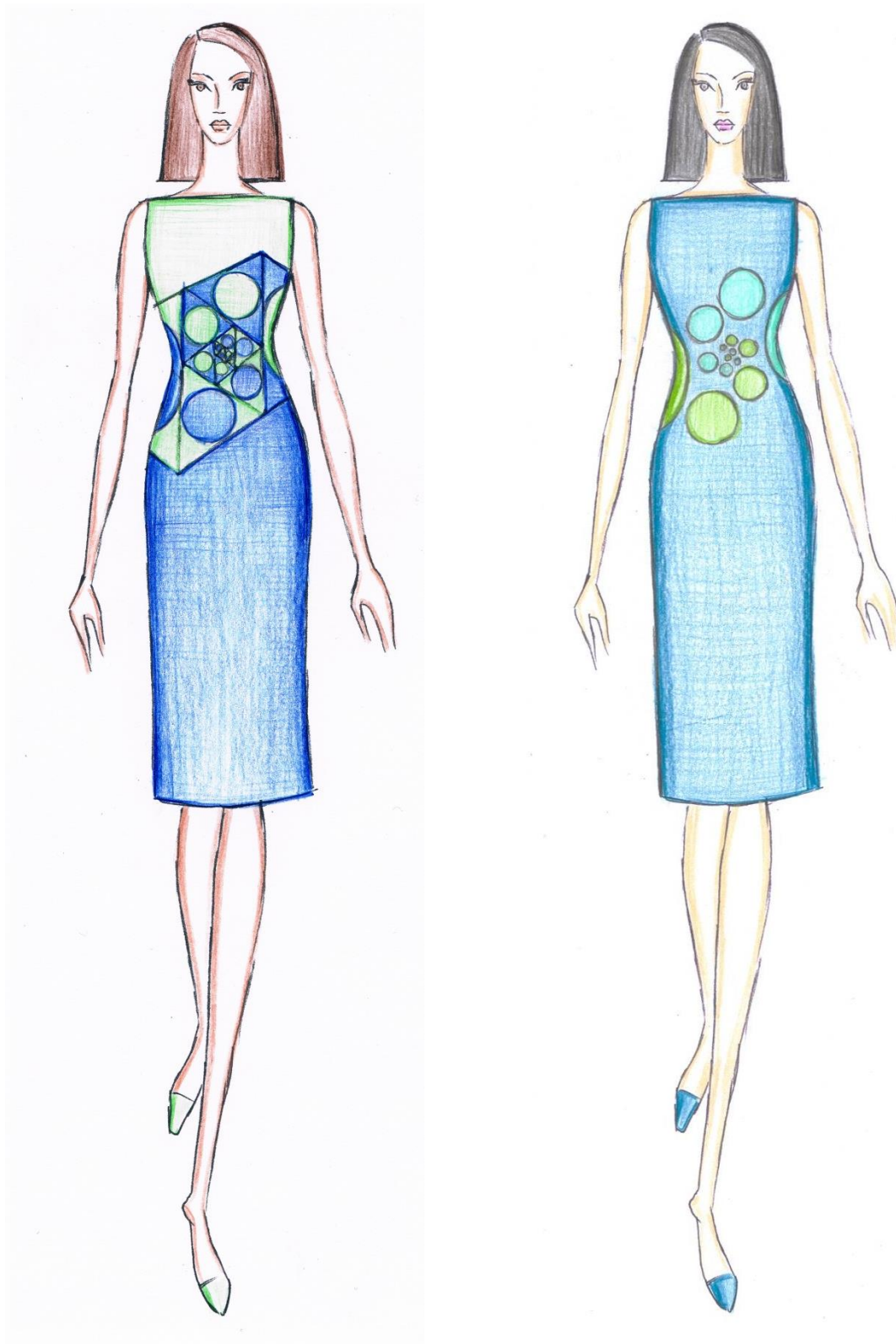
Figures 10 and 11. Design of ladies' dresses using a double spiral from circles which are entered in the triangles of Fibonacci rose

3. CONCLUSIONS

As a result of the use of Fibonacci rose for designing of aesthetic, beautiful and harmonic clothing, it can be concluded that in fashion design Fibonacci rose can be used in different ways of colour combinations, proportions toward the clothing sizes, and as a frame of creations of design elements.
Fibonacci squares can be used in fashion design as application, fabrics' design, pieces of the main clothing parts, etc.
The different position, proportions and color combinations of use of Fibonacci rose in fashion design according to the body type and size can cover some bodily defects and enhance the beautiful forms.

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THE CONCEPT AND DESIGN OF A WEARABLE SYSTEM USED BY A BLIND PERSON AND HER GUIDE DOG

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Abstract: *The purpose of this paper is to present the idea of wearable systems to create communication between a blind woman and her guide dog in order to assist the handicapped in the bustle and hustle of the cities of today. The key concept is to use new technologies such as flexible solar panels and flexible rechargeable batteries with existing technologies such as Bluetooth, GPS, Speech Recognition and Speech Generating Devices in order to create a garment that will ease and improve the current situation between a guide dog and his owner.*
Keywords: *Wearable Systems, Flexible Electronics, Body Area Networks.*

1. INTRODUCTION

Creating wearable systems has become of importance in today's society, especially in the field of medicine, in which it has been applied to assist traditional methods in order to create new and improved methods and treatments.

Dating back to as far as the 16th century, the guide dog has been a traditional means of getting around for the blind. The Seeing Eye Inc., the oldest existing guide school in the world, surveyed its students at the end of class and five years of survey results revealed that 93.4% of students said they are more mobile than before they had a dog [1], thus Seeing Eye dogs are of importance to blind people.

Guide dogs are trained to lead a person in a straight line, to turn left or right or stop on command, to stop for all changes in elevation, including curbs and stairs, to stop for overhead obstacles, such as tree limbs and to avoid obstacles in their path. The two things Guide Dogs cannot do is determine the route to a new destination and to read traffic signals [2]. This paper examines ways to improve the relationship between the owner and her/his Guide Dog.

When discussing wearable technology we have to keep in mind that our aim is to create garments that are comfortable to wear by applying the latest flexible technology, and also garments that are 'wash and care' convenient - the latter being of concern for the fashion designer.

2. TECHNOLOGY

The technology that will be used in this project is a combination of one of the most recent technological trends, such as flexible solar panels and flexible batteries technology along with embedded circuits.

2.1. Flexible Solar Panels and Flexible Batteries Technology

With the vast change of technology we have shifted into a time where flexible technology allows us to implement embedded systems on clothing without limiting the design aspect. The garment for this project will use flexible solar panels in order to charge rechargeable flexible batteries. Silicon Solar provides Flexible Solar Panels that are durable and paper thin making it appropriate for use on garments. The Flexible Solar Panels come in a variety of wattage and current with a 15.4 Voltage.[3]

Figure 1. Silicon Solar Flexible Panel [3]

On the other hand, a rechargeable flexible battery is to be connected to the solar panel, providing power to the embedded systems on the coat. The flexible rechargeable batteries available on the market are Imprint Energy Zinc Battery and the FlexEl Battery Cloth. LG's has developed a flexible Li-Ion Battery, although it is not on the market.

Figure 2. Imprint Energy [4]　　Figure 3. FlexEl Battery Cloth [5]　　Figure 4. LG Flexible Li-Ion Battery [6]
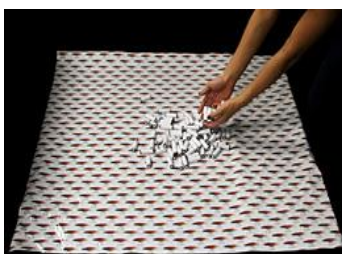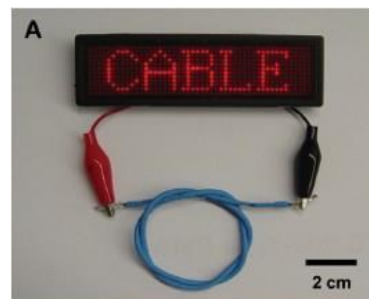
Imprint Energy's rechargeable battery is zinc-based making it safer and less toxic than lithium-based batteries. They are a safer option for creating devices that sit on the body [4]. This battery is printable hence can be ordered in any shape. FlexEl's Battery Cloth uses electrochemistry based on properties of ruthenium oxide in an electrochemical energy cell and yields 200Ah of unit capacity per square meter, scalable to even larger capacities in larger form factors (equivalent to 100 AA batteries). Its high discharge rates and capacity is proportional to size and shape. It is rechargeable at an ultra-low voltage and is ideal for wireless recharging systems including solar [5]. Finally, LG's flexible Li-Ion Battery is shaped like cable wires making it easy to bend and wrap around devices[6], below shows the chart of the voltage produced proportional to the length of the cable and in a 'bending' condition or 'not bending' condition.
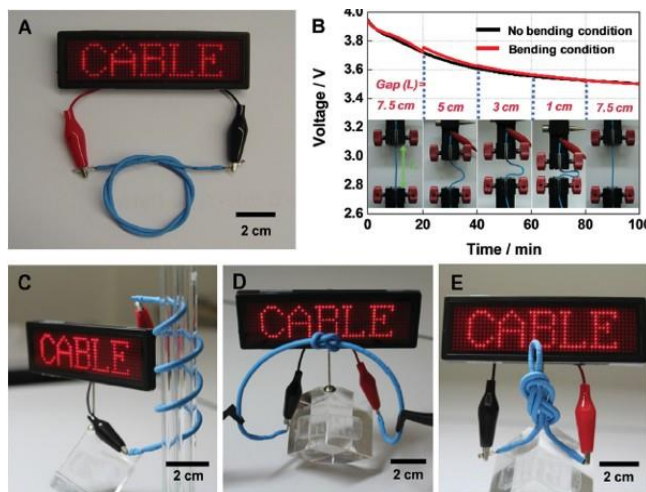
Figure 5. Voltage vs Time [7]

2.2. Microcontrollers and Modules Technology

The Microcontroller system that will be used is the Arduino Uno Board. The Arduino Uno has 14 digital input/output pins, 6 can be used as PWM outputs and 6 analogue inputs, a 16MHz ceramic resonator and a reset button. It has a USB connection and a power jack. It is equipped with an ICSP header which is an AVRtiny programming header for the Uno which consists of MOSI, MISO, SCK, RESET, VCC and GND.
The modules are listed below:
  i.   Bluetooth
  ii. GPS
  iii. Speech Recognition
  iv. Speech Generator
  v.   Color Sensor

3. METHOD

Below is a flowchart of the functionality of the coat. Given the voice command to turn on/off, the system uses voice recognition to identify the owner of the dog, once it has accepted the command it then either turns the coat on/off and sends the same command to the dogs vest. The owner then inputs directions into the GPS, the system has the option of storing the owner's usual destinations by name, for example 'office' or 'home', and to enter new destinations. Recieving the destination from the owner, the GPS sends the appropriate information to the dog, for example 'left' or 'right', which is heard by the dog through a voice generator. The command 'rest' tells the dog to stop. Once the dog reaches a curb, it is trained to stop, since it cannot identify color the colour sensor on the coat will work to identify the traffic lights, whether it is green or red and using the voice generator will command the person to go or stop.

4. MATERIALS

The textile to be used for this project is GORE-TEX due to the fact that it is durable, waterproof, windproof and breathable hence making it the most appropriate. The notions used have been limited to make it easy for the wearer. Velcro will be the main notion used in construction. Zips are used for the inside compartments of the vest and for the seasonal transformation of the coat.

Figure 6. Flowchart of system

5.   DESIGN

Collar – Colour
Sensors, Audio In,
Audio Out

Solar Panels

Left Hand Inside
Pocket – GPS

Bluetooth

Solar Panels

Microcontroller &
Embedded System
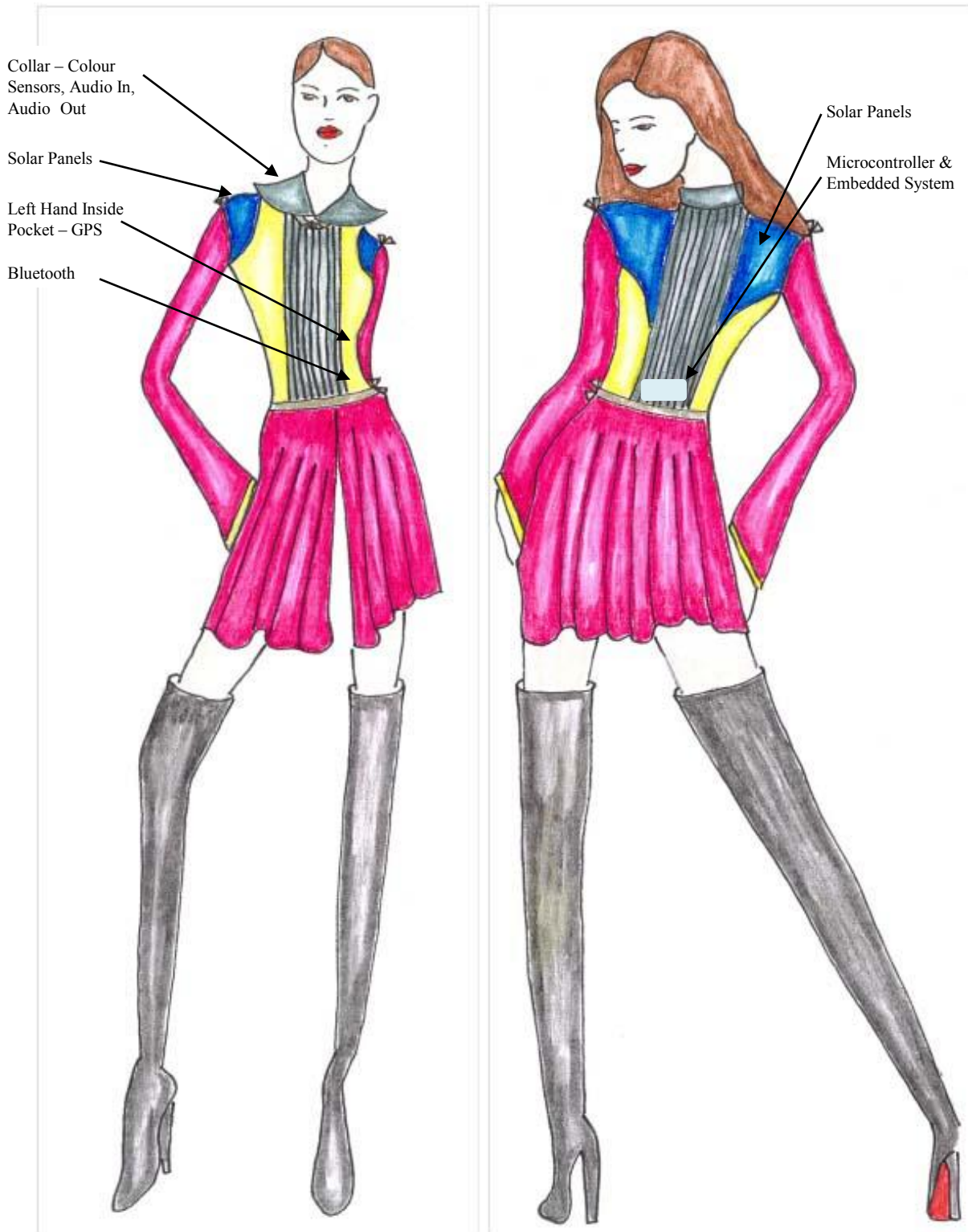
Figure 7. Front and Back of Design

Panels are placed on the back and the front in order to accumulate the maximum amount of sunlight possible. The speaker and microphone are situate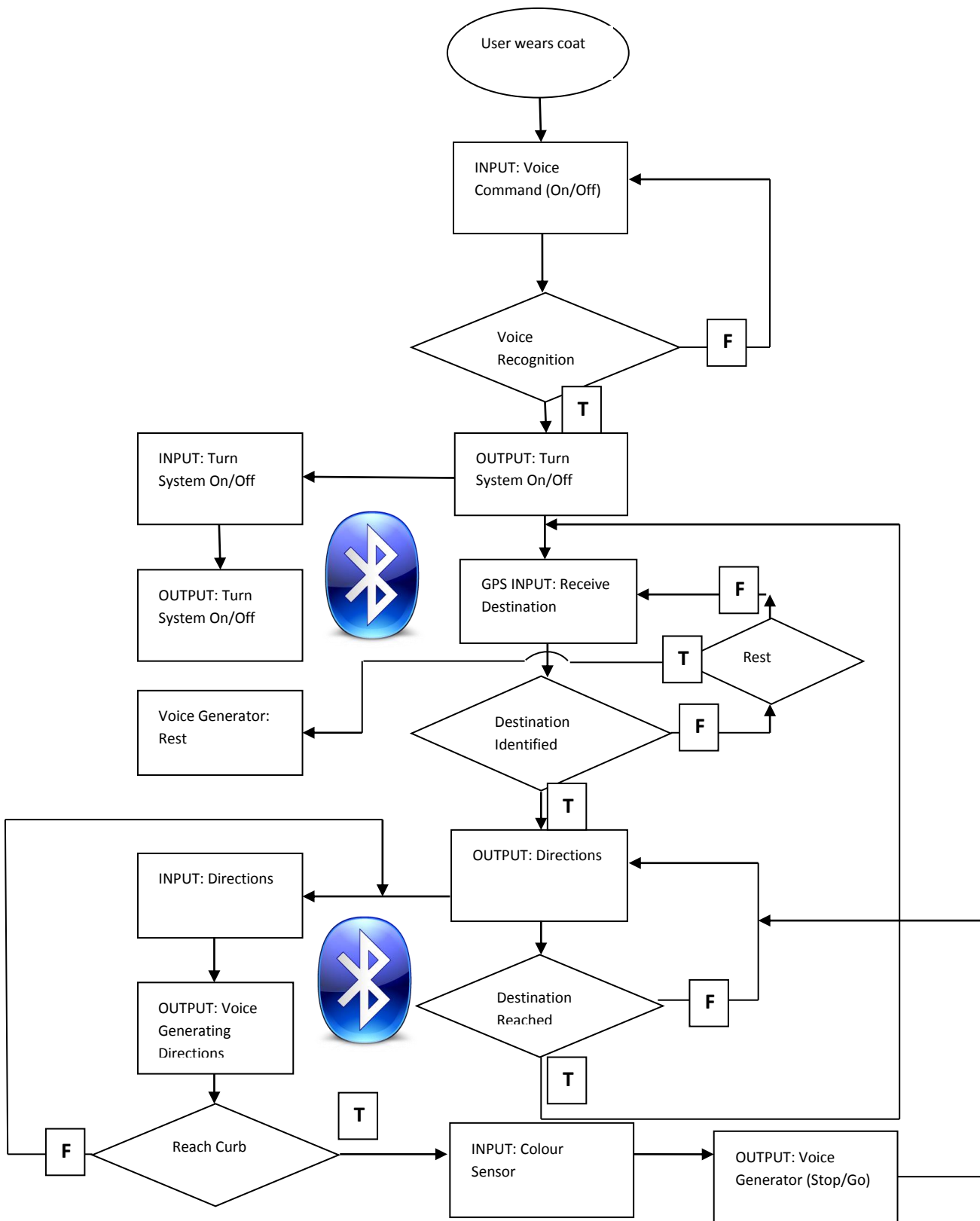d on the collar of the coat to be close to the ears and mouth. There are two colour sensors placed on the edge of each collar and the Bluetooth is situated at the front of the coat having taken into consideration that the guide dog is always in front of the owner. The functionality of the GPS is placed within the lining of the coat at the waistline. The solar panel can be removed and charged separately from the garment.

The coat has been constructed to be feminine, functional and to be worn throughout all seasons. The sleeves and the bottom half are removable, thus creating a vest for summer, a jacket for autumn and a coat for winter.

6. IMPLEMENTATION

Taking into consideration that the coat is to be washed and cared, for special detail must go into the construction with the use of specific sewing notions. Considering that you can sew the solar panels, Velcro will be used to place the solar panels on the coat. Velcro sticky back coins are also available for the speaker, microphone, colour sensors and Bluetooth. The GPS system is located on the inside pocket on the left side of the coat whilst the heart of the system, the microcontroller is located in a zipped compartment in the lining of the coat at the waistline. The placement of the rechargeable battery has not been identified given that we have not clarified which battery will be used.

The coat is created from the pattern pieces shown from Figure 8 through to Figure 12. After overlocking all pieces and closing darts, place the Velcro where required. To start putting the pieces together, the zipper is added to the two pieces in Figure 9 and then sewn at the shoulders to the back bodice, Figure 8. The zippers are then added to the armscye and to the sleeve. They can then be joined. Then the collar is added, Figure 12 completing the jacket. For the coat, the zipper is added to the jacket and to the full skirt, Figure 11. To complete, finish hem at required length. The electronic components are added by hand at the end of construction.
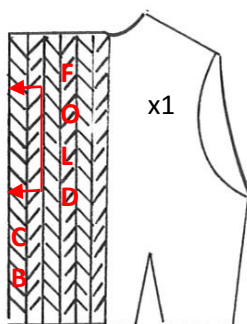
Figure 8. Back Bodice   Figure 9. Front Bodice   Figure 10. Bishops Sleeve
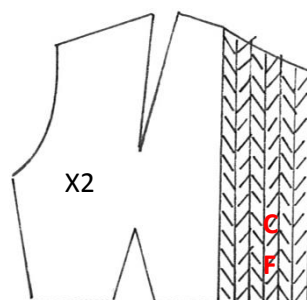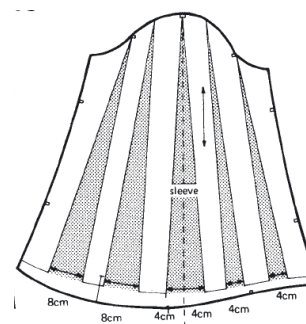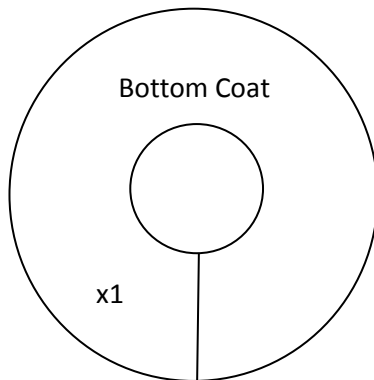
Figure 11. Full Circle Skirt with Opening   Figure 12. Wing Collar
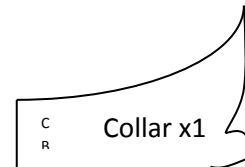
7. FURTHER RESEARCH

The above research presents the use of flexible technology which allows us to create wearable technology, with the use of current technology in order to create a garment which will assist the blind people. The next step of this project is to further research the flexible batteries mentioned in the paper and to start the implementation of the design concept towards the construction phase.

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A NEW WEARABLE ANTENNA DESIGNED USING GENETIC ALGORITHMS AND PARTIALLY MADE OF TEXTILE MATERIALS

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Abstract: *Research and technology development on smart textile technology has rapidly emerged during the last decade due to their numerous applications in the health and safety sectors. Until now it had been demonstrated that it is feasible to integrate electronic components in textile structures and clothing; now, researchers are focusing their efforts on developing electronic systems that are fully made of textile materials. In this context, wearable antennas made of textile materials exhibit multiple beneficial characteristics such as light weight and low profile and they are transparently embedded into clothing. On the other hand, the development of textile antennas is a very challenging task due to inherent impairments of antenna operability when integrated into garments (e.g. bending and crumpling due to the user's mobility etc.). In this paper we report the evolution of a textile antenna system that was designed as a conventional planar antenna and was modified to include a textile substrate instead of the original rigid FR4 substrate. Measurements results demonstrate that the operational characteristics of the semi-textile antenna remain relatively unaltered and generate the motivation for future development of a fully textile antenna.*

Keywords: *Textile Antennas, Smart Textiles, Textile Electronics.*

1. INTRODUCTION

During the last decade there has been a rapid advancement in the research of smart textile technologies and systems, mainly due to their applications in the health monitoring, human safety and security sectors. A smart cloth or textile structure is essentially a platform carrying sensory and actuator systems that may be used for developing applications around a person or groups of persons. Electronic textiles are a subset of smart textile systems that comprise of either electronic systems embedded into textile structures and clothing or electronic components and circuits that are made of textile materials per se. For example, the recent development of new conductive fabrics has given the opportunity to apply specific conductive layouts within conventional dielectric fabric substrates thus resulting to radiating structures (i.e., antennas). Of course, a wearable sensory and communications system shall consist of several components like sensors, actuators, processing units, energy supplies, communication systems etc. The research effort is focused on either embedding such systems into clothing or developing them using textile materials. In this context, there has been an intense research effort regarding the design and development of textile antennas and integrated textile electronic systems within the Department of Electronics, TEI of Piraeus, Greece. Textile antennas are a key component in wearable electronics evolution since they do carry out the entire process of wireless signal transmission and reception.

Textile and wearable antennas have been proposed for various applications in the literature [1-2]. However, the development of textile antennas is still an active topic due to the inherent anomalies and discontinuities of textile substrates. Also, the special operational environment of wearable antennas causes bending and crumpling that alter their characteristics. The first

wearable antennas partially based on textiles were presented by Salonen et al. [3] who investigated their radiation characteristics. Subsequent research led to wearable antennas also made partially of textile materials by Klemm and Troester, Santas et al. and Nurul et al. in independent works [4-6]. Wearable antennas made exclusively from textile components have been proposed by Hertleer et al. [7] and Vallozzi et al. [8] operating at 2.4GHz. Alomainy et al. [9] investigated the performance of textile antennas vs. distance from human body while Bai and Langley [10] studied the effects of bending and crumpling. Results from Kennedy et al. have demonstrated textile antenna designs that exhibit robust performance with moderate amounts of bending, similar to that of conventional metallic body-worn antenna arrays [11].

