ISSN 2490-2330

TECHNO Science

INTERNATIONAL SCIENTIFIC JOURNAL OF TECHNICAL SCIENCE

ARCHITECTURAL CONCEPTS OF CONTEMPORARY SKYSCRAPERS

NATURAL SCIENCES IN TECHNICAL ENVIRONMENT

USING QR CODES AS THE TARGET FOR AUGMENTED REALITY APPLICATIONS

HIGH QUALITY PRINTING – HI-FI PRINTING

THE APPLICATION OF NANOTECHNOLOGY IN TEXTILES

VOL 2 ISSUE 3
APRIL 2017

Association for Research, Education and Development

TECHNO Science

INTERNATIONAL SCIENTIFIC JOURNAL OF TECHNICAL SCIENCES

VOL 2 ISSUE 3
APRIL 2017

NIA
Association for
Research, Education
and Development
Travnik, Bosnia and Herzegovina

TECHNO SCIENCE
International Scientific Journal of Technical Sciences
Vol. 3, Issue 2 June 2017
ISSN 2490-2330
e-ISSN 2490-2438
Catalogued in COBISS BH

Indexation
Indexation in international databases will be made after the release of the third edition of the journal.

Publisher
Association for Research, Education and Development "NIA"
Aleja konzula No. 5, Travnik, Bosnia and Herzegovina

Print
Print d.o.o. Travnik
Circulation: 300 copies

Communication
Association for Research, Education and Development "NIA"
Aleja konzula No. 5, Travnik, Bosnia and Herzegovina
Tel: +387 30 540876;
GSM: +387 61 225299
Fax: +387 30 540876
e-mail: info@technoscience.ba
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www.technoscience.ba

Publishing
Techno Science publishes twice a year in English with Bosnian abstracts.
Full journal text available at http://www.technoscience.ba

Content

Sadržaj

Dear reader,

You have before you the third issue of the magazine, which is, in relation to the previous two magazines, designed in a different way through the Editorial Board. It is our pleasure to have implemented the idea of individual collaboration through team work that has shown a high level of the individual teams' organisation and responsibility.

We have restructured the Editorial Board and named the heads of individual scientific fields within the area of technical sciences that are the object of interest in relation to the potentials NIA, Association for Research, Education and development, the publisher of this magazine, currently has.

The Impressum lists the heads of the scientific fields who have consolidated their areas and, within the field of their common sphere of interest, chosen the papers to be published in this third issue. Taking into account that these are eminent experts in their fields, who have great experience and have gained a high level of authority - scientific, expert and professional - we believe that this approach will bring forth a high quality work and results, visible through scientific and professional papers.

The previous two issues stated that the magazine was conceived as a publication intended to recognize technical sciences in international environment as a unique area in which joint action, cooperation and exchange through professional and scientific research is possible. In the perception of the Techno Science publication, the field of technical sciences is not limited to specific areas and branches, but is open for all matters which are in the function of technical sciences, with the aim of achieving the highest academic standards and monitoring flows of modern technology and the needs of society at the global, international level. This concept provides an opportunity for other fields of technical sciences and neither excludes new fields of research, nor limits itself to the fields, the presented papers in this issue belong to.

The new Editorial Board structure was modelled with an intent to strengthen the magazine's Editorial Board through previously established human resources presenting the greatest potential Techno Science will have in the future. Through the stated concept, NIA will establish the previously defined goals, its mission and vision. In this way, Techno Science will be placed in the centre of all events, and it will, through networking and partnership, meet the requirements for entry and indexing in the referent international scientific bases, which are the main strategic goal and task of the publication.

We sincerely hope the third issue will fulfil your expectations and that the new Editorial Board structure will contribute to the magazine's promotion, visibility and quality. To the heads of scientific fields, we wish success in their future endeavours and an open and creative approach leading to innovation and change in accordance with the development of technology and new achievements in science and practice.

The last pages of this publication contain instructions to authors available at the web site www.technoscience.ba, alongside additional important information. We would like you to freely approach us with all your proposals, suggestions and comments related to the quality and progress of the publication. Feel free to state anything you think will improve our work.

We are looking forward to our future cooperation and making each issue special with introduced changes to motivate you to become a part of the story that is Techno Science!

