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## THE ROLE OF TRAFFIC POLICE IN THE CONTROL OF TRAFFIC IN BULGARIA

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**Abstract:** *The report examined the role of traffic police, as state administrative body which is part of the national police and the Interior Ministry has the task to ensure the safety of road traffic in Bulgaria. The basic activity-carried the bodies of the traffic police, which are aimed at road users and aim to raise their good conduct to comply with traffic rules and other requirements of the law. Also the types of measures for administrative impact applied by the traffic police to influence the mind and behavior of road users are listed are. The measures are divided into several groups: administrative and preventive; administrative procedure; administrative enforcement; administrative penal.*

**Keywords:** *Traffic participant, Traffic police, Traffic accident (RTA).*

### 1. INTRODUCTION

The rapid development of the world economy is accompanied by the improvement and expansion of road transport. Its benefits and collective character are astonishing. All of us participate in the daily traffic, whether as drivers or as passengers or as pedestrians. Having this in mind it is necessary for the transport to have a sustainable development consisting in facilitating the movement of people and goods, energy and environmental efficiency, and ensuring the safety of traffic.

We should focus on the fact that the main purpose of the Law on Road Traffic is to protect the life and health of road users, facilitating their movement, protection of the property of legal entities and individuals, as well as the environmental pollution from motor vehicles.<sup>1</sup>

Very unfortunately, one of the most common tragic events accompanying the process of transport movement is the traffic accidents (RTA). Any accidents resulting in loss of life or injury to people, destruction of property have enormous socio-economic losses for the state and lasting psychological consequences for the people. Each year, national economies suffer losses exceeding 2% of the gross domestic product as a result of road accidents, for 2009 within the European Union we have reported losses of about 130 billion euros. Governments around the world can not afford the luxury to have passengers dying and be injured, just because of their movement on the road.

The main role in ensuring the safety on the road is played by the authorities of the Ministry of Interior, in accordance with their competencies provided by the law.<sup>2</sup> Furthermore, the provisions of the Law for movement on the roads provide specified by the Minister of Interior bodies to perform specific tasks in relation to providing the safety of traffic. These bodies are the specialized structural units of the traffic police who<sup>3</sup>:

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<sup>1</sup> See. h l. 1, para. 2 Traffic Law of Bulgaria.

<sup>2</sup> See. Art. 14, para. 1 and Art. 30 para. 1, p. 5 of MIA - Prom. SG. 53 on 06/27/2014, as well as art.165 Traffic Law of Bulgaria - Prom. SG. 20 of 05/03/1999, with the last recorded.amend. and supplemented.

<sup>3</sup> See. detailed tasks referred to in Art. 165, para. 1 Traffic Law of Bulgaria.

Monitor road users to comply with the rules and requirements of the law;  
Regulate traffic and assist participants;  
Monitor the condition of the road infrastructure take notice of infrastructure malfunctions or failures;  
Implement preventive activity with road users;  
Visit, investigate and analyze accidents, and propose measures to reduce their number;  
May introduce temporary traffic organization when the conditions are dangerous, and later notify the owner of the road;  
Exercise control over the execution of additional training for drivers;  
Create and maintain records of drivers with data on offenses and penalties, as well as records of vehicles and accidents.  
For the effective implementation of the key tasks in traffic safety, police authorities are provided by law<sup>4</sup> with special powers:  
Have the right to stop vehicles to check identity documents and driving license, and all documents related to the management of the vehicle and the shipment;  
Have the right to seize and detain documents in cases provided by law;  
Have the right to arrest drivers involved in accidents when necessary for the investigation of the case;  
When dealing with infringement of the rules on the road traffic police have the right to use equipment or systems, filming or recording date, the exact time of the offense and/ or the registration number of the vehicle.  
Controlling the safety on the road aims to provide optimal conditions for trouble-free flow of transport movement. While this control objective is to make the road users' behavior to comply with the rules to prevent violations, and avoiding the creation of preconditions for road accidents. It is also very important to control the traffic with having in mind violations directly related to safety (speeding, driving under the influence of alcohol or drugs, use of seat belts or helmets, tailgating, improper overtaking, etc.).  
In this regard, we could say that the bodies of traffic police carried out preventive activities with the educative goal of reducing the number of road traffic accidents (RTA) and prevention of the infringements of the rules in order to ensure road safety.

## **2. KEY ASPECTS OF THE IMPACT ON THE BEHAVIOR OF ROAD USERS OF TRAFFIC POLICE**

Since most activities performed by Traffic Police to ensure safety on the road are aimed at influencing the behavior of road users, it is useful to highlight the importance of the human factor that is part of this consideration by some authors<sup>5</sup> more specifically the system "person - car - road - environment". It is the man as a participant in the traffic<sup>6</sup> who is able to conform their behavior to the changing elements of the system in which the processes of traffic occur in order to achieve the maximum level of safety.

In the management of public relations related to traffic safety on the road, there are two basic methods for influencing the minds and behavior of the participants - the method of persuasion and coercion method<sup>7</sup>. In reality there we can see their application in practice

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<sup>4</sup> See. Art. 165, para. 2 Traffic Law of Bulgaria.

<sup>5</sup> See. Chakov P. Traffic control . APU "Free University", 2005, p. 20-27.

<sup>6</sup> These are drivers, passengers, pedestrians and persons working on the road - see. ie. 28, § 6 of the provisions of Traffic Law of Bulgaria.

<sup>7</sup> See. Ivanov, P. I. Traffic control -part second. Academy of the Ministry of Interior, C 2004, p. 125-126.

with the different preventive measures which are used to clarify the rules for safe movement, and to make the citizens aware with the help of the media of various dangerous situations on the road and the causes and conditions for the occurrence of accidents.

Conviction is a way to influence citizens as legal entities, which the government uses to achieve different goals and objectives. This method aims at creating moral values and demand for legal order and proper behavior. The method of persuasion is a complex of organizational, educational and incentive measures, the authorities of traffic police use for reaching a positive influence on the minds and behavior of individuals to motivate them in lawful behavior on the road. This is achieved by: explanation, accession, justification, discussion, presentation of positive models, different incentives, and competition<sup>8</sup>.

In some cases, the method of conviction has no impact on the behavior of road users and then the officers from traffic police are resorting to the method of coercion. The state protects the right of coercion, the legal norms of failure or a risk of failure. It is necessary and useful, because it aims to be effectively used against offenses and to ensure sufficient public law. State coercion is also a social necessity, because with its help the state regulates social relationships. State coercion applied by the police to ensure traffic safety on the roads is guided by the administrative law. It is a kind of state activity (used by competent state authorities) whose main objectives are the protection of life and health of road users, their property, and preservation of the environment from pollution by the transport. It is legal because the measures apply by this activity are regulated by law. It is also administrative because it is applied administratively by executive body, such as the police<sup>9</sup>.

For the management and control of the public relations related to the safety of the road, the bodies of traffic police can influence the minds and behavior of its participants, using administrative measures impact. In this regard, we fully agree with some authors<sup>10</sup> to group the measures in the following way:

- Administrative and preventive;
- Administrative Procedure;
- Administrative enforcement;
- Administrative penal.

## 2.1. Administrative preventive measures in accordance with traffic law

They are aimed at preventing the occurrence of accidents and to eliminate the causes and conditions leading to their occurrence, and mitigation of them. Usually they are applied without violations of traffic rules, but when there is opportunity and when its likely violations to be carried out. But above all we must stress that preventive measures are mainly aimed at helping road users, and to explain the rules and requirements to them. Therefore, preventive measures applied by police authorities are:

Monitor the condition of the road and writing infrastructure warn owners to repair them.

Stop (in whole or in part, or deviate temporarily) the movement of vehicles on certain roads or areas when there is danger, after consultation with the owners of the road. If necessary, bring temporary traffic organization (accidents occurred, snow, ice, etc.).

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<sup>8</sup> More about the method of persuasion see. Lazarov, K. Administrative Law "Feneya" in 2006 with. 229; Dimitrov, D. Administrative Law general part. "Sibi" 1994.

<sup>9</sup> More on administrative coercion see. Lazarov, K. Administrative Law "Feneya" 2006. 229; Chakov P. control traffic. APU "Free University", 2005, p. 51.

<sup>10</sup> See. Ivanov, Pl. Traffic control - Part II S. 2004; Chakov P. control traffic, APU "Free University", 2005.

Regulate traffic in case of need (creating an obstacle to the normal course of the transport process - clogging roads, conducting mass events, accidents, disasters, etc.).

Investigate and analyze areas with a concentration of accidents and the proposed measures to remove the causes and conditions of their occurrence.

Organize and carry out preventive actions (campaigns) to educate participants about road safety.

Propose projects, make suggestions and give advice to the competent authorities to improve road safety.

Cooperate with the media, NGOs and citizens to improve traffic safety.

Most - generally speaking, these are the activities of the control authorities of the Traffic Police, aimed at helping road users and prevent the commission of offenses aimed at avoiding dangerous situations leading to the occurrence of accidents. These measures have the most clear preventive impact using the method of persuasion to road users.

## 2.2. Administrative and procedural measures

These measures are ancillary and serve to ensure and facilitate proceedings for the imposition of administrative sanctions and the application of appropriate administrative measures when there is a violation of the legal provisions. The bodies of the traffic police can implement the following measures for administrative supervision:

Stop users and vehicles they drive and inspect the regularity of identity documents, manage vehicle registration documents, and other documents related to the transportation.

Seize and detain those documents permitted by law.

Do not allow driving of a driver who is under the influence of alcohol or other intoxicating substance, they don't permit the movement of a vehicle having a malfunction or damage affecting safety<sup>11</sup>.

Arrest participants in road accidents when such action is necessary for accident investigation.

## 2.3. Coercive administrative measures

In order to ensure the safety of traffic and to prevent and stop the infringements on traffic law, the legislature has provided for the implementation of Coercive administrative measures, in accordance with the requirements of the Administrative Procedure Code. These measure application adheres to the objective of the law<sup>12</sup> protecting the life and health of the participants in the movement on the roads, their property and the environment from pollution. In its legal nature, the coercive administrative measures in the traffic law constitute as individual administrative acts<sup>13</sup>. To ensure safer road conditions these different coercive measures are applied:

Suspension driving license of a driver (there are 6 hypotheses of the law). The measure is applied by the competent authorities<sup>14</sup>.

Temporary immobilization of the vehicle (there are 8 hypotheses. The measure is applied by the competent authorities.

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<sup>11</sup> As referred to in Art. 101, para. 3 Traffic Law of Bulgaria.

<sup>12</sup> See. Art. 1, para. 2 Traffic Law of Bulgaria.

<sup>13</sup> See. Art. Section I of Chapter Five of the Administrative Code - prom. SG. pcs. 30 of 11.04.2006 with messages. amend. and supplemented.

<sup>14</sup> Under the provisions of Traffic Law of Bulgaria, applied by the heads of departments to control or authorized by them officials.

Retention of custody license of vehicle, which is registered or to be registered subject to missing or deletion or changed identification number on the frame (chassis).

Seizure of driving license of a person who has failed to fulfill its obligations to return his license after having lost capacity due to the exhaustion of all control points. The measure is administered by a reasoned order of the competent authorities.

Forced movement of parked vehicles without the knowledge of its owner or his authorized driver (there are three hypotheses).

Suspend the activities of persons conducting additional training of drivers - to stop the violations. Measure is administered by a reasoned order of the competent authorities.

A proceeding on the application of coercive administrative measures to traffic participants and drivers and the appeal process is in accordance with the provisions of traffic law and Administrative Procedure Code.

## **2.4. Administrative measures**

Imposition of sanctions envisaged by traffic law for violations of the rules on the road aims to reimburse damaged or threatened public interest (in this case safety), to have a positive impact on the offender, for example to educate him in respect to the legal provisions and to warn other drivers participating in traffic that the failure of traffic rules will lead to the imposition of sanctions provided by the law.

For violating road traffic conditions, authorities of traffic police impose the following administrative penalties:

- fine;
- deprivation of the right to drive;
- public reprimand.

Production of establishment of administrative violations, imposing administrative penalties on users, as well as the procedure for their appeal, made on the basis of the traffic law and the Law on Administrative offenses and penalties. Here are the possible ways of establishing infringements and imposing administrative penalties on traffic law:

### **2.4.1. Establishment of administrative violations and imposing a fine slip**

For minor cases of violations that are established at the time of their execution, the place of the offense can be fined by a slip of up to 50 leva. Minor violations are those that do not create public hazard to traffic and its participants and could lead to the occurrence of accidents. The imposition of a fine slip is possible only if:

- the offense was minor and the imposition of a fine amounting to 50 leva;
- it is established at the time of its commission;
- there is only one offense;
- the person agrees to sign the slip.

### **2.4.2. Establishing administrative violations and impose fines under the traffic law by electronic card**

Electronic card is an electronic statement, recorded on paper, magnetic or other media created by administrative information system based on the received and processed data on violations of automated technical means for filming or recording the date, exact time and / or the registration number of the vehicle.

When infringements are detected through the use of technical means of control, filming or recording the date, exact time and / or the registration number of the vehicle in the absence

of the offender an electronic card is drawn for the imposition of a fine provided for that particular offense. Electronic coupon is sent to the owner of the vehicle for payment of the fine. After receiving the electronic card owner can:

- Pay the fine (if you pay the fine within 14 days of receiving it the fine is reduced to only 70 percent of its size);
- There is the hypothesis that within 14 days of receipt of the fine the owner of the vehicle may indicate the person who committed the offense by completing purpose statement with data for the driver;
- There is the hypothesis that within 7 days of receipt driver may file an objection to the Director of the regional directorate of ministry of the interior;

Within 14 days of its receipt driver can appeal the fine to the District Court.

The establishment of administrative violations under traffic law starts with drafting an act of administrative violation or (administrative offense) and the imposition of administrative penalties.

The administrative fine form is of special type and it is approved by the Minister of the Interior. It is written in three copies (in carbon or carbonless paper) in the presence of the offender and witnesses. Witnesses included in the administrative fine form may be witnesses – present in the infringement, or in drafting of the act for the fine, and when they are lacking, it is drawn in the presence of two other witnesses, who are specifically mentioned in it. Witness in administrative offense may be the official (police officer). Regularly drawn up administrative fine forms have proof value until proven otherwise. The probative force of the act is determined by its function - declaratory (notes), accusatory and referral.

Proceedings for imposition of administrative penalties is a set of procedural actions carried out by the higher administrative body authorized by the person who is compiled. They are competent to examine the findings and the described illegal facts and circumstances in the search and discovery of the objective truth about violations of traffic rules, and depending on it impose or not, the sanctions provided by law.

Imposition of penalties in these cases by penal provision are issued by a competent administrative body specialized in punishing. The penal provision is a judicial act that the punishing body decides independently and autonomously issues covering in every case:

- has there been a violation or not;
- by whom;
- under what circumstances;
- is the driver guilty or not;
- is the offender pleading guilty or has he any objections.

The penal provision have provided statutory penalty for the offense committed when a person whose trial provided statutory prerequisites for this. Hence it appears that the sanctioning body is independent and is provided by the laws of discretion in order to find the objective truth.

### 3. CONCLUSION

In relation to improving the safety of traffic and the implementation of the goal of the National Strategy to improve traffic safety on the roads of the Republic of Bulgaria for the period 2011-2020, - reducing the number of deaths in road accidents by 50% to 2020., we will try to bring some priorities in the activities of the traffic police:

First - strengthening the preventive work of traffic police in the conduct of campaigns and actions with different categories of study in dozens road.

Second - increased presence of traffic policemen on distinctive for their vulnerability places on the road to regulate traffic and assist participants in the traffic.

Thirdly - the implementation of enhanced control over traffic participants through:

- Establishment and improvement of the network of automated traffic control;
- Providing more police checks;

Fourth - effective control on the report of the drivers who are the most important element from the human factor.

Fifthly - improving the interaction between traffic police and other services, both in the Interior Ministry and other government bodies. It is also necessary to strengthen interaction with NGOs, citizens and businesses, which would increase confidence in the Institution of the Ministry of Interior and the noble cause of the activities of the traffic police to support and secure the road.

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## ANALYSIS OF SOUNDS GENERATED FROM WELDING MACHINE WHILE IN IDLE AND OPERATIONAL MODE BY ACOUSTIC METHOD

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**Abstract:** *The sound levels of welding machines used in Welding laboratories in the initial conditions and while in operation case were analyzed in this study. The study was conducted at the Welding Laboratory of Central Vocational and Technical High School in Kirklareli, Turkey. The existing Welding Laboratories at Industrial Vocational High School were used the field of study in the experimental study. The sounds emerged from Arc welding machine, inert-gas welding machine and Spot welding machine in non-operational mode as well as in operational case were recorded and analyzed. Since sounds emerging from machines in inoperative and operational case are different, both of the cases were analyzed separately in the study. In the application stage, three welding machines were put to work separately in the environment where the students of Kirklareli Industrial Vocational High School and their sound data were analyzed. The sounds generated by machines during welding were seen to be distinguished when the sounds made during pre-welding and welding were analyzed.*

**Keywords:** *Acoustic Method, Welding, Sound Analysis.*

### 1. INTRODUCTION

Nowadays, one of the factors that negatively affects the quality of the environment that we live in and the human health is the noise or the sound. Noise is defined as unpleasant, unwanted and disturbing sound [1-3]. Sound is an objective and measurable concept and noise is a subjective concept. As can be understood from definitions, characterizing a sound as a noise or not can vary depending on the individuals. The disturbances felt from noise increased with unplanned and intertwined development of residential and industrial areas, the increase in traffic density and inclusion of electrical, electronic and mechanical devices more into our everyday lives especially in fast-growing cities. Noise is generated in the work environment as well as in traffic and cities, and the health of people working all day long in noisy work environment is in great threat [1-3].

Noise evaluation measure is decibel (dB) based on the sound pressure level. The measure of noise level is dBA or dBC in accordance with the weight curve used. The sensitivity of the human ear to the sound depending on the frequency is best represented by a weight curve. Therefore, it is usually measured as dBA. C weight curve is used in the measurement and evaluation of the impact noise and is measure as dBC [1,3].

In today's developing technology, various materials are manufactured in many fields such as automotive, shipbuilding, industrial plants, architectural buildings and transportation etc [4]. The metal or metal derivative materials are used in the manufacture of these buildings. Metal constructions, used especially in the foundation of many structures are manufactured by making use of welding or welding technologies. Manufacturing is carried out outdoors, in the laboratory environment or in industrial plants. In these stages of manufacturing, technical staff, who especially work with welding machines, breathe in, touch or use many chemical materials. They are also affected by sounds generated from the materials they work with in addition to the negative situations caused by these chemicals.

Chemical effects suffered by technical staff during welding were not analyzed, but sounds, generated by welding machines during welding, were researched in this study. There many studies about welding machines and welding works in literature and some of these studies are related to the current drawn by the welding machine [2,5]. Many studies especially about the roughness on the surface where welding is carried and the mechanical analysis of these materials can be mentioned here [5-9]. However, there are not many studies in literature on the sound generated during welding and while welding two pieces together. Despite the wide range of fields of applications in the industry, welding operations with acoustic monitoring techniques are not analyzed much by researchers [4,6-9].

Sounds, generated by using Arc welding machine, Inert-gas welding machine and Spot welding machine in idle mode as well as in operational case were analyzed in this study.

## **2. WELDING METHODS**

Welding, which is used as a non-removable joining process in many fields of industry, is an essential issue of the industry. Even though the use of welding robot has become widespread with each passing day in the field of welding as in all fields in the industry today, manual welding has a significant place in the repair and production stages. Because, it may not be possible to use welding robots everywhere. Since the welding process is a type of non-removable joining process, it requires more attention and care than other joining processes [10-13].

### **2.1. Arc Welding**

It is a type of joining method carried out by using the heat that will arise from the passing of continuous electrical arc through the parts to be joined with the help of an additional electrode. Power is the conversion speed of the energy from one form to another in Arc Welding. Almost all of the electrical energy is converted into heat when considering a welding arc. Only a small proportion of the heat is used to produce ultraviolet radiation and bright light diffused by the arc. Power input can be determined as Watt since current and voltage can be easily measured [10-13].

### **2.2. Inert-gas Welding**

Inert-gas welding is an arc welding method in which the necessary heat for welding arises due to the arc created between the consumed electrode and the work-piece. The method is also called Metal Inert Gas (MIG) welding due to the use of melting metal electrode and inter gas [10-13].

### 2.3. Spot Welding

Spot welding can be defined as the process of fixing the work-pieces in regular intervals in order to maintain them in appropriate sizes. The angles of work-pieces and distances with each other should not be changed during welding in order to complete the welding process successfully.

The spot size should be 4 times higher than the thickness of work-piece. If whatever type of electrode will be used in the welding process, spotting should also be carried by the same type electrode [10-13].

## 2. DATA COLLECTION SYSTEM

In this study, the data collection system was schematically shown in Figure 1. Data collection in this study was analyzed separately by using three different welding machines and their data on sound was recorded while machines were idle or during welding. There was no inference to the ambient noise in laboratories either in idle case or during operation case in the study. It was conducted in laboratory conditions of Kirlareli Industrial Vocational High School Laboratory. In the study, sounds collected by the sound sensor (microphone) were transferred to a computer environment after being recorded by the appropriate acoustic sound software and were analyzed by using MATLAB software program. Ambient temperature was not conditioned during welding and experiments were conducted at room temperature in a laboratory environment. There was no need to isolate the ambient sound in order to make the study appropriate to the actual working conditions. Since the sound intensity is inversely proportional to its distance from the sound source, it was observed that external sound recordings were not affected by the sound recordings taken from L distance to the sound source and the absence of another sound course at 5L distance and it remained at low noise level. Sound recording time was limited between 5-7 seconds and analyses were taking these durations into consideration. Photos from three welding machines used in this experimental study and implementation were shown in Figure 2.