Moreover, Zhu and Langley [12] reported dual-band antennas, Sankaralingam and Gupta developed a rectangular patch for deployment on different cotton substrates while comparing rectangular and circular shapes [13], Hao et al. presented the analysis of antenna diversity for on-body communication systems, at 2.45 GHz and 5.8 GHz [14], Osman and Rahim investigated the relative permittivity on different textile materials for the application of a microstrip antenna [15] and Osman et al. developed an Ultra-wideband (UWB) antenna using jeans fabric as a substrate while the radiating element and ground plane are made from copper tape [16]. Finally, Applications of textile antennas in health and safety include the development of a baby monitor suit bye Coosemans et al. [17] as well as a textile belt that monitors electrocardiogram and respiration rate in children by Catrysse et al. [18].

In the following, we present a short discussion on the design of the proposed planar antenna using an in-house developed optimization tool based on genetic algorithms in Section 2, while in Section 3 we present the simulation and measurements results of our proposed antenna; the paper concludes with Section 4.

2. PATCH ANTENNAS AND A GENETIC ALGORITHM TOOL FOR PLANAR ANTENNA DESIGN

Planar microstrip patch antennas are considered as the most viable approach in wearable antenna design and development due to their natural low-profile characteristics that makes them easily embedded into clothing. Furthermore, patch antennas radiate most of their input power towards the direction that is perpendicular to the substrate surface and opposite to the ground plane, thus naturally protecting the human body. Various patch layouts are proposed in the literature, like rectangular, circular, ring etc. A typical layout of a conventional rectangular antenna is demonstrated in Figure 1.
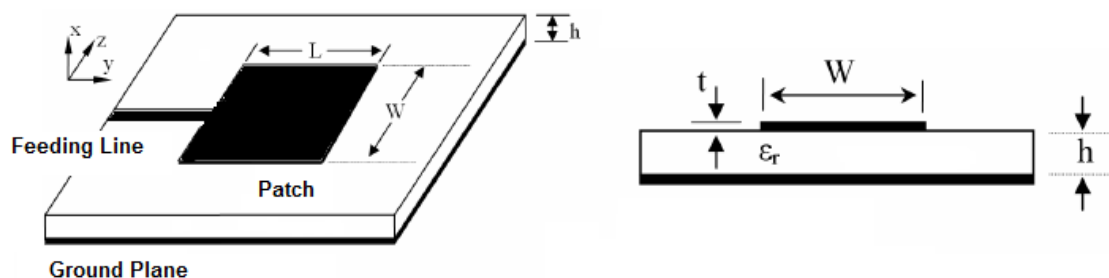
Figure 1. Typical layout of a rectangular patch antenna

As long as the shape of the patch antenna is considered, the special operational environment of a textile antenna imposes certain challenges to the antenna design engineer. In order to develop antennas that need to retain their operational characteristics under bending, crumpling, wet conditions etc., we have developed a special genetic algorithm (GA) optimization tool that is capable of producing patch antennas of arbitrary, original shapes that do not look like any ordinary shape found in the literature [19]. The proposed GA is of the floating point type while the functions of selection, crossover and mutation are of roulette, simple or arithmetic, and uniform type, respectively. The population size is 80, while the maximum number of generations has been set up to 100. The arbitrary shape of the antenna patch is optimized as follows: the metallic rectangle of the antenna top layer (see Figure 1) is meshed to a number of smaller rectangles; the total number of rectangular elements is a parameter of the solution. A GA's chromosome gene corresponds to a rectangular element and is assigned with a binary value of either 0 or 1, with "0" corresponding to "no-metal" and "1" corresponding to "metal". This means that if the GA assigns the value of "0" to a gene, then at the respective rectangular element there will be no metallic patch surface (and vice versa in the case of "1"). Thus, a patch of arbitrary shape is generated. For example, consider the patch illustrated in Figure 2 that consists of 16 rectangular elements for clarity. The specific chromosome "1110001001100111" corresponds to the patch illustrated to the right side of the figure.
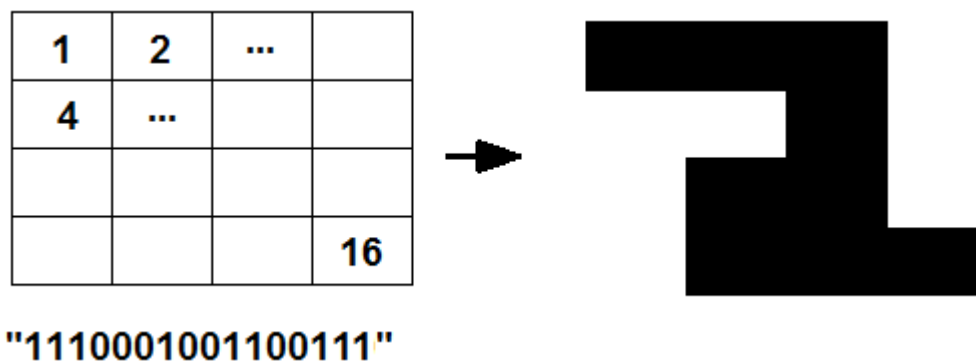
Figure 2.
Example of a GA chromosome and the respective patch antenna layout

Finally, a GA's performance strongly depends on the design of its fitness function. The fitness function of the proposed GA is calculated as follows: after a patch model is generated by the GA's chromosome, it is passed to an electromagnetic (EM) solver. The EM solver then outputs a text file that includes the gain, radiation pattern and reflection coefficient of the patch. The fitness function takes into account that the maximum gain of the patch must be the highest possible; thereupon it first calculates an error value using

$$e_1 = \left[\frac{(5 - MaxGain)}{5} \right]^2, \tag{1}$$

where $MaxGain$ is the maximum gain of the patch. The value of "5" is selected because the desired gain of our antenna 3 dBi; thus, with this selection our patch is forced to outmatch this limit getting close to 5 dBi. Then, the fitness function takes into account that the reflection coefficient, S_{11}, must be less than -10 dB; thereupon it calculates another error value as in

$$e_2 = \left[\frac{(10 - S_{11})}{10} \right]^2 . \tag{2}$$

Moreover, the fitness function also takes into account the variance of the patch's horizontal gain since it needs to be kept as low as possible for uniform radiation. Thus, the fitness function also calculates a third error term as in

$$e_3 = \sum_{\varphi=0°}^{\varphi=360°} \left(MeanGain_{phi} - Gain_{phi}(\varphi) \right)^2 , \tag{3}$$

where $MeanGain_{phi}$ is the mean horizontal over φ for $\theta = 20°$ and $Gain_{phi}(\varphi)$ is the horizontal gain vs. φ for $\theta = 20°$.

Finally, the cumulative error is calculated by

$$A = w_1 \cdot e_1 + w_2 \cdot e_2 + w_3 \cdot e_3 , \tag{4}$$

where w_i is the weight of the error e_1, and the fitness function value is calculated by

$$Fitness = \frac{1}{1 + \sqrt{A}} . \tag{5}$$

The specific formula for Eq. (5) is heuristic and implies that a "good" chromosome with a low cumulative error will correspond to a fitness function value close to unity, while a "bad" chromosome with a large cumulative error will correspond to a fitness function value close to zero.

3. A NEW PLANAR ANTENNA PARTIALLY MADE OF TEXTILE MATERIAL

In order to demonstrate the design capabilities of the proposed platform, various runs of the proposed GA tool have been executed in order to design a micro-strip wearable antenna with a center frequency of 1.5 GHz. The proposed wearable antenna shall consist of two copper-made metallic plates of arbitrary shape (the top layer shape will be determined by the optimization tool while the bottom layer is the antenna ground) on the two sides of a textile dielectric material (substrate). The proposed architecture corresponds to the well-known sandwich-like architecture that is popular in the literature. The dielectric substrate of the antenna is a jeans fabric with yarns made of cellulose; the yarns to void ratio in the fabric was estimated equal to 50% while the packing factor of the yarn was estimated equal to 70%. The antenna is fed via a coaxial cable and a through launcher that delivers the power to the antenna through the substrate and the ground plane, as illustrated in Figure 3.
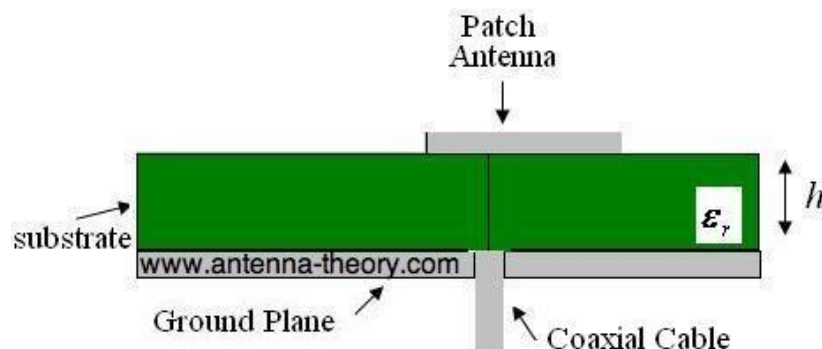
Figure 3. Feeding of the proposed antenna using a through launcher (image available at
http://www.antenna-theory.com/antennas/patches/patch3.php)

It is noted that the dielectric constant of the jeans fabric to be used has been calculated in
[20] using the equation

$$\varepsilon_{r,fabric} = d_2 \varepsilon_{r,yarn} = d_2 d_1 \varepsilon_{r,cellulose} , \tag{6}$$

where d_2 and d_1 represent the yarns to void ratio in the fabric and packing factor of the yarn
respectively, while $\varepsilon_{r,cellulose}$ is the dielectric constant of cellulose that is used as the yarn
material. The dielectric constant of cellulose may vary from as low as 3 up to as high as 7.5.
For the specific antenna presented herein, a value of $\varepsilon_{r,cellulose} = 4.6$ has been selected; this
value corresponds to a dielectric constant of the fabric equal to $\varepsilon_{r,fabric} = 1.6$.

Two prototypes of the designed antenna were implemented. These prototypes are illustrated
in Figure 4, while the antenna's measured performance characteristics are summarized in
Table 1. It is worthwhile noting that the implemented antenna exhibits superior input
reflection characteristics ($S11 = -15$ dB), with a sufficient bandwidth of 50 MHz that is larger
than most conventional patch antenna designs. The gain of the antenna is equal to 1.7 dBi
that is lower than the desired one; it is considered that this deviation is due to the amount of
air that exists between antenna layers and due to the curvature of the denim fabric. Both of
these limitations are expected to be removed during the transition of a fully textile antenna
since in this case there will be no air gap between top, bottom and substrate layers.

Figure 4. Photo of the implemented antenna and laboratory measurements of input reflection
coefficient

Table 1. Performance characteristics of the implemented antenna

Resonant Frequency	Bandwidth	Substrate Material	Dielectric Constant of Substrate	S11 at resonant frequency	G at resonant frequency
1.5 GHz	50 MHz	Denim cotton fabric	1.6	-15 dB	1.7 dBi

4. CONCLUSIONS

Textile antennas are a promising but also challenging field of research, with many potential future applications. In this paper we presented the evolution of textile antenna research in the Department of Electronics of the TEI of Piraeus, with recent results on the implementation of an antenna partially made of textile materials. Measurements and simulation results demonstrate good agreement between each other; this means that the transition from solid copper and FR4 materials to textile materials was relatively smooth and with minor effects on the antenna operational characteristics. These findings generate a strong motivation for the development of fully textile antennas in the near future.

5. ACKNOWLEDGEMENT

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SINGLE-CLICK TO DATA INSIGHTS
TRANSACTION REPLICATION AND DEPLOYMENT AUTOMATION MADE SIMPLE FOR THE CLOUD AGE

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Abstract: In this report we present out initial work on making the MonetDB column-store analytical database ready for Cloud deployment. As we stand in the new space between research and industry we have tried to combine approaches from both worlds. We provide details how we utilize modern technologies and tools for automating building of virtual machine image for Cloud, datacentre and desktop use. We also explain our solution to asynchronous transaction replication MonetDB. The report concludes with how this all ties together with our efforts to make MonetDB ready for the age where high-performance data analytics is available in a single-click.
Keywords: Databases, Cloud Computing, Deployment Automation, Transaction Replication.

1. INTRODUCTION

Cloud computing has become one of the leading utilities for data processing. Cloud service helps both the academic researcher and commercial organizations in getting more out data with fewer resources. In just a few minutes one can launch a high-performance virtual instance running in the cloud and shut it down once its now longer needed [10].

The MonetDB column-oriented store has a long track record in business analytics and it is often used as a scientific database, managing large volumes of data. A cloud deployment of MonetDB will give its users the fast query responses of in-memory optimized database, while maintaining the convenience of immediate access to compute resources.

Cloud computing and analytical database systems are not only useful to research institutions, but to enterprises as well. As such, adapting the cloud deployment of MonetDB to support industrial customers will support a wider range of users easy access to a high-performance database. In our cloud integration effort we focus on both making the process of using MonetDB effortless, as well as making it an appealing tool to both academic and industry users.

Our design extensions to the database system focuses on long-term maintainability. We achieve this by re-using the existing facilities in both MonetDB and third party software, avoiding major redesigns. For our cloud integration we have opted for a toolset that allows us to automate the process of creating a virtual image for multiple platforms. With a 'write once use many' approach we cover a large range of cloud service providers with a single set of deployment templates and scripts. Similarly, the database replication technology of MonetDB uses as much as possible its proven transaction logging subsystem. With transaction replication support, we have added a high-availability feature to MonetDB.

Deployment automation and transaction replication together make MonetDB more appealing to a larger set of users. Next the ease of use deployment, high availability is a critical requirement for commercial database users. Downtime can negatively impact both

researcher and industrial user on database systems. With this work we aim to bring MonetDB in the Cloud age, giving data analysts a powerful tool that is only a single-click away.

2. CLOUD DATABASE DEPLOYMENT

Cloud computing significantly shortens the time it takes to bring an idea from inception to implementation. While previously one had to wait for authorization or even procurement of the compute resources, nowadays accessing high-performance is a click away [10]. Such a convenience was previously only available if one had direct access to the hardware and software required to do the job. In the case of large-scale data analytics a more powerful machine would have been required, thus more resources to be spent on their procurement. Buying hardware generally falls under capital expenses, which are planned a year in advance. In other words the decision to buy new hardware for a project was made well ahead of time. As a result the machines are ordered at potentially higher prices, since hardware prices are constantly decreasing, as new and better performing models are released. In comparison, money spent on cloud instances generally fall under operational expenses, which can be allocated at much shorter periods. Additionally, underutilization of the hardware is a waste on both the initial investment and electricity. In contrast, cloud-computing resources can be used when needed and then shut down [3]. Given this trend, one can consider Cloud resources as of a common utility of the 21st century. In that is respect, cloud service providers are comparable to gas, electricity and telephone companies [4].

As mentioned, access to cloud resources, even very high-performance such, has never been easier. This is especially relevant for work that involves data processing. In both academic research and commercial companies, data analysis is often done in batches. Large dataset are processed, the output is analysed and presented. Once new data arrives, a new dataset is again processed. In most cases newer data is appended, with limited modifications to the previously stored information. For data intensive tasks, database management systems (DBMS) are a natural choice. As such, deploying an analytical DBMS in the Cloud is powerful tool for data processing and analysis.

3. COLUMN STORES AND MONETDB

MonetDB is an open-source DBMS for high-performance applications in data analysis, business intelligence, OLAP, GIS and data warehousing. These applications are characterized by very large databases, which are mostly queried to provide business intelligence or decision support. Similar applications also appear frequently in the area of e-science, where results from experiments are stored in a scalable system for subsequent scientific analysis.

The design of MonetDB is built around the concept of bulk processing: simple operations applied to large volumes of data make efficient use of the hardware for large-scale data processing. This focus on bulk processing is reflected at all levels of the architecture and the functionality offered to the user. MonetDB achieves its goal by innovations at all layers of a DBMS, e.g., a storage model based on vertical fragmentation (column store), modern CPU-optimized query execution architecture, automatic and self-tuning indexes, and run-time query optimization [7].

MonetDB stores data in columnar format and the columns are virtually stitched together to form tables (Figure 1**Figure 1**). This is one of the main differences between MonetDB and the common database systems, which store data in rows. The vertical storage given column-stores some advantage in read-intensive workloads, such as data analytics. At the same time MonetDB is a fully functional relational database. It provides an SQL:2003 compatible
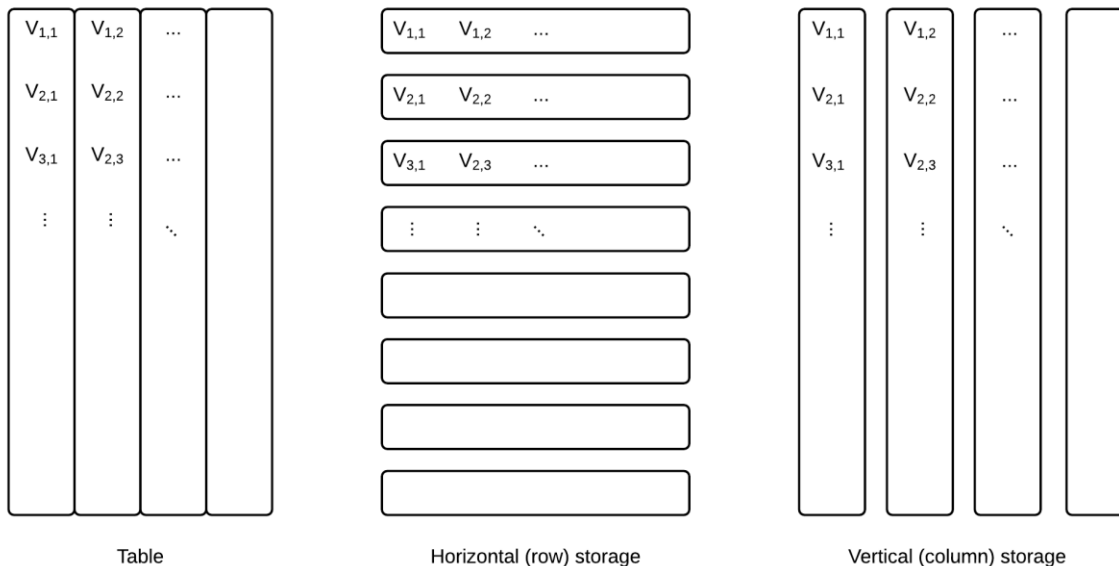
Figure 1. Row vs. Column oriented storage

query layer and connectors for most programming languages. This means that the common tools and applications designed for working with SQL systems will easily integrate with database system. In addition, MonetDB makes use of a number of novel techniques for efficient support of a priori unknown or rapidly changing workloads [7]. "Recycling" is a fine-grained flexible intermediate result caching technique [8]. "Database cracking" is an adaptive incremental indexing technique [17].

To further improve data analysis capabilities, MonetDB is also being integrated with the R statistical analysis software [11]. This will work both ways: a connection to database can be established from R and functions written in R can be evaluated directly in MonetDB. Statistical packages are optimized for advanced algorithms, while database systems provide fast access to large volumes of data. Their combination creates a powerful platform to speedup data discovery. The MonetDB.R connector decides which portions of the data analysis should be performed by either statically software or the database. This way each systems is used to its best performance. The user is freed from the tedious task to shuffle data around. This also significantly reduces the overhead of shuffling data between different systems, improving data processing times [9].

4. DEPLOYMENT AUTOMATION

In the MonetDB cloud integration we focused on facilitating easy deployment of ready-made MonetDB virtual images. The main idea is to make MonetDB easy to run and operate in both public and private clouds environments, as well as creating small enough images for desktop users to test. In other words, support faster deployment of MonetDB in any environment with a single click.

The main issue for such effort is the lack of coherent standard for a cloud platform or virtual machine (VM) images. OpenStack is an initiative to provide a standard open-source Infrastructure-as-a-Service (IaaS) platform, and while it has many industry supporters, most of the big public cloud providers do not support it [13]. Rather, the OpenStack APIs closely mirrors the Amazon Web Service (AWS) EC2 and S3 APIs [12]. As a result, deployments designed to work with OpenStack can be ported to AWS with limited effort. The importance of AWS compatibility (or portability) stems from the AWS position as an undisputed leader as a cloud service provider; both in terms of computing power availability and richness of available services [1]. While the emerging standard for VMs for commercial deployment is based on the Docker container concept, the big cloud service providers have just started supporting Docker [5].

This makes exclusive selection of the either OpenStack or Docker as the primary platform for VM image format not wise for the moment. We also observe a lot of development in the cloud services area and new standards or new adopters of existing APIs appearing quite frequently. Given these issues and trends, at the beginning of the project we set out to find a solution that allows us to easily maintain the VM images for most platforms with as little effort as possible.

We have chosen to use Packer - a tool for automating the VM image generation [15]. Packer is a versatile tool that supports most VM image formats including: Amazon Machine Images (AMIs) for AWS, Docker containers, VirtualBox OVF images, Google Compute Engine (GCE) images, OpenStack images, etc. The definition of an image generation is provided in a JSON templates and Packer can execute provisioning scripts before, during and after the process. In addition, Packer supports most common cloud configuration management tools such as: Chef, Puppet and Salt, providing end users a powerful array of enterprise-level tools for instance management [16].

Since our implementation focused on maintainability of the VMs, we used a more software engineering process for writing our Packer templates and provisioning scripts, unlike the more system administrator approach of ad-hoc scripting. As such, the templates and scripts were designed to be highly reusable, with little to no code duplication.

The templates cover the VM image generation for common operating systems used in public and private cloud deployments: CentOS 6.5 (upgraded to version 7) and Amazon Linux 2014.03.1 (upgraded to version 2014.09). The Packer templates were initially configured to generate VirtualBox OVF images for desktop testing and AWS AMIs. We eventually added Docker containers as well. With these three VM image formats we covered the three critical user groups of MonetDB:

- VirtualBox OVF for desktop users, to try MonetDB on their workstations, before moving to a full-scale deployment on more powerful machines.
- AWS AMIs for public cloud users, looking for a ready-made MonetDB deployment, so that they can start with a single click in the AWS cloud.
- Docker containers for private cloud/datacenter, users who are looking to build their own infrastructure with MonetDB, based on existing hardware and their own virtualization resources.

The implementation methodology and configuration scripts re-usability enables creation of new VM images with very limited effort. Over the course of several months, new versions of the initially used operating systems were released and we upgraded our temples and scripts to support the new release. This was done in a straightforward and easy way, verifying our choice in methodology and technology.

The provisioning/configuration scripts were cut into small parts, each executing a specific part of the operating system configuration during the image building process. Like the templates, the scripts were also designed to work on as many operating systems (and OS versions) as possible. The provisioning scripts are meant to be simple and highly reusable –

being the building blocks of our implementation. The major actions performed by the scripts are:

- Unattended installation of the OS (which is needed for creating some image formats):
- Operating systems initial setup
- Adding software repositories
- Software installation
- Adding (unprivileged) users and groups for process sandboxing
- Software and services configuration
- Additional image/OS specific software installation
- Clean-up

The installed and configured software always includes:

- Base OS - for fast boot times and lightweight containers
- MonetDB with SQL and GEOM/GIS modules
- R statistical software, configured with MonetDB.R for direct data access

The end results are a number of small and easy to maintain templates and scripts that can be automatically executed and generate up-to-date virtual images with MonetDB and R. Publication to the public cloud or another repository can also be automated as Packer post-processor actions.

5. TRANSACTION REPLICATION

High-availability is critical for production environments. Downtime in an academic research organization can cause one to miss important deadline or delays in research results. Availability of mission critical commercial systems is of even higher importance. If the data warehouse goes down, neither business reporting nor planning can be done. High-availability is often achieved via redundancy of critical components. For database management systems this is achieved using multiple instances of the database running in parallel. The data is continuously synchronized between the instances. This ensures that in case a single server is lost, the other replicas can still serve queries.

To increase the availability of MonetDB servers, we have extended the system with support for transaction replication. This is achieved via log shipping (of the transaction logs) of a master instance to a number of slave instances. It is generally described as a pull model [14], where each slave pulls transactions independently and asynchronously. There is no master-slave information exchange (aside from transactions). Formally this is considered Lazy Centralized replication with Limited Transparency [14].

By default the MonetDB kernel stores transactions in Write-Ahead Log (WAL) files, before the transaction are persisted in the primary persistent storage. During the database start up, the transaction log files are read and any data changes non-persisted in the primary storage are applied. A MonetDB slave instance can be configured to read the WAL files of a master instance, load the transactions and persist the data in its own persistent storage.

On the master instance, the MonetDB should be configured to keep all transaction log files, even those for transactions already persisted in the primary storage. By default, the database cleans- up persisted transaction log files. The transaction log files on the master have to be shipped to the slave instance(s), which can be done using a highly available shared filesystem or alternative means.

On a slave instance, the location of the master transaction log files must be configured. In addition, the transaction drift threshold between the slave and the master must be set. The drift is the difference between the transactions processed by the master and the slave. If a slave detects that it has passed a pre-set threshold, it will not process any additional client

read queries until it catches up with the master. A slave must also be set to run in read-only mode.