Amra Tuzović, Ph. D.
Techno Science Editor in Chief

Dragi čitatelju,

Pred Vama je treći broj časopisa koji je u odnosu na prethodna dva dizajniran kroz uredički kolegij na drugačiji način. Naše zadovoljstvo ogleda se u tome što smo realizirali ideju individualnog grupiranja u timskom radu koji je pokazao zavidan nivo organizacije i odgovornosti pojedinačnih timova.

Uradili smo redizajn uredničkog kolegija i imenovali voditelje po naučnim poljima unutar oblasti tehničkih nauka, a koja su predmet interesovanja u odnosu na potencijale koje Udruženje za istraživanje, edukaciju i razvoj (NIA) kao izdavač časopisa trenutno ima.

U impresumu su navedeni voditelji po naučnim poljima koji su objedinili svoje prostore i u okruženju zajedničke sfere interesovanja odabrali radove za ovaj treći broj. S obzirom na to da se radi o eminentnim stručnjacima u svojim oblastima koji imaju veliko iskustvo i stečeni naučni, stručni i profesionalni autoritet verujemo da će ovakav pristup donijeti kvalitetan rad i rezultate koji će kroz naučne i stručne članke biti vidljivi.

U prethodna dva broja naveli smo da je časopis zamišljen kao publikacija čija je namjera da se tehničke nauke u međunarodnom okruženju prepoznaju kao jedinstvena oblast u kojoj je moguće zajedničko djelovanje, saradnja i razmjena preko istraživačkih radova stručnog i naučnog karaktera. U percepciji publikacije Techno Science oblast tehničkih nauka nije ograničena na posebne oblasti i grane već je otvorena za sve sadržaje koji su u funkciji tehničkih nauka sa ciljem postizanja najviših akademskih standarda i praćenja tokova savremene tehnologije i potreba društva na globalnom, međunarodnom nivou. Ovakav koncept otvara prostore i za druga polja tehničkih nauka i nikako ne isključuje nova područja istraživanja i ne ograničava se samo na polja koja u ovom broju prezentiraju svoje radove.

Redizajn uredničkog kolegija je modeliran sa namjerom da se ojača uredništvo časopisa kroz dokazane ljudske potencijale koji će u budućnosti biti najveći potencijal Techno Sciencea. Kroz navedeni koncept NIA će ostvarivati prethodno definisane ciljeve, svoju misiju i viziju. To je put da se Techno Science stavi u centar svih dešavanja i da se kroz umrežavanje i partnerstvo steknu uslovi za ulazak i indeksaciju u međunarodnim referentnim naučnim bazama što je osnovni strateški cilj i zadatak publikacije.

Iskreno se nadamo da će treći broj ispuniti Vaša očekivanja, da će redizajn uredničkog kolegija doprinijeti promociji časopisa, njegovoj vidljivosti i kvaliteti. Voditeljima naučnih polja želimo uspjeh u budućem radu, otvoreni i kreativni pristup koji će voditi ka inovacijama i promjenama koje će biti u skladu sa razvojem tehnologije i novih dostignuća u nauci i praksi.

Na zadnjim stranicama ove publikacije nalaze se uputstva za autore koja su dostupna i na web stranici www.technoscience.ba kao i ostale značajne informacije. Želimo da imate otvoren pristup prema nama, sa svim svojim prijedlozima, primjedbama i sugestijama koje ćemo staviti u funkciju kvaliteta i napretka publikacije. Sve što mislite da će unaprijediti naš rad, budite slobodni da nam to i kažete.

Radujemo se zajedničkom putu na kojem želimo da svaki broj bude poseban, sa promjenama koje će i Vas motivirati da budete dio Techno Science priče!

doc. dr. sc. Amra Tuzović
Glavna urednica časopisa

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Sciences

Non-urban scene analysis: reactivating the bobsleigh track on Trebević mountain

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ABSTRACT

Nature can be explored and loved in little things: in drops of water, in a test tube, in a cage. But the greatest honour and pleasure of exploring nature in the large and largest is - from the foothills to the top of one giant mountain. (Conal Elliott). This analysis covers the Trebević Mountain in Sarajevo through detailed attention paid to biodiversity of flora, which adorns the mountain. Since it has significant flora, Trebević is considered to be the lungs of the city of Sarajevo. The grandeur of flora on the mountain could be seen through the botanical garden, which adorned it and a multitude of rare herbs gathered in one place, which attracted many visitors. Unfortunately, the garden was destroyed and attention is no longer paid to the plants. At the same time, other activities lost their importance, namely, the Bobsleigh track. The paper deals with a detailed analysis of flora and proposes the less demanding and more affordable solutions to reactivate the Bobsleigh track, which is one of the landmarks of this mountain.