Figure 1.  
Schematic view of Experiment Set



Figure 2. A View from Welding Machines and Implementation

### 3. APPLICATION OF DATA

In the study, data from three welding machines was collected in Welding Laboratory. The data collection system is presented in Figure 1. Photos related to welding machines and implementations are shown in Figure 2. In the study, the data collection process was conducted respectively in following order: collection of sounds from Arc Welding Machine before welding and during welding, sound recordings from Inert Gas Machine before welding and during welding and sound recordings from Spot Welding machine during welding. Sound recording time was limited between 5-7 seconds.

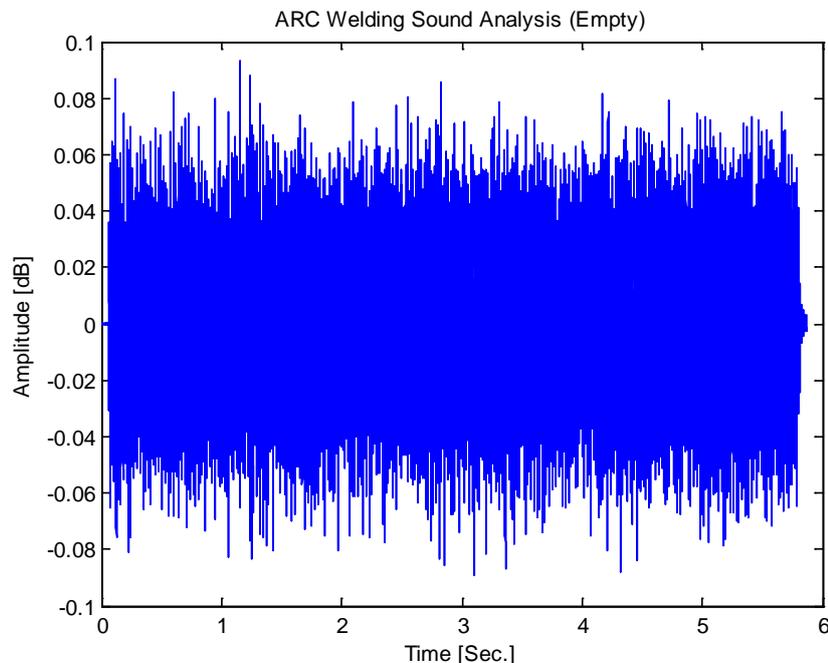


Figure 3. Idle Runtime of Welding Machine

Graph related to the data on sound of Arc welding machine before welding operation was given in Figure 3. All data has been recorded between 5-7 seconds and can be clearly seen from the graph. The sound emerging from the machine before welding can be seen to vary between 0.08 dB and 0.04 dB on average when sound data before welding was analyzed. The data on sound from Arc welding machine during welding was seen to take higher values in comparison with those on idle operation when they were analyzed in Figure 4.

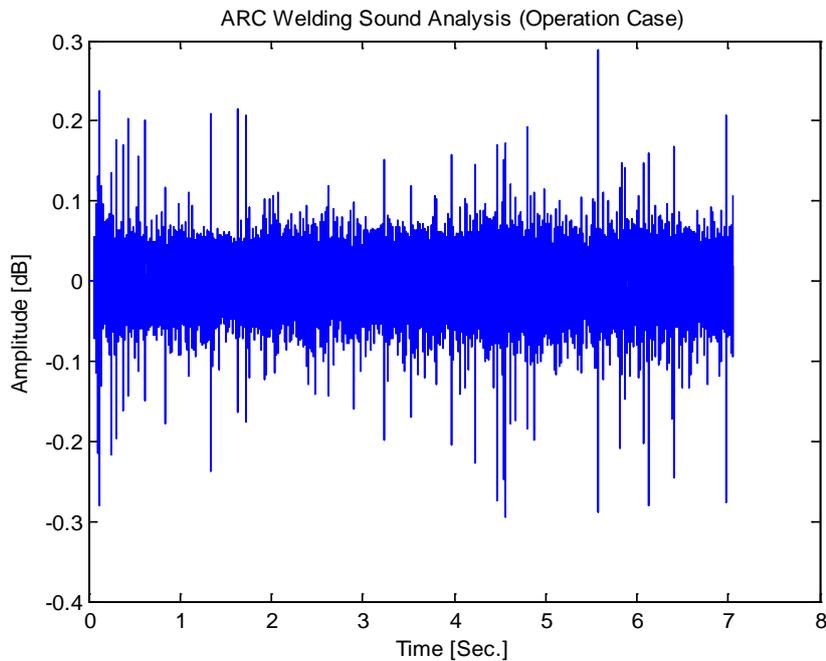


Figure 4. Sound of Welding Machine during Welding

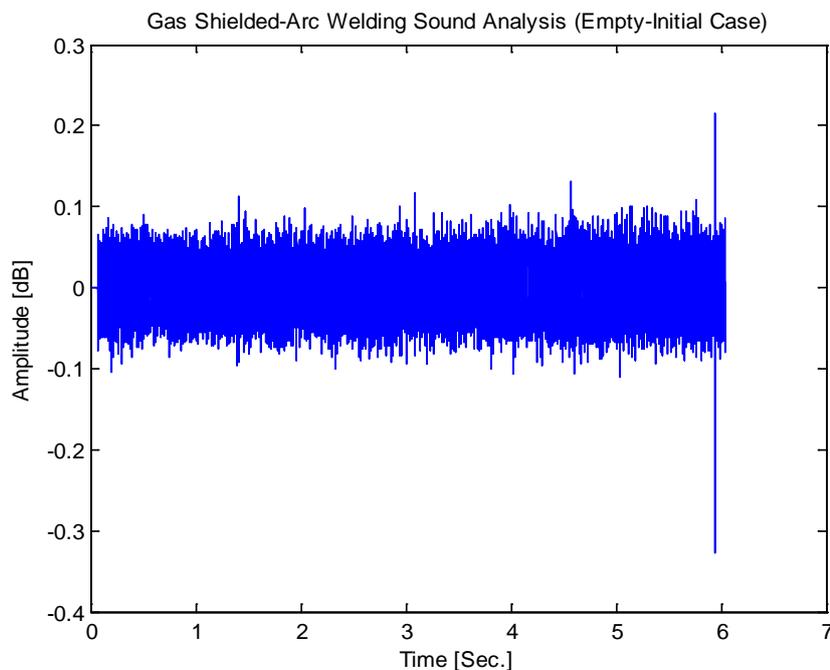


Figure 5. Sound of Inert-gas Welding Machine while working in Idle Mode

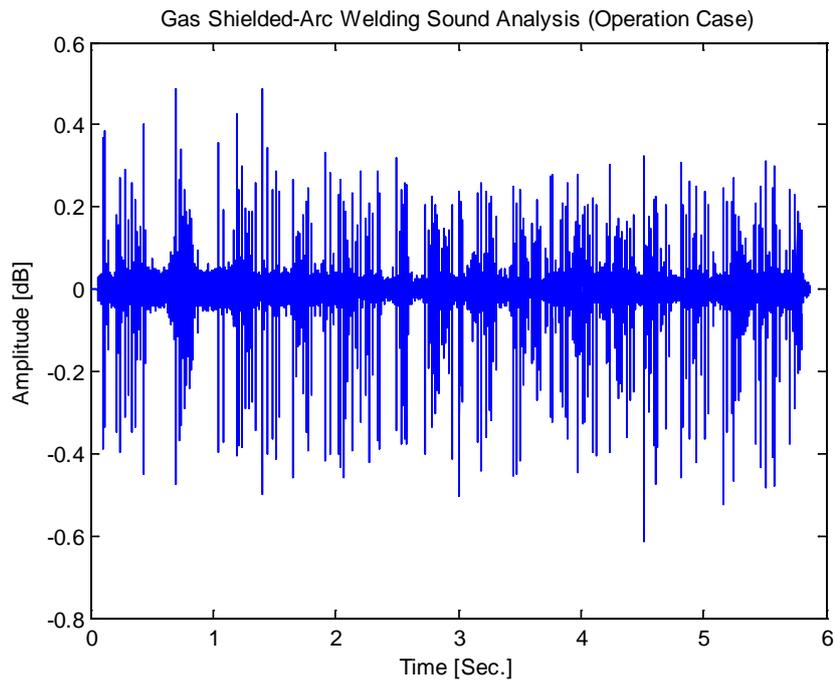


Figure 6. Sound of Inert-gas Welding Machine during Welding

Graphs related to the data on sound from Inert-gas welding machine before welding and during welding were given in Figures 5 and 6. In Figure 5, data on before welding was seen to take values lower than the value of 0.1dB and they reached the value of 0.5dB during welding.

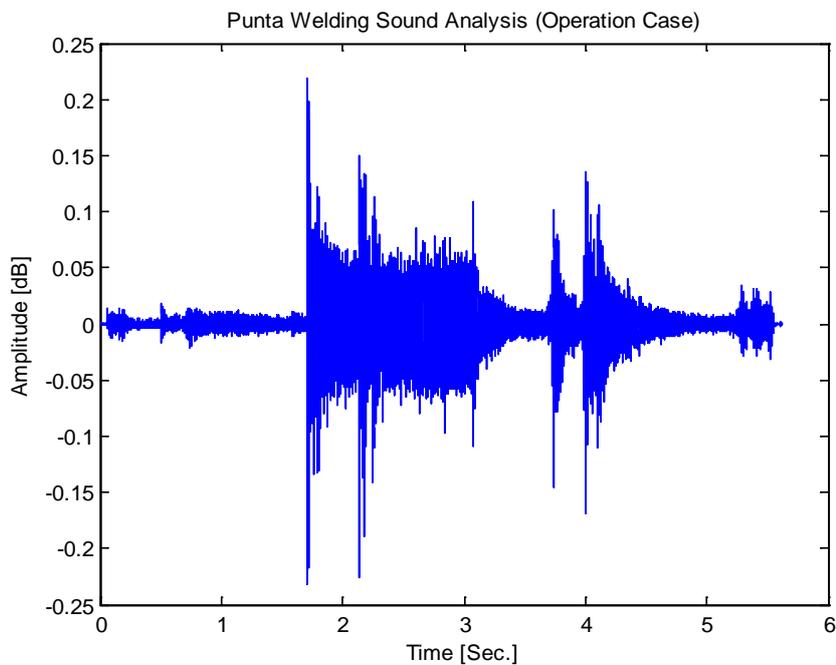


Figure 7. Sound Graph of Spot Welding Machine during Welding

Graphs related to the data on sound from Spot welding machine recorded during welding were given in Figures 7. There is no data on before welding since Spot welding machine makes sound only during welding. The sound intensity can be seen to vary between 0 and 0.25 when analyzing the data.

Data on before welding and during welding can be seen to be distinctive when analyzing the data from each of the three welding machines. Data on before welding takes lower dB values in comparison with those on during welding work.

#### 4. FOURIER TRANSFORMATION AND FFT ANALYSIS

Fast Fourier Transform (FFT) based on statistics, is a mathematical process. FFT is used for decomposition of mixed signals. The frequency characteristics of the signals extracted by FFT. To sum up the FFT is used in the transformation of the time domain to the frequency domain of the signal [14-17]. A function  $g(t)$  is defined by Equation (1).

$$\mathcal{F} = g(t) = G(f) = \int_{-\infty}^{\infty} g(t) \cdot e^{-2\pi ft} \cdot dt \quad (1)$$

Inverse Fourier transform equation is given in equation 2.

$$\mathcal{F}^{-1} = \int_{-\infty}^{\infty} G(f) \cdot e^{2\pi ft} \cdot df = g(t) \quad (2)$$

Here, the transformation can be expressed as in equation 3.

$$g \overset{\mathcal{F}}{\leftrightarrow} G \quad (3)$$

FFT analysis of the signals was carried out during the pre-welding and welding operation analysis. Analysis results were shown in the following figure (Figure 9 – Figure 11).

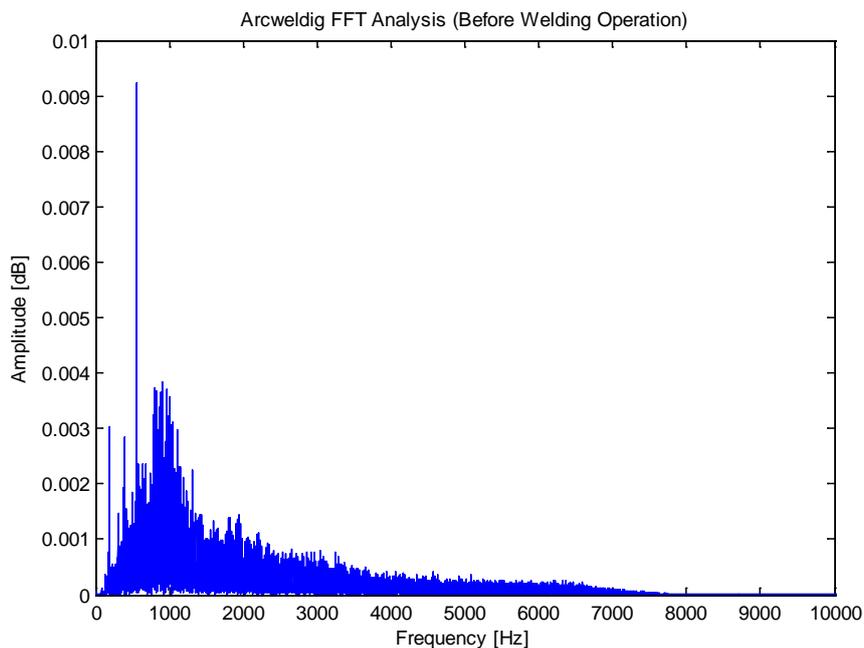


Figure 8. FFT Graph of Arc-Welding Machine before Welding

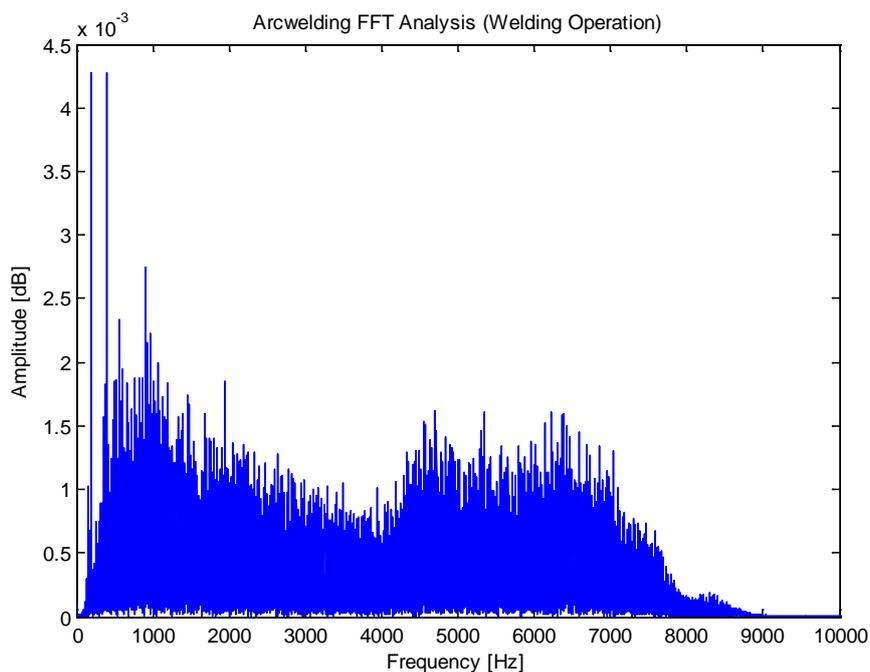


Figure 9. FFT Graph of Arc-Welding Machine during Welding Operation

Frequency content of the welding sound signals during welding operation is spread to the entire frequency band (0-9000Hz). Before welding operation the frequency is in the range 0-3000 Hz. FFT analysis is a very effective method to determination the situation of the pre-welding operation and welding operation.

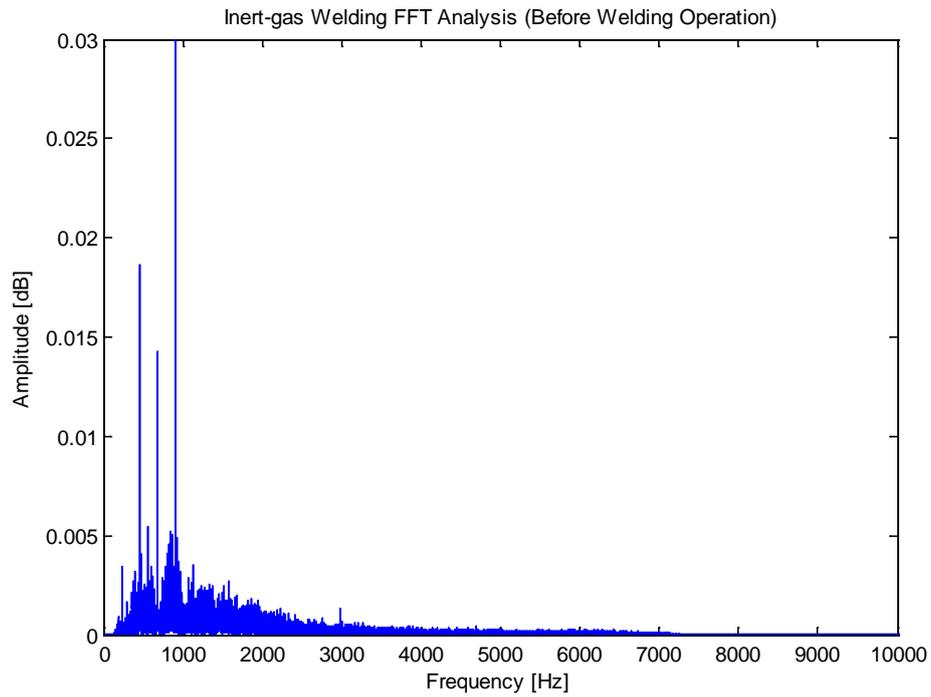


Figure 10. FFT Analysis of Inert-Gas Welding Application (Before Welding Operation)

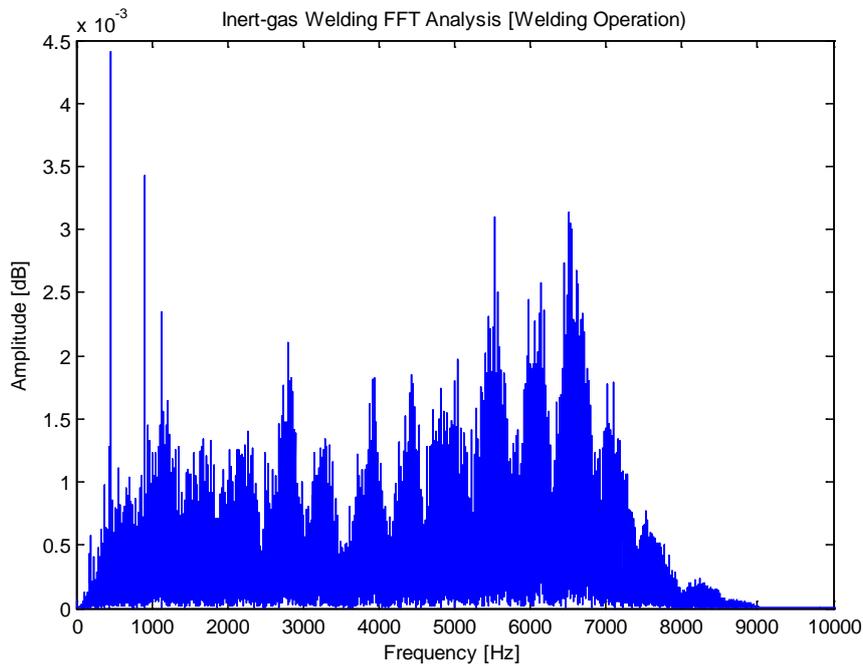


Figure 11. FFT Analysis of Inert-Gas Welding Application (Welding Operation)

## 5. CONCLUSION

This study was conducted in Welding Laboratory of Central Vocational and Technical Anatolian School in Kırklareli, Turkey. It was conducted in actual laboratory conditions and sounds generated by three different welding machines before welding, during operation and welding were separately recorded and analyzed by data collection system prepared for the study. Sounds, collected by the Microphone which is a part of the data collection system, were recorded and transferred to the computer environment by appropriate acoustic sound software and were analyzed by using MATLAB software program. Welding Laboratories that are used with the purpose of education were selected as the study field and sounds generated from Arc Welding machine, Inert-gas Welding machine and Spot Welding machine before welding and during welding were recorded and analyzed in this experimental study. Sounds, generated from machines while operating in idle mode and operation case, were seen to be distinguishably different when analyzing the obtained data. Before welding and during welding phases of welding machines can be determined and their operational modes can also be identified by this method. Distinguishing sounds before welding and during welding phases are planned by using different mathematical methods in subsequent studies.