The master is the only instance that can apply changes to the data (e.g. create, update, delete) to avoid any data inconsistencies. As such all slave instances must run in read-only mode, where data changes will be propagated only through the transaction-replication mechanism.

There are two possible cluster configurations, each with its pros and cons:
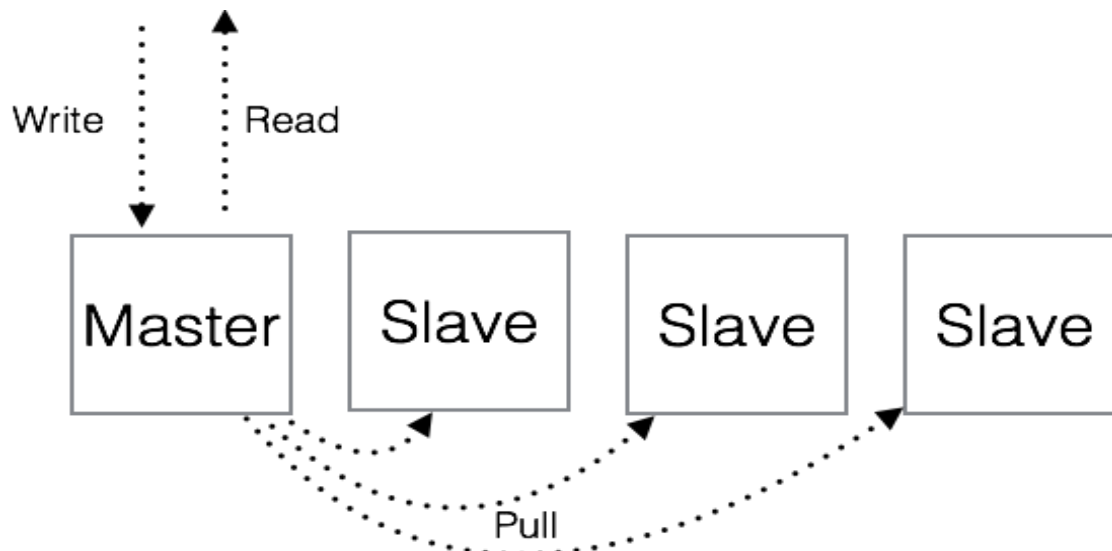
Figure 2. MonetDB warm standby configuration

- Warm standby slaves (Figure 2)
    ◦ Single master instance, which can do read and write operations.
    ◦ One or more slave instances processing no queries, only replicate the master transactions asynchronously.
    ◦ Upon master failure, a slave instance can be restarted in non-read-only mode, to take the role of a master.

The warm standby configuration has the advantage that it can provide increased fault tolerance and is relatively simple to setup. Since the instance loading the data can be queried only, the queries operate on an always up-to-data store. The most significant disadvantage is the somewhat wasteful use of resources, as the slaves will to do any query processing

- Active-active with read-only slaves (Figure 3)
    ◦ Single master instance, which can do read and write operations
    ◦ One or more slave instances that can do read operations, next to replicating the master transactions asynchronously
        ▪ These read-only instances can improve the read query load
        ▪ Load-balancing must be provided on the client side
    ◦ Upon master failure, a slave instance can be restarted in non-read-only mode, to take the role of a master.

The active-active configuration provides improved query capacity, compared to the single read instance warm standby. At the same time, queries sent to the slave instances can be executed on not-up-to-date data, since the transaction replication is asynchronous. This setup also comes at the price of increased complexity at the client side, due to the load balancing required for query distribution.

MonetDB is primarily designed as an analytical database. As such, data is best loaded in large bulk transactions. This will also guarantee that only single large files are shipped to the slaves for replication, minimizing the transaction drift.
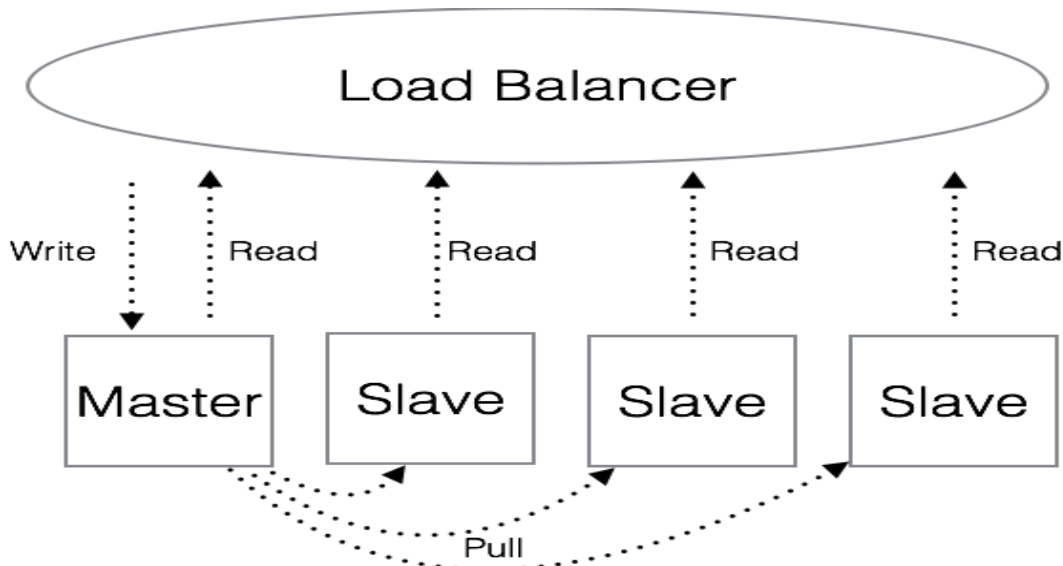
Figure 3. MonetDB active-active with read-only slaves

To set-up MonetDB transaction replication, first and foremost, the shipping of the transaction log files between the master and the slave instance(s) must be configured. The most straightforward way is to use a shared filesystem that can also provide high-availability for the master transaction log files. It is advisable to choose a shared filesystem that is also fault tolerant, such that loss of the master MonetDB instance will not lead to loss of the master transaction logs as well. This way the shared filesystem provides both log shipping, as well as log backup. Since the master instance preserves all transaction log files, there will be a complete copy of the database (in form of the transactions).

Good examples of such filesystem include Ceph and GlusterFS [6]. For public cloud deployment, the native storage of the cloud provider can be used. For example, in AWS one can setup WAL file replication to Amazon S3. S3 has high durability and availability [2], making it ideal for both log shipping and backup. If the MonetDB transaction log is written on S3, slave instances can read the files directly from the remote store over HTTP or mounted locally in user space. At the same time the high durability guarantees constant backup of the data. The main drawback is that S3 is object based [2], and on file update, the complete file must be uploaded. In the case of MonetDB, as the older transaction log files are not modified, the effect will be minimal. In addition, if the data is loaded in large bulk transactions, the impact is further minimized, since there will not be many files.

For the implementation of the transaction replication support we decided to take the path with least risks. First we evaluated the existing transactions logging scheme. On a slave instance, if the correct flags are set, the database will set up a second, read-only logger. Every few seconds the logger will scan its own (shared) directory and if new transactions are detected, it will load them and persist them in the local storage. If new tables or schemas were created in that transaction, these changes will not be visible immediately. To fix it, we also party reload the SQL store, forcing it to update the schemas and tables.

Figure 4. MonetDB transactions processing on a slave instance

The mode of operation of a slave instance is shown on Figure 4. The instance will start up in maintenance mode, not processing any queries. Any data in the slave's own WAL will be persisted first. Next the WAL synced from the master will be examined. The salve will verify if
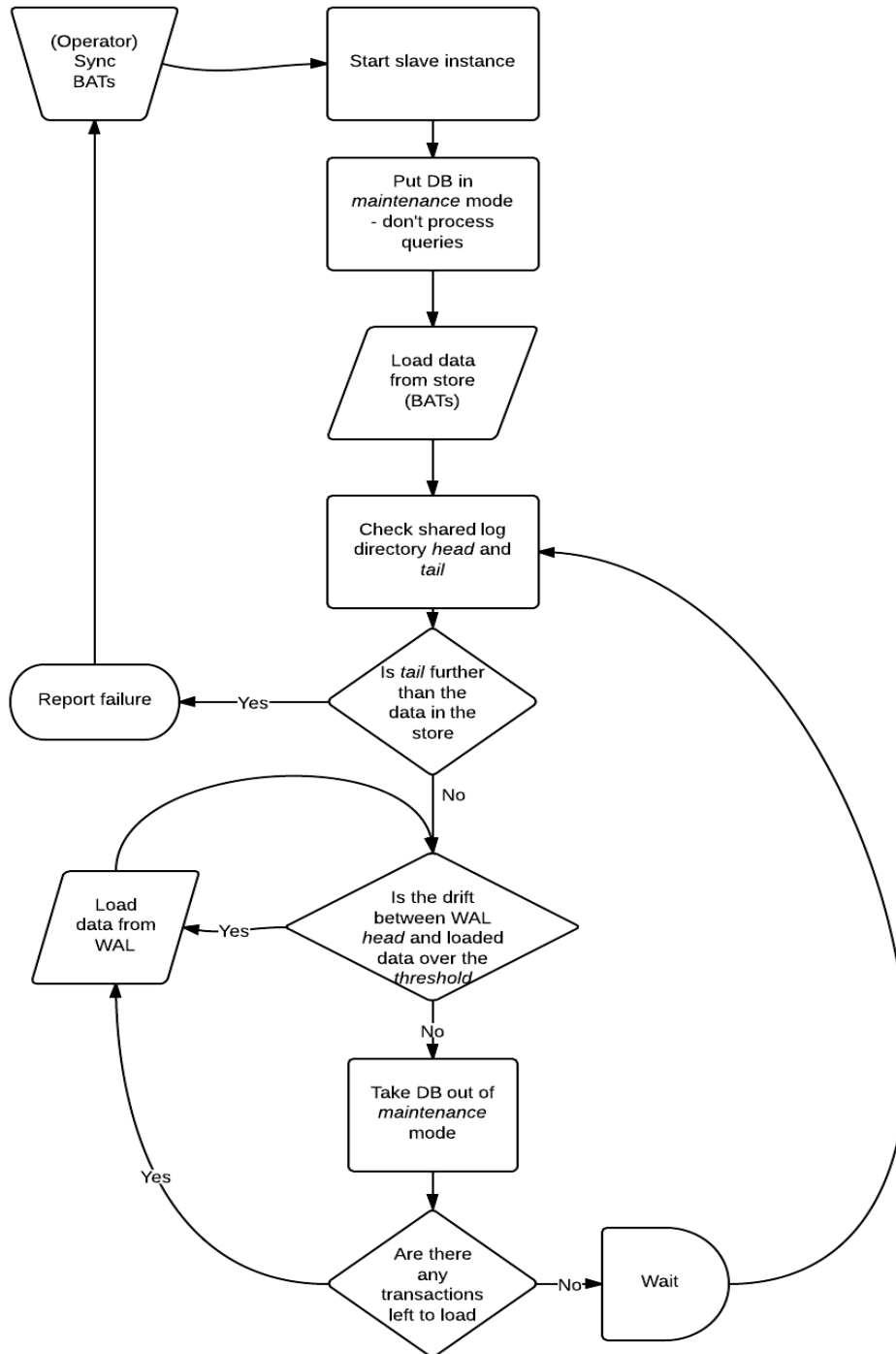
it can replicate all data. In case the tail of master data is further than the head of the transactions on the slave, the instance will report failure. An operator/DBA must manually sync the instance coping the persisted data from the master to the slave. If tail of the master transaction is behind the head of the salve, the slave will then verify if the drift between the two instances is past the threshold. If that is the case, the slave will load all needed transaction from the synced master WAL. Once it's passed the threshold, it will unlock the store and begin to process read queries. At regular time interval the synced master WAL will be re-examined and the replication process begins anew.

On the master instance, as little as possible changes were done, in order not to compromise the performance of the database. The only major change is that more than one transaction is now preserved. This is needed since there is no communication between the master and the slave instance and all transactions that have to be replicated at the slaves need to be available.

6. CONCLUSION

Database systems running in the cloud have significantly reduced the time to process large volumes of data. To support this process database management systems have also adapted to the paradigm of the cloud age. As part of the cloud integration of MonetDB, we focused on the activities that serve the needs of data analysis best. Our deployment automation process ensures that the process of starting a new virtual instance with MonetDB is always simple. Pre-configured versions of MonetDB and R are ready to launch on demand. In addition, the methodology and technologies used minimize the maintenance effort and make upgrade simple. The transaction replication support, on the other hand, guarantees high-availability of running the MonetDB instances. The log shipping based approach reuses as much as possible the existing system. This way the risk and time to market of this solution is minimized. As a result, it now takes only a few clicks to start a new cloud instance of get insights from your data.

7. ACKNOWLEDGEMENTS

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ARCHITECTURE FOR INTEGRATED MANAGEMENT INFORMATION SYSTEM FOR TRAKIA UNIVERSITY OF STARA ZAGORA

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Abstract: *In this report we present the possible solutions for architecture for the Integrated Management Information System (IMIS) of Trakia University – Stara Zagora. Several possible implementations for the system are reviewed and compared. The first one takes into consideration the use of regular web servers, connected to databases, along with a backup system. The second one is based on consolidated hardware, using blade servers, on which virtual servers are deployed. The backup system is an iSCSI-based Storage Area Network. The considerations for the selected solution are presented, along with its advantages and disadvantages.*
Keywords: *Information Systems, System Architecture, Blade Servers, Virtualization.*

1. INTRODUCTION

The Integrated Management Information System of Trakia University aims at the development and integration of information resources in order to improve the quality of management of Trakia University. Its implementation allows for achieving the following **goals**:
- Analysis and improvement of the educational process for students, masters and Ph.D. candidates in today's competitive educational environment, according to the requirements of the national qualification framework and the future employers.
- Analysis and evaluation of the system for management of the research and development and international activity, and improving its quality in accordance to the criteria of the rating system for universities, the criteria of National Evaluation and Accreditation Agency and the necessities of all the interested parties (professors, students, business and real-life applications).
- Management and development of the organization of the Trakia University by establishing and implementing mechanisms and procedures for feedback from the future employers and the students and by using this feedback information for taking better management decisions by the staff at Trakia University.
- Improvement of the system for quality management at Trakia University by designing new procedures and further developing the existing ones to include measurable key efficiency indicators.

The main tasks, performed by the Integrated Management Information System are:
- Collecting and analyzing data, access to the information in real time at global level, as well as the ability to track and evaluate the achieved results against set performance rating;
- Creating tools and methods for tracking and improving the performance using the criteria provided by the rating system of the universities in Bulgaria;

- Developing flexible tools for assessing the achieved quality of educational services in professional fields according to the criteria for evaluation and post-accreditation control by the National Evaluation and Accreditation Agency;
- Development of up-to-date methods for providing educational services, based on increasing the consumers' access to the educational documentation in order to manage the quality of the education and to achieve the criteria set by the implemented rating system of the universities and the European qualifications framework for lifelong learning;
- Development and implementation of mechanisms and procedures for feedback from the future employers and the students and using this feedback information for taking better management decisions at Trakia University;
- Periodically monitoring the compliance of the education with the current needs of the job market;
- Improvement and development of the system for management of the quality at Trakia University – Stara Zagora by transforming all of the main and ancillary work processes into documented procedures, work instructions and operational documents;
- Application of new technologies for motivating the students for higher achievement and better learning outcomes by promoting them to future employers;
- Creating tools and mechanisms for tracking the professional realization of the students and maintaining a feedback with the graduates.
- Maintaining and analyzing the historical data for the last five years, which is imported from the existing information system at Trakia University.

2. RELATED STUDIES

It is necessary to follow some major fundamental aspects for implementing and developing an information system and integrated information system in order to present the physical layer of the Integrated Management Information System. These aspects relate mainly to the application of modern approaches, methods and technologies for designing and developing an Integrated Management Information System.

For this implementation we made use of the U.S. Department of Defense Instruction (DoDI) Architecture Framework [11].

The architecture development of Department of Defense Instruction (DoDI) include **6-step process**:

Step 1: Determine Intended Use of Architecture
Step 2: Determine Scope of Architecture
Step 3: Determine Data Required to Support Architecture Development
Step 4: Collect, Organize, Correlate, and Store Architectural Data
Step 5: Conduct Analyses in Support of Architecture Objectives
Step 6: Document Results in Accordance with Decision-Maker Needs

It is important to note that the development of Architectural Description is an iterative process and a unique one, in that every Architectural Description is:

• Different in that architecture creation serves a specific purpose, and is created from a particular viewpoint.

• Serving differing requirements, necessitating different types of views to represent the collected data.

• Representative of a 'snapshot in time' (e.g., the Architectural Description may represent the current view or baseline, or it may represent a desired view in some future time).

• Changeable over time as requirements become more focused or additional knowledge about a process or requirement becomes known.

The methodology is designed to cover the broadest possible set of circumstances, and also to focus on the most commonly used steps by the architecture community.

Data mining and machine learning.

Applying data mining and machine learning techniques on of IMIS data provides many opportunities for improving possibilities of analyzing data and efficiency of their usage. There are many sources and uses for educational knowledge, many methodologies and standards for representing the knowledge are integrated. Furthermore, mined knowledge can be automatically extracted from IMIS databases through data mining and AI techniques, to be incorporated into human-generated knowledge that enhances their decision-making processes [9].

Both types of knowledge can be represented as logical conditions, rules [6], graphs/networks, or structural representations [2]. Predictive Model Markup Language (PMML) (Data Management Group [1] and GLIF (Guideline Interchange Format) [14] are examples of knowledge representation languages that are used to acquire and integrate knowledge.

Service oriented architecture (SOA).

A SOA has been widely adopted to solve the interoperability of the involved heterogeneous distributed systems [7,10]. This architecture plays a key role in the integration of heterogeneous systems by means of services that represent different system functionality, independent of the underlying platforms or programing languages, and interacts via message exchanges. Web services also play a critical role in systems' interoperability. Web services technology is defined as a systematic and extensible framework for application-to-application interactions that is built on top of existing web protocols. These protocols are based on XML and include: Web Services Description Language (WSDL) to describe the service interfaces, Simple Object Access Protocol (SOAP) for communication between web services and client applications, and Universal Description, Discovery, and Integration (UDDI), to facilitate locating and using web services on a network [5].

Depending on the hardware system used to host the IPS²-ES, another layer may have to be used. For a cloud-computing environment, as assumed in Figure 3, a cloud system layer might be present. The hardware layer is mostly irrelevant for the platform-independent IPS²-ES.

3. IMPLEMENTATION AND RESULTS

Multi-layer architecture (Figure 1) of Integrated Management Information System of Trakia University include the following levels: Web-based Graphical User Interface and Web Application, Java Server Pages Presentation Layer, Business Logic Objects, Data Access layer and PostgreSQL Databases, Middleware Layer, Cloud System Layer, Physical Layer, and Server Layer.

In this paper we present the Physical Layer only and decisions for him.
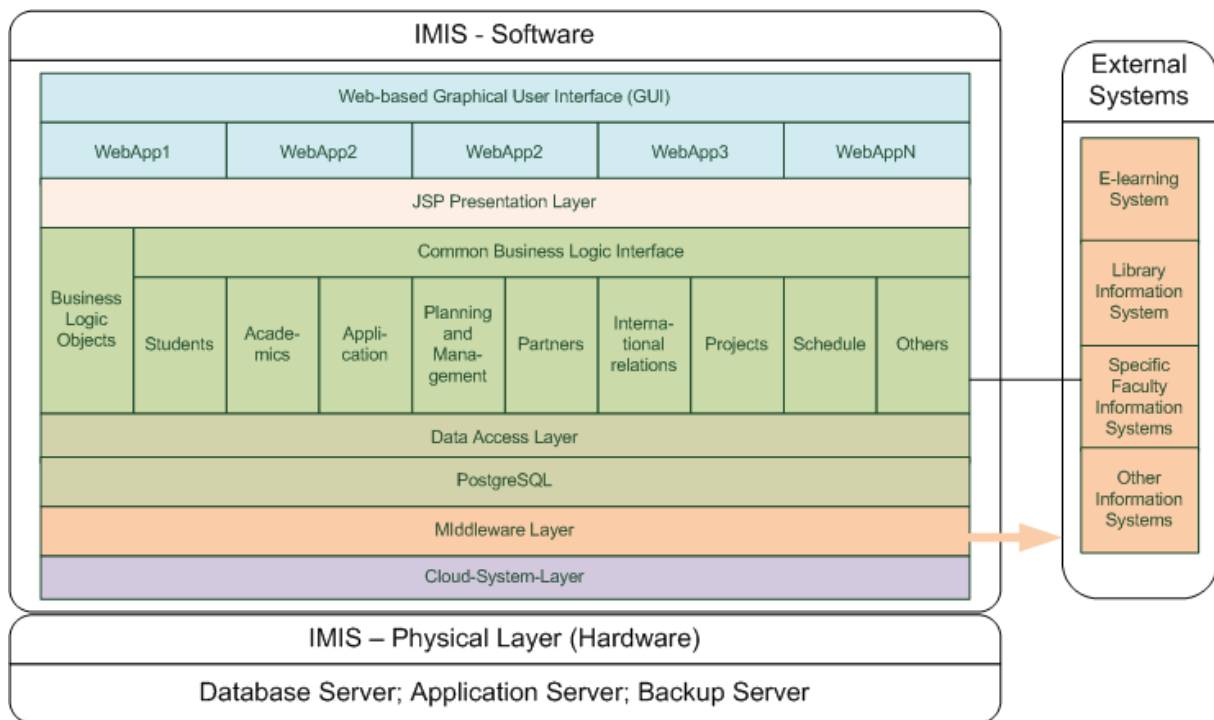
Figure 1. Architecture layers of the IMIS of Trakia University - Stara Zagora

One of the solutions (Figure 2) includes hardware configuration, which includes servers for the applications, server for backup, servers for the databases and system for backup. The allocation servers are two and they have the following basic functions: server for the applications and server for the business logic /middleware layer/. Based on this distribution of functions the traffic is distributed between the two applications' servers.

The backup server has basic functions, which include night-time archiving of the applications; of the database; of the documents and other information. In addition he maintains a weekly archive of the backup system. Its secondary functions are to be a standby/reserve server for the applications, databases and documents. This way it can be used as an additional third server or as a failover instead of another server. The database is configured in such a way that when the loss of the database server or a larger traffic occurs, this backup server is synchronized with the database and can be used as a reserve/standby server. Similarly configured are the applications, by which when a server is lost or a larger traffic occurs they can use the backup server as a reserve.

Both database servers are in a cluster configuration and synchronized. At some point the third server is configured and synchronized but does not respond to requests – it only functions as a failover. These servers not only maintain the database but also function as document file storage.

A failover cluster is a group of servers that work together to maintain high availability of applications and services. If one of the servers, or nodes, fails, another node in the cluster can take over its workload without any downtime (this process is known as failover).
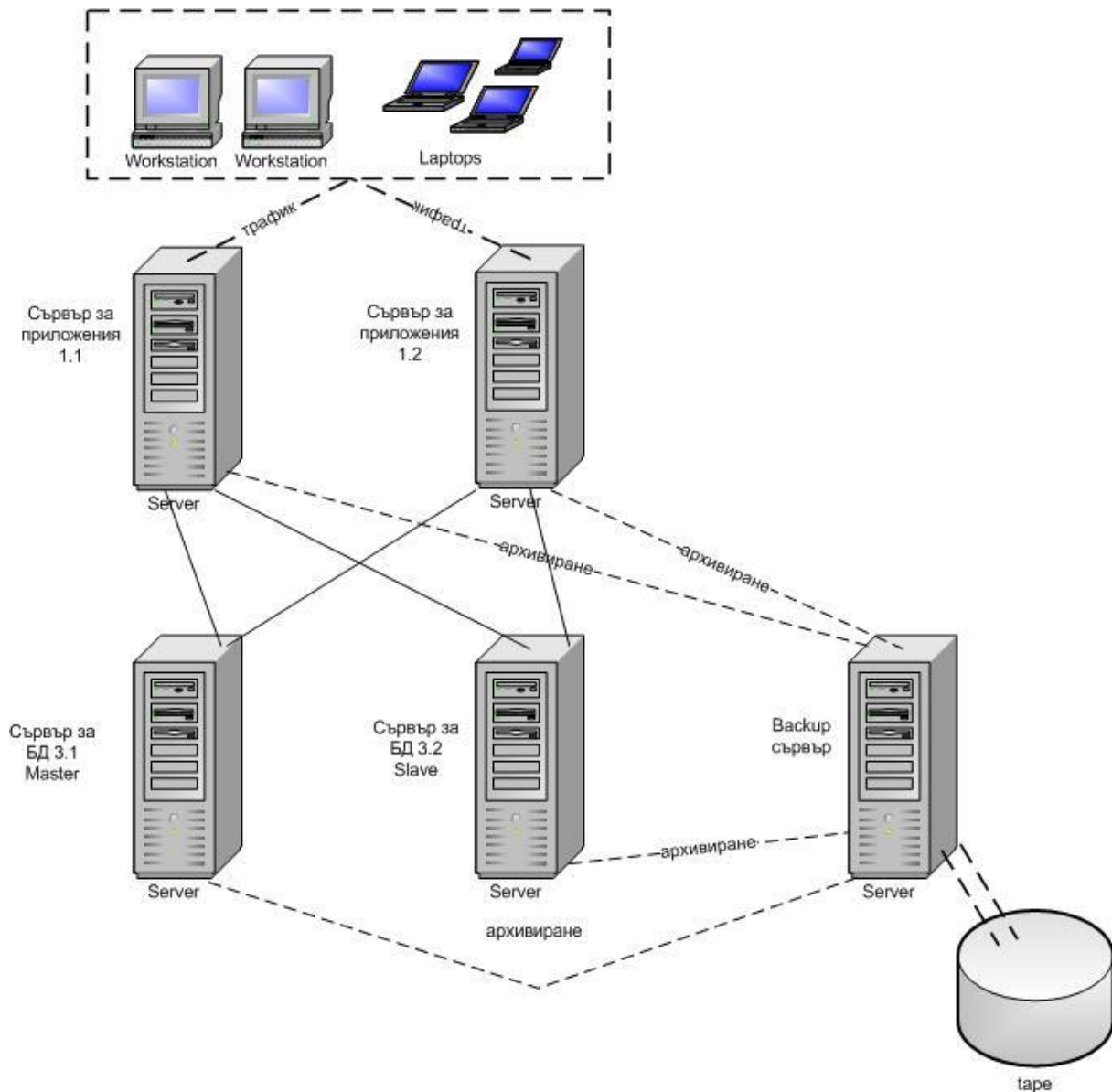
Figure 2. Physical Layer diagram of the IMIS

The second solution for technical implementation of the Integrated Management Information System is based on blade servers and is called „DataCenter in a Box", using which a server complex is created that is based on the newest hardware and software technologies. This server complex is centralized and virtualized. The consolidation of the server resources is done using blade-based technologies. The blade technologies provide an extremely reliable, manageable and efficient environment. Since the servers are in a common chassis, they use the same electricity and centralized management. The virtualization of the centralized server complexes provides the efficient use, maintenance and management of the hardware and increases the reliability of the operations in the application systems. The virtualization software can execute a planned move of the virtual machines from one to another host server.

The technologies, on which this decision is based, are: server blade architecture, SAN storage architecture with automated backup of the virtual environment and the data, Intelligent Disk Subsystems.

The emerging server blade architecture promises to alleviate many of the data center issues brought about by the shift to scale out architectures featuring standards-based, rack-dense servers. Server blades have the potential to increase server density, improve manageability, lower power consumption, and enhance deployment and serviceability, all resulting in lower total cost of ownership. Although the initial incarnation of blades is well suited for expansion into the front end of the IT infrastructure, the architecture is likely to evolve and play a significant role throughout the data center [8].

A newer I/O architecture, like InfiniBand (IB), may drive the modular server landscape because it provides a universal interconnect fabric that is ideal in situations where space is limited and multiple fabrics such as Ethernet, Fibre Channel/SCSI, IPC (inter-process communication) are not possible (Figure 3). IB can offer the following benefits for server blades:
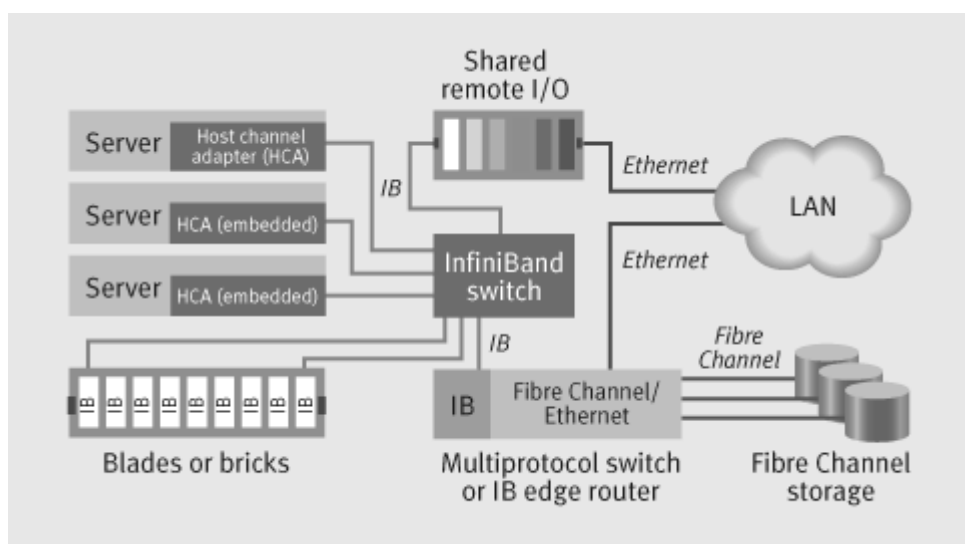
Figure 3. InfiniBand fabric topology [8]

• IB provides a high-performance, low-latency, blade-to-blade interconnect for high-performance computing and database clustering.

• IB provides connectivity to external storage and Ethernet networks through InfiniBand -to-Fibre Channel or InfiniBand -to-Ethernet gateways or "edge routers." This architecture lets vendors use the capabilities of IB but does not force customers to re-cable the data center for InfiniBand.

• IB allows multiple blades or multiple enclosures to share legacy PCI peripherals by providing connectivity to external PCI expansion modules. Not only does this approach save space, but it also allows customers to leverage devices over multiple servers.

• Native InfiniBand storage, not yet available, will allow IB-enabled servers to connect directly into IB storage without changing protocols.

InfiniBand interconnects and new management tools can provide the foundation for true "utility computing" models, where data center administrators have a pool of compute and storage resources that they can dynamically allocate as required. This technology fosters a dynamic and modular data center, whether it belongs to a service provider or a brick-and-click enterprise.

Early versions of server blades will be primarily high-density, low-power devices with relatively low performance. This type of blade is suited for first-tier applications such as static Web servers, security, network services, and streaming media because the applications can be easily and inexpensively load balanced. The performance of an application depends on the aggregate performance of the servers rather than the performance of an individual server.

Higher performance, less dense blade designs will help drive blade usage into more mainstream applications in the corporate data center. These designs can offer the individual performance characteristics and features available in today's rack-dense servers along with the cost, deployment, serviceability, and density benefits of server blades. The blades will be well suited to high-performance Web servers, dedicated application servers, server-based or thin-client computing, and high-performance computing (HPC) clusters.

The disk subsystem of the database server with a modular disk array supports both SAS, SATA и SSD disks. The data is consolidates in IP SAN storage servers. It is a family of storage servers, which are highly reliable and use the newest technologies for storage and management of data. The reservation system maintains a cloud file system that can be accessed using the Internet. Four or more backup power generations for the servers are used for higher reliability. The backup of the virtual environment and of the data is centralized and automated. „BlueCloud" backup servers and software for automation of the backup are used. The software for system backup in the reservation system includes the possibility to automatically start the virtual machine using a backup copy, which is saved on the reservation system.

Data protection (Backup) is a central application in every IT system. Using network backup system it is possible to back up heterogeneous IT environment with several thousands of computers largely automatically [10]. Storage networks are complex systems made up of numerous individual components.

The iSCSI protocol utilizes Intelligent Disk Subsystems (Figure 4). All servers share the storage capacity of a disk subsystem. Each server can be assigned free storage more flexibly as required.

The bundles of physical hard disks brought together by the RAID controller are also known as virtual hard disks. The server that is connected to a RAID system sees only the virtual hard disk. The fact that the RAID controller actually distributes the data over several physical hard disks is completely hidden to the server. One factor common to almost all RAID levels is that they store redundant information. If a physical hard disk fails, its data can be reconstructed from the hard disks that remain intact. A defective hard disk can be replaced by a new one during operation if a disk subsystem has the appropriate hardware. Modern RAID controllers initiate this process automatically – this called hot spare disks. If a disk fails, the RAID controller immediately begins to copy the data of the remaining intact onto a hot spare disk. After the replacement of the defective disk, this is included in the pool of hot spare disks.
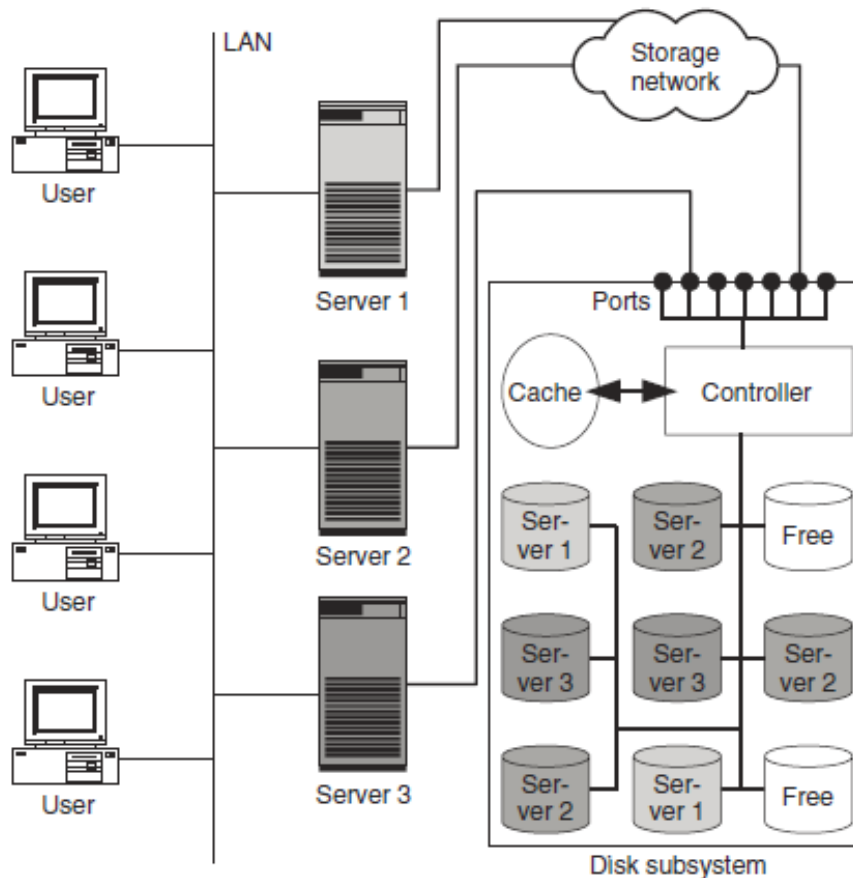
Figure 4. Server sharing the storage capacity of a disk subsystem [10]

As organizations evaluate how to evolve their internal infrastructures to a private cloud, some authors delineate how Platform ISF can facilitate this evolution [10]:
1. **Heterogeneous systems support** – Adapters within the Platform ISF integrate distributed and heterogeneous IT resources to form a shared system. All major industry standard hardware, operating systems (including Linux and Windows) and VM hypervisors (including VMware ESX, Citrix XenServer, Microsoft Hyper-V, and Red Hat KVM) are supported. Adapters are also available for provisioning tools (IBM xCAT, Symantec Altiris, and Platform Cluster Manager) to set up application environments on demand.
2. **Integration with management tools** – Platform ISF integrates with many third-party tools for various systems management tasks out-of-the- box, including directory services for user and account management, security, monitoring and alerting.
3. **Configurable resource allocation policies** – Once a pool of shared resources is formed, a set of site-specific sharing policies is configured in the allocation engine to ensure that applications receive the required resources. These policies also make certain that the organization's resource sharing priorities are applied, and that the quota constraints applicable to business groups sharing the cloud are reinforced. The allocation engine matches IT resource supplies to their demands based on resource-aware and application-aware policies. This private cloud "brain" is critical for IT agility.
4. **Integration with workload managers, middleware and applications** – Platform ISF provides interfaces to users and applications as well as supporting the lifecycle of cloud service management. Templates can be configured for simple and complex N-tier business

applications to automate their lifecycle management. Platform ISF allows for the starting of all the components of an N-tier application, the adding or removal of a resource, and monitoring and failure recovery. It also supports middleware such as J2EE, SOA, CEP and BPM, and workload schedulers such as AutoSys, Platform LSF and Symphony.
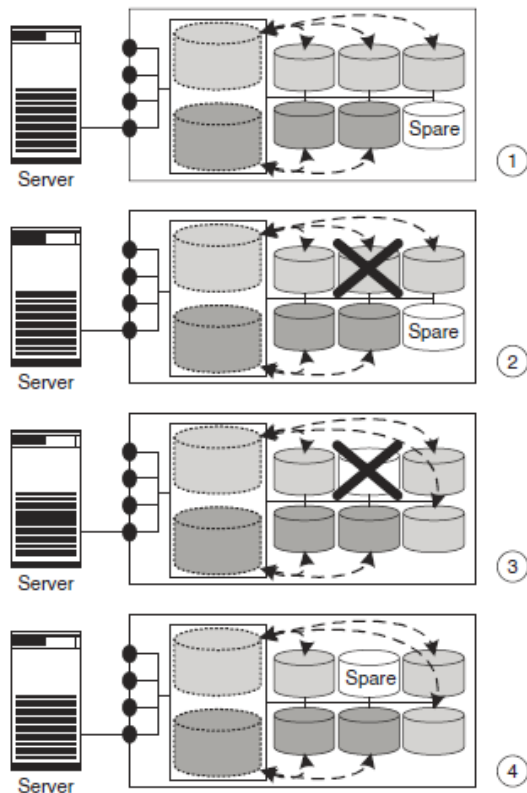
Figure 5. Hot spare disk:

1) The disk subsystem provides the server with two virtual disks for which a common hot spare disk is available:
2) Due to redundant data storage the server can continue to process data even though a physical disk has failed, at the expense of a reduction in performance.
3) The RAID controller recreates the data from the detective disk on the hot spare disk.
4) After the detective disk has been replaced a hot spare disk is once again available.

Figure 5. Hot spare disk [10]

5. **Support IT and business processes** – A self-service portal enables users to request and obtain physical servers and VMs in minutes instead of days or weeks. Platform ISF has a set of APIs that can be called by applications, middleware and workload managers to request and return resources without human intervention. The service offerings can be structured as: complete application environments (e.g., application packages, CPU, memory, storage and networking); as bare metal servers with an operating system installed; or as virtual machines. SLAs can be associated with each service offering.

6. **Extensible to external resources** – Platform ISF integrates with many service provider environments (e.g. Amazon Web Services via Amazon Virtual Private Cloud), enabling centralized access, management, tracking and billing of external services.

7. **Enterprise, not workgroup, solution** – Built on a technology foundation found in large scale production environments, Platform ISF is scalable to hundreds of thousands of cores under management which enables IT to start small and feel confident that their cloud will grow as more services are added over time.

Lastly, beyond the seven key components of enterprise cloud deployments, Platform ISF also collects all resource usage data and provides reports and billing information. Alternatively, the cloud administrator may choose to feed the usage data into site-specific reporting and charge-back tools. Below I've included our depiction of the private cloud management stack and the location of Platform ISF with its various capabilities.

4. CONCLUSIONS

The virtualization of the network infrastructure optimizes the work of the application systems and facilitates the management of the environment, which has the following characteristics:

- Highly reliable;
- Continuous work;
- No single point of failure;
- Managed centrally and remotely;
- With central backup and Disaster Recovery;
- Flexible decisions;
- Scalability;
- Optimization of the investments and their appropriate distribution in the different project stages.

Keeping in mind the chosen technological solution and technical support of the Integrated Management Information System, Trakia University starts off with low initial investments and configurations that is corresponding to the current needs and is gradually developing by adding functionality and hardware. They allow the development of the functionality of the system, its future integration in the record-keeping, financial, accounting and other systems of Trakia University.

5. ACKNOWLEDGEMENTS

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MODEL IDENTIFICATION IN SOME
BIOCHEMICAL ANALYTICAL TESTS

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Abstract. *Some biochemical assays require calibration of the experiment at a specific device and a specific set of reagents for analysis. The survey method is based on the construction of a standard curve. The analysis to construct a standard curve of agent-dependent parameter is carried out at precisely known reference values of the active agent. The approximation approaches for the construction of the standard curve that are recommended by the manufacturers of agents presume error, which subsequently affects the analysis of the experiments. Furthermore, this approach does not allow to define dependencies outside the range of the supplied reagents.*

This paper provides the identification of the experimentally measured values of the reference reagent with a suitable functional relationship. Identification is performed by the coordinate descent method. A user-friendly interface supports working with the program. The results are displayed in Cartesian coordinate system. Forward and inverse functional dependence is provided in analytic form to provide portability to common data processing software.

Keywords*: Identification, Modeling, Data Recognition, Mathematical Model, Standard Curve.*

1. INTRODUCTION

The research process in the field of medical and biological sciences is often linked to performing a variety of clinical and biochemical analysis. For this purpose, a number of methods have been developed: spectrophotometry, fluorometry, electrophoresis, mass-spectrometry, radioimmunoassay, enzyme-linked immune-sorbent assay, which are carried out with precision and sophisticated equipment. However, a number of factors that accumulate as a random or systematic errors may influence the experimentally obtained data. The use of approximation with average values has serious drawbacks - it requires a large number of experiments, and it is always expensive. One approach to minimize possible errors in the analysis process is to conduct them on reference samples (standards) with the set of reagents used for the study. These standards are substances for which some value of the independent parameter and the value that should be obtained for parameter are dependent on the chosen method and apparatus for testing. Comparison of the experimental data with the data obtained from the standards entails theoretical off error. Manufacturers of reagent sets for laboratory analyzes recommended the following technology application:

✓ The samples (standard and test) should be prepared according to the same method.

✓ The standards and the research material should be analyzed alongside. Thus, the possible errors of procedure and experiment will have a uniform effect on the standard, for which the parameters are know and the test samples, for which parameters are sought.

✓ Planned analysis should be implemented in order to obtain the parameters of the material under investigation and the reference samples.

✓ Based on the results obtained with the standard agent a calibration curve is build – a graph of "dependent parameter" - "independent parameter." This is used to measure and quantify the results of the experiment.
✓ In the experiment with the test substance what is measured is a dependent parameter. Using the standard curve and applying an inverse transformation the independent parameter value is obtained.

The standard curve is an essential tool for determining the unknown parameter of the test substances. The accuracy of the experiment depends on the correctness of the curve. Therefore, the process of its construction is the most important in the calibration. The most common consideration for the choice of approximating curve is closest similarity between data points and graphics of known functions. Linear regression, cubic spline, polynomial regression and so on is applied. A general-purpose software (MS Excel) or a specialized one: Matlab [1], KaleidaGraph [9], Prism [3], Korelia [4] can be also used.

When analyzing the most widely used reagents, the following features common for all standards were revealed.

1. The number of provided standard samples are six, rarely five. The values of the samples vary greatly depending on the purpose and character of the set of reagents.

2. The law of change of the active agent is not specified. Instead it is recommended the construction of the standard curve in one of the already discussed ways.

3. Usually is recommended to use a half-logarithmic scale, but without indicating the base of the logarithm. So implicitly a logarithmic relationship between dependent and independent parameter is applied.

4. It is not clear how to proceed in the event that any of the parameters of the experimental samples - dependent or independent, be outside the range covered by the standard set.

All this leads to the fact that the same standard with a selection of different curves for approximation or changing software, will change the data of the experiment. Perhaps this is one reason why in medical and biological sciences there are publications dealing with the same problem, but with differences in the obtained results. The relation "independent-dependent" parameter for the active agent is known and strictly obeys a nature law. This law is known for quality and subject to the description with a mathematical function. Quantitative expression is obtained by determining the concrete numerical values of the parameters of the mathematical function. Following the logic of the natural law in the construction of the standard curve, the set of reagents must be used for a quantitative calculation of its parameters, and not just for the construction of an approximating curve. This is a process of identification of a mathematical function in experimental data [6]. Because of the different nature of its complexity and the need for specialized skills, identification is not in the set of methods commonly employed by humanitarian professionals. Motivated by the desire to make this powerful scientific tool more available to humanities scholars we create a user-friendly software for the identification of some classes of standard curves. In selecting the model the user will be assisted by a recognition algorithm.

2. FORMAL DESCRIPTION OF THE STANDARD CURVE

The following conventions for the construction of the standard curve are accepted.

1. The independent parameter of standard samples is denoted by $\boldsymbol{\Gamma}$. $\boldsymbol{\Gamma}$ is represented by a set of admissible values $X_{\Gamma}^{S} \subset R$, which is bounded. The set X_{Γ}^{S} is represented by N number of standard values (5 or 6 as mentioned):

$$X_{\Gamma}^{S} = \left\{ x_{1}^{S}, x_{2}^{S}, x_{3}^{S}, ..., x_{N-1}^{S}, x_{N}^{S} \right\}, \quad \left| X_{\Gamma}^{S} \right| = N \tag{1}$$

2. The codomain of the dependent variable Λ is $Y_{\Lambda} \subset R$, which is generally bounded. For each $x_{i}^{S} \in X_{\Gamma}^{S}$ the value $y_{i}^{S} \in Y_{\Lambda}, i = 1, 2, ..., N$ is given by the manufacturer.

3. In the experiment for each reference value x_{i}^{S} is obtained $y_{i}^{E} \in Y_{\Lambda}$. This value will always be different from the standard y_{i}^{S}:

$$y_{i}^{E} \neq y_{i}^{S}, \quad i = 1, 2, ... N$$

y_{i}^{E} reflects differences in methods of research, accuracy of equipment, aging of standards, dispersion of parameters, subjective factors in the experiment, ie y_{i}^{E} carries a cumulative error.

4. The ordered pair $\left(x_{i}^{S}, y_{i}^{E} \right)$ will be called a standard (reference) point.

5. Important features of the standard points are:

a) the relation '<' is defined on the set X_{Γ}^{S}:

$$X_{\Gamma}^{S}: \quad x_{1}^{S} < x_{2}^{S}, < x_{3}^{S} < ... < x_{N-1}^{S} < x_{N}^{S}$$

b) $\forall i \neq j \Rightarrow y_{i} \neq y_{j}$

Thus the standard function f^{S} is defined as:

$$f^{S}: X_{\Gamma}^{S} \rightarrow Y_{\Lambda} \tag{2}$$

Its analytic form is known to the manufacturer of the kit, but in practice is not always provided to the users.

This condition allows to construct a standard graph $G^{S}(f^{S})$ of the standard function f^{S}:

$$G^{S}(f^{S}) = \left\{ (x, y) \mid x \in X_{\Gamma}^{S}, \; y = f^{S}(x) \right\} \subset X_{\Gamma}^{S} \times Y_{\Lambda} \tag{3}$$

This is a graph that provides qualitative and quantitative idea of the actual experiment. To obtain it is an approximation task that can be solved by choosing different curves. The correct approach is the approximation to the function (2), if it is provided by the manufacturer.

3. MODELS FOR IDENTIFICATION OF STANDARD CURVE

3.1. Exponential model
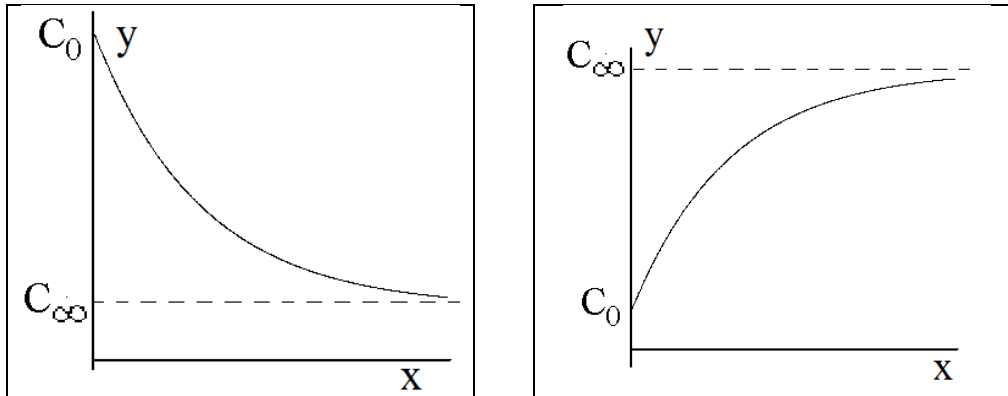
Figure 1. Exponential model

One of the characteristics common for standard curves is to represent processes of quantitative changes with speed proportional to the difference between the current and final quantity (Fig.1). Such processes are described by inhomogeneous differential equation of the first order:

$$\left|\begin{array}{l} \dfrac{dy(x)}{dx} + r.y(x) = k.U(x) \\ y(0) = C_0 \end{array}\right. \tag{4}$$

Where: r – the rate constant of the process
U(x) – the input step force
k – a proportionality coefficient

The solution of Eq.(4) is:

$$y(x) = (C_0 - C_\infty).e^{-r.x} + C_\infty \tag{5}$$

Where: $C_\infty = (kU)/r$ – the infinite asymptote

The identification vector is **Q=[C_0, C_∞, r]**. After determining the values of the identification vector, the equation of the inverse function is:

$$x = -\frac{1}{r}.ln\left(\frac{C_\infty - y}{C_\infty - C_0}\right) \tag{6}$$

The inverse transformation is necessary because in the experiment the dependent variable is read and the corresponding independent value is sought after.

3.2. Sigmoidal model

Another possible model of the standard curve is a sigmoidal curve (Figure 2). It represents the change of the dependent parameter when it is a with limited capacity. The model is a nonlinear first order Verhulst - Pearl equation.

$$\left| \begin{array}{l} \dfrac{dy(x)}{dx} = r\left[1 - \dfrac{y(x)}{K}\right] y(x) \\ y(x_0) = C_0 \end{array} \right. \tag{7}$$

Where: r – the slope or the growth rate parameter that specifies "width" or "steepness" of the S-curve.