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## IMPROVING COOPERATIVE LEARNING ACTIVITIES BY NEW MOODLE FEATURES

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**Abstract:** *The purpose of this paper is to focus on the new means of improving student collective work through the use of the improved features in MOODLE. We have devised a schema for the MOODLE application of virtual learning environment for cooperative learning in the “Multimedia for web-based learning” track in the Trakia University. In this paper we have analysed the two direction for improving of cooperative learning activities, namely through the principal requirements for cooperative learning and by using the features of MOODLE. In regards to that we have restructured the interaction between students and tutors during cooperative learning, as well as the learning conditions. We have emphasised on the new MOODLE features for the activities and resources for improved usability in collective tasks. We have presented an analysis of the collective work on the students in the Multimedia for web-based e-learning track.*

**Keywords:** e-learning, blended learning, Moodle features, cooperative learning.

### 1. INTRODUCTION

Electronic leaning (E-learning) is the process of education in electronic form globally via the Internet or an intranet, using a system for education management. At the Trakia University, Faculty of Technics and Technology (FTT) we have set-up the material and technical base, developed methods for e-learning, create teaching materials in electronic form in various courses/subjects and trained the staff to use the resources. The SEM provides the facilities for using Internet-base technology for creating, managing, accessing and securing wide selection for educational content. The system also securely stores the information for the students and allows for management of the stored data.

E-learning is a technology used alongside traditional forms of education in so-called blended learning. The use of e-learning steers the student towards a new style of working, developing skills and habits for life-long learning. Mastering this technology changes the one’s attitude towards education and gives the ability to train anywhere and anytime, as long as a student has an access to the system. E-learning technology is also applicable to study/work groups, according to the principles of cooperative learning.

The goal of this report is to elaborate on the ways of improving collective work of students in e-leaning through the use of new and improved features of MOODLE. We have developed a new algorithm (Figure 1. Resources and activities used during “Multimedia for web-based e-learning” track) for applying the Moodle virtual educational environment for cooperative learning “Multimedia for web-based learning” track. We have focused on the extended MOODLE functionality for the evaluated activities and resources, designed to improved their usefulness for collective assignments. We have presented an analysis for the group work of students in the “Multimedia for web-based learning” track.

## 2. MATERIALS AND METHODS

E-learning is electronic learning, in which the learner uses a computer to learn a task, skill, or process. It is also referred to as computer-based training, web-based training, and online learning. E-learning is inclusive of, and is broadly synonymous with multimedia learning, technology-enhanced learning (TEL), computer-based instruction (CBI), computer-based training (CBT), computer-assisted instruction or computer-aided instruction (CAI), internet-based training (IBT), web-based training (WBT), online education, virtual education, virtual learning environments (VLE) m-learning, and digital educational collaboration. These alternative names emphasize a particular aspect, component or delivery method. [4]

Online learning should rather be seen as a different teaching and learning method that can be used by itself or to complement classroom teaching. Similarly, online learning does not mean replicating face-to-face teaching in an online environment. The power of online teaching and learning is that it gives different – and sometimes better – learning experiences. [2]

Virtual learning environments (VLEs) consist of a wide range of tools, including: search engines, internet voice communication, instant messaging, chat groups, emails, RSS feeds, blogs, social networking platforms, online video conferencing platforms, learner management systems such as Moodle (<https://moodle.org/>), Sakai (<http://www.sakaiproject.org/>), Canvas ([www.instructure.com](http://www.instructure.com)) and BlackBoard ([www.blackboard.com](http://www.blackboard.com)), and e-portfolio programmes such as Mahara (<http://mahara.org/>), Learner Journey (<http://www.learnerjourney.com/>), foliofor.me (<http://foliofor.me>), and ePortaro ([www.eportaro.com](http://www.eportaro.com)), as well as in-house e-portfolio systems designed by specific universities.

Virtual learning environments present many possibilities but also potential pitfalls, particularly when trying to transfer traditional teaching methods to virtual environments. Although they have great potential, virtual learning environments are often not used as innovatively as they might be. [57] Designers of online learning must select the components of the virtual learning environment carefully, bearing in mind the needs and life situations of the students. [2]

At the Trakia University all (geographically separate) faculties have access to the virtual learning environment, built on MOODLE 2.8. The Faculty of Technics and Technology has already developed virtual learning courses and has trained faculty members in creating and expanding e-learning course. The FTT makes use of the so called blended learning. Blended learning tries to provide a common platform for traditional learning aspects with possible combinations from virtual learning technologies. [9]

The interaction of teacher and student is dialogue, which is built on a problem related to real life familiar situations. We emphasize that knowledge is formed individually in terms of social cooperation with the other of the group and instructor, according to their interpretation in terms of learning situations close to reality. [7]

Reconstruction of classical teaching by using the opportunities of modern information and communication technologies allows personal growth and professional development of academic staff. In blended learning students can easily assess the quality of teaching, as professional and social teaching experience is supported by contemporary digital technology. [8]

The access of students to materials of online courses improves academic achievements, as indicated by the data from previous studies of authors. The majority of surveyed lecturers emphasize first the formation and structuring of content and capabilities of online technologies as an opportunity to increase the motivation of students and the quality of teaching in the auditoriums. [8]

E-learning approaches can combine different types of e-learning components, including [1]:

- (a) e-learning content;
- (b) e-tutoring, e-coaching, e-mentoring;
- (c) collaborative learning; and
- (d) virtual classroom.

(a) E-learning content can include:

- simple learning resources;
- interactive e-lessons;
- electronic simulations; and
- job aids.

(b) E-tutoring, e-coaching, e-mentoring

Services which provide human and social dimensions can be offered to learners to support them through the learning experience. E-tutoring, e-coaching and e-mentoring provide individual support and feedback to learners through online tools and facilitation techniques.

(c) Collaborative learning

Collaborative activities range from discussions and knowledge-sharing to working together on a common project. Social software, such as chats, discussion forums and blogs, are used for online collaboration among learners. Online discussions, Synchronous and asynchronous online discussions are designed to facilitate communication and knowledge-sharing among learners. Learners can comment and exchange ideas about course activities or contribute to group learning by sharing their knowledge. Collaborative project work implies collaboration among learners to perform a task. Collaborative activities can include project work and scenario-based assignments.

(d) Virtual classroom

A virtual classroom is an e-learning event where an instructor teaches remotely and in real time to a group of learners using a combination of materials (e.g. PowerPoint slides, audio or video materials). It is also called synchronous learning. This method requires the least amount of effort to convert materials (but instructors still have to prepare them). Appropriate technology must be in place for both the learners and providers (e.g. software for the virtual classroom and good connectivity).

Blended learning combines different training media (e.g. technologies, activities and events) to create an optimum training programme for a specific audience. The term "blended" means that traditional instructor-led training is being supplemented with electronic formats. In a blended approach, e-learning sessions can be integrated with face-to-face traditional activities using a variety of approaches [1].

A training program may aim at developing different types of skills [1]:

- cognitive skills, which can involve knowledge and comprehension (e.g. understanding scientific concepts), following instructions (procedural skills), as well as applying methods in new situations to solve problems (thinking or mental skills);
- interpersonal skills (e.g. skills involved in active listening, presenting, negotiating, etc.);
- psychomotor skills, involving the acquisition of physical perceptions and movements (e.g. making sports or driving a car).

There are three basic ways students can interact with each other as they learn. They can *compete* to see who is "best"; they can work *individualistically* on their own toward a goal without paying attention to other students; or they can work *cooperatively* with a vested interest in each other's learning as well as their own. [5]

Different interaction is selected based on these concepts and the desired skill development. What remains of primary importance is the effective interaction in all of these models.

In a *cooperative* learning situation, interaction is characterized by positive goal interdependence with individual accountability. [5] There is a difference between "having students work in a group" and structuring students to work cooperatively. There needs to be an accepted common goal on which the group will be rewarded for their efforts. A cooperative group has a sense of individual accountability that means that all students need to know the material or spell well for the group to be successful. Putting students into groups does not necessarily gain positive interdependence and/or individual accountability; it has to be structured and managed by the teacher or professor. [5]

In Table 1 you can find the differences between the traditional group and cooperative group learning.

Table 1. Comparison between traditional and cooperative group learning

<b>Traditional groups</b>	<b>Cooperative groups</b>
Low interdependence	High positive interdependence
Member takes responsibility only for self	Members are responsible for own and each other's learning
Focus is on individual performance only	Focus is on joint performance
Individual accountability only	Both group and individual accountability Members hold self and others accountable for high quality work
Assignments are discussed with little commitment to each other's learning	Members promote each other's success doing real work together, helping and supporting one another's efforts to learn
Teamwork skills are not directly taught	Teamwork skills are emphasized
A leader is appointed to direct members' participation	Members are taught and expected to use social skills Leadership is shared by all members
No group processing of the quality of its work	Group processes quality of work and how effectively members are working together
Individual accomplishments are rewarded	Continuous improvement is emphasized

For the "Multimedia for web-based e-learning" track the groups are created by the tutors immediately before starting a cooperative learning task. Each groups consists of no more that 5 students.

### 3. DISCUSSION AND RESULTS

The course is developed according to the standard for creating e-learning courses in Trakia University – Stara Zagora. During a blended learning course, certain order of activities is followed, along with dedicated resources. The students are evaluated based on the achieved results during the course.

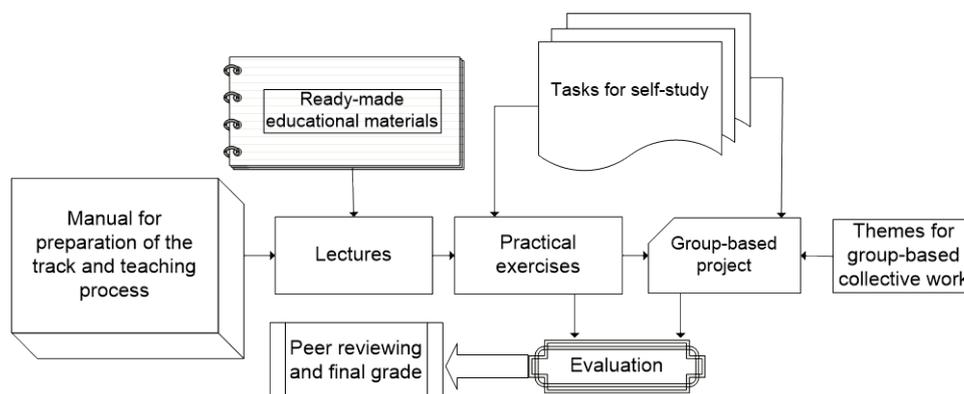


Figure 1.

Resources and activities used during “Multimedia for web-based e-learning” track

In the “Multimedia for web-based e-learning” track we make use of the following resources and activities:

- Manual for preparation of the track and teaching process;
- Lectures for the course;
- Practical exercises for working with software for development of multimedia materials;
- Themes for group-based collective work;
- Group-based project for cooperative learning – collective group task;
- Ready-made educational materials for working with the resources and activities in MOODLE.
- Evaluation of the material developed by student – taking part in the creation of a glossary, wiki and forum moderation;
- Peer reviewing for the collective developed material, with a common grade per group;
- Analysis of the results and final grade.

The collecting work of students in small groups consists of:

- Presentations on specific topic;
- Graphical objects, schematics, figures, presenting topic material;
- Glossary for the common terminology on the topic;
- Audio for part of the sub-topics;
- Video for a specific sub-topic;
- Animation, where appropriate;
- Wiki;
- Forum.

For most lectures, the e-learning system provides supporting resources, such as presentations and lecture notes, web resources for additional/reference information. The students can also get web-based conferences, wikis and forums, some of which can be created by the students themselves, but are moderated by the tutors. All students in a course can take part in these activities and contribute to the common resources. The students can be listed to the lectures and also participate in hands-on exercises. During the development of the cooperative assignment and group tasks, the students also act as tutors and save the materials developed by them in the e-learning system. This allows for the individual work of every student (additions to the glossary, wiki and forum) to be evaluated, contributing with their activities on the collective part of the work.

During assessment, each group presents their materials to the tutors and other students, and the groups evaluate one another. This way not only the work is collective, but so is the evaluation, which makes the final grade more objective.

Improving cooperative learning can only be achieved by the correct usage of the principals of this type of learning. For successful group-based cooperative learning and its further improvement, the following conditions must be met:

1. Selection of suitable e topic for the task assignment in the groups in the “Multimedia for web-based e-learning track” track. According to [5] cooperative learning groups have shown to be especially effective where problem-solving, conceptual learning, or divergent thinking are required.
2. We have made discussions for:
  - Optimising the group size, based on the topic;
  - Student selection in each of the groups: A lot of the power for learning in cooperative groups come from the need for discussion, explanation, justification, and shared resolution on the material being learned. [5]
  - Arrange the classroom. Group members need to be close together and facing each other, and the teacher as well as members of other groups need to have clear access to all groups. Within the groups, members need to be able to see the relevant materials, converse with each other easily, and exchange materials and ideas.
  - Access to appropriate materials (forum, wiki, dictionary etc.) through the virtual learning environment for this course. Every student can see the asked question, the answers, recommendations and the enquiries made by each of the other course taker, even not belonging to the same group.
3. We have explained the tasks for the assigned collective work and the common goal of all group members. A clear and specific description of the task needs to be given coupled with an explanation of the group goal. The group goal communicates that group members are in this together and need to be as concerned with other group members' understanding of the material as they are with their own. [5]
4. While the students are working collective on each group task, we are monitoring the process using the virtual learning environment. During this process, according to [5] the tutor needs to monitor carefully how well the groups are functioning; determine what skills are lacking, both related to the subject matter and to the interaction; set up a way for the groups to process how well they functioned and discuss how to do even better; and intervene where problems are serious to help groups work out their own problems.
5. Include etiquette guidelines: It should not be assumed that students participating in an online course or learning environment will necessarily share the same understanding of etiquette and how to work together. For this reason it is important for the instructor to map out initial guidelines for interaction. The difference between cooperative work (where individual students each submit their own contribution) and collaborative work (where students work together as a team to produce one product) should be explained. [2]

On the other hand, the new features of MOODLE will enrich the cooperative learning activities. For the “Multimedia for web-based e-learning” track we are relying on the improved capabilities of the virtual learning environment transitioning from MOODLE version 1.9.5 to 2.8, which is currently used.

<b>External Tools</b>	Moodle 2.6, 2.8	Add Turn It In to an Assignment, Forum, or Workshop
		Create a VoiceThread Presentation
		Create Quizzes Offline with Respondus
		Delete an Audio Segment on a Slide in VoiceThread
		Download & Install Respondus Quiz Builder
		Enable Completion Tracking
		Import a Participant List from Moodle into TurningPoint (version 5, Mac/Windows)
		Playback Options on VoiceThread
		Require Respondus Lockdown Browser for Quizzes
		Respondus LockDown Browser Overview
		Send an Email via UofM Gmail
		Add a Video Resource
<b>Forums</b>	Moodle 2.4, 2.6, 2.8	Automatically included in most new site requests
		Embed a YouTube Video to a Forum Posting
		Search Forums
		Subscribe or Unsubscribe to a Forum
		View All Posts from a Student
		View All Posts from a Student
		Add a Question and Answer (Q and A) Forum Applies to: Moodle 2.4, 2.6, 2.8. Description Q and A Forums are used to present a question and answer format that requires students to post their answers before viewing other student postings. Once a student sends a post, they must wait 30 minutes (the allotted time to edit their own post) before...
		View All Posts from a Student
		Add a Question and Answer (Q and A) Forum Applies to: Moodle 2.4, 2.6, 2.8. Description Q and A Forums are used to present a question and answer format that requires students to post their answers before viewing other student postings. Once a student sends a post, they must wait 30 minutes (the allotted time to edit their own post) before...
		Add a Scale Item in the Gradebook
Create an Assignment		
Download Student Assignment Submissions		
<b>Assignments</b>	Moodle 2.6, 2.8	Enter Grades and Feedback via the Activity Interface
		Grade Assignments with the Detailed View
		Grant an Extension to an Assignment
		Students can submit, enter and edit their text, or upload and/or remove files while a Moodle assignment is open. If there is a Date Due and late submissions are Not allowed, any submitting or editing will be prohibited at that time.
		The feedback or attached file can be retrieved (deleted) from that student feedback area and enter text and/or...
		The Question Bank is organized to include a "default" category for the course and for each quiz
		Allow a Student to Take a Quiz After the Due Date. You can extend the time for the quiz, change the password for it, and provide the password to the student. Allow another attempt through User Override Open the quiz.
		Create a Printable View of a Moodle Quiz

<b>Quizzes</b>	Moodle 2.6, 2.8	If there is more than one essay question in a quiz you will see a menu or table to select a question for evaluation
		Import/Export Questions from a Quiz
		View Quiz Reports (Quiz Results)
		Add Images to a Question
		Add a Chapter or Sub-chapter to a Book
		Dialogues allow students or teachers to start two-way dialogues with another person. They are course activities that can be useful when the teacher wants a place to give private feedback to a student on their online activity
		Add a SCORM Activity
<b>Other Moodle Activities</b>	Moodle 2.6, 2.8	Add a Simple Certificate
		Add an Attendance Activity
		Users enrolled in Moodle course sites can be assigned different roles in various contexts. For example, you can assign User A the role of a Student in the context of your course, and the role of an Instructor in the context of the individual forum. User A will have student access...
		Embed a Qualtrics Poll in an HTML Editor
		Generate Attendance Reports
		The Lesson FlowViewer allows course instructors, designers, and TAs to view their Moodle Lessons in flow chart style. This view gives a clear visual indication of paths through the lesson, and the selections that will follow those paths
		Access old courses from the Moodle Kiosk The Moodle Kiosk is a block on the Moodle My home page which displays courses that are stored in the Moodle archives. This block appears directly below the Course Overview block
		Sites for academic courses hosted in Moodle 1.9 to 2.2 are located on a virtual archive server and are not available to students. To give students access to these archived courses, the instructor must request that they be copied with student data to the active version of Moodle
<b>Archives</b>	Moodle 2.6, 2.8	Assign a Grouping to a Resource
		Create Groups by Uploading a File
<b>Groups &amp; Groupings, Communication</b>	Moodle 2.6, 2.8	Send an Email to a Group
		Allow Students to Send Emails with Quickmail
		Acceptable Source Video Formats., such as YouTube
		Add a Link to a Website/Provide a URL
		Add an Event
<b>Content</b>	Moodle 2.6, 2.8	Add Files to a Folder Resource in Bulk (Zipped Archive)
		Backup or Restore Content
		Edit and Delete a Label
		Edit and Delete a Page Resource and URL Resource
		Copy and Paste from Word
		Add a Link to a Text Box or Description
		Add a Folder to Course Files
		Add a Video Resource using your Webcam
		Embed a YouTube, Vimeo, or Mediamill Video
		Link to a Netfiles Folder or Google Drive File from Moodle
		Obtain YouTube Video Code for Embedding
		Share a File in Google Drive

The new Moodle features can improve cooperative learning in groups with new possibilities in several ways: through improving the exiting capabilities of the virtual learning environment or by adding new capabilities. At the end of the training we made a short survey with the course participants, that aims to determine what is the general attitude of the student to this form of learning and the collecting tasks. Based on this survey, we can draw the following conclusions regarding cooperative learning:

- The students achieve better results that if working alone, competitively or individualistically.
- They are more motivated, as they represent not only themselves, but the group.
- This mode of learning stimulates the thinking process and discussion aimed at achieving the end goal. During the collective tasks execution, the students communicate, discuss encountered problems and make discussions together how to continue.
- Peer reviewing process helps improve the overall quality of developed materials.

#### 4. CONCLUSIONS

In essence, a development of organisational maturity is needed for institutions to benefit from their investment in e-learning. Organizational maturity captures the extent to which activities supporting the core business are explicit, understood, monitored and improved in a systemic way by the organization. Organizational maturity in the context of e-learning projects requires a combination of capabilities. As well as a clear understanding of the pedagogical aspects, project teams must be able to design and develop resources and tools, provide a reliable and robust infrastructure to deploy those resources and tools, support staff and students using them, and finally place their efforts within a strategically driven environment of continuous improvement. While individual staff may be enthusiastic and skilled, the ability of an institution to support and develop this wider set of capabilities is key to the ongoing sustainability of their work. [3]

The application of cooperative learning has a positive effect on both students and tutors. The student are more positive towards the study track, their tutors and the learning as a whole. Acquiring knowledge is more fun, while learning step-by-step, together with other students, without too much strenuous effort. They are also more positive about the other students, whom they work together with, independent of differences in potential for each of them. Personal relationships also improve, which allows them to select an appropriate interaction pattern suited to the situation.

During the next educational periods we will focus on the effective use of new or improved MOODLE activities and resources. We are also planning a larger number of collective task, not only for the final assessment, but also during the semesters. Sufficient time for presenting the work of each group will also be allocated. We plan to do a more detail study of cooperative learning activities in physical tracks, aimed a better motivating students and improving the result in of their education.

#### 5. ACKNOWLEDGMENT

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## DYNAMIC PARAMETERS FOR ASSESSMENT OF THE PHARMACOKINETICS OF ENROFLOXACIN TO DOGS

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**Abstract:** *We investigated the pharmacokinetics of enrofloxacin in dogs in terms of the control theory. The processes after single intravenous (i.v.), subcutaneous (s.c.) injection and oral administration (p.o.) in the form of tablets were studied, at a dose of 5 mg/kg body weight. The experiment was done on 6 healthy dogs in equal numbers of both sexes. The study was conducted in 3 consecutive phases, separated by a 3 weeks of washout period. Blood samples after i.v. injection were obtained immediately prior to the application of the drugs and at 0.08, 0.33, 0.66, 1, 2, 4, 6, 8, 12 and 24 h thereafter. At s.c. and p.o. administration the blood samples are received at the same time, starting from 0.33 h. The concentrations of the fluoroquinolone in a blood plasma were determined with a reverse-phase HPLC with fluorescence detection. It has been deduced a mathematical model for the deviation of the concentration of the enrofloxacin in a blood plasma for each administration route of the drugs. Dynamic parameters are derived with the program Korelia-Ident. The model identification is based on a differential equation of first order. Based on the model, new criteria for assessment of concentration changes are formulated and calculated their statistical parameters.*

**Keywords:** *identification, mathematical model, dynamic parameters, pharmacokinetics, enrofloxacin.*

### 1. INTRODUCTION

The Enrofloxacin is the first antibacterial product from the group of fluoroquinolones, which is synthesized for use in veterinary medicine. It is an antibacterial drug with a broad spectrum of activity, including Gram-negative and some Gram-positive bacteria, which makes it useful for the treatment of many infectious diseases in animals.