K – the carrying capacity, a measure of the available resources

This equation describes some of the so-called S-shaped curves representing the population dynamics of natural species in ecology, effective dose in pharmacology [8], Michaelis-Menten type enzyme kinetics in biochemistry, saturation curve for an enzyme reaction, inhibitory effects in systems and other [2]. Quantitative changes are initially exponential, but as time increases become inhibited by environmental factors which result in zero growth at the carrying capacity K.
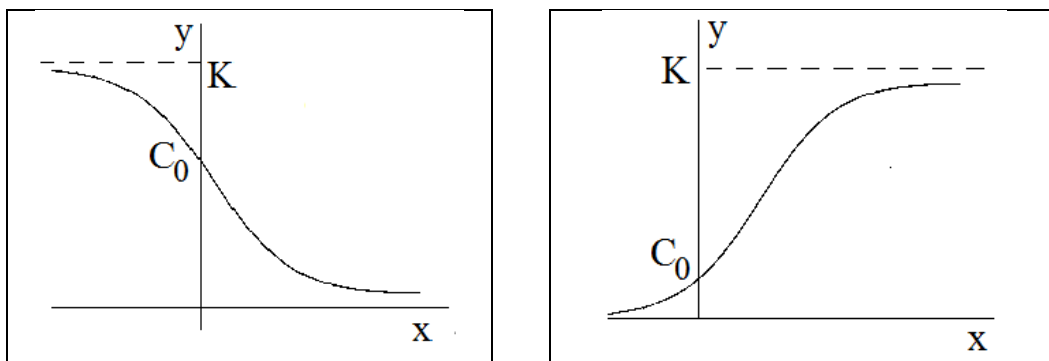
Figure 2. Sigmoidal curve

The solution $y(x)$ of Eq.(7) is a logistic model:

$$y(x) = \dfrac{K}{1 - \left(1 - \dfrac{K}{C_0}\right) e^{(-r.x)}} \tag{8}$$

This equation has the following disadvantages, which may hinder the identification process:
➢ It is possible the denominator to become zero.
➢ Does not reflect the possible translations of the curve along the coordinate axes.
Therefore a more suitable model is the following:

$$y(x) = \dfrac{K}{1 + A.e^{-[r.x+\beta]}} + C_\infty \tag{9}$$

Where: A - the number of times that the initial value y(0) must grow to reach 100%.

β - the correction parameter.

C_∞ - the infinity asymptote

The identification vector is **Q=[K , A, r, β, C∞]**.

These parameters must be identified by fitting the Eq.(9) to the standard points.

After determining the values of the identification vector, the inverse function is:

$$x = -\frac{1}{r}\left[\beta + ln\left(\frac{y + C_\infty - K}{A(y + C_\infty)} \right) \right]$$ (10)

4. IDENTIFICATION OF THE STANDARD FUNCTION

Let us chose as subject to identification the function $y(x,Q) \in Y_\Lambda$. As a result of the measurement we know the values y_i^E for standard x_i^S that must satisfy the condition:

$$y(x_i^S, Q) = y_i^E(x_i^S), \quad i = 1,2,...,N$$ (11)

The identification vector **Q** must be defined from the system (11). But this system is not well defined. For each point x_i^S the residual **Δᵢ** is**:**

$$\Delta_i = \left\| y(x_i^S, Q) - y_i^E(x_i^S) \right\|, \quad i = 1,2,...,N$$ (12)

The aim is to minimize Δ_i for the whole interval of identification X_Γ^S:

$$D(Q) = inf(\Delta_i) < \varepsilon, \quad \varepsilon > 0$$

Thus the identification goal is translated into an optimization problem**.** The optimization method is defined according to the way of minimization of **D(Q).** The various identification tasks differ depending on the way of defining of **D** and the chosen class of functions **Y.** In the program Korelia the optimization procedure is based on the coordinate descent method. The optimization can be performed by one of the three criteria:

➢ Least square fitting. An object of minimization is the functional:

$$D_{LS}(Q) = \sum_{i=1}^{n} \Delta_i^2 \rightarrow min$$ (13.a)

➢ Uniform fitting. The uniform fitting is aimed at minimizing the maximal deviation in the standard points $\left(x_i^S, y_i^E \right)$.

$$D_U(Q) = max|\Delta_i| \rightarrow min$$ (13.b)

➢ Coefficient of determination **R²**. It indicates how well chosen model fits the standard points. The maximal possible value of **R²** is 1:

$$R^2 = 1 - \frac{\sum_{i=1}^{n}\Delta_i^{\,2}}{\sum_{i=1}^{n}\left(y(x_i^S,Q)-\overline{y^E}\right)^2} \to 1$$

where $\overline{y^E}$ is the mean value of y_i^E, $i = 1,2,...,N$

And the criteria D_{R^2} is:

$$D_{R^2} = \frac{\sum_{i=1}^{n}\Delta_i^{\,2}}{\sum_{i=1}^{n}\left(y(x_i^S,Q)-\overline{y^E}\right)^2} \to min \qquad (13.c)$$

5. SOFTWARE REALIZATION

The approach for the identification of standard curves is realized in the program Korelia-Ident. The identification process follows the algorithm.

1. The test samples and the reference samples are prepared. The values y_i^E for the dependent parameter of the standard model are recorded.

2. The received standard experimental points $\left(x_i^S, y_i^E\right)$, $i = 1,2,...,N$ are introduced in the program.

3. Visualization of the standard points. There is a choice of linear or spline interpolation for determining the curve class.

4. Recognition of the curve class: exponential, sigmoidal or other curve. A recognition algorithm for determination of the nearest class of model to identify the standard curve is applied [7].

5. Identification of the selected class of the curve according one of the criteria (13.a-13.c).

6. Graphic visualization of the identified model - verification with standard points.

7. Generating of analytic form of the identified model.

8. Generating of the inverse function of the model.

6. USER INTERFACE

An important condition for a program to be user-oriented, is availability of user friendly interface. That means the program should work in an intuitive and spontaneous mode, using notions and terms of the subject area of the user, hiding the complexity of the system and showing only those options that are applicable at the moment. This conditions are met by software developers typically by introducing a Graphical user interface (GUI). GUI is a standard that is presented in tools for software development [10]. It helps to optimize the entry times and reduce the mis-types. It combines simplicity of expression means with great descriptive and modification ability. The great opportunities come together with minimal efforts from the user.

In developing the program we implement the GUI concept and meet the requirements for work with image data [5].

➤ Graphical operators. They modify graphical attributes of the object. In Korelia the basic graphical operations are: interpolation, integration, differentiation and translation of graphical classes.

➤ SET-operators. These operators change parameters of the graphic classes. For example, world coordinates, color and visualization mode of the interpolation curve, standard points, coordinate system, font parameters and so on.

➤ Get operators. They ensure access to the parameters of the concrete objects in the program: mouse coordinates, values of the identified parameters, identification errors: absolute, relative, quadric, coefficient of determination R^2.

➤ Calculation of some specific parameters of standard function [4]: steady state level, settling time, exponential constant, quality factor of regulation, normalized coefficient of quality factor, area under curve (AUC). The results of such calculations are displayed in a separate dialog box.

➤ File operations: write in a file of an identified function, read from a file of a function and visualization, print graph.

7. EXAMPLE
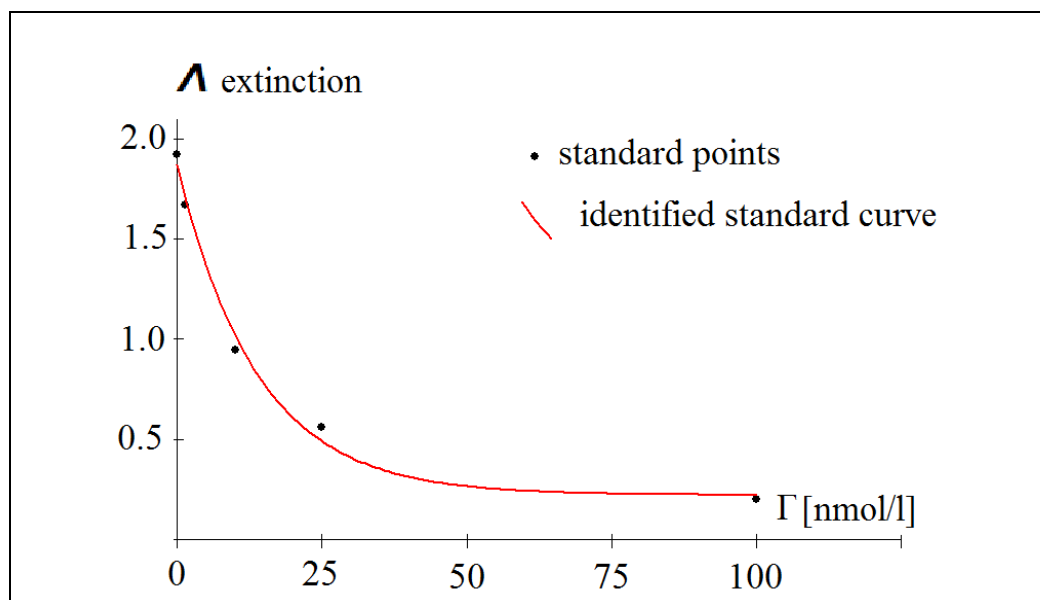
Figure 3. Progesterone enzyme immunoassay test kit

Progesterone concentrations in the plasma of animals was investigated. In the course of the experiment the extinction of the liquid was measured. The process is described by the Bouguer-Lambert-Beer law:

$$I(\lambda) = I_0(\lambda).e^{-k(\lambda).x} + C_{\infty} \tag{14}$$

Where:
I - light intensity;	I_0 - incident light intensity;
k(λ) - absorption coefficient;	λ - wave length;
x - concentration of the agent;	C_{∞} - steady state level;

The results of the experiment should be subject to this law. Numerical values obtained using 5 standard samples are indicated in Figure 3 as points. They will be used to identify the

Eq.(14). The concentration *x(I)* of the test material as a function of the measured extinction *I* was obtained using the inverse function (Eq.6):

$$x(I) = -\frac{1}{k(\lambda)} . ln\left(\frac{C_\infty - I}{C_\infty - I_0}\right)$$

(15)

The identification parameters are **Q=[I₀, k(λ), C∞]**. After identification the values of identified parameters are:

$I_0 = 1.6470$	$k(\lambda) = 13.8100$	$C_\infty = 0.2224$.

The values of the identification errors are:

absolute: 0.12445	relative: 0.13155	quadratic: 0.03681	Coefficient of determination R^2 0.98557

The identified exponential curve is indicated in Figure 3 with a solid line.
The Beer–Lambert–Bouguer law is:

$$I(\lambda) = 1.6470 e^{-13.81.x} + 0.2224$$

(16)

The concentration equation is:

$$x(I) = 0.0724 * ln(0.702 * I - 0.156)$$

(17)

8. CONCLUSIONS

The article describes the applications of the system Korelia-Ident for identification of experimentally measured standard curves. The standard curve is recognized and identified toward two graph classes, representing processes described by first-order differential equations. A friendly user interface for identification and editing of models of standard curves is designed. It facilitates the user and gives opportunity to run identification procedures without specialized knowledge of the underlying control theory and computer software. It combines graphic entities, mathematical modeling and numerical solvers to offer a complete identification environment, and a friendly, effective way to study and explore natural processes.
The equations of the identified curve and its inverse function are obtained in analytic form. The software is intended to provide a highly interactive environment for researchers to examine the properties of dynamic systems, and to explore and construct models of real-world situations, as well as design models for experimental systems.

9. ACKNOWLEDGMENTS

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EDUCATIONAL GAMES AS A MOTIVATIONAL TOOL
FOR DIGITAL STUDENTS
(A CASE STUDY)

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Abstract: *The paper is focused to building a model for development and application of educational computer games in educational process at schools. The main goal of this initiative is to be deployed the potentialities and motivation of the students to achieve proactive involving in learning process. A case study of the current research in this field is provided as well as some definitions are given and a problem domain is outlined. The most important characteristics of the educational games are discussed and their role as a motivational tool is also specified.*
Keywords: *Educational Games,Learning Games, Teaching, Gaming, ICT, WEB, Education, Motivation, Digital Generation, Digital Pioneers, Digital Individual, Student Model, Interaction Model.*

1. PREFACE AND TERMINOLOGY

The goal of this study is to be analyzed the state of the art in the field of computer games used for educational purposes in order to be outlined their potential as a motivation tool for digital students. Based on the current research a wide range of terms could be summarized such as educational game, learning game, teaching game, gaming, gamification etc. Therefore we need to assume some unified terminology in further discussion:

- Educational tool used to provide "play and learn" activity in the learning process is referred as *educational game;*
- *Educational game* is a subclass of *computer game;*
- *Computer game* is subclass *of game.*

2. INTRODUCTION

On October 18, 1958 – one of the Lab's annual visitors' days at the Brookhaven National Laboratory, the first video game "*Tennis for Two"* was introduced. The game creator was nuclear physicist William Higinbotham. The reason of game`s creation was Higinbotham`s motivation to grab the attention of a pampered with technology audience.

The motivation is crucial for the success of each undertaking. Considering this typical human characteristic we have to remark that when its conscious power is combined with good qualification and professionalism, the modern teacher could reach significant success with his students along with achieving his own personal goals and system level tasks.

The conscious motive and the natural child curiosity are two main characteristics of the learning, therefore the school teaching process should be focused primarily on them. The increasing requirements to the teacher and the pupil, growing up among high-tech environment and forming a new model of the student, form a complex and dynamic relationship.

This two-component element of the educational process is in a dynamic balance and its integrity depends mostly on the pedagogical methods, principles and approaches, applied by teacher – digital pioneer and the manifested interest, curiosity and achievements of the pupil – digital individual. Naturally comes the question*: Where is the place of Motivation?*

The Motivation should be present on the both sides of the teaching process – teacher and student.

Undoubtedly the basic approaches to perceive the world – *primary reflection* and subsequent *building of cause and effect relationships* are based on the game. This intuitive and inherent for each human being approach is so natural and intrinsic that it is reasonable to be raised the question: *Why the modern educational process is lagging in its attitude towards the digital image of this typical human quality – the game?*

Initially gaming territory was occupied by the entertainment industry on understandably reasons as the investments in this market have been growing rapidly. According to Forbs [2] referring the forecasts of the market researcher DFC Intelligence (www.dfcint.com), the outcomes of video games will increase from $67 billion in 2012 to $87 billion in 2017. A cursory glance would show that the main users of these products are children and teenagers. A huge and continued interest is observed in this target group. Considering educational methodologies, a solid theoretical and research production has been accumulated worldwide arguing for the application of educational games in school. The cooperation between government institutions and software companies in USA closely with academics has shown positive outcomes. Coming out of fundamental theoretical postulates about the need of active development and implementation of educational technologies by means of ICT, educational institutions in USA implement practical IT game models in a didactical aspect.

3. ANALYSIS OF THE PROBLEM

Only a cursory glance at the condition of the Bulgarian educational process and its relation to ICT will find some problem domains as well as a number of unused opportunities and poor ICT application in practice. The home usage of computer systems by Bulgarian pupils is lagging in comparison with their European classmates – as the Executive Agency on Education, Audiovisual and Culture reported in 2011, only 64% of Bulgarian students announced availability of home computers [3].

According to a report of the Control Center on Evaluation and Quality of Education for 2009 in each computer room in Bulgarian schools average of 12 computer systems are provided, ensuring 92% of workplaces for the lesson. Media-projectors are available at 57% of the classrooms [4]. Regarding peripheral devices the collected data are not optimistic. Within the National Program "ICT in Schools" more than 65 000 computer systems were delivered in schools for the period 2005-2007. At the present days most of them are obsolete, out of operation or with limited functionality [19]. This picture of IT school environment, including software, hardware, LAN infrastructure, internet connections, back-up systems and learning management systems defines extraordinary high level of requirements for the *actors* participating in the educational process.

This is, however, one side of the coin. We couldn't discuss the quality of education, while determinant factors of the educational process are not in balance. The key point is the human factor thus the bilateral connection Teacher – Student is *conditio sine qua non* for the educational process itself.

This case study puts emphasis on achieving a complete interrelation Teacher – Pupil through methods, summarized as educational games.

In order to examine the level of usage of educational games in the secondary education we should provide in-depth analysis of the main determining factor – the *game* or *gaming.*

3.1. Definitions

Before discussing educational games it is reasonable to study the essential part of the term "*game". What is a game? And which fields are typical for the game?*
Online Encyclopedia Britannica [17] outputs 2644 results (on 06.10.2014) filtering the key word "*game"*. Among these results there is not common or generalized definition of game, but in all 2644 definitions, the term "game" is referred to certain human activity. According to Oxford dictionaries a "*game"* is a form of competitive activity or sport played according to rules.
The "*game"* could be regarded as a *universal tool for formal interpretation of real or imaginary existence by means of predefined regulations, which cause emotional effect.*
The research of using computer games for educational purpose makes references to various definitions of the term "*game"* and allow drawing the conclusion, that formulating a definition of "game" is difficult and complex task [14]. According to [14] prof. Richard Mayer from University of California, Santa Barbara, generalized four key structural characteristics of the game:

- Rule based
- Responsive
- Challenging
- Cumulative

The game has been present in the human life for millennia and through it the human has been interpreted his own life by gaming approaches. Except pure entertainment, one of the valuable features of the game is opportunity to learn. Regarding to subject of the study and topic`s details, the research led to implementation of educational games via ICT is briefly introduced.

3.2. Problem Domains

At what level are introduced educational game technologies in Bulgarian school education?
On figure 1 under certain conditions a generalized diagram of the problem domains and their level of relation with the educational process is shown.
The problem domains on the diagram are specified on the basis of current research and statistical data [20] that point to some alarming conclusions: for the period 2007-2012 only 1.2% of Bulgarian teachers have been included in long term training programs. Even assuming that a part of the teachers continuously develop their skills in an informal environment, we shouldn't accept there is no need of vocational training. In the same source [20] the following conclusion is drawn: "*Given the continuous introduction of new technologies and techniques, updating the skills of the teachers in vocational training is particularly important because a majority of teacher`s basic theoretical knowledge of the university is dated more than 20 years"*
And here comes the rhetorical question: *How could a teacher with outdated skills and theoretical knowledge be able to use modern ICT games and WEB technologies in the classroom?*
In The National Strategy for Introducing ICT into Bulgarian Schools [21] among the objectives that should be achieved by 2010 is: *Develop the skills of the teachers for using ICT for teaching and learning.*
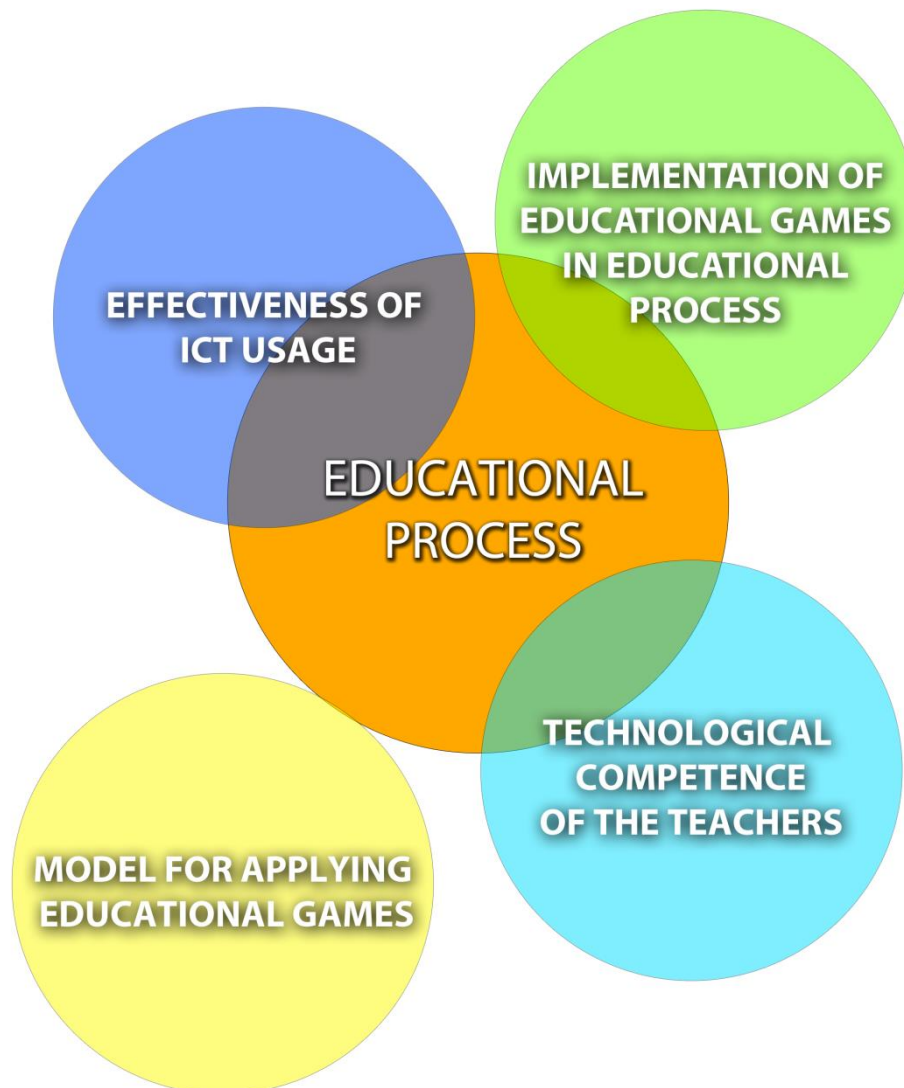
Figure 1. Problem domains of educational process

It is embarrassing that in the framework for measurement of achievements of the National Strategy for Life-long learning for 2014-2020 the group of the teachers is not considered but at the same time the teachers are those who actually conduct the educational process.

A study on using computer games in Bulgarian education [22] states there is still a lack of scientific research on the impact of computer and video games as well as their educational and pathogenic aspects on different age groups. The conclusions point to a necessity of in-depth research covering wide range of educational institutions.

The lack of clear conception of using educational games or educational game platforms leads to the following conclusions:

- There is insufficient research in this area;
- There is a weak effectiveness of ICT usage in education;
- There isn't a model for applying educational games in school education;
- There aren't educational games implemented in educational process and further explored to provide analysis of their effectiveness as a motivation factor;

- There is a lack of technological competences of the teachers which could produce new or adapt the existing educational game platforms in the class.

The indicated above weak and problem domains in school education regarding ICT are general, but they are a prerequisite for relevance and adequacy of the subject of this work.

It is logical to be specified the research domain subject to further discussions namely development of educational/learning games and their application in school curriculum. Thus becomes important the deployment of academic and teaching as well as business potential, for development of software platforms for educational/learning games as a basic component of a Motivation Strategy for school education in Bulgaria, based on ICT.

3.3.   Current Research

The research of educational games worldwide has got significant achievements. One of first scientists, who starts researching this field in early 90s, is Professor Kurt Squire from Wisconsin University, Madison. Squire argues: "*the play is among the oldest form of learning*" [5]. The pioneer-researcher also claims: "*In brief, my research is guided by the observation that interactive digital entertainment technologies (or games) are a powerful, untapped medium for learning.*" [24]. Here the adjective "untapped" is essential.

One of the first publications announcing systematic use of computer games as educational tool is an article of *Creative Computing* [6] magazine: "*Not until the last 10-15 years of the educational innovation, however, have games ever been used primary as an educational tool where learning is primary purpose of playing.*"

Almost a decade before the Logo programing language had come up to the light, which mathematical and programing conceptions are considered as entertainment.

Margret Gredler states that games and simulations had come up on the educational stage at 50`s of XX century. Until 1970 they were not part of the instructional design movement. This type of exercises was primary developed by business and medical education faculties and sociologists who adapted instructional developments by the military services. Despite the popularity of the games and simulations their use in the public schools is declined by the basic-skills movement [11]. From a modern perspective Gredler [11] outlines two major problems:

- Comprehensive design paradigms have not been available derived from learning principles;
- There is a lack of well-designed research studies for developers and users of games and simulations.

Gredler summarizes the widely held view of misunderstanding of the meaning of the games and simulations as a result of which the variety of truncated exercises appeared in many disciplines. Gredler, also highlights the major mistakes in determining educational content and in methodology of simulation. Regarding research the university professor from South Carolina goes further. She argues that the much of the published literature consists of anecdotal reports and testimonials. As a weakness is referred to the circumstance that often simulation is compared with the classroom instruction (lecture and/or classroom discussion). Also Gredler say that the instructional goals could be most effective in different ways. The lecture method, according to Gredler, is better in transmitting items of information. And simulations, in turn, have the potential to develop students' mental models of complex situations as well as their problem-solving strategies. In his work Gredler determines a definitive framework for using games and simulations in the education, considering two concepts:

- Surface-structure characteristic;
- Deep-structure characteristic.

She displays main characteristics and differences between games and simulations:
- Games have competitive exercise;
- Games are typically linear;
- Games consists of rules.

And the simulations:
- are demanding responsible roles or professional tasks;
- are nonlinear;
- have dynamic set of relationships among several variables.

Prof. James Paul Gee in his research argue: "*Beyond using the learning principles that good games incorporate, I also argue that schools, workplaces, and families can use games and game technologies to enhance learning*" [10]. Gee formulated 36 principles that should be incorporated in good games. This set of principles is defined after series of personal experiments conducted by the professor from National Academy of Education himself with certain video games.

Gee`s thesis that games are excellent educational tool is discussed and largely supported by Marc Prensky – a visionary and author of a book series about digital generation and its education. In [15] Prensky refers to an article by Seymour Papert: "*Game designers have a better take on the nature of learning than curriculum designers.*"

Digital thinker completes his vision with the speech of Danny Hillis – a scientist from Walt Disney Imagineering who said: "*In a playful context (e.g. Pokémon) kids seem to have an almost infinite capacity for learning. It's easy, effortless, exciting. If you put kids in a video game they'll pick up new skills very quickly, and learn how to do things at an amazing rate*" [15].

Prensky traces the process of perception and impact of games on adolescents:" *Today's kids want to be engaged, and their games not only engage them, but teach them valuable lessons in the process-lessons that we want them to learn. Video and computer games, in fact, are an important way that our kids are learning to prepare themselves for their 21st century lives to come.*"

3.4. State-of-the Art in Computer Games

Thanks to the invention of the personal computer 80s witnessed the evolution of a new kind of educational games. These games started from the video arcading and console game platforms integrating narrative and visual effects from the pop culture as initially were targeted to the students from the primary and second degree schools. Companies like Minnesota Educational Computing Corporation, Learning Company and McCormick and Davidson and Associates were the pioneers who created software titles like Oregon Trail, Reader Rabbit, Number Munchers and Math Blaster [13].

In 2009 visionaries from The John D. and Catherine T. MacArthur Foundation launched the first U.S. public school curriculum based entirely on game-inspired learning. Selected sixth graders can learn by playing video games such as "Little Big Planet" and "Civilization," as well as non-digital games ranging from role-playing scenarios to board games and card games.

IT game approaches in education give an opportunity to be achieved not only higher efficiency but also to be minimized the number of the students considering the learning process as tedious and unnecessary task in their agenda. The understanding that with a tool as ICT the teacher would be able to encourage the use of digital content reducing in the same time the negative aspects of learning outcomes, behavior, attendance and more broadly – crime and antisocial behavior – is widely spread in educational institutions abroad. The cooperation with the business is developed in parallel. Out of the pure entertainment,

some software products for educational purposes have appeared: *http://smarttutor.com*, *www.readingrockets.org*, *http://springboardprogram.collegeboard.org* etc.

Learning software developers rely on the enthusiasm of the children to play computer games taking advantage of their potential to develop skills such as decision making, information processing and group working [9]. Moreover, in the United States has started a broad campaign to promote and announce educational software. Annual prizes are awarded for the best educational software (Best Educational Software Awards BESSIE) and annual awards for the best edition of the training software (Education Software Review Awards EDDIE) from ComputED Gazette [12]. The stable trend of using educational games in school has a solid background of scientific research. The paradigm "*Educational game in school*" is not merely epistemological interpretation but actual collection of scientific fundamentals formed as a result of a series of studies in the scope of national education systems.

Despite of this in the Western and overseas education systems there isn't a consolidated and complete theoretical model for smooth and consistent transition from conventional game to its computer version in the learning process.

Looking at the situation of Bulgarian education we could raise the following question: *Whether Bulgarian pupils differ from pupils abroad?*

It is hardly to find a serious and self-respecting author of a scientific publication claiming that Bulgarian pupils don't use computer and video games as often and for long as their peers in other countries from Europe, USA or somewhere else. But the lack of scientific research related to application of adapted or Bulgarian educational games in education system is a serious obstruction. Episodic project implementations of models of educational games (ARGuing for multilingual education in Web 2.0 2009) cannot accumulate a critical mass of empirical models contributing to define the fundamental paradigm of educational games in Bulgaria.

4. CONCLUSION

The goals of the government educational institutions should be determined on contemporary basis, according to up-to date requirements and good implementation practices from other countries.

The existing ICT infrastructure at Bulgarian schools as well as the ICT competences of the teachers do not provide an appropriate environment for implementation of the discussed above game approach in classroom.

On the other side the teachers should not be forced to develop and create educational computer games. Their role rather lies in the synthesis of pedagogical gaming scenarios, adequate to the skills and knowledge level of students and the course subject. The proper actions should be aimed at development of tools helping teachers to create educational games that will ensure achievement of specific pedagogical goals in specific subject domain.

Considering reviewed research and starting from the idea that the teaching is a subjective, thematic independent and versatile activity, we can bring forward the following principles when developing educational games. An educational game should be:

- Thematic independent;
- Platform independent;
- Network oriented;
- Adaptive;
- Fun

and should provide:

- Multimedia features;
- Generation of progress report;

- Centralized control;
- Content versatility.

In general could be formulated the following theoretical and practical tasks for solving the problems considered above:

- synthesis of adequate **student models** and **models of interaction** between the student and educational game;
- synthesis of pedagogical scenarios to be implemented in the educational game;
- formulation of approaches and strategies for development and implementation of educational games and educational game platforms with dynamically content building as well as examination of their effectiveness in real classroom environment.

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EVALUATION OF THE APPLICATION OF INTERACTIVE PRESENTATION SYSTEMS IN HIGHER EDUCATION

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Abstract: Interactive presentation systems (IPS) are modern learning tools that allow classes to become more informative and attractive and to meet the expectations of contemporary students for interactivity, high level of visualization and dynamics in the learning process.
The hereby report presents a survey conducted among students and lecturers from the University of Ruse (UR) and the Faculty of Technics and Technologies in Yambol, Trakia University (FTT), and aims to determine the intensity and effectiveness of the use of IPS with students, if/to what extent IPS are preferred to the traditional means and methods of teaching and training and to get both groups' opinion on the IPS efficiency in supporting the learning process. An assessment has been made of the teachers/lecturers' disposition to use IPS and AD (additional devices) during theoretical and practical training as well as their disposition to the adjustment of the Higher Education Institutions' (HEI) system to both current and future digital generation students.
Keywords: Interactive Presentation Systems, Digital Generation, Higher Education.

1. INTRODUCTION

Technical learning devices (TLD) based on modern hardware and software solutions are particularly appropriate for training Digital Generation students who have visual/kinetic learning styles. At present, IPS rank among the first most widely used TLD in the world. Their use during classes may raise further the interest of the students, encourage them to participate more actively in the learning process and help them to better comprehend the teaching material [3, 4, 6].

The complete utilization of the IWB (interactive whiteboard) functions and the additional devices that go with it, alongside their management software, allow the learning process to leave the walls of the classroom and transfer to the Internet space and computing clouds, which digital students are well familiar with and which guarantee them a free access to learning resources at anytime, from anywhere and from any device connected to the internet - PC, laptop, tablet, or a smartphone.

A survey has been carried out among teachers/lecturers and students at the Trakia University in Stara Zagora, Faculty of Technics and Technologies (FTT) and the Angel Kanchev University of Ruse. The survey aims to determine the intensity and effectiveness of using IPS with students and if/to what extent it is preferred to the traditional means and methods of teaching and training as well as to provide the assessment of respondents from both groups of the IPS ability to support the learning process. An assessment has been made of the teachers/lecturers' disposition to use IPS and AD (additional devices) during theoretical and practical training as well as their opinion about the adjustment of our Higher Education Institutions' (HEI) system to both current and future Digital Generation students.

2. RESEARCH METHODOLOGY

Figure 1 illustrates the general methodology of the survey. The purpose of the first step is to devise a plan for the survey. It contains the main objectives, tasks, parameters to study, target groups, context of study (teaching subjects to be covered by the survey) and time periods (academic years/ semesters) during which events will be held for data collection and corresponding result analysis. Various hypotheses and predictions related to the objectives and tasks of study are defined at this stage as well.
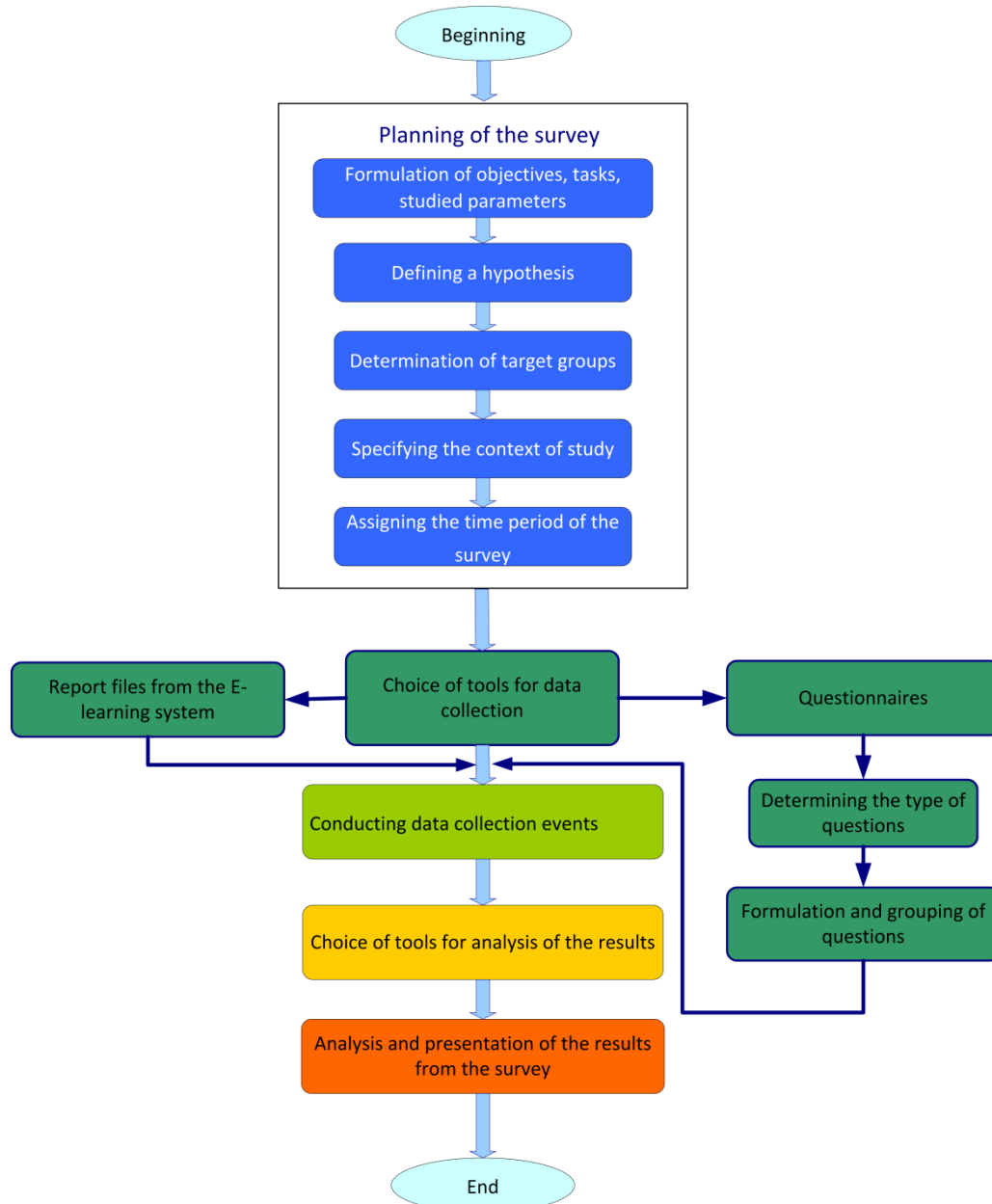
Figure 1. General Methodology of the Survey

Data collection is carried out through questionnaires composed of closed-ended questions and delivered to the participants on paper or in e-format. The questions are related to the aims and objectives of the study and can be Multiple choice questions, dichotomous or two-point questions, or Scaled questions based on a five-level Likert-type scale (possible answers such as "Strongly disagree', "Disagree", "Neutral", "Agree", "Strongly agree"). Each questionnaire features a set of questions that determine the profile of the participant: course of study, major, sex, age group and faculty. The collection of data regarding the intensity of use of web-based resources is carried out through report-files, generated by the administration tools (Reports/Report and Reports/Participation report) in the FTT's E-learning system.

Data collection events, referred to as the next step in the general methodology, are carried out for a period of three academic years (2011/2012, the 2012/2013, and 2013/2014) and cover five semesters and 6 subjects - "Programming and Use of Computers - Part I", "Programming and Use of Computers - Part II", "Informatics - Part II", "CAD systems", "Programming Languages and Systems in Automation" and "Computer Organization". IPS have been used to a different extent in each of these subjects during lectures and seminars as well as for self study. Self-study learning materials have been offered to the participants in this survey in the form of videos made using the IPS functions and uploaded in the E-learning system.

The choice of tools for the analysis of the collected data has been made according to the goals and objectives of the survey, the nature of the indications to be studied, the measuring scale, and respectively, the statistical methods of analysis which are required and can be applied. Statistical evaluation and testing of hypotheses have been performed by the relevant software (MS Excel and "Statistica" programming medium for statistics and analysis). When processing the data, frequency analysis and descriptive statistics have been used and the distributions of frequencies during the academic years/periods of the survey have been compared. The analysis results have been presented graphically in the relevant types of diagrams. Parametric and nonparametric (according to the type of indications to be studied) methods have been used in the testing of statistical hypotheses [5, 7, 8]. All respondents' replies have been coded and filed in an appropriate format (.xlsx) for further statistical processing in MS Excel or Statistica programming medium for statistics and analysis).

The final phase of the analysis features an assessment of the advantages of IPS as modern educational tools that meet the requirements and reflect the preferences of current and future students; an assessment of the IPS capacity to support the learning process; an assessment of the results in higher education where IPS has been used; and recommendations regarding the further implementation of IPS in the process of teaching and learning.

3. PROCESSING AND ANALYSIS OF THE SURVEY RESULTS

3.1. Processing and analysis of a survey conducted among students from the FTT the UR

The study was conducted in the period 2011- 2014 among 231 students from the Faculty of Technics and Technologies of Trakia University of Stara Zagora and the Angel Kanchev University of Ruse. The respondents are both full time (176 students, 76.19%) and part time (55 students, 23.81%) students. During the 2013/2014 academic year, 42 (29.17%) women and 102 (70.83%) men were interviewed; of these 1 student (0.69%) was born before 1965, 57 students (39.58%) were born between 1965 and 1991 and 86 students (59.72%) were born after 1991.

3.1.1. Assessing the intensity of the use of distance learning materialsAssessment of the intensity of use made with the E-learning system's tools

A survey has been conducted to assess the intensity of use of distance learning materials made with IPS. These are videos recorded using the ID Interwrite DualBoard's software (some were made with ID eBeam's hardware). They are uploaded in the **E-learning system** and represent guidelines for the completion of the term paper as well as extra materials for self-study for the following courses: "Informatics - Part II", "Programming and computers" Parts I and II and "CAD systems". The study was conducted among students from the following specialties: "Automation, Information and Control Engineering (AICE)", "Electrical and Electronic Engineering (EE)", "Motor transport and agricultural machinery and technologies (MTAMT)", "Design, management and marketing in the fashion industry", "Heat and gas supply." Table 1 presents the intensity of use of materials developed for distance learning for the period 2011- 2014.

Table 1. Intensity of use of video resources

Subject	Semester	Year of studies	Time period	Specialty	Number of resources	Max/ Min number	Average number of times resources were accessed	% of students who accessed the resources
1. Programming and Use of Computers - Part I	Winter	I	2012/ 2013	EE, AICE full and part-time	3	14/1	2,91	59%
2. Programming and Use of Computers - Part I	Winter	I	2013/ 2014	EE, AICE full and part-time	6	28/1	3	64%*
3. Programming and Use of Computers - Part II	Summer	I	2011/ 2012	EE, AICE full-time	1	19/1	4,3**	60%
4. Informatics - Part II	Summer	I	2011/ 2012	MTAMT full-time ***	1	18/1	3,35**	51%
5. CAD systems", "Programming Languages and Systems in Automation *	Winter	II	2013/ 2014	EE, AICE full-time	4	11/1	1,64	48%

Notes: * The percent of students who accessed the resources has been calculated for the first group of resources on the subject. The percent is calculated against the total number of students who published their solutions. ** The higher average value is explained by the number of resources (1 piece). Regardless of which part of the problem they needed, the students accessed the video anyway. In all other subjects, video resources available are more than one. *** The video was used by almost all students in the faculty while only one of the groups (Motor transport and agricultural machinery and technologies, comprising of 29 students) was included in this study and was informed of the availability of the resource in the system by their lecturer who conducted the study.

The first part of the video presents the guidelines for doing the assignment and marks the highest attendance – it was accessed 200 times by 43 students, the maximum number of visits by one of the students is 28 and the average number of visits to the resource is 4.65. The total average number of visits to all the resources is 3.64% of the students who submitted a solution to the problem in the system used the video resources.

Processing of the survey data (frequency analysis, descriptive statistics)
Intensity of use was also surveyed through the questionnaires filled out by the participants in the study.

81.94% (118 students) out of the 144 respondents in the survey during the academic 2013 / 2014 year responded with "yes" to the question "Have you ever used the materials for self-study in the form of videos posted in the e-learning system?" This proves the high intensity of use of distance learning materials created with IPS.

The allocation of frequencies for three academic years can be seen in Figure 2. The results of the 2011/2012 academic year have been combined with those from the following year due to the small number of students participating in the survey during the first academic year when IPS was used at the Faculty of Technics and Technologies.

The tables and charts hereby show that there has been a high level of use of the uploaded distance learning materials (videos) during both periods of the survey. A hypothesis was proven that *there is no difference in the intensity of use of the published video resources among students from different courses, type of study and age groups, and between the academic years in which they were used*.

3.1.2. Assessing students' preference for the use of IPS to that of the traditional teaching tools

This survey has studied the students' preference for IPS to the traditional means of teaching and training both during lectures and seminars and for self-study (i.e. the use of distance learning materials developed through IPS). 2 particular questions were included in the questionnaire for the sake of the study:

A) Preference for the use of IPS during lectures and seminars
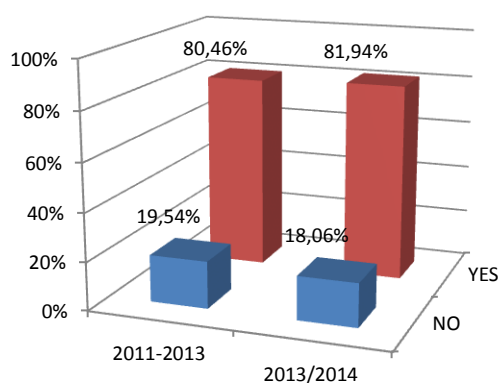
Figure 2. Comparison of the intensity of use of video resources for the 2011-2013 and 2013/2014 year periods
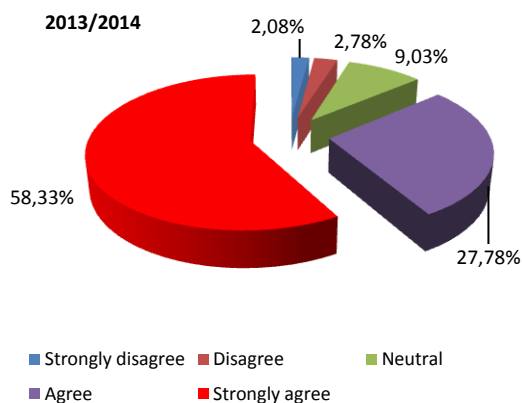
Figure 3. Preference for the use of IPS during lectures and seminars

The results of the frequency analysis are shown in Figure 3 144 students were interviewed during the 2013/2014 academic year. The highest absolute and relative frequency belongs to the answers "strongly agree" (84 responses, 58.33%) and "agree" (40 responses, 27.78%) The cumulative % of the other responses ("neutral" inclusive) is under 15 %.

B) Preference for videos created with IPS tools for the needs of self-study

The one-dimensional allocation of the frequencies of students' answers to the question "Do you prefer the learning materials that you use for self-study to be in the form of: Text files uploaded in the **E-learning system**; Videos uploaded in the **E-learning system**; Consultations with a lecturer/professor; Others", is shown in Figure 4. 168 students have answered this question, providing a total of 292 responses. The largest share (almost half) belongs to "Videos posted in the e-learning medium" and comprises 48.29% of the responses given by 83.93% of the students interviewed.

3.1.3. Assessing the IPS capacity in supporting the learning process (during lectures and seminars as well as for self-study)

A) Assessing the IPS efficiency during lectures and seminars

IPS efficiency in supporting the learning process has been surveyed with the help of 3 questions included in the questionnaire. The first question relates to the IPS capacity to support the work during lectures and seminars as well as the didactic effect of their use.
Students are required to answer the question: "How do you feel about the use of an interactive presentation system during classes in this subject." Respondents give an answer according to a five-level Likert-type scale ("strongly disagree", "disagree", "neutral", "agree", "strongly agree"): 1 - Helps for the better visualization and understanding of the material; 2 – Its use increases the interest in the subject; 3 – Its use makes the course study material more attractive; 4 – Its use leads to an increase in students' activity during the lessons; 5 - Its use accelerates the dynamics and pace of lessons.
The highest percent (over 50%, see Table 2) of the interviewed have responded with "strongly agree" to all the above listed possible effects an IPS may have when used to support the learning process during classes. "1 - Helps for the better visualization and understanding of the material" is the answer that has collected the largest number of 'strongly agree' responses, followed by "3 – Its use makes the course study material more attractive".

Table 2. Assessment of the IPS capacity to support the learning process

Responses	1			1			1			1			1		
	Number	%	Cumulative %	Number	%	Cumulative %	Number	%	Cumulative %	Number	%	Cumulative %	Number	%	Cumulative %
Strongly disagree	1	0,69%	0,69%	1	0,69%	0,69%	0	0,00%	0,00%	0	0,00%	0,00%	3	2,08%	2,08%
Disagree	3	2,08%	2,77%	7	4,86%	5,56%	1	0,93%	0,93%	7	4,86%	4,86%	3	2,08%	4,17%
Neutral	3	2,08%	4,85%	13	9,03%	14,58%	8	7,41%	8,33%	21	14,58%	19,44%	17	11,81%	15,97%
Agree	34	23,61%	28,46%	43	29,86%	44,44%	35	32,41%	40,74%	40	27,78%	47,22%	45	31,25%	47,22%
Strongly agree	103	71,53%	100,00%	80	55,56%	100,00%	64	59,26%	100,00%	76	52,78%	100,00%	76	52,78%	100,00%
Total number	144	100%		144			108			144			114		

B) Assessment of the distance learning materials created with IPS

Furthermore, students within this study have also expressed their preference for the learning materials created with IPS and uploaded in the e-learning system and have pointed out the reasons. Most of the students appreciate the video materials because they find them highly informative and understandable (Figure 5).
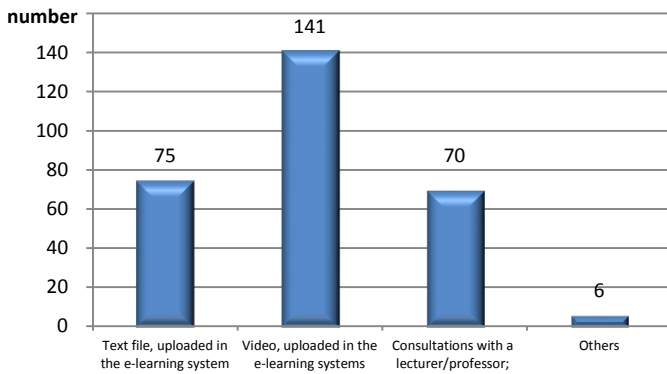
Figure 5. Absolute frequencies of responses to the preferred format of self-study materials for students
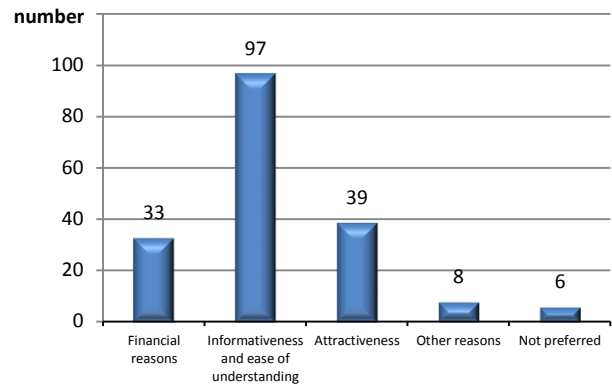
Figure 6. Absolute frequencies of the responses about the reasons IPS is preferred

C) Assessment of the IPS capacity for sharing the IWB's content with remote users

A further assessment has been made of the IPS' capacity to support the learning process in relation to the administration of the means for sharing the IWB's content with remote users. The respondents in the survey demonstrate appreciation of the use of web-based server that allows remote users simultaneous work on a virtual/ real-life whiteboard for problem solving and consultations.