Pharmacokinetic studies conducted in several animal species have an indication that it has a good absorption, high bioavailability, a large volume of distribution and low protein binding after injection and internal applying. The concentration change in the blood plasma of dogs after a single intravenous (i.v.) and subcutaneous (s.c.) injection of the substance of enrofloxacin hydrochloride and per oral applying (p.o.) in the form of tablets is very important to study the pharmacokinetics of this drug.

In this study the aim was to track the change in the concentration of enrofloxacin in the blood plasma of dogs, applying the methods of control theory. Thus, one can obtain an overall picture of the pharmacokinetics of enrofloxacin in the different methods of applying of a drug in dogs.

### 2. MATERIALS AND METHODS

#### 2.1. Animals and growing

The data on the concentration of enrofloxacin in the blood plasma of dogs are obtained in experiments conducted with 6 clinically healthy adult dogs of mixed breed, weighing 18-25 kg

(of both sexes in equal numbers). The animals were housed indoors, in individual metal cages with wooden floors with controlled microclimatic parameters, ambient temperature 20-22 °C, mixed light regimen, relative air humidity of 55-60 %. They were fed with dry pelleted feed for dogs. Two days before the trials was tracked the health status of the surveyed dogs.

## 2.2. Medicines

Pharmacokinetic studies included the intravenous (*i.v.*) and subcutaneous (*s.c.*) injection of the substance of enrofloxacin hydrochloridum (Chemos GmbH, Germany), at a dose of 5 mg/kg body weight and per oral (*p.o.*) in the form of tablets, at a dose of 5 mg / kg body weight.

## 2.3. Experimental design

The study was conducted in three sequential phases (*i.v.*; *s.c.* and *p.o.*), divided inbetween by 3 weeks washout period. Blood samples intravenous administration were obtained immediately prior to the injection of fluoroquinolones and 0.08, 0.33, 0.66, 1, 2, 4, 6, 8, 12 and 24 h after *i.v.*, and *s.c.* injection. The *p.o.* application were obtained immediately prior to administration of enrofloxacin and 0.33, 0.66, 1, 2, 4, 6, 8, 12 and 24 h post treatment [1]. Fluoroquinolone concentrations in blood plasma was determined by high effective liquid chromatography (HPLC) method with fluorescence detection.

## 2.4. Mathematical methods

Three groups were formed according to mathematical processing method of treatment with the drug.

The statistical data processing of the plasma concentrations was performed with MS Excel. For each parameter of the research process within the group are defined arithmetic average  $\bar{X}$ , standard deviation, SD, asymmetry coefficient SKEW, coefficient of excess KURTOSIS and dissipation factor of the V formula.

$$V = \frac{SD}{\bar{X}} \cdot 100 [\%] \quad (1)$$

Because of that, it can not ensure the representativeness of the population, these statistical parameters are used to assess the nature of the distribution [2, 3]. The sample number is limited since the medicines and materials are too expensive. The experimental protocol of the study was approved by the Institutional Animal Care and in accordance with the national regulations, and European Directive of 22.09.2010 (210/63/EU) concerning the protection of animals used for scientific and experimental purposes.

When assumed  $p$ -level = 0.05 was calculated with Student-Fisher t-test a statistically significant difference between the corresponding parameters in the three groups. Identification of the mathematical model and calculation of dynamic parameters based on the model is made with program Korelia-Ident [4]. The program has a user-friendly interface, conditioned by the presence of language for model description [5], module for process recognition [6] and dynamic data structures for identified models [7].

The dynamic parameters of the process are calculated according to the algorithms described in [8].

### 3. RESULTS

#### 3.1. Statistical parameters

In Table 1 are given the statistical parameters of the change of the concentration of enrofloxacin in the blood plasma of dogs following a single intravenous (*i.v.*) injection, in Table 2 – after subcutaneous (*s.c.*) injection and in Table 3 – following *p.o.* administration.

Table 1. Concentration of enrofloxacin after single intravenous (*i.v.*) injection of dogs (n = 6)

Time, [h]	Arithmetical mean value [µg/ml]	Standard deviation	Dissipation factor [%]	skewness	kurtosis
0	0	0	-	-	-
0.08	2.05	0.17	8	-0.27	-1.57
0.33	1.63	0.09	6	0.00	-2.01
0.66	1.40	0.03	2	-1.33	1.71
1.00	1.30	0.03	2	0.90	0.89
2.00	1.07	0.11	10	0.36	-2.24
4.00	0.66	0.06	9	0.50	-1.17
6.00	0.44	0.07	15	0.35	-0.84
8.00	0.29	0.08	27	-0.37	1.17
12.00	0.11	0.03	28	0.20	-0.97
24.00	0.09	0.03	33	-0.35	-1.78

Table 2.

Concentration of enrofloxacin after single subcutaneous (*s.c.*) injection of dogs (n = 6)

Time, [h]	Arithmetical mean value [µg/ml]	Standard deviation	Dissipation factor [%]	skewness	kurtosis
0	0	0	-	-	-
0.33	1.11	0.51	46	-2.29	5.37
0.66	1.66	0.20	12	-0.71	-1.39
1.00	1.56	0.18	12	-0.65	-1.30
2.00	1.22	0.21	18	-0.13	1.44
4.00	0.68	0.25	37	1.23	1.70
6.00	0.34	0.22	67	2.07	4.39
8.00	0.21	0.16	75	2.06	4.54
12.00	0.11	0.07	57	1.64	3.31
24.00	0.09	0.06	67	1.59	3.06



Table 3. Concentration of enrofloxacin following *p.o.* administration of the dogs (n = 6)

Time, [h]	Arithmetical mean value [µg/ml]	Standard deviation	Dissipation factor [%]	skewness	kurtosis
0	0	0	-	-	-
0.33	0.35	0.07	20	-0.21	-1.85
0.66	0.66	0.11	17	0.08	-1.46
1.00	0.78	0.15	19	0.34	-0.91
2.00	1.22	0.21	17	-0.76	0.18
4.00	0.85	0.22	25	-0.19	-1.37
6.00	0.53	0.30	57	0.62	-2.05
8.00	0.28	0.20	74	1.46	1.69
12.00	0.15	0.10	67	1.30	1.74
24.00	0.09	0.09	99	1.75	3.14

### 3.2. Mathematical model

In the three ways of treatment of experimental animals, the process of amending enrofloxacin concentration in blood plasma is with very steep forefront of growth, followed by monotonically decreasing. This change of pharmacokinetics is isomorphic with the dynamic parameters of differentiating link. Because an object of study is the concentration, the rear, falling edge of the data will be modeled.

The concentration is described by differential equation of the first order:

$$\begin{cases} \frac{dC(t)}{dt} + r.C(t) = K.U(t) \\ C(0) = C_0 \end{cases} \quad (2)$$

Where  $r$  – the rate constant of the process;  
 $K$  – the proportionality coefficient;  
 $U(t)$  – the substance dose;  
 $C_0$  – the initial value of the concentration

The solution of Eq.(1) is:

$$\begin{cases} C(t) = (C_0 - C_\infty)e^{-r.t} + C_\infty \\ C_\infty = \lim_{t \rightarrow \infty} C(t) = \frac{K.U}{r} \text{ - infinite asymptote of } y(x) \end{cases} \quad (3)$$

For each dog is carried out according to the identification data and the change in the concentration of enrofloxacin and determined individual identification vector [4]:

$$Q_i = [C_0, C_\infty, r].$$

The identification vector is calculated as for the optimization criterion is selected the minimization of the quadratic error. For each model are also calculated the absolute error and the coefficient of determination  $R^2$ . The values of the identification parameters of the three groups are shown in Table 4.

Table 4. Values of identification parameters for the three groups studied

Parameter	Intravenous (i.v.) injection			Subcutaneous (s.c.) injection			P.o. administration		
	$C_0$	$r$	$C_\infty$	$C_0$	$r$	$C_\infty$	$C_0$	$r$	$C_\infty$
Arithmetical mean value	1.89	0.33	0.12	2.08	0.31	0.05	2.04	0.25	0.05
Standard deviation	0.11	0.03	0.05	0.24	0.07	0.04	0.2	0.06	0.07
Dissipation factor [%]	6	8	39	11	24	74	10	24	138
absolute error	0.18892			0.0661			0.06527		
quadratic error	0.09976			0.01231			0.00954		
Coefficient of determination $R^2$	0.97631			0.99591			0.99031		

The graphs of patterns of each of the cases of application of the drug are in Figure 1.

The identified mathematical models are:

- ✓ Intravenous (i.v.) injection

$$C(t) = 1.77e^{-0.33t} + 0.12 \quad (4)$$

- ✓ Subcutaneous (s.c.) injection

$$C(t) = 2.03e^{-0.31t} + 0.05 \quad (5)$$

- ✓ P.o. administration

$$C(t) = 1.99e^{-0.25t} + 0.05 \quad (6)$$

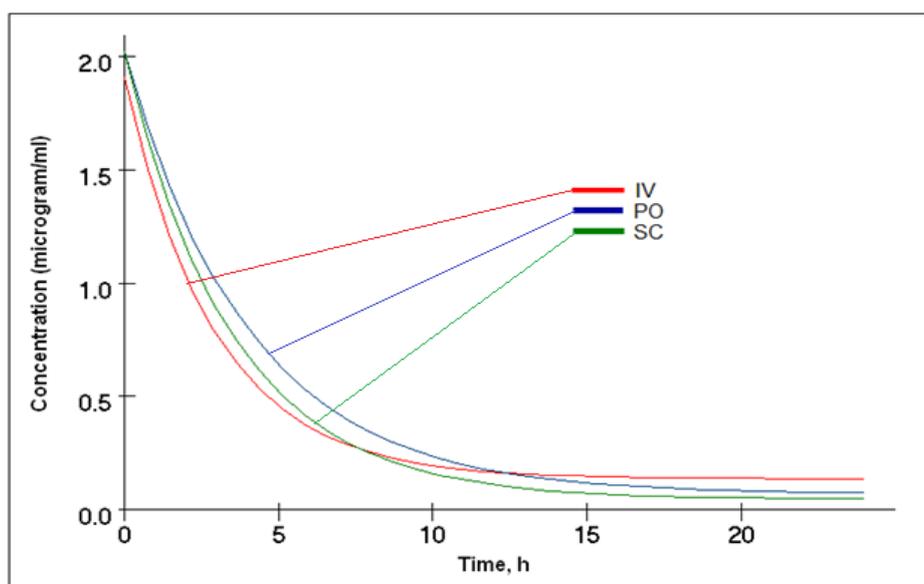


Figure 1. Fluctuation of enrofloxacin

### 3.3. Compare the dynamic parameters of the three groups

For each dog is calculated with Program Korelia-Ident dynamic parameters according to [8] in selected tolerance band  $\delta = 0.05$ . The program calculates 8 parameters of dynamic processes. They will be taken into account only those who demonstrate a statistically significant difference.

#### 3.3.1. Settling time $t_s$

The settling time is the time required for the unit step response to reach and stay within the tolerance band  $\delta$ , i.e. steady state level  $Y_s$  is reached.

#### 3.3.2. Half-time $t_{1/2}$

The time when the process reaches half of steady state level. In the field of pharmacokinetics is used to evaluate the absorption of drugs

$$t_{1/2} = \frac{1}{r} \cdot \ln(2) \quad (7)$$

#### 3.3.3. Process area $S_R$

This is a rectangular envelope of the process:

It is used as a normalized value for the evaluation and comparison of the parameters representing the areas of the simulation process.

$$S_R = |Y_s - C_0| \cdot t_s \quad (8)$$

#### 3.3.4. Quality factor of regulation $S_p$

Integral criterion of the quality of regulation. Connects two important indicators: maximum dynamic deviation and duration of the transition process and determines how the system responds to the input optimal impact. It is estimated by the area of regulation  $S_p$ , which is located between the line  $C = C_0$  and the curve  $y(t)$  of the transition process:

$$S_p = \int_0^{t_s} [Y_s - C(t)] dt \quad (9)$$

#### 3.3.5. Area under plasma concentrations-time curve (AUC)

To measure the signal strength using the area under the curve. Is calculated as the difference between Process area  $S_R$  and Quality factor of regulation  $S_p$ .

$$AUC = S_R - S_p \quad (10)$$

#### 3.3.6. Signal energy $E_\gamma$

The term signal energy is used to characterize the presence of the process. They are not actually measures of energy. The formula for calculating signal energy in the signal  $C(t)$  is:

$$E_Y = \int_0^{t_s} |C(t)|^2 dt \quad (11)$$

### 3.3.7. Process power $P_Y$

Power concept also characterized the presence of process. Power is a time average of energy in a period  $t_s$ :

$$P_Y = \frac{E_Y}{t_s} \quad (12)$$

## 4. DISCUSSIONS

The results are obtained by subcutaneous injection and the internal application data is characterized by a high coefficient of scattering unlike the venous treatment, wherein the coefficient of scattering is smaller. In the three methods of application was noted an increase in the coefficient of dispersion after 6 h. Upon intravenous injection avoids the passage of the drug through the digestive canal as it falls within the general circulation, its bioavailability is 100%. Side factors (interference) influencing change in concentration is low.

During subcutaneous injection there is a greater dispersion of reaction – there is possibility to reach blood vessel. The subcutaneous fat has its role there and, *i.e.* s.c. injection side effects may be more – not all of the drug enters the blood stream.

The biggest factor of distraction was observed in internal application. This involved taking many mechanisms affecting concentration, absolute bioavailability is reached more slowly and is associated with the passage of the drug through the digestive canal.

In the three types of treatment with the medicament, there are slight positive skewness and expressed plateau distribution.

The parameters with statistically significant difference when comparing the different methods of administration of enrofloxacin are shown in Table 5.

Table 5. Parameters of a statistically significant difference when comparing *i.v.* and *p.o.* administration and *i.v.* and s.c. injection

Parameter	I.V. ↔ P.O.	I.V. ↔ S.C.
Rate constant r	0.0192	-
Infinity value C	-	0.0141
Time constant T	0.0408574290	-
Steady state level Ys	-	0.0498
Settling time $t_s$	0.0408568816	-
Half-time $t_{1/2}$	0.0282	-
Process area $(Y_s - c_0) \cdot T_s$	0.0082095024	-
Area under curve (AUC)	0.0082095017	-
Quality of regulation $Sp$	0.0082095041	-

P-values for Process area, Area under curve and Quality of regulation are very close. These are integral characteristics related to the calculation of areas. Therefore, it can be used only one of them in comparing of the processes. Preferably this is the Process area, because most easily calculated.

## 5. CONCLUSIONS

We examined the change in the concentration of enrofloxacin in the blood plasma in dogs in three ways of treatment with the drug - intravenous and subcutaneous injection, and internal administration.

Based on the experiment three mathematical models are created and three processes identified according to the way of applying the drug. The change of the concentration is described by a differential equation of the first order.

The dynamic parameters for the three sets of data from the point of view of the control theory are calculated and compared.

In the study was established statistically significant difference in seven of the parameters in the treatment of dogs intravenously and internal.

The dynamic parameters for the three sets of data in terms of control theory are calculated and compared.

This indicates that the two methods of applying of the medicament are statistically different.

Such a difference of two of the parameters has been established also for intravenous and subcutaneous applying of enrofloxacin.

During subcutaneous and internal applying of the drug has not been established reliable statistical difference (because such was not found in any of the parameters) therefore they are statistically identical.

## 6. ACKNOWLEDGMENTS

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## MATHEMATICAL MODEL OF PHYSICAL DEVELOPMENT OF SUCKLING CHILDS

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**Abstract:** *In this paper the development of children under 12 months of age in terms of control theory is evaluated. The samples are divided into two groups by sex. A mathematical model of the weight changes for each group are made using software Korelia-Ident. The model identification is based on the differential equation of the first order. Dynamics characteristics of children growth are estimated with the same program. Using the formulated mathematical model a new parameters for appresiation of childrens are calculated.*

**Keywords:** *identification, mathematical model, ordinary differential equation, dynamic parameters.*

"However, I assume that every natural concept contains as much real science as it contains mathematics."

Immanuel Kant

### 1. INTRODUCTION

The change in weight and height in the first year after birth (breastfeeding period) are extremely important to the overall process of growth and development subsequently. Children are born with different anatomical and physiological parameters. Each one is unique and has its own rhythm of growth. Pediatricians and parents have tables that can be used to compare the development of children.

The disadvantage here is that the tables give anthropological traits with their absolute values. The growth of children is a dynamic process, and in terms of cybernetics a process has a number of parameters. In literary analysis no study to address this problem was found.

In this work we aim to follow the development of the weight of children from birth to 12 months of age applying methods of control theory. So a full picture of adolescent development as a process described by parameters object of cybernetics can be achieved.

### 2. MATERIALS AND METHODS

Data for the weight of 13 girls and 13 boys for every month from the moment of birth until the age of 12 months has been provided by the parents. The data is formed in two groups by gender. For each group, it is assumed that there is a normal distribution of the data for individual months.

The statistical data processing was carried out with MS Excel. For each month within the group defined average value  $\bar{X}$ , standard deviation SD, asymmetry coefficient SKEW, coefficient of excess KURTOSIS and dissipation factor V:

$$V = \frac{SD}{\bar{X}} \cdot 100[\%] \quad (1)$$

Because the representativeness of the sample can't be ensured, these statistical measures were used to assess the type of scattering [3,4], and to compare the results with literature data.

With p-level = 0.05 and using the Student-Fisher t-test was found a statistically significant difference between the corresponding parameters in both groups. Of interest is the data with p-level <0.05.

Identification of the mathematical model and the calculation of its dynamic parameters is made with the program Korelia-Ident [9]. The program has user-friendly interface, driven by the presence of language to describe patterns [6], module for recognizing the researched process using teaching set [7] and the used dynamic data structures for identified models [8]. The dynamic parameters of the process according to the algorithms described in [10] are calculated.

### 3. RESULTS

#### 3.1. Statistical parameters

In Table 1 are given the statistical parameters of the process of increase in weight by months of male children, and in Table 2 - female. This table also shows the p-level of the two groups.

Table 1. Statistical parameters of weight in boys

Months	Average weight [kg]	SD	Dissipation factor V [%]	Skew	Kurtosis
0	3,365	0,425	12,637	0,086	-0,506
1	4,281	0,538	12,557	-0,740	-0,923
2	5,471	0,595	10,880	-0,355	-0,728
3	6,436	0,633	9,829	-0,237	-0,485
4	7,075	0,690	9,749	-0,038	0,942
5	7,775	0,815	10,503	0,106	1,541
6	8,167	0,789	9,660	0,272	1,548
7	8,583	0,909	10,593	0,518	1,065
8	8,998	0,859	9,543	0,299	0,551
9	9,452	0,992	10,498	0,726	1,048
10	9,888	1,109	11,219	0,176	-0,249
11	10,313	1,177	11,410	-0,212	-0,960
12	10,753	1,138	10,585	-0,140	-0,669

Table 2. Statistical parameters of weight in girls

Months	Average weight [kg]	SD	Dissipation factor V [%]	Skew	Kurtosis	p-level
0	3,028	0,392	12,954	0,108	0,239	0,0334
1	4,033	0,613	15,213	0,750	-0,704	0,2113
2	4,980	0,694	13,942	0,413	-0,917	0,0414
3	5,637	0,728	12,914	0,175	-0,903	0,0035
4	6,402	0,711	11,121	0,442	-0,905	0,0179
5	6,887	0,637	9,261	0,599	-0,802	0,0047
6	7,324	0,652	8,912	0,322	-0,625	0,0057
7	7,681	0,716	9,325	0,933	0,413	0,0079
8	8,203	0,798	9,728	1,135	0,815	0,0189
9	8,656	0,900	10,406	1,482	2,456	0,0408
10	8,960	0,982	10,966	1,274	1,721	0,0258
11	9,250	1,087	11,751	1,427	2,410	0,0189
12	9,692	1,090	11,253	1,154	2,081	0,0164

In both groups, the coefficient of variation does not exceed 14%, skew and kurtosis are about zero. Therefore it can be assumed that each group is homogeneous and has a normal distribution. Graphic study shows the same dependency.

Figure 1 shows a graph of change of weight of boys according to our measurements, and data derived from the [1] and [5]. Figure 2 shows the analogous curves for girls.