Figure 6. Absolute frequencies of responses, related to the capacity for sharing the IWB's content

The students interviewed appreciate most of all the speed and the convenience of this particular function when using IPS (Figure 6). A 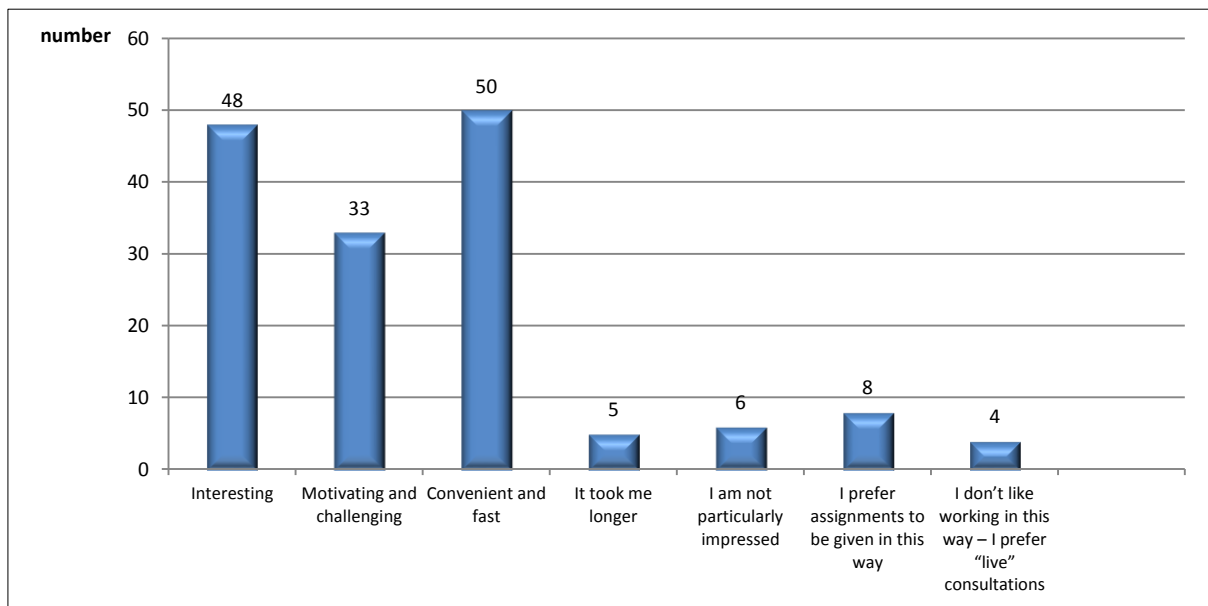two-dimensional frequency allocation including responses to the above question and indicators such as age or use of the resources, shows that those who have already used the above IPS function, have in general selected the "fast and convenient" response. Students born before 1991 alongside the group of those unfamiliar with the resource have selected mostly the "interesting" response.

3.1.4. Assessment of the effectiveness (efficiency) when using the available distance learning materials

A) Analysis of achievement in the particular subject

The data related to the academic achievements of students who have used the video resources for self-study has been analyzed. The video resources include Guidelines for doing a task assignment paper in subjects such as Programming and Computers Parts I and II and Informatics Part II as well as videos designed for self study in subjects such as CAD-systems and Computer Organization.
Most of the students who have used the resources have achieved "Good" (follow those with "Very Good"). The average grade of students who used the resource is Very Good (4.55), and for those who did not use them - Good (3.82). The box-plot diagram in Figure 7 shows the differences in the average grades of both groups – standard error values have been taken into account.

Hypothesis Testing
To test the hypothesis: *There is a difference between the two groups of students' (those who used the video resources and those who did not) achievements in the subject,* the t – criterion (test) for the difference between the average of two independent samples has been used.
A null hypothesis, H_0, has been defined as follows: There is no difference between the achievements of the two groups of respondents (those who used the resources made with IPS and those who did not). H_1 is the alternative hypothesis which states that there is a difference in the achievements of the two groups of students, namely, the average grade of those who used the video resources is higher, i.e. H_1 is defined by one-sided critical area.
The calculated value of *t* is 3.35 when α *(p)* = 0.001. It is higher than the critical value in the standard tables, which when α = 0.05 and with the respective degrees of freedom, equals 1.64. This is a reason to reject the null hypothesis and accept the alternative one. In other words, the data obtained from the study creates the grounds to raise a claim with a 5% risk of error, that the difference between the average grades of the two groups of students (those who used the video resources and those who didn't) is statistically significant (not accidental).
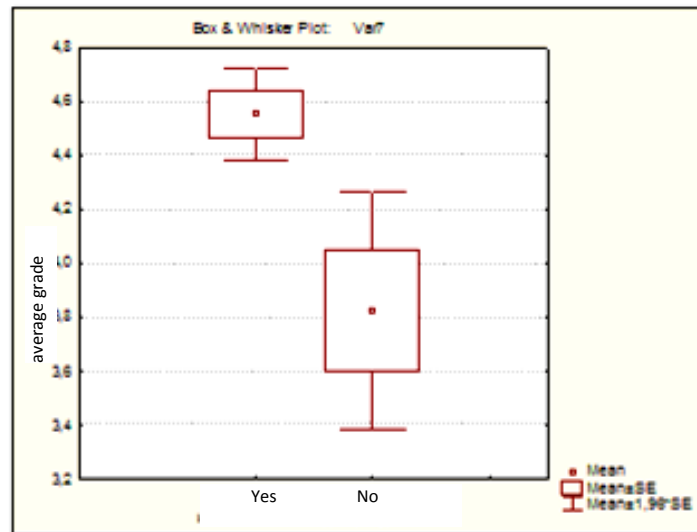
Figure 7. Box-plot diagram of the average grade of the two groups

3.2. Processing and analysis of the HEI teachers and lecturers' survey results

The survey was conducted among lecturers from two universities in the country - RU "Angel Kunchev" and Trakia University - Stara Zagora, Faculty of Technics and Technologies as follows: 46 lecturers from different faculties of the RU (51.69% of respondents); 43 lecturers from different faculties of Trakia University (48.31% of respondents). All participants have completed training course for working with IWB.

3.2.1. Research on teachers and lecturers' attitude towards the use of IPS

Figure 8 shows relative frequencies of the responses. Most of the teachers/lecturers have responded to all the questions with "strongly agree". The majority (over 50%) is the relative number of teachers/lecturers who would use the IPS in the preparation of and during lectures as well as during practice and laboratory exercises.
Table 3 presents one-dimensional frequency allocation of the responses to the question: *Do you think that learning to work with and using IPS will cost you unreasonable amount of time and effort and bring no positive results in the comprehension of the teaching content*?
Teachers/lecturers responses to the above questions suggest that they do not think they will face particular difficulties in working with IPS. The percent of those who selected "agree" and "strongly agree" for the use of IPS in the learning process is the highest.
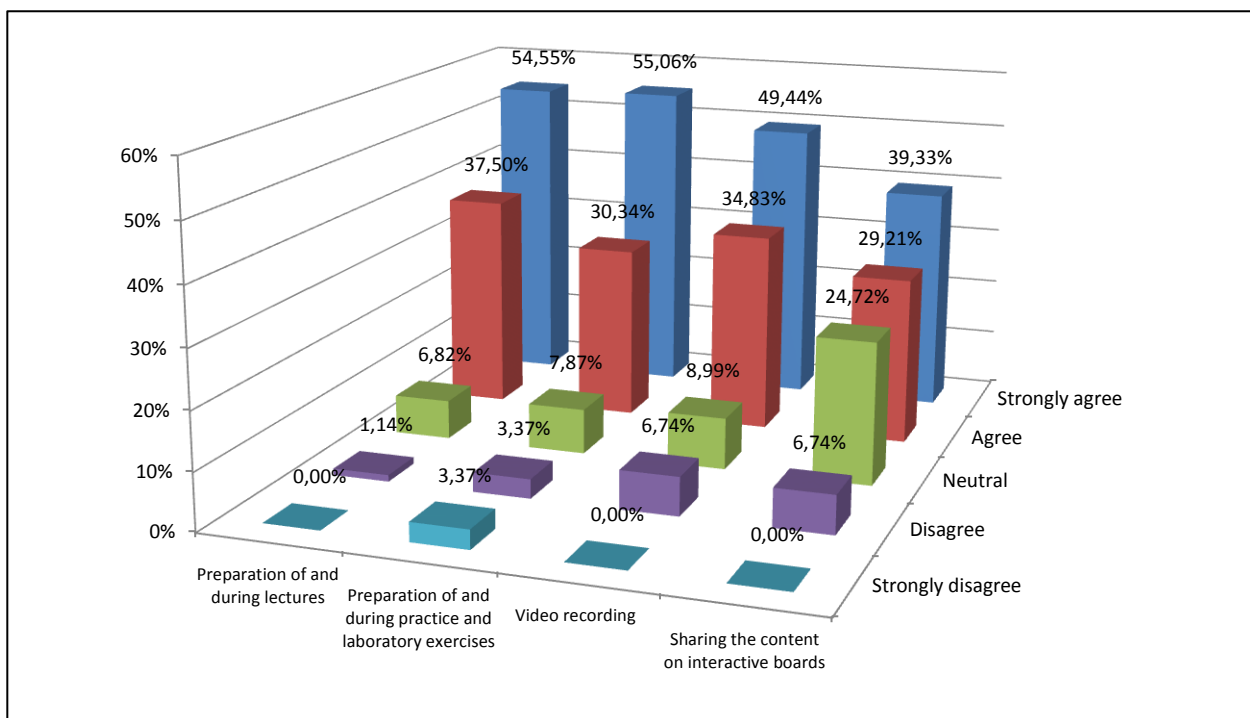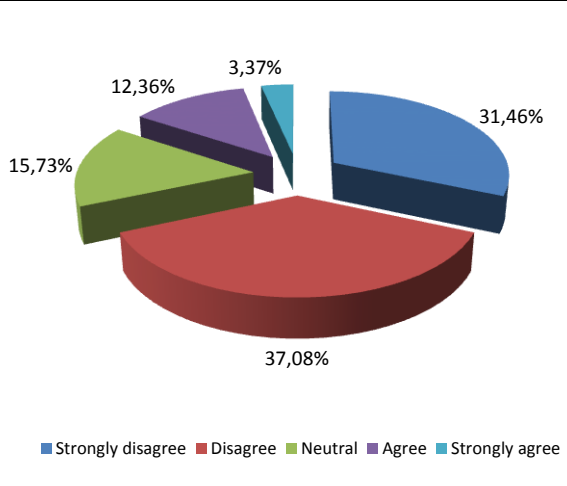
Figure 8. Relative portion of the responses to the questions about the use of IPS
in university teaching

Table 3. Frequency allocation of responses to the question about difficulties in learning to use
and working with IPS

Responses	Number	%	Cumulative %
Strongly disagree	28	31,46%	31,46%
Disagree	33	37,08%	68,54%
Neutral	14	15,73%	84,27%
Agree	11	12,36%	96,63%
Strongly agree	3	3,37%	100,00%
Total	89	100,00%	380,90%

3.2.2. Research on the attitude towards the use of IPS tools and enhancements/additional devices

Figure 9 shows the results from the frequency analysis of the responses to question *"Would you use some of the IPS enhancements/additional devices to prepare and conduct your classes?"*. There is a multiple choice of responses. 89 teachers/lecturers have responded by giving 215 responses. The largest number of teachers/lecturers have selected the "electronic color markers" response. Working with the latter is very similar to the traditional lecture

method whereby IWB is used in whiteboard mode. Fewer teachers have selected the "operational support systems" response – mainly because the use of CPS (Classroom Performance System) is still limited in our country.
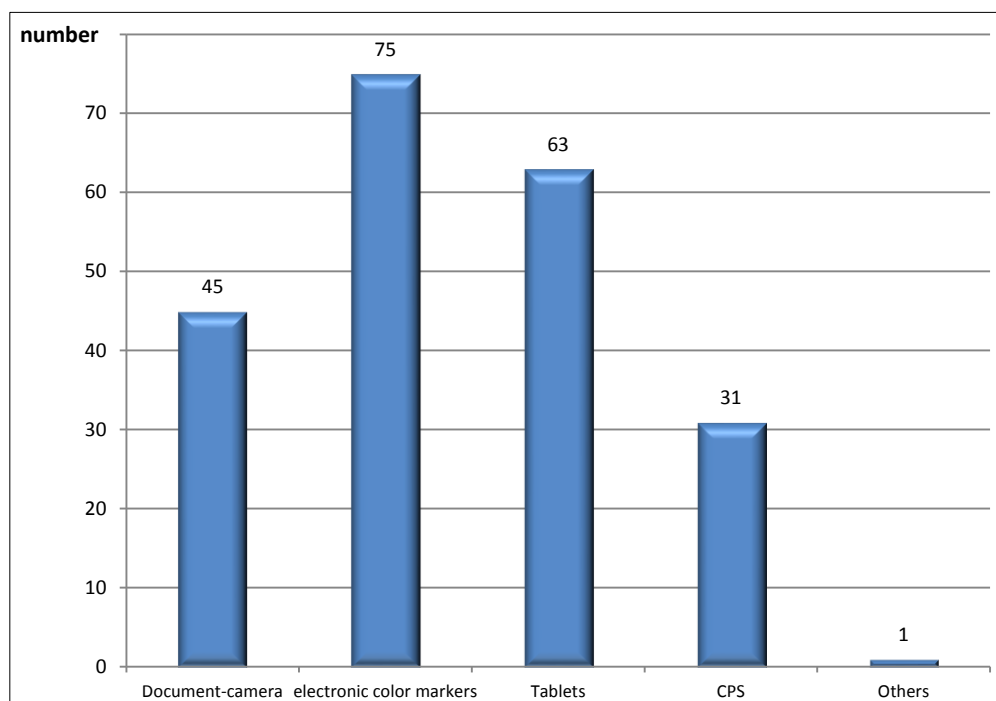
Figure 9. Absolute frequencies of the responses regarding the attitude towards use of additional devices to the interactive boards

To the question about the most favored IWB tools, over 60% of the answers selected are "annotation and note-taking tools", "multiple file format tools" and "image gallery". The largest number of teachers/lecturers have selected the "annotation and note-taking tools" response (13.66% of the responses and 69.66% of the teachers who were interviewed).

3.2.3. Research on the attitude of teachers/lecturers towards IPS capacity to support the learning process

Teachers/lecturers have assessed the IPS capacity to support the learning process through a five level Likert-type scale with answers "strongly agree", "agree", "neutral", "disagree", "strongly disagree". The highest percent of teachers (67.42%) have selected "strongly agree" for the response "Helps for better visualization and understanding of the teaching material."
A Mann Whitney U-test has been used to prove the lack of difference in the opinions of teachers/lecturers and students regarding IPS capacity to support the learning process. The calculated Z - evaluations (all lower than the 1.96 when $α = 0.05$ critical value specified by the standard tables) provide grounds for accepting the null hypothesis, i.e. the difference between the assessments of students and teachers/lecturers of the use of IPS in the learning process is false.

3.2.4. Research on the attitude of teachers/lecturers towards adjusting the Higher school education system to the Digital Generation needs and requirements

Respondents were asked the following questions: 1. Do you think that it is necessary to adapt the higher education system to the characteristics of the digital generation? 2. Do you think it is necessary to change the role of the teacher – from an instructor and a major source and supplier of knowledge to a mentor and expert? 3 Do you think that the use of interactive tools and technologies in education will motivate current and future students for a more active participation in the learning process? 4 Do you agree that the use of interactive learning technologies must be combined with the use of interactive teaching approaches?

The highest percent (65.17%, see Figure 10) of teachers/lecturers indicated that in HEI the use of interactive technologies must be combined with the use of interactive teaching methods. The cumulative % calculated for this response up to "neutral" inclusive, is less than 10%. Since it is below 20% for the rest, we can therefore conclude that 80% of the respondents have selected positive answers such as "agree" and "strongly agree".
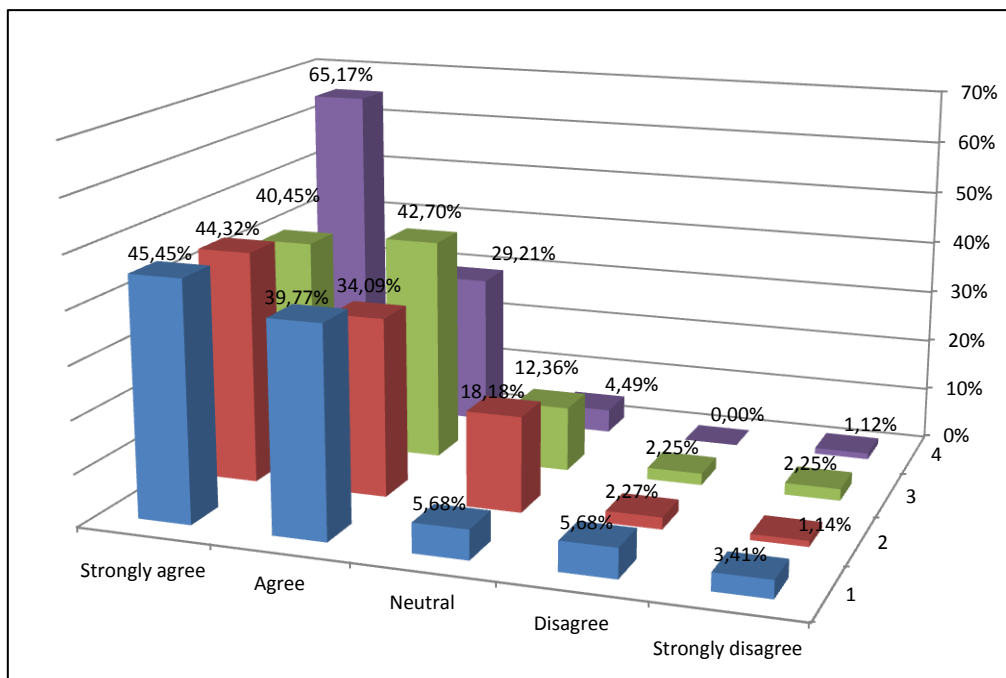
Figure 10. Percent allocation of responses to the questions about the attitude of teachers/lecturers towards the adjustment of higher school education system to the Digital Generation

The estimated indicator of the central tendency (trend) shows that the most common response for almost all questions is "strongly agree". The only exception is the question about motivating the students to participate more actively in the learning process with the help of IPS.

An additional correlation analysis has been made along this survey (using Spearman correlation coefficient) [1, 2] and the following correlations (dependencies) have been studied and analyzed:

✓   An analysis of the correlation between the teachers/lecturers' opinion that it is necessary to adapt the system of higher education to the digital generation and their inclination to use IPS during lectures (ρ_1) and practical exercises (ρ_2) has been made.

The calculation results show $\rho_1 = 0.351$ and a significance level of 0.0008, which is lower than $\alpha = 0.05$ (the accepted one); $\rho_2 = 0.311$ and a significance level of 0.003, lower than $\alpha = 0.05$ (the accepted one);

The H_0: $\rho = 0$ hypothesis has been tested and shows that there is no connection between the parameters studied, therefore the calculated coefficient might be considered random. Student's t-criterion has been used to test the hypothesis. The estimate value ($t_1 = 3.445$, $t_2 = 3.035$) in both cases is higher than the critical value of 1.98 (relevant degrees of freedom taken into consideration) and therefore the null-hypothesis can be rejected, i.e. there exists a medium correlation between the 2 indicators. There is a dependence between the HEI teachers/lecturers' willingness to adapt the HEI system to the Digital Generation and their positive attitude towards the use of IPS in the teaching process.

✓   The correlation between the willingness of teachers/lecturers to adapt the higher school education system to the digital generation and their attitude towards the use of interactive approaches in conjunction with interactive tools in the learning process has been analyzed. Spearman Coefficient is calculated $\rho_3 = 0.435$ at a significance level of 0.00023, which is lower than the accepted valued of $\alpha = 0.05$

The H_0: $\rho = 0$ hypothesis has been tested, i.e. there is no connection between the parameters tested and the calculated coefficient might be considered random. Student's t-criterion is used to test the hypothesis. The estimate ($t = 4.48$) value is higher than the critical value of 1.98, relevant degrees of freedom taken into consideration. The null hypothesis is therefore rejected, i.e. there is a medium correlation between the two indicators. A statistically significant correlation exists between the teachers/lecturers' willingness to adapt the HEI system to the Digital Generation and their positive attitude towards the use of interactive methods and tools in the teaching process.

4. OUTCOME AND CONCLUSIONS

1. The analysis of the survey results shows that students use widely the distance learning materials, which have been developed with IPS tools and then uploaded in the E-learning system. No correlation has been detected between the use of video resources and the respondents' profiles. The number of students who prefer to use IPS alongside the traditional means (computer, projector) during classes is significant. The most favored self-study tools pointed out by the students (regardless of whether they have full or part time status) are the video resources published in the E-learning system.

2. The survey conducted among students and faculty members at the HEI shows that both groups appreciate the IPS capacity to support the learning process. Most of the respondents from either of the groups believe that IPS helps for a better visualization and understanding of the learning material during the classes. The main reason why students prefer distance learning materials created with the help of IPS is that they find them informative and understandable. The IPS functionality for sharing the virtual or real-life white board contents with remote users is defined as interesting and convenient.

3. The survey results show that there is a correlation between the students' achievement and the use of video resources created by IPS and posted in the E-learning system. The average grade of students who have used the resources is very good and higher than that of the students who did not use them; the number of students who believe that these resources have helped their learning is very high and does not correlate to the study status (full time or part time).

4. The survey conducted among HEI teachers/lecturers shows that they have a positive attitude towards the use of IPS. However, since most of them have been only trained yet have not had the chance to use IWB in their teaching, they still prefer tools and enhancements that stand closer to the traditional lecture mode where a presentation or an ordinary whiteboard are used. It can be only expected that teachers/lecturers will gradually get acquainted and assimilate the rest of the IPS tools, enhancements and additional devices in the process of their implementation in the teaching process and that they will eventually find their optimal application. This will make their lectures and seminars more comprehensible, interesting, attractive, flexible and dynamic in accordance with the needs of the modern students.

5. The statistical processing and analysis of this survey data may lead to the conclusion that the HEI groups of teachers/lecturers interviewed deem it necessary to adapt the system of higher education to the digital generation and to modify the role of the teacher from a supplier of knowledge to an instructor and mentor. Using IPS to improve students' motivation for active participation in the learning process is the only point which does not show "strongly agree" as a major response. The problem with modern students' motivation and its solution through different means is the key to fixing the problem with the quality of higher education in our country. IPS are certainly not the only solution, but in conjunction with the interactive teaching methods that teachers/lecturers so highly approve of, they are definitely a step in the right direction.

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ROLE OF INDUSTRIAL DESIGN
IN THE PROCESS OF PRODUCT DEVELOPMENT

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Abstract: Industrial design is a strong blend of art and science to improve the look, ergonomics, functionality and even the use of the product can also be used to improve the market value , even the production.
Industrial design is the outward appearance of the product in whole or in part which is determined by its features, especially the lines, contours, colors, shape, texture and materials of which the product is made of or decorated, and/or its ornamentation, under the industrial design Law.
Keywords: Industrial Design, Product, Innovation, Designer.

1. INTRODUCTION

"We do not think that the good desigh can make bad product better, no matter if it is a machine, building, promotive leaflet or business. However, we are sure that the good design can significantly help the product in its realization with full potential. In short, we think that a good design is a good business." – Thomas Watson
At the end of the 19th and beginning of the 20th century, working procedure and production method were manual, the craftsman had to meet all features and qualities of a product by his skill, cleverness and personal taste for aesthetics of objects. Through traditional skill for shaping, it was necessary to select the correct material and by applying artisan process to turn it into a shape with defined function and aesthetical needs of the object. .
The products, whether with a good or bad design, were made to meet the needs od some social layer. The first objects made by the people for their existence, later as objects of folk manufacturing, were developed and upgraded to get artistic value later. Design gets other meaning when human hands and individual work of people take part only in production preparation, while the machine performs the automatic process. After the World War I, the English painter Joseph Sinel introduced the term industrial design for the first time. Then, the long-lasting meaning of the design was changed. The design does not mean unique product, artefact or artistic-craft skill any more, but now, it means an area, creative discipline and ready product.

Figure 1. Industrial design – table inspired by a tin
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2. METHODS

Industrial designer has double function. He serves to satisfy the need for beauty and benefit. As per his essence and his form presented in public, he is on a half way between the innovation and pure art. Because of that, there is legal protection of industrial design, which is in the middle between innovation and a copyright.

The research subject of industrial design is functionality, shape and connection between the product, user and environment.

Industrial desigh is a right of industrial property that refers to the specific look of the form of the body, contour, colors combination, their texture or composition , that meets the conditions for novelty and distinction compared to those previously known to the public. Industrial design gives the products defined visual, aesthetic, ergonomic, practical and target quality differentiating them from other products present in the market.

Good desigh sells the product. Many people neglect the possibilities and potentials of industrial design, which, like the trade mark and the patent, represents intelectul property of enterprises, that can often increase competitiveness in the market.

Figure 2. Industrial design – shelves for books

Industrial design may significantly overlap with engineering design. In different countries , the boundaries between these two concepts can vary, but generally, the industrial design is focused on functionality or use of the products, while the engineering design is focused on aesthetics and the aspects of connection of the product with the user. However, as an activity industrial design is more concerned with the product aesthetics and style. There is not a correct or not correct answer here, but this is an important issue , because there is a lot of space for ambiguousness and missunderstanding. The lack of clearness contributes for not efficient use of the industrial design.

Industrial design is an integral part of innovations and can make contribution in three wide categories of innovative activities:

•   Individual innovations – improvement.
•   Variety of innovations – styling / redesign.
•   Radical innovation, new possibility.

Industrial design consists of creation of shapes, configuration or composition of forms and colors or combination of shapes and colors in three-dimensional form that contains artistic values. Industrial design can be presented in two-dimensional or three-dimensional form that is used for production of a product.

Aesthetics of a product is one of the designer's main aims. Aesthetics is a subject of studying in the industrial production. Industrial aesthetics is performed on the working place and its environment, on the means for production and for the products themselves. It defines 13 laws of the industrial aesthetics which describe the scope of industrial aesthetics.

1)   The Law of economy: - the expenses for materials and resources, and with that to decrease quality and functionality.

2)   The Law –option of functional values: only those objects that are well adapted to their function can have industrial beauty. Industrial aesthetics includes harmony among functional properties and the exterior.

3)   The Law for unity and composition: - for harmony, separate parts have to be in function for each other, and as a function in whole. They have to match proportions of the rules for static and dynamic balance, at the same time taking care for the material characteristics.

4)   The Law for harmony between the environment and the use: - there should always be harmony between aesthetic pleasure felt by not interested observer and practical pleasure that the objects give to the user.

5)   The Law for style:- is a review of aesthetic features in order to be adjusted for normal duration. Aesthetic creations of some period – style shaping, which is an expression.

6)   The law for development and relativity: - industrial asethetics is not definite and it has been constantly developed. The beauty is in function of technical improvements. All new technologies needed during maturation, and maturity phase are found to match the aesthetic expression.

7)   The Law – appellation: - atractiveness contributes to structure, proportion, line, materials selection, details, colors, and all these in conformity with the law for economy.

8)   The Law for pleasure: - is an expression of function that provides creation of beauty in the way with which it activates all senses (for seeing, touching, smelling, hearing, tasting).

9)   The Law for movement: creations that move, for example the transport, generation of movement done based on their aesthetics.

10)   The law for hierarchy or finalization: - industrial aesthetics cannot exclude the finalization of industrial creation.

11)   Commercial laws: - number of users and scope of the sale cannot be considered as a criterium for aesthetic values.

12)   The Law for honour: - the raw materials selection and industrial aesthetics imply honour and sincerity, and that which contains elements of hypocrisy and deceit, cannot be

considered as beautiful. Coverings and protective coverlets are justified provided the basic product functions are properly expressed, but not if they are hiden materials or structures which can put the value of the product good functioning under the question.

13)   The Law for covered art:- industrial aesthetics comprises inclussion of art in the structure of noted reflexions of creating, which means that the concept of the model technics can be combined or joined with them.

The designer's activity is realized basicaly on the process of projecting, i.e. product development. It can be seen as consequential activities for reaching identified results, as logic of projecting thought development for total product transformation, as relations of dynamic changes among individual elements, participants in projecting.

In the process for product development, the designer faces different limitations, some of which are present in the task itself, while others are born with the idea or in the process of realization. That means that the designer cannot reformulate the task and in this way some of the limitations to be left out by themselves. Associated with the object aims, needs, conditions, the limitations go through the prism of connection and the world acceptance of the designer: even more due to the fact that the designer formulates them alone.

Characteristic of the designing proces is one mutual influence between the object and the subject , between the object for projecting and designing project – from the one hand of the needs, given conditions and requests for the object, and the designer's subjective viewing and presumtion, on the other hand, infringing the professional experience and knowledge through individual qualities and attitudes.

Figure 3. Transformation of elements , where only one of the methods for modular construction with transformation of morphological relations of one detail, is shown.

In order to assess the look and directions for devloping product of industrial forms, naturally we should aplly criteria that have already been imposed in this period here and at the same time to match them with the criteria in the world design. Although criteria for assessing are very different in each separate design sphere , and each criterium itself is dependant on some special peculiarities and has its own typical specification , it is often concluded from the nature of industrial technology that there are some mutual characteristics. Thanks to these

mutual characteristics, it is possible to talk about professional creative dimensions of designing activity.

Generally for all kinds of product development, project creation is primary.

Almost all methodical materials for projecting in the sphere of design determine the first step as a preliminary one. The step for examining is indispensable precondition for efficient work in designing.

The basic elements and steps in the process for product development

The product development is a sum of procedures that lead to final solution. It is very important to define all important facts even in the beginning of the work, which are of high importance for the success of entire work.

Understanding of the process for product development as a logic development of the designer's creative activity for creating aesthetic product, means to find out the basic projecting moments, from the task formulating, getting an idea up to its realization into a project form and model or a prototype, which will later be produced industrially.

There are different attitudes to the steps and sequence in the product development flow. Projecting includes three basic steps:

Analysis (dividing the task into parts)

Synthesis (connection of the parts in a different way)

Mark (studing of consequences from the expansion of new solution).

These three steps through which projecting goes are also called divergity, which means that the boundary of project situation is widened in order to provide wide field for finding solution for the task.

Figure 4. Design development

Contemporary designers tend to optimize one design in order to answer all demands of today markets in the best possible way. But, the context in which designing is carried out , is created by driving forces influencing designer's decisions. Here, the most important are : the market, technology, investing climate, environment and industrial design.

The process for product development is subject to numerious influences from outside. A good designer always keeps pace with technology development, as a result of scientific researches. New technology is applied in ways that are compatible with the company's investing climate , which depends on the economic conditios in the countries where the product will be produced and applied.

Care to minimize ecological difficulties arrising by excessive production of various products, increases consciousness for environmental designing, in other words design for the

environment protection. In the markets of the 21st century, the consumers expect more from a product that functions well and is at affordable price. They want satisfaction and pleasure, giving high priority to the industrial design and aesthetics.

Design as a process can take over many forms , depending on the object to be designed and the individual or individuals taking part in it.

The products design can be original or adaptive one. Starting point in the designing process is the market's need or a brand new idea.

Reaching optimal designing solutions requires effective designing process which provides framework without which the designers will not be able to deliver high quality work constantly.

One complete process for a product development consists of 3 steps:
• Research
• Design
• Development support

During the researching step for a product development, the attention is directed towards understanding strategic aims for developing efforts of a product; learning the characteristics of users' aims and the tasks performed by them , using the product through searching , modeling and analyzing the tasks; finding out and defining the product's needs associated with the designing problem to be solved.

Figure 5. Thinking process

There are many activities in the researching step, but from all of them, we can set aside the following ones:
• Users studying
• Users modeling
• Analysis of users' tasks
• Finding out and defining the product's pure demand

In any step of this interactive process design, other members of a team in the process itself, can evolve the designs through designing check outs and tests for usage, and in this way the design will be corrected and their information will be included.

The process of a product development is carried out in three main phases: conceptual, evolving and detailed development of a product.

•   Conceptual development of a product – defining the way by which the product will meet the requested needs.

•   Evolving development of a product – takes any concept that promises and evolves it, analyzes its operations and examines alternative choices of materials and treatments.

•   Detailed development of a product – precise details, examining of critical properties , testing of a whole group of prototypes.
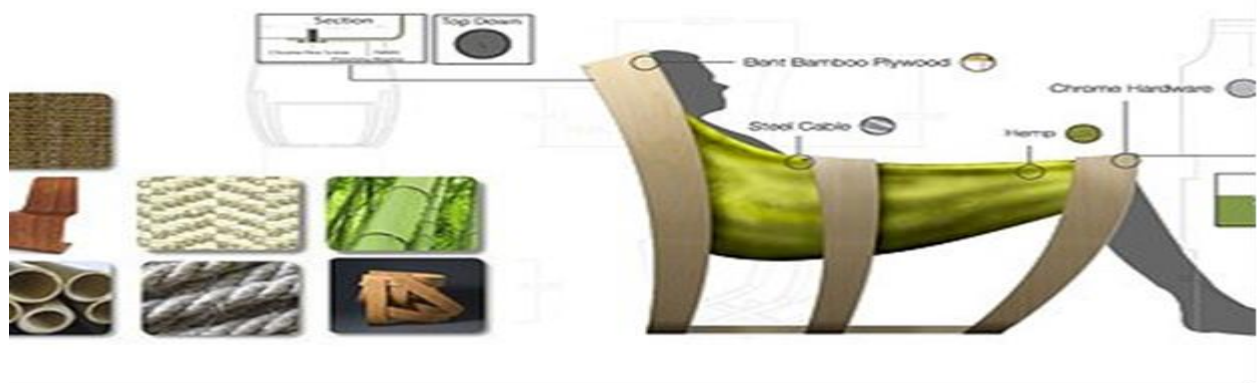

Figure 6. Direction towards designing process

3. INFERENCE

Product development includes different experts (electrical technicians, engineers, architects etc.), who enable good and easy performances. But, without including industrial designers, they would be only a little bit better designs. The industrial design has defined the shape, dimensions and human factor (ergonomics, aesthetics), which were crucial for the outstanding product success.

The role of the industrial design is responsible for the product aspects connected with that how the user experiences the product, and that is the aesthetic image (how it looks, sounds, smells and acts) and financial mediation (how it is used). Marketing is based on the product technical characteristics, while the buyer is interested in technical characteristics, aesthetics and style.

The advantage of applying industrial design is improved appearance of the product, higher pleasure of the user due to the additional characteristics, or better, strong identity of the product brand, distinguishing the product among other products. This usually results in increased sale or expansion of that product on the market. The contribution can be seen best with redesigning of the existing product and its increased sale on the market.

Industrial design has big contribution in establishing corporative identity, which is created by visual style of organization that in the firm is positioned on the market due to the reasons that the company identity comes out from that what the users can see, and that is the product. Here the advertisements, logotypes, marks, uniforms, buildings, packaging and design of the product itself, are included.

4. CONCLUSIONS

The basic aims of the industrial design when developing new products:
-        Utilitarity: relationship between the product and the user has to be safe, simple and intuitive use, and every characteristic must have a function for the user.
-        Apperance: Lines, proportions and color have to serve for integration of the product, in order to satisfy everything.
-        Low price: The product shape and characteristics have important part in processing and in production costs, and because of that they are considered by a developing team.
-        Communication: The product design should manage to convey to the user the entire philosophy of creating and its mission through the product visual features.
-        Simple maintenance: The products should be designed in such a way that they only will inform the user how to maintain and repare them.
With the costs for industrial design of simple industrial products, there is not any dependance between the product and the user. Under dependance we mean user's managing with the product , i.e. the information that the product offers for working. From the other side, the costs for the products with significant visual importance and dependance on relation product-user, are in millions. The share is smaller in the total costs with techically sophisticated products, contrary to less technically sophisticated products. This does not mean that with technically sophisticated products, the industrial design is less important, but only the costs for techical development are higher.
Large number of products on the market can be improved by the industrial design. All products which are managed, which are used, which are seen by all of us, depend a lot on the industrial design. In that sense, the basic dimensions of the product are aesthetics and ergonomics, where under ergonomics we mean all products connected with the relation product-user. The questions associated with these two aspects , and which point out the importance of industrial design are:
•   How much simplicity of use is important? Simplicity of use is of extreme importance for the product that is frequently used (printer, for instance) or that is rarely used (fire fighting apparatus, for instance). The simplicity of use is important with a product which has several functions for managing, ways of use or those that can even confuse and frustrate the user. Here, the industrial design should determine the product characteristics , which will enable transfer of information to the user how to use them easier.
•   How much is simple maintenance important? Maintenance and reapiring are of high importance for the product. That product should transfer the information about its use.
•   How much user's interaction is needed in order to realize the product functions? As higher is the number of necessary interactions, higher is the role of industrial design , too.
•   How big is innovativity of interaction needs? Gradual improvement of the existing design during the new product development is not necessarily needed, they happen during the design development.
•   Which are the requests for safety? All products have requests for safety.
•   Is different visual appearance needed? The products which are not visible for the users are not dependant on industrial design , while the visible product are. The products of the stable market and technology are explicitly dependant on industrial design and aesthetic appearance that visually differentiates them from other similar products.
•   How much are image and fashion important? The product perception by the buyer depends a lot on its aesthetic appearance. The attractive product should be associated with haute couture , and the image should give a feeling of pride . The role of the industrial design with these products is the base for success.

• Will aesthetically shaped product motivate the developing team? A product with aesthetic appearance will suggest pride in the team , and that will motivate and unite them. In that sense, the industrial design has a big importance for the team itself and the product development.

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BIONICS IN INDUSTRIAL DESIGN

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Abstract: *The design represents the external appearance of a product or object. The design is what makes the product appealing, beautiful and desirable, and thus significantly affects the product sales and the increase in its commercial and artistic value. The industrial design of a certain product is consisted of three-dimensional and two-dimensional features of the product visible in its normal use. The three-dimensional features are the form and the lines of the product, and the two-dimensional are the patterns, lines, colours, texture and their combination. The basic conditions what a design should fulfil are individuality and uniqueness, and its features not only to meet the technical function but to have an artistic value as well.*
Keywords: *Design, Bionic, Aesthetics, Furniture, Architecture.*

1. INTRODUCTION

The designers and innovators are constantly searching for inspiration to create new designs. One of the sources for inspiration is the nature. Examples from the nature and inspiration from natural forms that surround us every day have been a solution for creating many designs, both in the past and today. The designers have used natural forms, compositions, and mechanisms and applied them in many designs. In the world of industrial design the natural forms were not visible in the past, but today there are serious attempts to use the nature as inspiration for design - Bionic, innovation inspired by nature.

In 1995, the American scientist Jackie Steele introduces the word "bionic" to express the symbiosis between nature and technology. This is an original interpretation of bionics, which derives from the terms "bio" and "technique". But Jackie Steele believes in the principle of "learning from nature", so he defines the bionics as learning from the nature. This principle is commonly used by various specialized sciences such as mathematics, engineering and architecture. It basically determines a way of exploring living systems with an analytical criterion, in order to find better solutions for our human needs. Bionics isn't a scientific discipline, but a certain method in which we should implement our fantasy with an understanding of why and how things work in nature. Bionic explains all forms representing imitation of the forms of nature. One of the main reasons why bionics is more popular today is that the man finally has the tools and capabilities to analyze the nature and learn many processes from it.

Historically, animals have served as inspiration in technological design. During the Renaissance, sea animals have been identified as balanced bodies with reduced resistance which can be used in the production of various products. Between 1505 and 1508, Leonardo da Vinci was particularly interested in the flow of water. He wrote for the function of the unified bodies that reduce resistance, and retains the shape of the fish as a good example. He claimed that the fish moves in the water with little resistance, due to its shape and allows the water to flow gently through the back without premature separation. Such a design similar Da Vinci showed in the hull of ships, although far better known is his flying machine that was based on the study of anatomy and flight of birds.
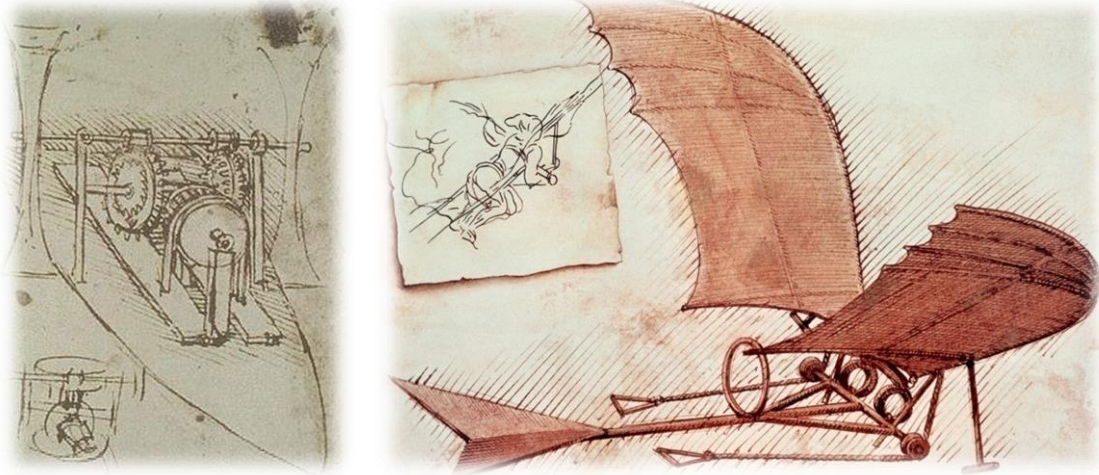
Figure 1. Da Vinci works inspired by nature

2. BIONICS IN INDUSTRIAL DESIGN

In recent years the bionic gained popularity, so more and more it is seen as a model and measure. Millions of years of evolution in nature produced mechanisms and compositions that are very effective, avoid waste and are sustainable in almost a closed system. The bionic can be defined as the study of the form, structure and function of the biologically produced objects and materials, as well as biological mechanisms and processes in order to create products that will be an imitation of nature. The field of bionics is interdisciplinary and covers the study of biological functions, structures and laws of the nature, which are studied by biologists, chemists and other scientists. By studying the successful solutions in nature, are solved many human problems in the field of design and construction of products. This way of designing and thinking can be defined as an innovation inspired by nature.

The inspiration for the development of new technologies is at the core of the approach of the bionics. The great diversity of biological forms allows certain attributes to be used as inspiration for new and innovative design solutions. The insects, plants and animals are everyday engineers and teachers with a lot of knowledge. They are one whole system that works and is all around us. The nature is a big secret to the man, and all his understanding of that system is a big step.

The conscious imitation of nature is a human strategy for survival and a path to a secure future. The more the man comes closer to the nature the more it grows the chance of survival. The inspiration of the designers did not just wake the forms in nature but also the processes and ways of survival of living organisms. Today, more and more one seeks to understand the nature and to take advantage of all its benefits, transforming its processes and forms in his designs that facilitate human life.

The bionic slowly finds its place in the design and in terms of form and materials of design decisions. While the methodology for complex imitations of nature in terms of structure, processes and functions will develop more and more in the future. The furniture industry has many examples that are created by the principle of bionic. Furniture, lighting fixtures, decorations and other items with natural forms such as bird nests, leaves, spider webs, flowers.

New bionic inspired aesthetics of lighting in interior design is achieved not only by imitating natural forms, but also with the imitating the natural bioluminescence process, a natural chemical phenomenon that organisms living in deep seas, and certain types of fungi,

bacteria, insects and worms, create light to survive in a hostile and dark environment. The bionic inspired lighting "Anemix" in the interiors create a 3D effect. Imitating the natural process of bioluminescence not only promises better lighting, but also more efficient and effective lighting.

Figure 2. Anemix lighting– 3D effect

The bionic researches on the properties of materials are particularly important for the design. According to the principle called "lotus effect" characteristic of the lotus leaf, and thanks to the discovery that microscopic lumps covered with a layer of wax reject water drops and also removes dirt, it is designed a fabric and "Lotusan" color with properties of rejecting water and self-cleaning. These materials have a high potential for use in interior design.

Figure 3. Lotus leaf

In the arrangement of internal spaces interesting are the bionic inspired discoveries of more material, such as anti-microbiological material that mimics the structure of the skin of the Galápagos sharks; the "Morfotex" fabric made by imitation of the morphology of the wings of butterflies, a blend of nylon and polyester whose colors can flare and cannot fade; bio-plastic derived from shells of crabs and CO_2 technology that mimics the metabolism of plants; strong adhesives and adhesive "Geckskin" materials that can hold items weighing up to 317 kilograms attached to smooth wall, inspired by the lizard's feet.
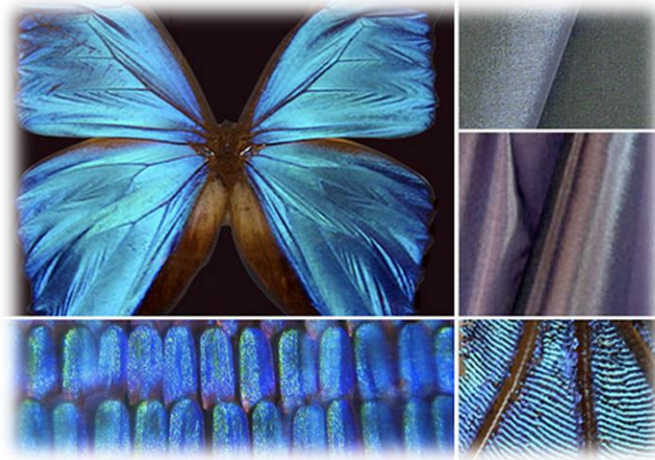
Figure 4. Morfotex fabric

Besides the aesthetic and functional values, the bionic design solutions have environmental and economic value also. Today, more and more attention is paid to the properties of such designs, and designers strive to create environmentally friendly design solutions. Such example is the "Columbia Forest Products PureBond" adhesive, which is inspired by the natural glue shell and is without formaldehyde.

These few examples of designs inspired by nature are mainly used in interior design, and although they are few and not sufficiently sophisticated unlike other areas where bionics is applied, it's clearly shown the extent to which bionics can and should serve as the basis for further development of interior design. Because of the wide field of application, as well as their aesthetic, functional, economic and environmental values, the bionic design promises great achievements in the future of humanity and changes once understanding of technology, industry and design.

3. DESIGNS INSPIRED BY NATURE

During millions of years of continuous evolution, nature has perfected solutions to many of the questions posed by contemporary engineers, architects and designers. But perhaps now, the most intriguing question is how the integration of bionic findings can transform into practice? The easiest way may be thought to be the direct imitation of nature, but this is often difficult if not impossible. Nevertheless, studies have found that is favorable to understand the principles of how things work in nature, than to perform copying natural models.

The bionic design is an innovative approach in which nature and natural processes look for inspiration to create products, processes and facilities, i.e. with it the functional design challenges are dealt with finding and applying natural strategies, methods and principles. In the bionic are made efforts to answer several questions, for example: how nature solves the problem of isolation, how nature reduces friction and stifling the noise, how nature solves the problem of moisture, how it collects energy and gathers water and many other questions which man tries to discover and to make life easier. The bionic approach aims to create a design that is not only visually appealing and elegant, but also functional. The design solution can be bionic in terms of shape, material, structure, function or process.

Today, there is a great interest for bionics and biologically inspired design that is used in a number of industrial areas and in a number of products. We see such products constantly, and they are especially noticeable in the area of architecture. Wide range of furniture is

exactly inspired by natural forms, and as such is used in all kinds of interior and exterior. The transformation of natural forms provides an opportunity for designers to combine different shapes, colors, textures.

The form of the shells is inspiring form, and is often transformed into some kind of furniture, and even architecture. This form provides an opportunity for designers to create interesting shapes that will suit multiple purposes. There is an elegant line, and fits into any space perfectly. Starting form sofas, shelves, chairs, armchairs, sinks and other parts of the interior, the shape of the shell is found in whole architecture buildings. Such buildings have interior space that can be adjusted in an interesting living space and the external look is unusual and interesting.

Figure 5. Sitting furniture inspired by the form of the shell

This interesting seating furniture inspired by the shell can be combined in the interior and exterior solutions. It can fit in different design styles, and can give emphasis to the space.

Finding inspiration in the form of a shell, the designers have created interesting designs with a different purpose. In this way, through a variety of design solutions, industrial products are coming closer to the nature, mimicking its forms, processes, materials. But besides furniture, the shape of the shell was inspiring for architects as well who created interesting architectural buildings.

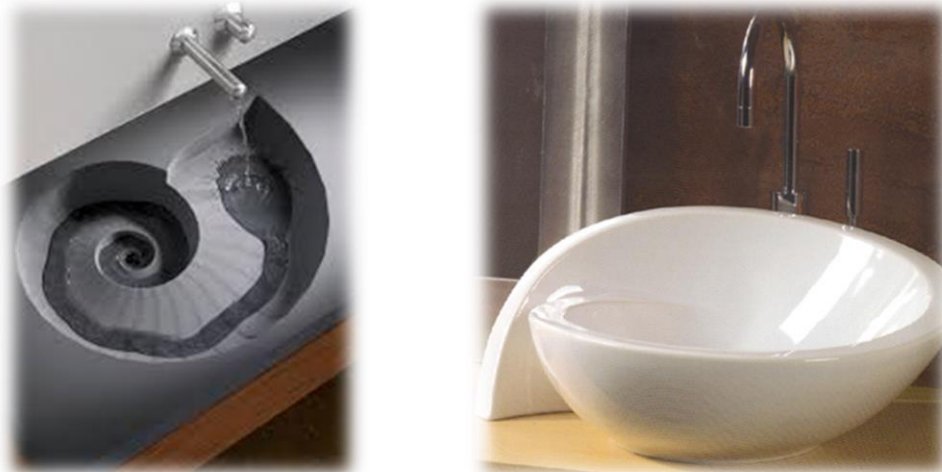Figure 6. Shelves inspired by the form of the shell

Figure 7. Sinks inspired by the form of the shell

Figure 8. Architectural buildings inspired by the form of the shell

The beautiful, unique and irreplaceable form of the shell is one of the cutting-edge designs of nature. The shell was inspiring long ago. Primitive civilizations made drinking vessels and vases shaped as a shell. Later in the Greco-Roman period were created domes, spiral staircases and moldings on walls in the form of a shell. At the time of rococo one of the main features of this style was the decoration in the form of a shell. Today this form of inspiration is reflected in the design of furniture, decorative items, and even architecture.

4. CONCLUSION

The inspiration from nature is expected to contribute to the improvement of technology and its impact to be felt in all spheres of life. Some design solutions may seem impossible to make today, but more and more is improved the human understanding of the nature and the skills so that in future all design solutions can be implemented.

Process modeling in bio-architecture includes a systematic study of natural forms and analysis of their geometric grounds. In this process, there is usually incredible precision with which nature makes its ideal geometry calculations, although sometimes it is hidden and difficult to distinguish. However, by consciously learning, feeling great and having an open soul, designers can find inspiration in such research.

Over the years, many designers and architects were seeking funds to help in the process of creating new harmonic forms. With the development of technology, the discovery of new materials the conditions were improved for new designs, new shapes and interesting solutions. Today, a very important feature is the ecological value of the produced goods. Man tries more and more to adapt to the nature and to create a healthy environment. Many design solutions, architectural buildings, industrial products, furniture and materials were created by transformation of the natural forms and processes. Studies of the nature and the desire of man to get closer to it and to create in the same way, is bigger and in the future will develop even more.

5. REFERENCES

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