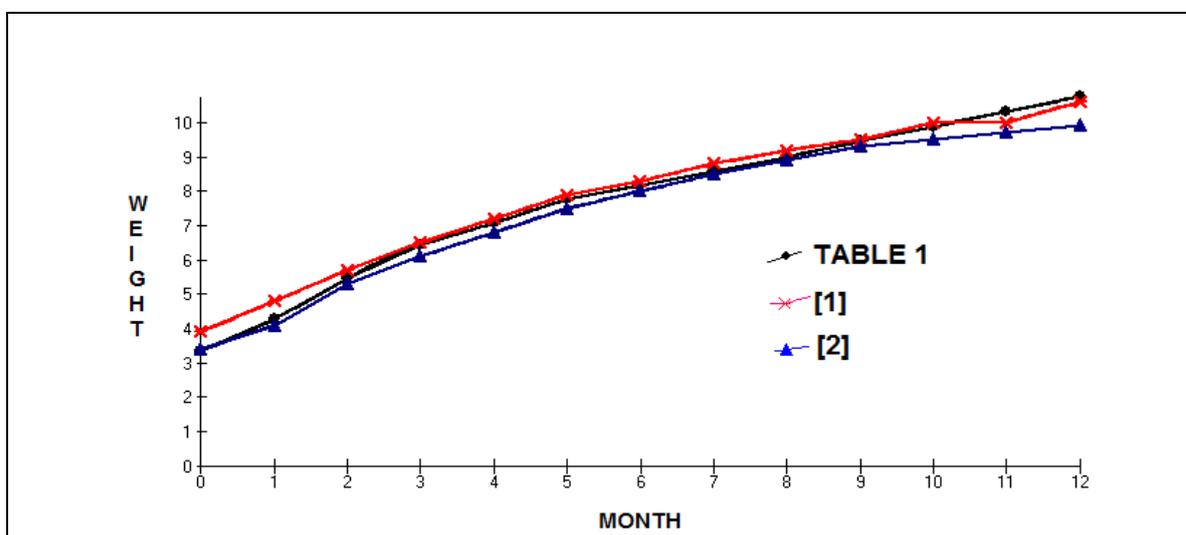


Figure 1. Comparative chart weight in boys, according to Table 1

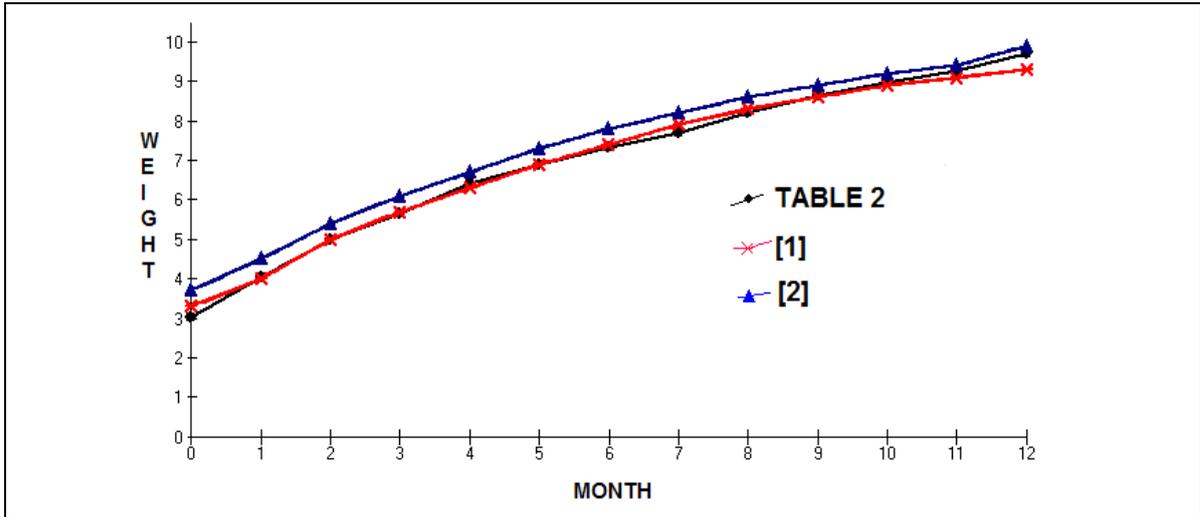


Figure 2. Comparative schedule of weight in girls according to Table 2

### 3.2. Mathematical model

The graphs in Fig. 1 and Fig. 2 show a clear growing monotonous process. It can be described with a differential equation of the first order:

$$\begin{cases} \frac{dy(t)}{dt} + r \cdot y(t) = K \cdot U(t) \\ y(0) = C_0 \end{cases} \quad (2)$$

Where:  $y(t)$  - the weight at a time  $t$ .  
 $r$  - the rate constant of the process;  
 $K$  - the proportionality coefficient;  
 $U(t)$  - the input step force;  
 $C_0$  - birth weight

The solution of Eq.(1) is:

$$y(t) = (C_0 - C_\infty) \cdot e^{-r \cdot t} + C_\infty \quad (3)$$

Where:  $C_\infty = \lim_{t \rightarrow \infty} y(t) = \frac{K \cdot U}{r}$  - infinite asymptote of  $y(x)$

Identification according to growth data is done for each child. The identification vector [9] is also defined.

$$Q_i = [C_0, C_\infty, r].$$

The identification vector is calculated as for the optimization criterion is selected minimizing the quadratic error. For each model the absolute error and the coefficient of determination  $R^2$  are also calculated.

Statistical values of identification parameters and error for both groups are shown in Table 3.

Table 3. Value of identification parameters for both treatment groups

	parameter	Average weight [kg]	SD	Dissipation factor V [%]	Absolute error	Quadratic error	$R^2$
<b>boys</b>	$C_0$ [kg]	2,911	0,271	9,3	0,2115	0,2286	0,9964
	$r$ [month <sup>-1</sup> ]	0,117	0,020	17,1			
	$C_\infty$ [kg]	13,346	0,855	6,4			
<b>girls</b>	$C_0$ [kg]	2,727	0,507	18,6	0,1798	0,1045	0,9980
	$r$ [month <sup>-1</sup> ]	0,172	0,010	5,7			
	$C_\infty$ [kg]	10,297	1,038	10,1			

The initial value  $C_0$  ( $p = 0.0449$ ) and  $C_\infty$  ( $p = 0.0094$ ) showed a statistically significant difference. The mathematical model for boys:

$$y(t) = -8.833 * e^{-0.169*t} + 11.977 \quad (4)$$

The mathematical model for girls:

$$y(t) = -7.57 * e^{-0.172*t} + 10.297 \quad (5)$$

The graphs of the models are shown on figure 3.

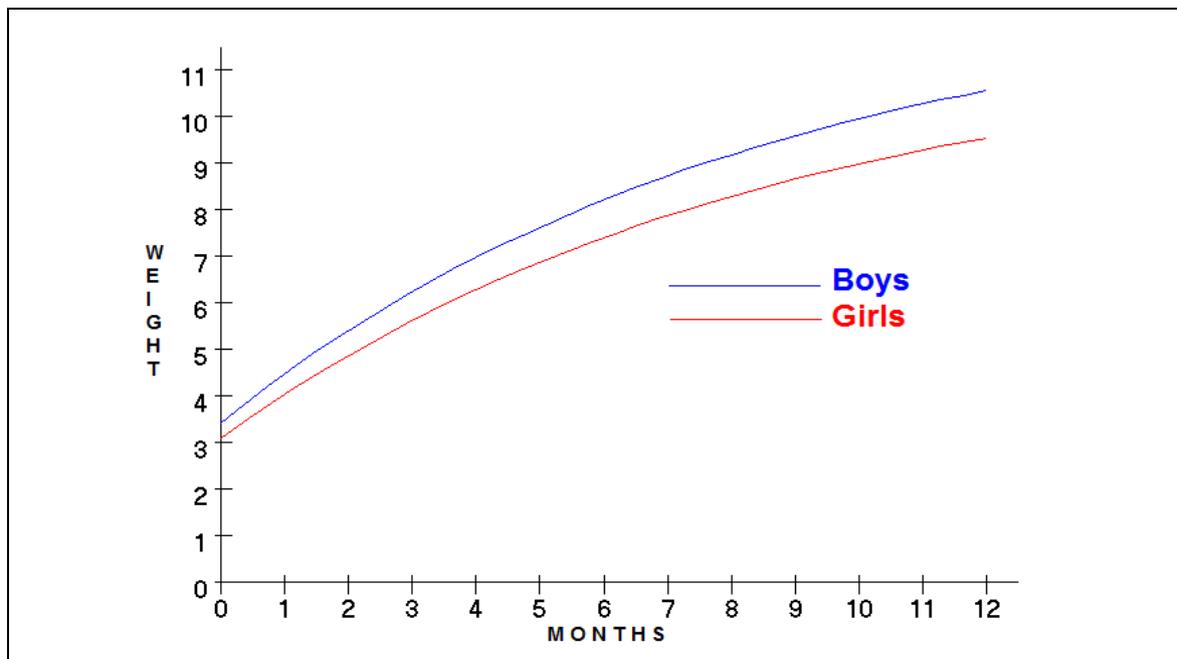


Figure 3. Mathematical model of boys and girls

#### 4. DYNAMIC PROCESS PARAMETERS

The dynamic parameters according to [10] for each child were calculated using the software Korelia-Ident. The tolerance band was chosen to be  $\delta=0.05$ . Korelia-Ident estimates 8 parameters of the dynamic processes. Into account will be taken only those that demonstrate a statistically significant difference when comparing the two groups.

##### 4.1. Initial value $C_0$

$C_0$  is the weight with which the child is born.

##### 4.2. Infinity value $C_\infty$

Asymptotic value which tends to the child's weight at the end of the twelfth month. This value is derived from the formulated mathematical model. Due to the fact that  $C_\infty$  is the asymptote of the process, it is difficult to use it for practical purposes.

##### 4.3. Steady state level $Y_s$

This is a value which in practice is used instead  $C_\infty$ . Its value depends on the amplitude of the process and the selected tolerance band  $\delta$ :

$$Y_s(\delta) = C_\infty + \delta * (C_0 - C_\infty) \quad (6)$$

##### 4.4. Settling time $t_s$

It is time that the process reaches  $Y_s$ . This time also depends on the tolerance band  $\delta$ :

$$t_s(\delta) = \frac{1}{r} \ln\left(\frac{1}{\delta}\right) \quad (7)$$

This value shows no statistical difference, but is important because of its participation in the formation of other parameters of the researched processes.

##### 4.5. Process area $S_R$

Steady state level and Settling time form a rectangle that wraps the process.

$$S_R = |Y_s - C_0| * t_s \quad (8)$$

##### 4.6. Quality factor of regulation $Sp$

It shows how much the system response is optimal. It's measured using the area determined by the actual curve of the transition process and the shell of the process:

$$S_P = \int_0^{t_s} [|Y_S - C_0| - y(t)] dt \quad (9)$$

#### 4.7. Area under curve (AUC)

This parameter is associated in the literature with the area under the curve of the researched process:

$$AUC = \int_0^{t_s} y(t) dt \quad (10)$$

This formulation is valid only for increasing processes. In [10] general definition is given, which is a consequence of the Process area and Quality factor of regulation:

$$AUC = S_R - S_P \quad (11)$$

AUC has a wide popularity in medical and biological sciences for evaluation of drug absorption, drug bio-availability and drug concentrations over time, integral muscle force and so on.

The next two parameters are abstract in nature, but are often used to evaluate and compare the signals [2].

#### 4.8. Energy E

Signal Energy defined as:

$$E_Y = \int_0^{t_s} |y(t)|^2 dt \quad (12)$$

#### 4.9. Power P

Power P is the average power for the period of child development:

$$P_Y = \frac{E_Y}{t_s} \quad (13)$$

The calculated values of dynamic parameters for both groups and their p-level values are in Table 4.

Table 4. Dynamic parameters showed statistically significant differences

	boys			girls			p-level
	Average value [kg]	SD	V [%]	Average value [kg]	SD	V [%]	
Settling time $t_s$ [month]	26,22	4,206	16	17,44	0,920	5	0,33
Initial value $C_0$ [kg]	2,91	0,271	9	2,73	0,507	19	0,044
Infinity value $C_\infty$ [kg]	13,35	0,855	6	10,30	1,038	10	0,0094
Steady state level $Y_s$ [kg]	12,83	0,810	6	9,92	0,993	10	0,0087
Process area [kg*month]	262,19	65,229	25	125,99	21,372	17	0,04769423
AUC [kg*month]	179,05	44,543	25	86,04	14,594	17	0,04769422
Quality of regulation $S_p$ [kg*month]	83,15	20,685	25	39,96	6,778	17	0,04769427
Energy E	4836,15	1414,176	29	1910,42	457,687	24	0,0103
Power P	182,30	24,164	13	109,01	23,165	21	0,0105

## 5. DISCUSSIONS

The study confirmed the known fact that there is a statistically significant difference between the weight of boys and girls

The formulated and identified mathematical models of both processes show statistically significant difference in two of the parameters -  $C_0$  and  $C_\infty$ . This is evidence that both models should be considered separately.

There was no difference in the rate constant for the two processes.

The dynamic parameters of the two processes are calculated and a statistically significant difference for many of them is found.

Near the accepted limit of 0.05 is the initial value  $C_0$  ( $p = 0.044$ ).

The difference in parameters characterizing the weight at the end of the test period is significant: Infinity value ( $p = 0.0094$ ) and Steady state level ( $p = 0.0088$ ). That indicates that the final weight is an important parameter for assessing the development of children.

This work examined three parameters that are related to the assessment of areas: Process area, Area under curve and Quality of regulation. Typical for them is that they have the same values for the level of significance and for inter-group comparison could be used only one of them.

## 6. CONCLUSIONS

In this work was studied the weight development of children during infancy. The statistical parameters of the first order (average value) and second order (standard deviation) were calculated and the parameters of the third (skewness) and fourth (kurtosis) order. This gives fullness and completeness of the statistical analysis of the sample.

A mathematical model of change in children's weight, for both sexes, is found. The model identification is based on the differential equation of the first order. The credibility of the model is high. The coefficient of determination is not less than 0.98.

For all calculations, the data of interest in the article, is calculated p-level between the groups. This helped to identify parameters, highly dependent on the sex of the children. Exactly these parameters can be used as a criterion for the development of both sexes in infancy.

Special attention may be paid to Infinity value and the closest in meaning Steady state level, which show smaller inter-sexual significance respectively 0.0094 and 0.0088.

The three parameters related to evaluation of areas are equivalent as a statistically significant difference. Therefore the recommendation is to use the most easily calculable (Process area) as a parameter to compare .

Using the model are formulated new criteria for assessing the growth of adolescents and calculated their statistical parameters.

## 7. ACKNOWLEDGMENTS

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## SECURITY CAMERAS AND REAL TIME SURVEILLANCE

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**Abstract:** *This report serves as an extension to the report Smart home, and puts the emphasis on the security of the home. The report compares and highlights the higher possibilities of the IP cameras, which provide a much better quality at acceptable prices, in comparison to the analog cameras. One of the main advantages of the IP cameras is the ability to ensure surveillance using the global network and mobile devices and thus allow us to monitor object from great distance. In combination with the ability to be positioned and the various sensors for smoke, movement, etc., this type of cameras makes the home not only smart but also safe.*

**Keywords:** *IP camera, Smart home, advantages and disadvantages of the IP cameras.*

### 1. INTRODUCTION

The contemporary technologies are constantly improving and one of the guidelines is the creation and implementation of systems for real-time monitoring and connecting these systems with most of the mobile devices. An essential part of the Smart Home ("smart house") is the safety and the security of the home. Wherever we are, equipped with "smart devices" we have control over it and can watch for possible thefts through our smartphone or tablet. This effectively supports the maxim "My home is my castle".

### 2. DIGITAL IP CAMERAS

The Internet Protocol (IP) camera is a digital security camera and it is meant to be used for video surveillance. When compared to the analog Closed-circuit television (CCTV) cameras the most significant difference is that the IP cameras are capable of sending and receive data via a computer network or the Internet. Network cameras directly visualise the signal that is transmitted through different environments (LAN / WAN / Wimax) to a central recording device (NVR - Network Video Recorder) and thus prevent the repeatedly conversion of the signal from analog to digital and vice versa. Several important parameters determine whether a camera is suitable for a particular application.

Table 1 presents the basic parameters of an IP video cameras. [10] H.264 is one of the most appropriate compression formats for network cameras, because it generates less traffic and allows the transmission of video over external networks separated by a greater distance. It is not always necessary the video from the cameras to be recorded at frames per second, since the human eye detects a delay in the frames at 12 fps [12]. Recording at lower transmission rate allows to store larger amount of information and therefore 6 fps are sufficient for the needs of the video surveillance of objects which less dynamic.

The network cameras for video surveillance provide a higher resolution than analog as they are fully digital and do not need to convert the image (avoid reducing the resolution when recording). Furthermore, IP cameras allow a higher data transfer, through signal transmission

via FTP network cable. For these reasons, wireless IP camera with VGA (0,3 megapixel) resolution have a very good and clear picture.

Table 1. Parameters of the IP cameras

Parameter	Description
Resolution of the IP Camera	CIF (352x288), VGA (640x480), D1(720x576) and megapixel cameras with higher resolution: 1; 1.3; 2; 3; 5 up to 20MP
Compression	The most frequently used compressions: H.264, M-JPEG and MPEG4
Baud rate (frames per second)	15/25/30 fps depends on the resolution of the record
White balance	It achieves greater color accuracy/ credibility
Night vision	The selection of an IR backlit depends on the number of LEDs and their operating range

1Mp is the lowest resolution for a megapixel camera, but compared to the capabilities of analog camera, it's a much higher class. Network cameras with 5 or more megapixels resolution can be selected depending on the purpose of the camera. The market for the single pixel IP cameras with high-definition (HD) video resolutions 720p or 1080p is increasing. On Figure 1 is shown comparison between the quality of the analog and the digital cameras.



Figure.1. Pictures taken from analog and digital IP-camera [14]

The rest of the parameters that can be improved and are usually offered as an option by the manufacturer are: auto-focus; backlight compensation; sound; motion detection - triggers alarm if it detects motion; 360° viewing angle and automatic object tracking (for IP PTZ cameras).

The viewing angle, the scaling of the picture and the size of the area that is being under surveillance are determined by the size of the lens. Manufacturers offer cameras with fixed lens (3.6, 6, 8, 12mm) and variable lens 4 ÷ 9mm, 2.8 ÷ 12mm. The smaller the size of the lens, the wider is the field of scope and vice versa. Most cameras on the marketplace have 3.6mm fixed lens, which is designed to provide approximately 72° viewing angle. The difference between 3.6 and 6mm lens is shown on Figure 2.



a) 3.6 mm lens



b) 6 mm lens

Figure 2. The differences between pictures taken with camera with 3.6 and 6mm lens [13]

In the reviewed literature are discussed the advantages and disadvantages of IP cameras. According to some of the authors the advantages are enough and they undoubtedly prefer the IP cameras when they need to establish modern video surveillance and control systems. Whereas some of the authors point out only the disadvantages. After examining various sources and taking into consideration different points of views about the IP cameras, the information was combined and summarised in Table 2.

Table 2. Advantages and disadvantages of the IP camera

Advantages	Disadvantages
<p><b>Remote access</b> Video cameras provide surveillance in real time using any computer or mobile device anywhere in the world, including iPhones, laptops, and Windows Live Messenger.</p>	<p><b>Different standards</b> The different IP cameras can use a different interface, which affects the compatibility of the cameras with the network recorders.</p>
<p><b>Advanced installation system</b> It is easy and simple to add/remove cameras to already installed surveillance system.</p>	
<p><b>Digital transmission/storing information</b> Provides highest picture quality.</p>	<p><b>Higher selling price.</b></p>
<p><b>High resolution of the image.</b></p>	
<p><b>Flexibility</b> The IP camera can be moved anywhere in the IP network (including the wireless network).</p>	<p><b>Higher requirements for network traffic</b> The simple IP camera with a resolution of 640x480 pixels and 10 frame / s in MJPEG mode requires about 3 Mbit / s.</p>
<p><b>High levels of security in data transfer</b> Encryption and authentication methods such as WEP, WPA, WPA2, TKIP, AES.</p>	
<p><b>The IP cameras are able to work only with wireless network (Wi-Fi)</b></p>	<p><b>Vulnerability of the system</b> Breaches or hacker network attacks.</p>
<p><b>The initial configuration must be made through a router, then the camera can be used with wireless network.</b></p>	
<p><b>PoE (Power over ethernet)</b> Power supply via Ethernet. A higher end IP cameras can work without additional power supply.</p>	<p><b>Difficult software installation</b> The network surveillance cameras need router tuning, IP address, network settings, DDNS.</p>
<p><b>Transmission of commands of the PTZ (pan-tilt-zoom) cameras via only one network cable</b></p>	

### 3. IP CAMERAS IN THE “SMART HOME” SECURITY SYSTEMS

In the "Smart Home" system could be added technical tools which provide security, fire safety, lighting and comfort of the residents. The security of the house includes the need to protect peoples` life, property, and belongings. Examples of providing security are: identification of the vehicles which stop and leave in the area of the protected property, controlling the access to the house, detection and prevention of robberies and theft.

One of the main equipments in the security system is the video camera, as well as systems for detecting presence, alarms, access control systems, protection of personal information and communication.

The aforementioned advantages of the IP cameras make them a convenient means for providing the security in the "Smart Home". Due to the network interface they can be directly connected to the main computer network in the house and be accessible via the Internet for PCs or mobile devices, regardless of the location of the user. Another use of the reviewed cameras is in the industrial production for tracking the technological processes and quality control [7] as well as in distance learning which alleviates the work of the teacher when presenting the educational content [1].

In the available literature the authors infer that the independent use of technical tools for security (alarms, video cameras, presence sensors, sensors for fire) is impractical. To ensure both the security and the comfort of the people, those tools must be linked in a complex automated systems using appropriate hardware and software and can be accessed both locally and via the Internet or the GSM network [11]. Recent studies aim at recognising the emotions of the people and regulating the lighting according to the mood and even starting an appropriate music [8]. In the smart home through video cameras can be controlled various household appliances by gesture recognition [3]. Another aspect of the application of the cameras is the recognition whether the person in the room has health problems. The IP cameras can also detect the position of the body or the head of the person in order to determine whether he had fainted. [4]

### 4. HOME SECURITY AND MOBILE DEVICES

Park and Kim [5] state that the existing systems for transmission of information to a mobile device do not allow the host computer to extract video information, unless it is not transmitted from the IP camera. The authors created a host-active application program, which extracts the video information from the host through the IP address of the camera.

Reddy and Ravi [6] present security system in "Smart Homes" based on ARM technology and Linux operating system for transmitting of video information to a mobile device using 3G network. Apart from the camera, the system receives information from the presence detectors, sound detector, and has a connection to the GSM network.

Bhatt [2] states that the individual security systems are outdated and at this stage they are transformed into intelligent computerised network-based systems for building automation. The author presents his project to create a functioning model of fully automated complex security system - a wired connected sensor devices and video cameras in a common network which can be accessed locally via Internet and GSM network. The author makes a detailed theoretical explanation for the used software and hardware tools. He also cites the disadvantages of the system - the need to create opportunities for personalisation which makes it suitable for creating a "Smart home" system into every home and the possible integration of the system in addition to the already existing one.

5. DISCUSION

The IP camera technology is relatively new - the first publications are made during 1997. Over time, the interest in that kind of technologies is growing. They find application in different fields of both science and in everyday life. The improvements in image processing, encryption and network technology outweigh the costs and imperfections. The benefits of the IP CCTV cameras are highlighted in many publications.

In order to study the interest in the application and the development of the IP camera technology and "Smart Home" it is made a research using two search engines Science Direct and Google Scholar. Figure 3 shows the number of publications which include the keywords "IP camera" by years.

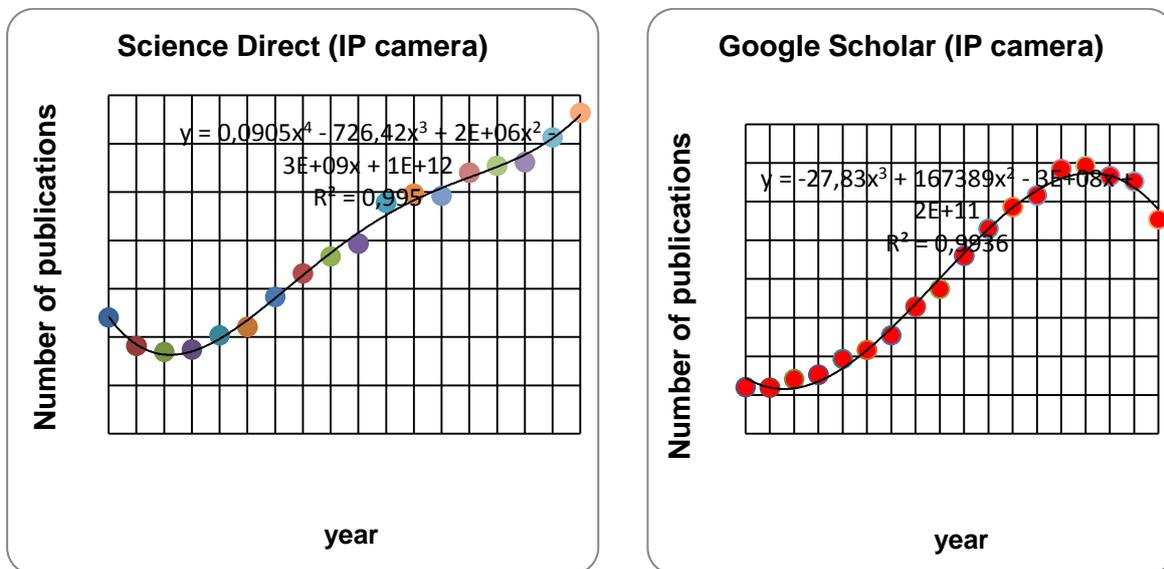


Figure 3.  
 Results from the searches with the keywords "IP camera"

The study from the both search engines shows that the interest on the topic is growing, especially in recent years, while the second has some fluctuations after 2011. The trend is probably due to the fact that IP cameras grow not only as technology, but also as entering into the science, education, industry and people's lives. We can seek the explanation for the trend in the listed advantages of the cameras, especially the ability to record high resolution videos on NVR devices and the possibility to connect with mobile devices and to control and monitor in real-time.

In order to explore the interest and the application of the IP cameras in the "Smart Home" system in these two search engines are assigned both concepts in combination. There is a increasing interest, particularly in the period after 2010. Figure 4 shows the number of publications by years including the keywords "IP camera and Smart Home".

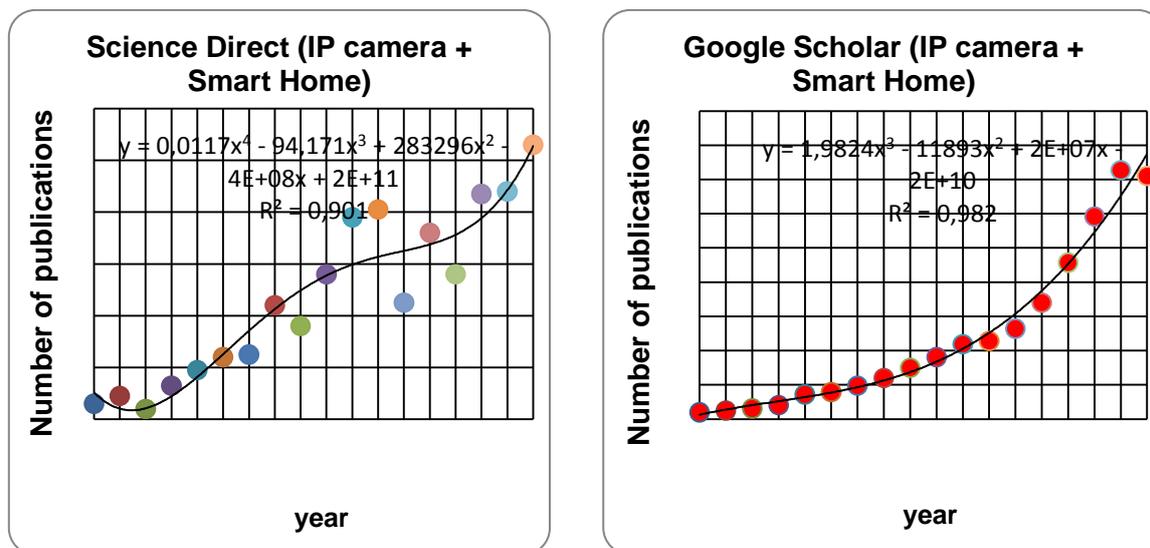


Figure 4.

Results from the searches including the keywords "IP camera and Smart Home"

## 6. CONCLUSIONS

The review of the concepts and the research over the advantages and imperfections of the IP cameras indicate that there is a search for even more advanced and innovative solutions for their development and application in the "Smart Home" security system. The camera completes the system of "smart" devices and makes people's lives not only easier, but also more safe and secure.

At following phase several researches are foreseen which aim at domestic electric appliances recognition as well as devices for image recognition and their application in systems such as "Smart home" by using a remote control.

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## ANALYSIS OF MEASURES TO IMPROVE ENERGY EFFICIENCY OF FACULTY "TECHNICS AND TECHNOLOGIES" OF YAMBOL, TRAKIA UNIVERSITY OF STARA ZAGORA

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**Abstract:** The report presents an analysis of the investigation into the proposed energy efficiency measurements in the Faculty "Engineering and Technology" – Yambol. Proposal is made to replace the existing boiler and the expected results of the implementation of energy saving measures package.

**Keywords:** energy auditing, heated area, heated space, heat transfer coefficient, energy conservation measures, energy consumption.

### 1. INTRODUCTION

In August 2014 in order to meet the requirement of Article 19 paragraph 2 of the Energy Efficiency Law [1] and in connection with applying for external funding of energy efficient reconstruction of the building of the Faculty of "Technics and technologies", the town of Yambol is performed audits energy Efficiency from "Energiconsult" Ltd. - Stara Zagora (scheme 1) [2].



Scheme 1.  
Exterior of Faculty of "Technics and technologies", town of Yambol – northwest, northeast

In designing an energy transmission process is performed calibration and normalization of the model. Calibration of the model is calculated annual reference energy consumption for heating 48,4 kWh/m<sup>2</sup>. In normalization model is fixed annual base energy consumption for heating 97,9 kWh/m<sup>2</sup>, to maintain the legally required temperature at the existing condition of the building. The reference annual energy consumption for heating in 2014 - 29,2 kWh/m<sup>2</sup> is calculated for the specific building, the values of the standard features of the building envelope are adopted according to the technical requirements in force at the time of the energy audit standards 2009 comparison shows that the normalized energy consumption for heating is 3,4 times larger than the reference building [2].

To determine the class of energy consumption according to article 18 paragraph 3 of the Ordinance № RD-16-1058 / 10.12.2009 indicators for energy consumption and energy performance of buildings are set [3]:

- ✓ specific annual consumption of energy needed, which should be delivered in the building – EP=110,6 kWh/m<sup>2</sup>;
- ✓ total specific energy consumption for heating, hot water, lighting and appliances according to the currently valid norms – EP<sub>max,r</sub>=42 kWh/m<sup>2</sup>;
- ✓ total specific energy consumption for heating, hot water, lighting and appliances standards at entry into service – EP<sub>max,s</sub>=78,7 kWh/m<sup>2</sup>.

At the time of the model study of the building is determined class of energy consumption "F", in fulfillment of the condition  $1,25 EP_{max,s} < EP < 1,5 EP_{max,s}$  [2].

In the model study of the building are simulated energy-saving measures aimed to increase energy class:

- thermal insulation of external walls;
- thermal insulation of floors over unheated basement;
- thermal insulation of roofs;
- replacement of wooden and steel windows;
- repair of heating system;
- construction of solar hot water installations;
- energy saving lighting.

The aim of the publication is an analysis of the proposed measures for energy efficiency of the building of the Faculty of "Technics and technologies", town of Yambol at Trakia University - Stara Zagora and examination the possibility of using renewable energy sources for heating.

## 2. MATERIAL AND METHODS

Methodologies for evaluating the energy savings are developed on the basis of Article 22, paragraph 3 pt. 4 of the Ordinance under Article 9, paragraph 2 of the Law on energy efficiency [1].

Saved energy determined by measuring and / or calculating the energy consumption before and after, accordingly with preconceived baseline levels in implementing the measure or program to improve energy efficiency in providing normalized adjustments corresponding to the influence of specific climatic conditions on energy use. The amount of energy saved is equal to the difference between the energy used before the introduction of the measure or program to improve energy efficiency and use of energy, measured then input [6].

Energy savings from replacing a boiler  $FES_k$  for a year is calculated by the formula 1 [5]:

$$FES_k = \left( \frac{1}{\eta_c} - \frac{1}{\eta_n} \right) \cdot SHD \cdot A, \quad kWh/y \quad (1)$$

where  $h_c$  – nominal efficiency of the old boiler in a technically data of the manufacturer/supplier or the seasonal efficiency of the old boiler, documented in a report by the verification procedure of the ordinance under Art. 32, Law on energy efficiency;  
 $h_n$  – nominal efficiency of the new boiler in a technically data of the manufacturer/supplier or seasonal efficiency established by inspection under the ordinance of art. 32, Law on energy efficiency;  
 $SHD$  – specific annual energy consumed for heating after the implementation of the package of energy saving measures proposed in the energy audit from the replaced boiler, kWh/y;  $A$  – heated area, m<sup>2</sup>.

The efficiency of the boiler in the opposite balance is determined by the formula 2:

$$\eta = 100 - (q_2 + q_3 + q_4 + q_5), \% \quad (2)$$

where  $q_2$  – losses with exhaust gas, %;  
 $q_3$  – losses with chemical incomplete combustion, %;  
 $q_4$  – loss mechanically incomplete combustion, %;  
 $q_5$  – heat losses to the environment, %.

In hot water heating boilers burning gaseous fuel losses  $q_3$  and  $q_4$  are negligible and are not defined. Losses with exhaust  $q_2$  are the main determining losses in boilers. They include two basic parameters: the temperature of the exhaust gases and the coefficient of excess air. According to EN 15378 are determined losses from heat exchange with the environment.

### 3. RESULTS AND DISCUSSION

Based on identified normalized annual energy consumption for heating and specific annual consumption of energy required in the model study of the building are simulated energy-saving measures aimed to increase the class of energy. It is established a potential for reducing normalized energy consumption in the building of the Faculty of "Technics and technologies", amounting to 662,565 kWh/y ecological equivalent of 269,19 t CO<sub>2</sub> emissions saved. The annual energy consumption is expected to decrease from 985,111 kWh/y to 322 546 kWh/y, which is a saving of 67.2% [2].

In an analysis of the model study of the building found:

1. It is not reflected in energy efficiency assessment existing at the time of coolant leaks from the tube bundles in the housing of the working boiler, which is a prerequisite for an overhaul;
2. It is not research the opportunities to use renewable energy sources for heating in the building of the faculty;
3. It is reported the efficiency of the boiler is 92.1%.

Based out experimental investigation of the products of combustion with gas analyzer TESTO 335, reported losses with exhaust  $q_2 = 8,1\%$ . According to EN 15378 are calculated losses from heat exchange with ambient  $q_5 = 2,8\%$ . The calculated efficiency of the boiler in reverse balance is 89.1%.

Given the amortization of the boiler KVN-1, equipped with a gas burner BALTUR TBG120P and to increase energy efficiency offers its replacement.

### 3.1. Proposal to reduce energy consumption for heating implementation of energy saving measure "Replacing the boiler KVN-1"

There are two variants for replacement of existing working boiler KVN-1:

- ✓ a heat pump water-water;
- ✓ a gas condensing boiler.

To maximize the effectiveness of the proposed energy saving measure is to be made a comparative assessment of the expected annual energy savings for heating in the two proposed options.

The forthcoming implementation of energy saving measures related to improving the thermal resistance of the building envelope proposed in the energy audit is a prerequisite to calculate the heat loss of the building - 312,7 kW when choosing a new boiler.

#### ➤ Variant for heating with heat pump water-water

When choosing the option of using the heating pump system water-water – „MEETING“ - WW 90 (Table 1.), the most important characteristics which should be carefully examined before a final decision to build a plant using energy source groundwater is their flow. The required flow  $m_w$  is calculated in Formula 3:

$$m_w = \frac{3,6 \cdot Q \cdot (\varphi - 1)}{c \cdot \Delta t \cdot \varphi}, \quad m^3/h \quad (3)$$

where Q – calculating heating power, kW;

$\varphi$  – coefficient of performance of the heat pump;

c – a specific heat capacity of water, kJ/kg.K;

$\Delta t$  – temperature difference of chilling groundwater, K.

The required flow rate is 52,9 m<sup>3</sup>/h.

Table 1. Technical characteristics of the heat pump system „MEETING“ - WW 90 [8]

Parameter	Measurement unit	Value
Heat power	kW	346
Power input	kW	67,4
COP	kW/kW	5,12
Freon		R407C
Maximum temperature of outgoing water	°C	60
Compressor Copeland scroll	бп.	3
Water flow from the well	m <sup>3</sup> /h	47,87
Water flow of heated water	m <sup>3</sup> /h	59,5

To preliminary exploring the possibility supply from groundwater for heating the building of the Faculty of "Technics and technologies" is prepared hydrogeological report. According to the conclusion of the report, the required water quantity can be provided through the construction of two pieces of tube wells "perfect" type of approximately 150 m west of the building in the alluvial gravels of the river Tundzha. Discharge of wastewater is best done in the river bed [7].

✓ **Variant heating with gas condensing boiler**

Table 2. Technical characteristics of the gas condensing boiler HOVAL UltraGas

Parameter	Measurement unit	Value
Nominal power 80/60 °C	kW	51-320
Nominal power 40/30 °C	kW	58-350
Nominal loading	kW	53-330
Efficiency at 30% loading compared to a net / gross heat of combustion value		
40/30°C	%	109,8/98,9
75/60°C	%	107,3/96,7
CO content in the exhaust gas min/max	%	9,0/8,8

Choosing the option for heating with gas condensing boiler „HOVAL UltraGas“ 350 with modulating control is a prerequisite to reducing the consumption of natural gas. The technical characteristics of the boiler are given in Table 2 [9].

The proposed options for replacing the existing boiler are the basis for transition to a low-temperature operation of the heating system parameters coolant 45/35 °C. This requires the replacement of all heating units with new with thermal power, determined according to the calculated heat loss of the premises and low temperature operation. Activities to implement the replacement of heating units are an accompanying measure of energy-saving measure "Replacing the boiler KVN-1".

### 3.2. Energy consumption for heating after accomplishing the proposed options for replacing the existing boiler

With the implementation of energy saving measures prescribed in the model study of the building of the Faculty of "Technics and technologies" is expected to reduce annual energy consumption for heating from 871,285 kWh to 258 890 kWh [2]. The purpose of replacing the existing boiler is to reduce this cost under 258,890 kWh/y, in the implementation of cost-effective measure. The expected savings of heating energy from replacing the existing boiler with a condensation gas boiler 33,531 kWh/y is defined by the formula 1. The efficiency of the gas condensing boiler is defined by formula 4:

$$\eta = \frac{Q_{\text{useful}}}{Q_{\text{upper}}}, \% \quad (4)$$

where  $Q_{\text{useful}}$  – theoretical maximum useful energy,  $Q_{\text{useful}} = 10,87 \text{ kWh/nm}^3$ ;  
 $Q_{\text{upper}}$  – the gross heat of combustion value of natural gas, at 0°C and 101325 Pa,  
 $Q_{\text{upper}} = 11,09 \text{ kWh/nm}^3$ .

The calculated efficiency of a gas condensing boiler is 98%. The energy consumption for heating in the annual plan by using the heat pump system is 66889,1 kWh / y and is formed as the sum of energy consumption in the compressors and submersible water pumps. In heat pump water-water system and provide the necessary quantity of water from tube wells we assume that COP e constant. Running time  $\rho_{\text{ГОД}}$  of the heat pump mode at nominal annual plan is determined by a formula 5:

$$\rho_{\text{год}} = \frac{SHD}{\dot{Q}_T} h/y \quad (5)$$

where  $SHD$  – annual required energy for heating after the application of energy-saving package of measures proposed in the energy audit (258890 kWh/y) [2];

$\dot{Q}_T$  – thermal power of the heat pump, kW (Table.2)

Running time of the pump rated speed in an annual plan is 748,2 h/y.

The energy consumption in the compressors with power consumption  $N = 67,4$  kW at  $\rho_{\text{год}} = 748,2$  h/y is 50428,7 kWh/y and submersible pumps „Wilо“ 6R-2013 -11 kW, 2 pcs., respectively 16 460 kWh/y.

The expected reduction in annual energy consumption for heating from 11755.6 lev, which is due to the replacement of the existing boiler with a heat pump system is formed as the difference between the cost of the annual required energy for heating 28477.9 lev [2] after application package of energy saving measures proposed in the energy audit and energy consumption for heating using heat pump system, whose price is 16,722.3 lev.

Annual savings of 3688,4 lev is calculated at the price of natural gas for industrial consumers of "Overgas East" – 0,11 lev / kWh and the price of electricity for industrial users IVN Bulgaria - 0.25 lev / kWh, to date 29.03. 2015.

#### 4. CONCLUSION

1. The analysis of the model study of the building of the Faculty "Equipment and Technologies" is found:

- it is not reflected in energy efficiency assessment existing at the time of coolant leaks from the tube bundles in the housing of the working boiler, which is a prerequisite for an overhaul;
- it is not research the opportunities to use renewable energy sources for heating in the building of the faculty;
- it is reported the efficiency of the boiler is 92.1%.

2. It is developed proposals for two options for changing the existing working boiler “KVN-1” with: gas condensing boiler and heat pump water-water system.

3. It is established that the potential to reduce energy consumption for heating from 258,890 kWh per year specified in the energy audit, to 225 359 kWh per year when replacing the existing boiler with a gas condensing boiler, and respectively to 66889,1 kWh per year in the implementation of projects with heat pump water-water system.

4. Annual savings from 11,756 lev, due the replacement of an existing boiler with a heat pump water-water are 2.7 times larger than those of its replacement with a gas condensing boiler (3688.4 lev). In deciding to implement the package of energy-saving measures with heat pump system should be made that the abstraction from groundwater is subject to authorization and shall be in accordance with the provisions of the Water Law and Ordinance №1 from 10.10.2007 to inquiry, use and protection of groundwater [4].

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## FASHION DESIGN USING DECORATIVE BANDS BASED ON THE GOLDEN AND FIBONACCI FORMS

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**Abstract:** *The paper presents fashion design of ladies' dresses using decorative bands. The main idea of design process is combination of the Golden and Fibonacci geometry as a symbol of beauty and harmony, the consumer preferences and the latest fashion trends. The decorative bands are created on the base the Golden and Fibonacci geometry forms after a study of connections between forms and colors. The basic motifs which are designed using the Golden and Fibonacci geometry are colored in two and three colors combinations. The color combinations are used on the harmony in the four basic color circle and the latest trends in colors according to Pantone. In results of investigation the suitable color combinations are chosen for the motifs of the bands, and created bands are used in the fashion design. The design process can be used in creation of other textiles – fabrics for clothing, interior textile, etc.*

**Key words:** *Golden Ratio; Fibonacci Sequence; Textile Design; Decorative Bands; Fashion Design.*

### 1. INTRODUCTION

Fashion design of ladies' dresses with the use of decorative textile bands is presented in the paper. The main idea of design process is combination of the Golden and Fibonacci geometry as a symbol of beauty and harmony, the consumer preferences and the latest fashion trends. The decorative bands are created on the base of the Golden and Fibonacci geometry forms after an investigation of connections between forms and colors. The basic motifs which are designed using the Golden and Fibonacci geometry are colored in two and three colors combinations.

### 2. GEOMETRICAL MODULS, CREATED ON THE BASE OF THE GOLDEN RATIO AND FIBONACCI SEQUENCE

#### 2.1. Fibonacci Rose

Fibonacci sequence is a sequence of numbers, in which every next number is a sum of previous two ones. Geometrical mosaics from equalitarian polygons have been created with proportions between sides, which are equal to Fibonacci sequence. The tiling with equalitarian triangles is named Fibonacci rose. Fibonacci rose, in which the triangle tiling forms two spirals, is presented in Figure 1. [1]

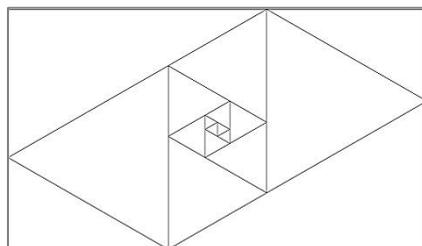


Figure 1. Fibonacci rose

In Fibonacci rose the both spiral forms, which triangles form, are seen well if they are colored in two different colors, as it is presented in Figure 2. Figure 3 presents another way of coloring of Fibonacci rose in which the triangles of both different directions are colored in different way. Around both spirals which are created by triangles real curved spirals can be drawn. The both curved spiral forms, colored in different colors, are presented in Figure 4. Figure 5 present the use of Fibonacci rose as a frame in which circles are entered. The circles form two spirals two and they are well seen with the help of different coloring too like the spirals from Figures 2 and 4. [7] In the Figure 6 the circles are entered in the frame, colored in the model, which is shown in Figure 2, as the circles are colored in opposite way. In Figure 7 the circles are entered in the frame, colored in the model, presented in Figure 3, as the circles are colored in the opposite way.

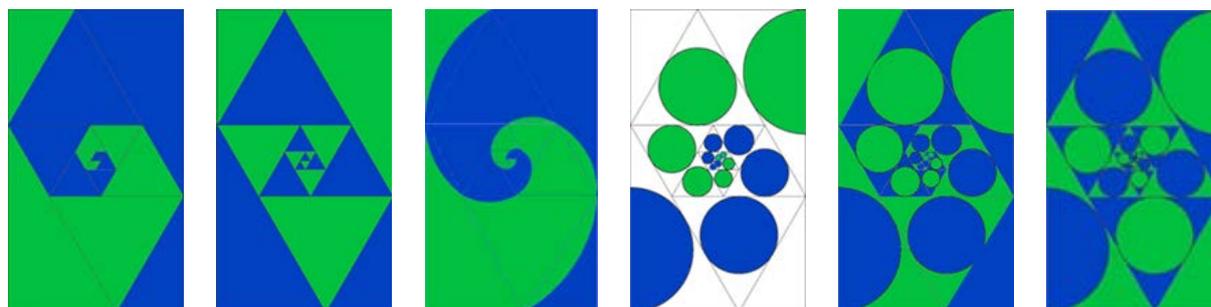


Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

- Figure 2. Fibonacci rose with different way of coloring of both spiral forms which are formed by triangles
- Figure 3. Fibonacci rose with different way of coloring of triangles in both directions
- Figure 4. Two curved spirals which are drawn around spirals which are formed by triangles. The both forms which are result of curved spirals are colored in different way
- Figure 5. Circles, entered in the frame of Fibonacci rose. The both spirals formed by the circles are colored in different way
- Figure 6. Circles, entered in the frame of Fibonacci rose which are colored in the model form Figure 2. The both circles spirals are colored in the opposite way
- Figure 7. Circles, entered in the frame of Fibonacci rose which are colored in the model form Figure 3. The both circles spirals are colored in the opposite way

The models in Figures 2, 3, 4, 5, 6, and 7 are motifs which can directly use in textile design. In the presented textile patterns they are used in square combinations with the help of suitable colors. Different variants of combinations of the motifs in two colors are presented in figures 8, 9, and 10.

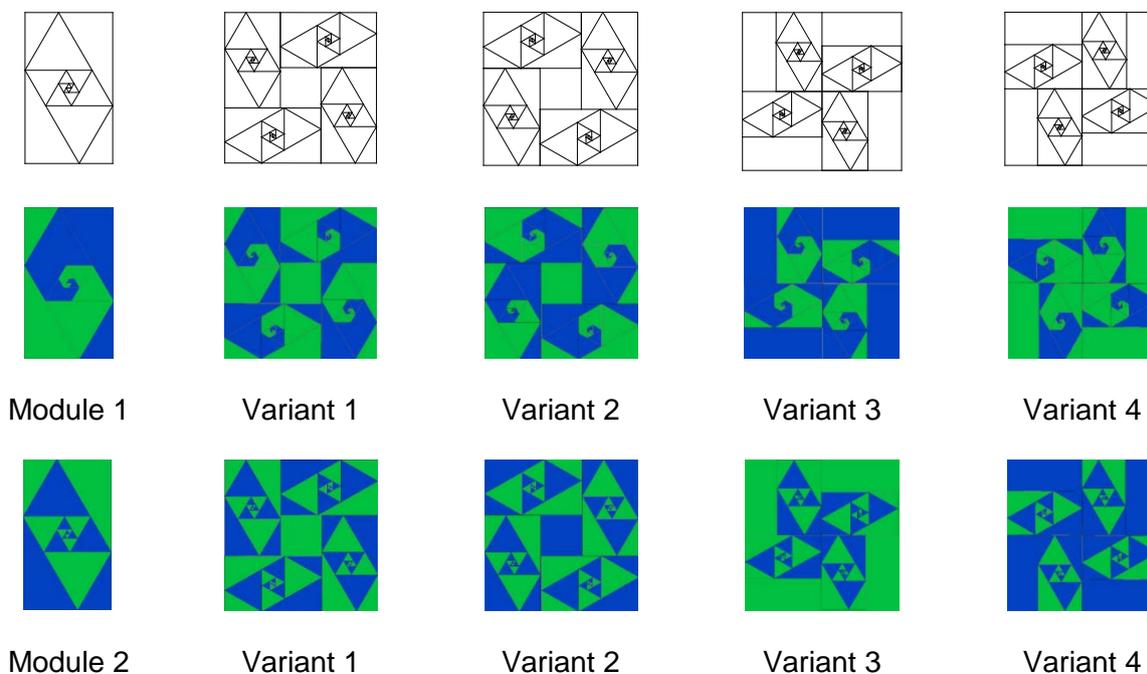


Figure 8.  
Variants of geometrical combinations on the base of  
Module 1 (Figure 2) and Module 2 (Figure 3)

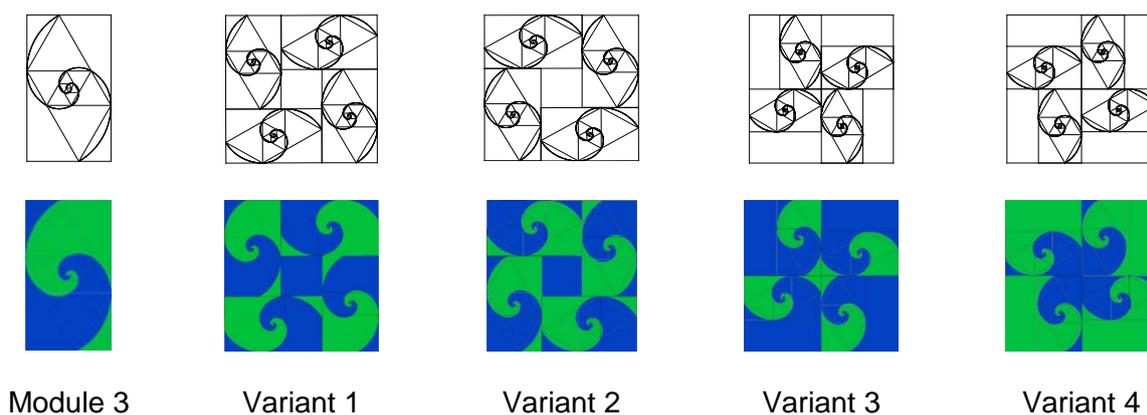


Figure 9.  
Variants of geometrical combinations on the base of  
Module 3 (Figure 4)

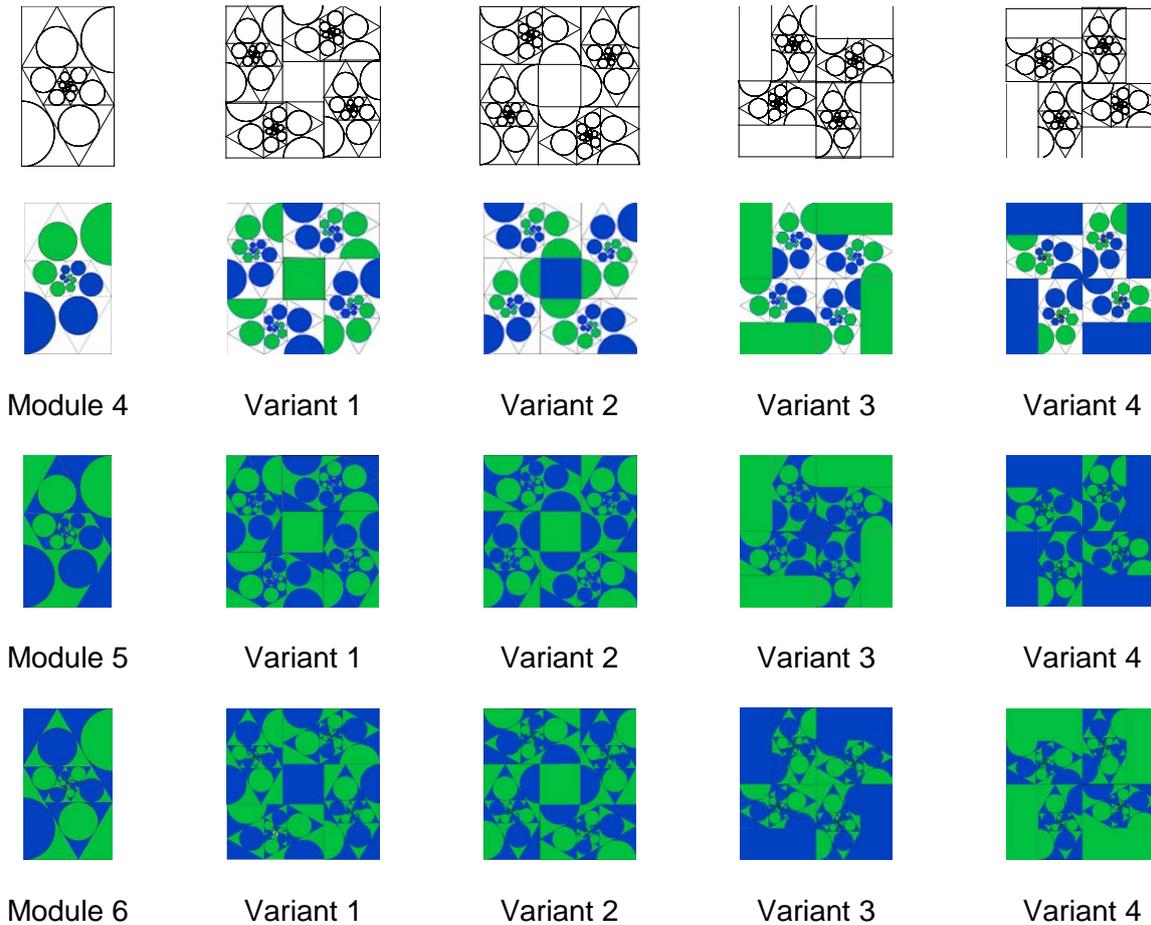


Figure 10. Variants of geometrical combinations on the base of Module 4 (Figure 5), Module 5 (Figure 6), and Module 6 (Figure 7)

## 2.2. Golden Spiral

The Golden spiral is created in the frame of a rectangle with sides in proportions of the Golden ratio or 1,618. For the creation of the spiral the rectangle is divided in a square and a rectangle. The smaller rectangle is divided in a square and a rectangle, and this continues in a spiral direction. Squared circles are entered in every square and by that way the Golden spiral are created. [10]

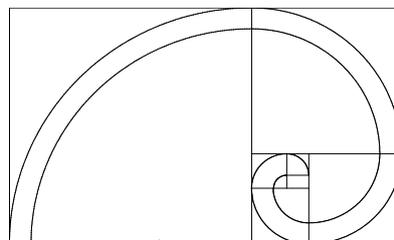


Figure 11. The Golden spiral in the Golden rectangle

The Golden spiral, presented in Figure 12, is well seen, because it and the Golden rectangle are colored in two different colors. The Golden spiral and the Golden rectangle are colored in different way too, but every neighboring square from the rectangle is colored in opposite way.

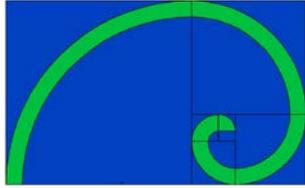


Figure 12.

The Golden spiral and the Golden rectangle, colored in different way

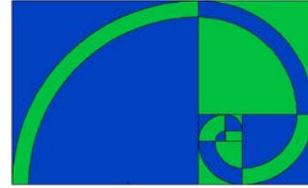


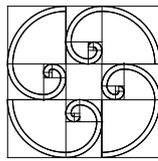
Figure 13.

Every neighboring square is colored in different way

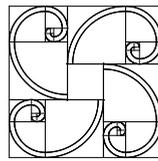
The modules which use the Golden spiral create geometric squared ornaments in squares or spirals forms on the base radial symmetry. The bi-colored variants are presented in Figures 14 and 15.



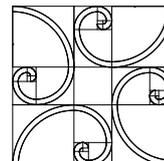
Geometric element



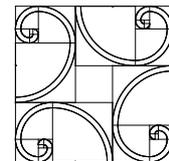
Geometric ornament 1



Geometric ornament 2



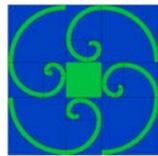
Geometric ornament 3



Geometric ornament 4



Module 1



Variant 1



Variant 2



Variant 3



Variant 4



Module 2



Variant 1



Variant 2



Variant 3



Variant 4

Figure 14.

Variants of geometric and color combinations on the base the Golden spiral – squared ornaments in forms of squares

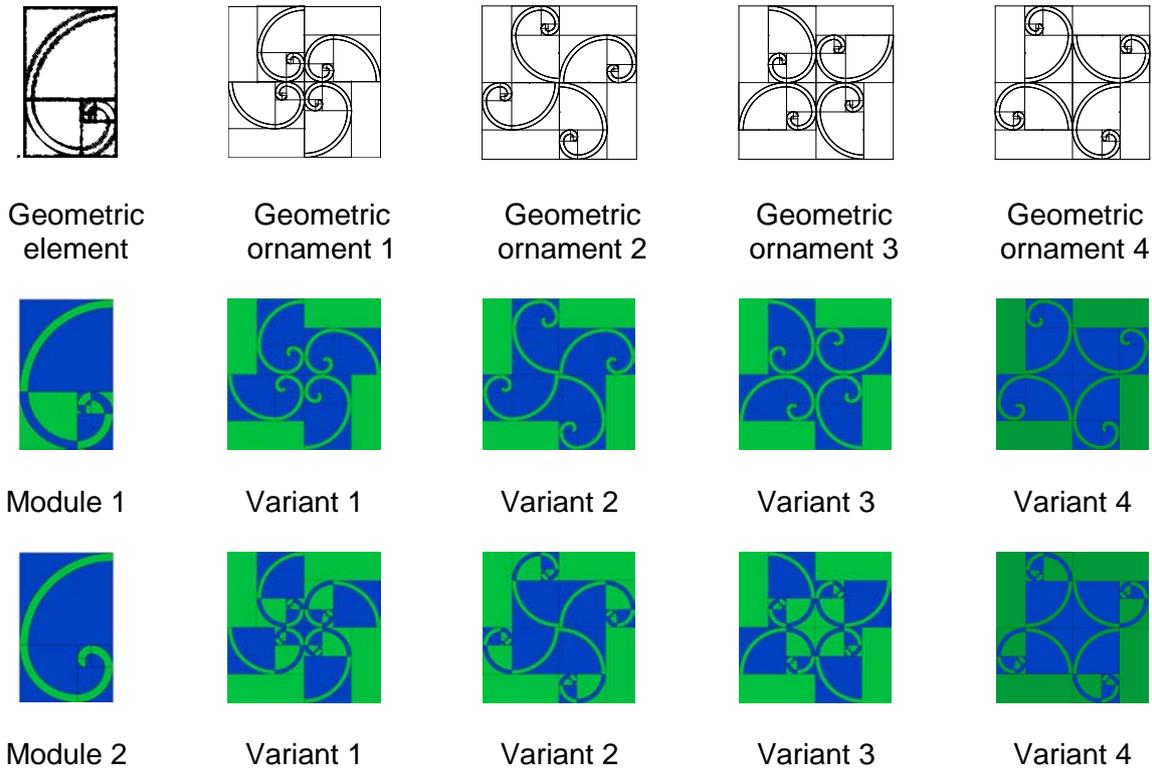


Figure 15.

Variants of geometric and color combinations on the base the Golden spiral – squared ornaments in forms of spirals

**2.3. Other creations constructed on the base of the Golden ratio and Fibonacci sequence**

Figures 16, 17, and 18 present variants of geometrical ornaments, created on the base of the spiral square. [3] The spiral square includes four logarithmic or Golden spirals. Figure 19 presents variants of coloring with combinations of two or three colors of the models, presented in figures 16, 17, and 19.

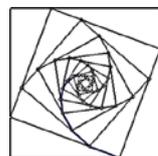


Figure 16

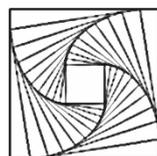


Figure17

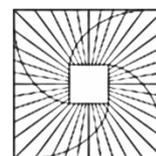
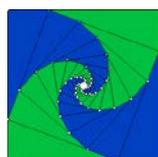
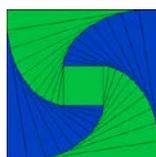


Figure18

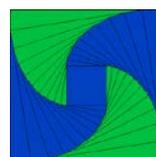
Figures 16, 17, and 18.  
Variants of geometrical ornaments,  
created on the base of the spiral square



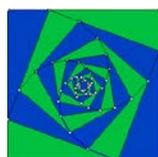
Variant 1.1



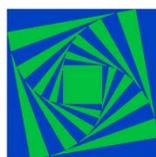
Variant 2.1



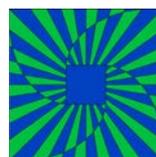
Variant 3.1



Variant 1.2



Variant 2.2



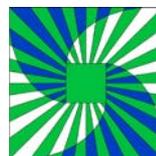
Variant 3.2



Variant 1.3



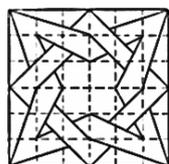
Variant 2.3



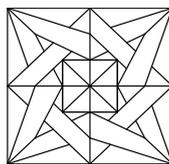
Variant 3.3

Figure 19. Variants of coloring of the ornaments, formed on the base of the spiral square

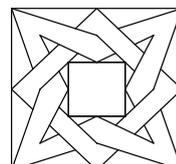
Another geometrical ornament, which is formed only by intertwist straight lines is star shape [5], in proportions of Fibonacci sequence is presented in Figure 20. The presented color models are in three colors combinations.



Variant 1.1



Variant 2.1



Variant 3.1



Figure 20. The geometrical ornament, formed in star shape by intertwist straight lines and variants of coloring

Figure 21 presents variants of decorative bands with part of geometrical ornaments on the base of the Golden ratio and Fibonacci sequence, presented in Figures 8, 9, 10, 14, 15, 19, and 20. The composition of the bands is constructed on the base of translated symmetry and linear rhythm. The presented decorative bands are designed in two, three, and four colours combinations.

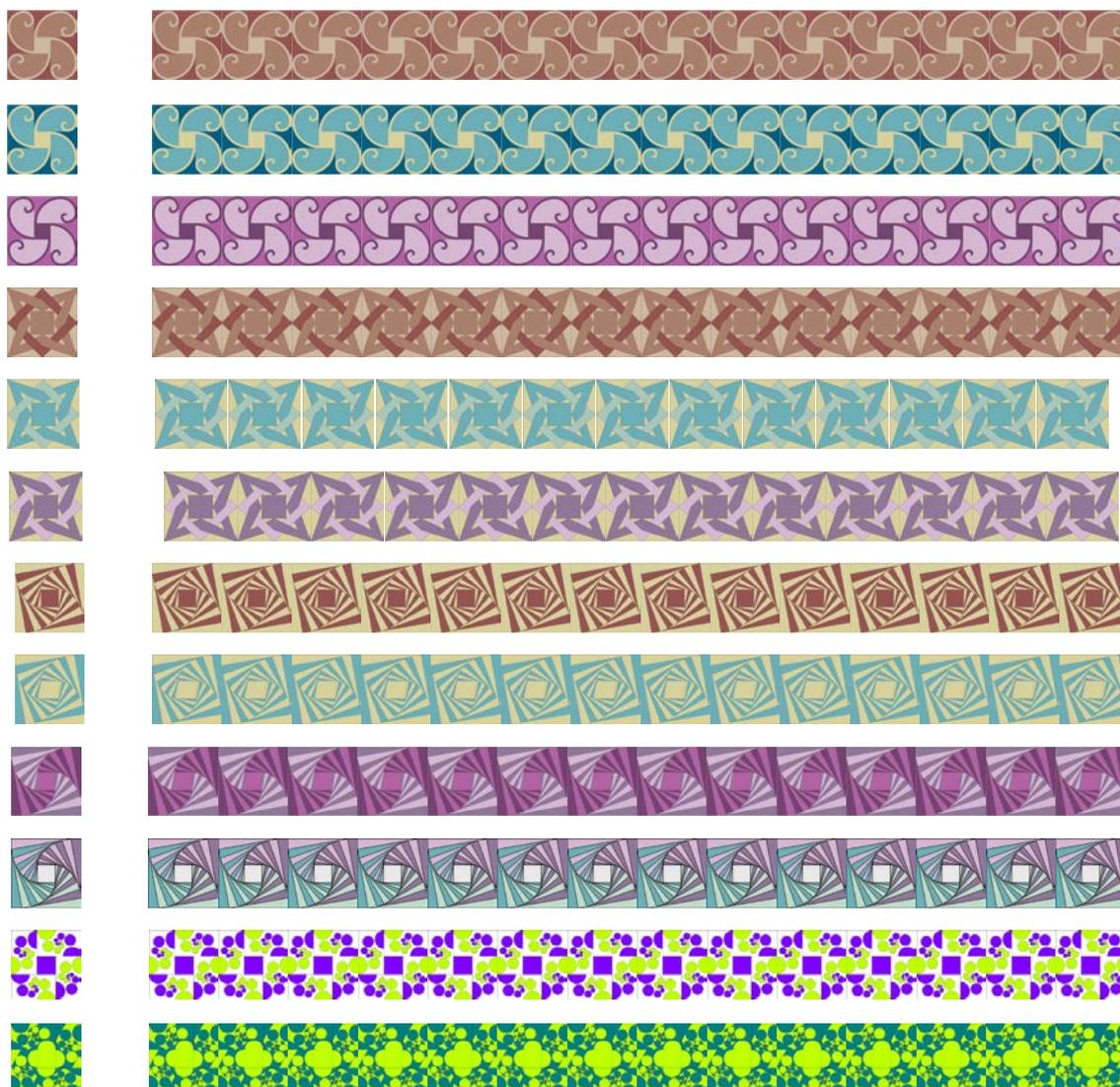


Figure 21. Variants of decorative bands, using the Golden and Fibonacci geometry in two, three and four color combinations

### 3. THE USE OF DECORATIVE BANDS IN FSHION DESIGN

The decorative bands with ornaments, constructed on the base of the Golden and Fibonacci geometry, which are shown in Figure 21, are used in fashion design. Models of ladies' dresses with some of decorative bands from Figure 21, presented in Figures 22, 23, 24, 25, 26, and 27.

In the composition of the ladies' dress the geometry of the ornaments in the bands is leading. The geometry of the ornaments is combined with suitable colors, which are suggested by PANTONE for the year 2015. [9] On their base of the silhouette, forms of details and elements and the main color of the dresses are determined.



Figure 22



Figure 23



Figure 24



Figure 25



Figure 26



Figure 27

Figures 22, 23, 24, 25, 26, and 27. Fashion design using decorative bands created on the base the Golden and Fibonacci geometry

#### 4. CONCLUSION

It can be concluded that presented ornaments, which are designed on the base the Golden and Fibonacci geometry lead to creation of beautiful and harmonic forms in textile and fashion design. And it is underline by the sentence of Prof. Adrian Bejan about the Golden

ratio: "Shapes that resemble the golden ratio facilitate the scanning of images and their transmission through vision organs to the brain. Animals are wired to feel better and better when they are helped and so they feel pleasure when they find food or shelter or a mate. When we see the proportions in the golden ratio, we are helped. We feel pleasure and we call it beauty." [2, 4, 6, 8].

The classic Golden spiral is very interesting for textile design and according to the textile technology, it can be replaced with Fibonacci spiral.

Fibonacci rose is very interesting for the textile design too, because Fibonacci rose is not too known like the Golden and Fibonacci spirals. Another reason is that Fibonacci rose can be used as frame for double spiral and entered geometrical forms.

The different module elements are used in different geometrical and color combinations, and that forms ornaments which can be applied directly in textile design. In this case they are used in design of decorative bands which are applied in fashion design. The geometrical ornaments can be used in creation of other textiles – fabrics for clothing, interior textile, etc.

## 5. ACKNOWLEDGEMENT

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## IMPACT OF WATER IN DESIGNING LANDSCAPE

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**Abstract:** *"The country music is for those who know how to listen." - William Shakespeare. Water is one of the most important components in natural landscapes and occupies an important position in the design or creation of green spaces, especially parks. Top major aquifers serve as a basis for the creation of an urban target and contribute to the organization of various compositions in the system of urban greenery. Rivers, lakes, all this enriches the landscape making it particularly versatile and picturesque combined with vegetation. The formation of compositions park water mirror separates as one of the leading details. Composition importance of water surfaces is so high that in the absence of natural water mirror is necessary to examine the possibility of construction of artificial lakes and reservoirs and fountains. Water surface is irresistibly appealing decoration of any garden, and is one of the most important natural components. The water like no other element in the garden, imports in the space particularly attractive changes that reflect the environment, sounds and movements.*

**Keywords:** *water, designer, landscape, art.*

### 1. INTRODUCTION

The rule of nature is smugly interpreted as an adequate substitute for governing themselves." - Rejnhold Nejbur.

Water in nature is of great importance to its surroundings and is one of the main factors in the implementation of landscape design.

Regardless of the size of the water surface, they enrich any space giving it freshness and liveliness with its overflow, spraying and purity with the clear and translucent appearance.

The major physical property of water is its flexibility, in other words, the possibility as a material to fit into any shape.

Water is one of the richest natural elements in the decoration of gardens and parks with the possibility of creating different details in the various forms of life gives special expression of elevated green colour.

The elements of water affect the microclimate, reducing the air temperature and increasing its humidity which is especially important for southern ends where it is used for recreation and sport, and ultimately important is the aesthetic value of water.

Applying the water as an element of artistic decoration of the park it is necessary to highlight all its natural properties. All this shows that it is necessary, if possible, to highlight the water surface in order to achieve maximum aesthetic and spatial effect and provide attractive and comfortable space for guests.

Large bodies of water have great importance as factors for improving the micro climate and the land that surrounds them. It is creating favorable living conditions for many plant species, by improving their growth and development.



Figure 1. Water surface – Ocean



Figure 2. Water surface in the park

Analyzing the use of the elements of water through history, we can conclude that its role is invaluable in the overall pictorial construction of any park even the smallest green areas, starting from the use of water from Egypt and Mesopotamia where water is used by a flood, then Persia occurrence of shallow pools, to the present day where the water is used rather freely can be called a trend in each park area.

Water for centuries attracted people to its shores create neighborhoods and it also had an important role in agricultural development and urban image of the city. The process of urbanization in many parts of the world was focused on river valleys. So many world cities have been established on the banks of major rivers.

## 2. EXPOSE

Water has several physical properties that influence the method of use in landscape architecture. Movement: by virtue of its water movement can be divided into two categories: static (peace still) or dynamic (moving variable) water body sound: when on the move or sharply hit a fixed object or surface and reflection: significant characteristic of the water and its ability to maintain the surrounding landscape. In calm water static state can function as a mirror depicting the layout so its environment (land vegetation buildings sky people) on a flat base. After emergence and importance of water and increased water elements can be divided into two groups:

I. Natural - seas, lakes, rivers, streams, waterfalls, etc.

- Sea - with its large water surface, it is participating in city planning as an important factor. Often along the sea levitating large park areas when the sea as a natural resource was allocated to its composition. Designing paths and plateaus letnikovac tied to the claim in the composition at any point of the visitors open-minded towards the seashore and lead to the shore as we felt that we would have enjoyed the games of the waves.

- Rivers - are an important factor in the life of the city is not only the workers' organizations populated areas, transportation and utility equipment like him and as an element of the urban landscape that can be enriched to make interesting and human.

- Streams - flows may well be used in various parks. Each river flow regardless of its size and an organic component such as heavily influenced by acting directly on the environment. That it might be fulfilled numerous functions which have small water courses is necessary their denaturalizacija-wide hydrological network of the city.

II. Artificial - artificial lakes small reservoirs cascades fountains pools, dams and other.

In the composition of green areas can participate as natural and artificial water bodies and water elements. The project of green areas can include natural water courses where natural conditions permit.

- Lakes - large bodies of water may be used for bathing water sports and fishing. Small bodies of water allow the organization Biography composition. Natural and artificial lakes formed in the park are the most beautiful detail and often achieve a dominant composition. Despite numerous purposes and use of the water surface and create opportunities for creating their coastal vegetation.

- Fountains - one of the most common elements formed with water fountains which are also the important element of free urban spaces parks and squares. When it comes to the fountains their compositional significance is great and especially its relation to surrounding buildings and its position in its space. Placed in central perspective space in front of the object axis of spatial vision or symmetric angle cross or pedestrian traffic flow.

- Swimming pools - as spatial element may be located within the city area of squares and other places. The relatively flat and free areas of scenic elements are parts of space with low elevations. They may be of different shapes and sizes and different purposes. Usually with a decorative character they can have decorative or sculptural elements.



Figure 3. Water area – Lake



Figure 4. Water area – Pool

- Waterfalls and Cascades - water that falls is another form of water in the landscape and emerges in the form: waterfalls and cascades that are created only by the presence of strong relief, and major water sources. Locating these elements is determined by technical possibilities.

- Dams - water barrier through which he screwed down over, creating another reservoir or lake.

One of the main factors in aquatic areas is shaping vegetation and also represents a major challenge for the designer. Water surfaces when rich plants become even more interesting and attractive.

Particularly significant is the question of the composition of green plantings in the landscape around the water surfaces that extracts three basic principles:

1. Creating dense coastal arrays (arrays that are located on the perimeter of the water mirrors constrained and closed area concealing the characteristics of the relief. The water surfaces in a given case are perceived deeper for creating the effect of different ranges that intersect in the eyes includes facilities).

2. Creating the background (the breakdown of coastal zones is the most complex form of the composition which forms the direction of sight more planned construction illusion of increasing the depth of the space and the size of the water mirrors. Arrays and groups find beg parallel line which forms a range of perspectives letnikovci reviewed from the coastal cliffs or bridges or other prominent places on the water surface).

3. Creating fields (fields can be broad and narrow to cross the coastal range. They should be observed clean-covered meadow vegetation flowers individually spaced or in groups or be offset with massif).



Figure 5. Water area, where special emphasis vegetation

For successful implementation of the natural lake it is very important to know the species and their natural features and to provide approximate natural conditions for cultivation.

Maintenance – With the arrival of the winter, in different aquifers varies depending on their size, materials that are built and functioning technology. So there are aquifers that would be damaged if they stay full, while other if empty.

Elements floating water is not as problematic as for wintering than those where water is static.

Those aquifers which are grown vegetation necessarily need to be cleared. When you need to empty a water element that has vegetation can act in two ways. If the plants are planted in containers can be transferred to a protected place (basement or garage) where it will remain until spring. Secondly, at the same time, the only possible way when the plants are planted directly into the bottom, is a textile or mulching layer of organic material (straw, sawdust, etc.). Before the spring comes, mulched are removed, and it is best to do this in the period before the pool to fill with water.

Ornamental ponds where the bottom is compacted gravel or clay, do not require emptying before the winter, since they cannot come popping the bottom pressure of the ice.

### 3. CONCLUSION

Because of the dominant character of water and its ability to subordinate all other elements in the garden, best small spaces to be used in the form of fountains and pools with smaller size and simple shapes.

Water elements form only the central content, and the water surface creates a distance - background on the perception of the landscape in the park.

Peninsulas and islands enrich the landscape water areas, forming scenes (sets) and closed perspective. They enhance the depth of space planning and create more paintings.

Water has always had, has and will have great importance in the life of man, is due to basic physical needs or aesthetic element. It will always remain an element without which life cannot be imagined.

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## MEDITERRANEAN IN DESIGN INTERIOR AND EXTERIOR

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**Abstract:** Today the term "Mediterranean" means a way of life characteristic of all these mixed cultures of peoples living on its shores. As is known Mediterranean music, Mediterranean cuisine etc., also very famous and constantly upgraded over the centuries represent and Mediterranean gardens. The main characteristic of Mediterranean design is simplicity, convenience, the colors of the earth and the sea, rich vegetation.

The main characteristic of Mediterranean style is to find a perfect balance between the interior and the natural environment, which in itself makes it unique. Basically, it's simple, easy and functional.

**Keywords:** designer, art, exteriors, interiors.

### 1. INTRODUCTION

Mediterranean design originates from the northern Mediterranean countries such as Spain, Greece and Italy, appeared in 40 of the XX century, the era of industrialization. You can see the sandy and pleasant decor patterns in colors that reflect the beauty of the Mediterranean coast.



Figure 1. Mediterranean style interior



Figure 2. Mediterranean style exterior

Mediterranean is a region with a lot of history, geographical area where a number of civilizations, religions and cultures have left strong and influential newspapers.

The warm Mediterranean Sea is a treasure of three continents, is a natural way for inter-ethnic and intellectual communication between Europe, Asia and Africa. Thanks to this communication, meditate a crossroads where a number of nations mutually exchanging their old cultures and customs. Her communication between peoples through time was not always quiet and peaceful, that was often with major crises, wars and conquests. However, such complex and furious history of mutual mixing of languages, exchange of commercial and cultural experiences contributed to the creation of a special "Mediterranean style".



Figure 3. Mediterranean style interior

## 2. INTERIOR

Mediterranean-style furniture ranges from simply functional to extremely formal.

Basically, Mediterranean style is light and functional. Its main feature is to find the ideal balance between the interior and the environment.

The choice of colors to match hues of nature like terracotta, brown as the color of the earth, soft citrus colors, blue, neutral white or soft lavender color of rust. Warm, soothing and neutral shades combined with blue, dark blue and gold. Blue-green color and sapphire color that can be linked with shades of the sea, while gold elements reflect the glow of sunset. You can combine the color of the walls, and dark color only one wall, while the other walls will be white.



Figure 5. Mediterranean style exterior - circuit inside to the outside world

Mediterranean style used roughly processed natural material that is most dominant rock and pine tree. Raw marble is used specifically for interior stairs. The materials are often confused and wooden furniture you can see details of stone and glass.

Rich textures characteristic of Mediterranean style. Spanish wall is often present in the interweaving of textures. Wooden beams on the ceiling, true or false creates striking visual effects.

Walls have vivid textures and can be made of rough stone in its original form, or made of hand painted ceramic tiles. The conventional walls during construction can make the recesses which serve as shelves.



Picture 6. Mediterranean style interior

Mediterranean cuisine includes many different elements, and the best thing about this concept is the freedom which allows at these. A very large number of topics and cultures involved in this the design and therefore have a lot of different options. Kitchens inspired by Mediterranean style almost always include natural earth tones and the use of wood.

Sometimes the look is completed with the bare visible wooden beams and arched vaults. The floors are terracotta tiles. The walls of the kitchen tiles use vivid, richly decorated in the colors of the earth, sun, sea...

The floors are mostly covered with tiles in neutral colors and parquet flooring. Instead parquet interesting choice is larger planks of wood that can be varnished or painted in thinner or thicker stripe white or brown. Floors are covered with tiles and terracotta. Carpets are rarely used, but if it put to adopt simpler cotton, almost monochrome versions.

Mediterranean-style furniture ranges from simply functional to extremely formal. Furniture are often made of materials such as woven wicker, wrought iron and wood, all of which are prevalent and bamboo, rattan and teak. Pieces are short with rich turned legs and feet, hardware and frames are heavy, often patinated or burned. Furniture should be practical, simple lines in natural color or painted in typical Mediterranean colors. With wooden furniture and fit pieces of wrought iron, such as for example on the table.

Decorative fabrics are placed furniture, sofa or chair should be easy and natural, and is ideal silk and cotton. Patterns may vary - stylized leaves and flowers, various geometric patterns, sea motifs. Curtains create a feeling of lightness and, therefore, must be light and light from natural materials. Curtains sheets, blankets, often monochrome or decorated with white and blue colors, floral or geometric patterns. Linen tablecloths and pillows are recommended

materials such as wool and cotton, which allow easier breathing of the skin, especially in the summer heat.

The walls can be empty, or with a refreshing light watercolors with marine motifs.



Picture 7. Mediterranean style interior



Picture 8. Mediterranean style interior

### 3. EXTERIOR

Very often they can meet Mediterranean gardens with a minimum slope of the terrain. This is done to achieve what is possible more natural-looking terrain. In other cases encountered and cascade arrangement on the ground with low retaining walls (60 cm.), So that the field is divided into several terraces and the goal to be reached is that the garden is located on a slope that descends to Seashore. Retaining walls are mostly dry masonry and made from raw natural stones, often in bright colors. In the cracks of the retaining walls must be planted miniature plants. The paths in these gardens are mostly bright gravel or sand, lined with curbs to avoid dispersal of the material on all sides.



Picture 8. Mediterranean style exterior



Picture 9. Mediterranean style exterior

Terracotta pots are unbreakable decor in each Mediterranean garden. They commonly grow flowering species or aromatic herbs (lavender, rosemary, oregano, basil), which when cooking in the kitchen can be used fresh from their own garden.

Because of the excellent climate most of the year, people who live in that part of the world spend time in their gardens. Because the places provided for rest are an inevitable part in these gardens. To this end, in addition to classic small squares to achieve greater effect and raise pergolas baldachin.

The shadow is a necessary moment in terms of rest in these gardens. Vines creeping roses and wisteria an excellent choice for greening the wooden or metal structures of the pergolas, thus providing a compact shadow. The furniture used in these gardens can be of wood, bamboo or wrought iron. The benches and armchairs are placed big fluffy pillows and blankets.

Mediterranean garden prevailing delicate colors: white, blue-green, gold and red. Pastel tones and shades are very rarely encountered. Because these gardens avoided using spring perennials flowers and placing them used rudbeckia, echinacea, and a number of ornamental grasses (*Carex* spp; *Festuca* spp.) And of course, plenty of roses, clematis, olives, tangerines and lemons in terracotta pots.

As one of the main species found in almost all Mediterranean gardens is the Mediterranean cypress (*Cupressus sempervirens*). He is refreshing in the vertical space of the open space in these gardens. Commonly planted in groups of a few trees or in the form of line plantings along the broad paths.



Figure 7. Mediterranean style exterior

#### Bows

One of the most recognizable features of Mediterranean architecture arches (arches).

#### Color

Color is a very important element in the design, which varies from style to style. By sea the most iconic image of the Mediterranean region, it is only natural that include blue Mediterranean inspired landscapes. Cobalt Blue captures the essence of the Mediterranean, photo blue dome roofs in Greece.

In this yard, cobalt blue tiles add to the color of white plaster structures behind the pool. A combination of glass mosaic tiles and hand-painted ceramic tiles complete Spanish theme in this yard.

### Sculpture and Pottery

We've all heard the phrase it is all in the details. This phrase is true when creating a courtyard in a Mediterranean style. Over the years, the Mediterranean cultures have enjoyed decorating outdoors with plants and fine statues. Bringing this tradition in your own backyard will help to create an authentic Mediterranean environment.

Around the swimming pool, blue pottery displays the upper limit, while small stone sculptures spraying water in the pool. You can repeat these elements as is done here, or you can opt for a larger piece that will serve as the main focal point.

### Terracotta

Nothing is more economical Mediterranean terracotta. Standing on top of a high mountain or in a church, you can see the roof after roof covered in red clay tiles. This classic European material can bring in your yard in the form of pottery. For a more authentic look, give the commercialized form available at big box nurseries and decide for urns, olive jars or bowls.

Terracotta urns were given a prominent place on the back wall of this Spanish-inspired pool. Each one stands on the top shelf, providing the necessary contrast with blue tiled arches.

### Rock

Many buildings along the Mediterranean being built of stone, some are even carved in the rocks along the coast. For this reason, it is common to include a stone in the landscape that aims to replicate the look and feel of this region. Most stones used around the Mediterranean are brightly colored.

This property, stone paving helps to emphasize Mediterranean atmosphere. Notice that the built-in seating, which is similar to the styles popular in the Greek islands, also clad with stone.

### Pillars

Maybe use more of arches in the architecture of antiquity, the pillars were popular in both Greek and Roman buildings. Parthenon in Athens, the example has 50 pillars around the perimeter. Although many columns may seem overwhelming at court, you can include more appropriate number. One of the most common uses is for outdoor pillars as the pillars of the pergola.

Eight pillars Mediterranean support this style pergola located near the pool, the patio Arizona. Special lighting emphasizes the shape of the piers at night.

### Olive trees

Italian cypress, lavender, grape vines are all iconic plants of the Mediterranean; however, olive trees can be overcome in terms of symbolism. Olive branches have long been a peace and hope and to this day they are used to adorn the heads of Olympic champions. Thus, olive trees are an appropriate choice for a Mediterranean garden.

Four olive trees occupy parts of these dilapidated walls made of granite in the yard. Reflectors are used to highlight the unique structure of the branches and leaves of trees.

## **4. CONCLUSION**

Mediterranean-style furniture ranges from simply functional to extremely formal.

The main characteristic of the Mediterranean style is to find the ideal balance between the interior and the environment.

Mediterranean style is characterized by the natural colors of the walls, decorative fabrics for furniture, using wood and stone etc.

Mediterranean gardens are known for their simplicity and elegance. They are visually spacious, bright gardens with clean lines, combined with a number of architectural elements and various different vegetations.

Mediterranean landscape is achieved by a combination of plant species with different color and texture.



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