Keywords: Eco-restoration of Trebević Mountain, habitat, flora, landmark.

Introduction

Mountains are landscapes that are the most sensitive to imbalance between nature and the human factor. Therefore, landscape protection is of key importance for successful and sustainable development of other layers. They encompass spectacular landscapes, a wide variety of ecosystems, a great diversity of species and distinctive human communities. Trebević Mountain belongs geomorphically to Jahorina Mountain. To the north, this mountain is bounded by the Miljacka River, to the south by the Kasindolski stream, to the east by Veliki Stupanj and Mali Stupanj and to the west by Sarajevsko polje. From the highest point (1629 m), there is a tremendous view of the Zvijezda, Ozren, Romanija, Jahorina, Treskavica, Bjelašnica, Prenj, Bitovnja, Vranica, Zec and Vlašić mountains. In simple terms, the structure of Trebević comprises five cliffs distributed side by side in a northwest-southeast direction, and it is this that gives the mountain its extraordinary beauty (Figure 1). Thus, it has a landscape that has a high aesthetic value with a great diversity in biological, soil and geological terms, which, together with the architectural heritage, and traditional values, as well as the proximity of the city, provides the necessary

Figure 1: A view from the Trebević Mountain towards Sarajevo city
Source: Personal archive / 26th May 2015

parameters for achieving eco, sports and recreational tourism, as well as making the visits pleasurable. All this is in line with the everyday ways of life and economic development activities consistent with the protection measures. "Category V, a protected area covers an area formed through the interaction of people and nature over time and is characterized by significant environmental, biological, cultural and aesthetic values. Preserving the interaction of people

and nature is vital to protection and sustainability of the area, with associated natural and other values." Accordingly, Trebević - an oasis of peace and greenery in the vicinity of Sarajevo – was once an important tourist and recreational centre, both in summer and winter. Today, it represents a testimony of human negligence and damage a human hand can inflict on a beautiful mountain.

The Mountain area has been affected by loss of diversity as a result of human activities, i.e. changes in land use. Mountain forests are threatened by uphill expansion of agriculture and human settlements, logging for timber and fuel wood, as well as turning them into highland pastures. Climate change largely affects mountain biodiversity by reducing available land area for organisms adapted to the cold. The pace of plant species moving uphill, possibly due to climate change, is quite high, increasing the number of species in the upper belts in the short term, but outcompeting rare species or those adapted to the cold in the long term.

This mountain was known for its botanical garden, Bobsleigh track and observatory as its most known landmarks. This is one of the reasons why many citizens fled from the polluted urban areas - to enjoy a walk in the fresh air. Accordingly, mountains offer specific activities to attract people. Lately, the constructed restaurants have attracted many citizens and in a way made this place vivid again. The Mountain is frequently visited, but people are mostly gathered around these objects, which is good from one point of view – Trebević is being visited again, but from the other side – it has many potentials to offer that are neglected at the moment and it is clear that insufficient attention is given to its reactivation. Consequently, it brings up the question: how to combine the available values of the mountain, in order to offer the activity that will return its original value and provide visitors with ample content?

Case study approach

Eco biodiversity

As a result of co-existence and a higher level of interaction between the biological and geological diversity, the whole area has a high level landscape diversity. Floristic diversity of the area is determined by geological and lithological structure and climatic characteristics.

Figure 2: A view towards the Trebević Mountain
Source: http://www.ekoakcija.com/ downloaded on 1st June 2015

"Trebević is characterised by coniferous forests (mainly spruce) on the northern slopes, and by deciduous forests on southern slopes. Also, there are many silver pine forests which are a result of anthropogenic influences. There was also an initiative to establish a botanic garden on Trebević by a group of scientists from the National Museum of Bosnia and Herzegovina." Regarding this, many locations on Trebević contain a lot of allochthonous vegetation like cultures of Picea omorika, Larix decidua, Pinus heldreichii, and many different shrubs and flora brought from all over the country. The southern parts of this mountain have always been inhabited and the land was cultivated for agricultural and livestock production. The northern parts were mainly used as forests, although many of the northern mountain slopes have been built-up over the past 20 years. After detailed analysis, the results have shown the following:
The real forest vegetation is dominated by:

- Thermophilic beech
- Oak and hornbeam or hornbeam forests
- Spruce-fir forests
- Beech-fir-spruce forests
- Hornbeam vegetation complexes with plant communities of rocks and rock creeps

Due to its potential, Trebević forest vegetation consists of:

- Hornbeam forests
- Oak and hornbeam forests
- Beech-fir-spruce forests
- Hornbeam vegetation complexes and black pine forests
- Thermophilic beech with plant communities of rocks and rock creeps

Within the entire area, there are a variety of plant communities which form different plant species. The area identified ten different ecosystems, as follows:

- The ecosystem of a pine forest on the rocks,
- Beech forest ecosystem,
- Thermophilic ecosystems consisting of coppice forests and shrubs,
- Ecosystems alternating from moderately moist to xerophilous meadows,
- Rocky substrates and talus ecosystems with pioneer vegetation,
- Spruce-fir forest ecosystem on deep soils,
- Spruce-fir forest ecosystem on shallow soils,
- Ecosystems on scattered and devastated habitats,
- Plantation sawmills (pine) ecosystems,
- Conifer plantations (fir, spruce) ecosystems.

In this area, apart from the above mentioned large number of lichen, mosses and mushrooms species, characterized by their wealth, moss phytocoenosis is very well developed in almost all parts of the area, and the highest abundance of moss can be found in damp, shaded habitats such as those unshaded by rocks in the woods, near or in watercourses themselves etc. Constant humidity made numerous streams, and an abundance of organic matter in the process of putrefaction has enabled the development of entire populations of fungi, both poisonous, and edible.

Bobsleigh track as a mountain landmark

The Bobsleigh track (Figure 3) was built for the 14th Winter Olympic Games held in Sarajevo in 1984. It was used for winter contests, two and four seater bobsleighing and sledging, and was the most difficult and most expensive project of the Olympics.

Figure 3: Bobsleigh track, Trebević
Source; Personal archive / 26th May 2015

Even after the games, the slide was self-sufficient. In addition to sporting events, it has become a favourite meeting place for young people due to the popular rubber Vučko, which is a well-known mascot for this activity. Unfortunately, the current state of the Bobsleigh track is not commendable. For many years, the Bobsleigh track is neither operative, nor is any attention paid to its maintenance. For this reason, the path is now overgrown with grass, destroyed with graffiti and has a poor general appearance. Throughout its length, the 1300 meters long track extends through the forest park where it directly interacts with the rich vegetation and consequently provides a great potential for interconnection.

Solution proposal

The Convention on Biological Diversity adopted the work programme on mountain biodiversity with a set of actions addressing the characteristics and problems specific to mountain ecosystems. It aims to conserve mountain biodiversity and maintain the goods and services of mountain ecosystems and contribute to poverty alleviation and to the achievement of the Millennium Development Goals, as well as improve the capabilities of institutions and organizations to promote conservation and sustainable use of biodiversity.

According to the main aims presented in the document "Privremene upravljačke smjernice za zaštićeni pejzaž – Trebević", prepared by the Sarajevo Canton (Cantonal public institution for protected natural areas), the two main objectives are:

- The protection and maintenance of important terrestrial, marine landscapes and nature parks with the values resulting from the interaction of people and nature through traditional management practices;
- General contributions to the preservation of biodiversity through species management within the cultural landscape and by improving the possibilities of preserving the highly exploited landscapes;

After a thorough review and adoption of guidelines for restoring parts of the mountain and a complete analysis of the current state of the flora biodiversity and other activities that the mountain offers, the proposed solution includes the field of vegetation and recreational activities. The question asked at the beginning of the work was: How to connect a

landmark mountain with the natural wealth of its vegetation. As explained above, when "Trebević" is mentioned, the first association is the Bobsleigh track, since it has a historical value for this mountain and the city as well. The Bobsleigh track is mentioned mainly in the past tense, because it was destroyed during the last war and has not been maintained ever since. In order to attract visitors and mountain lovers, a slide needs a function, which can be different than its original one. This means that the slide can have additional activity which will highlight the value of the mountain, but at the same time revive what is currently almost dead.

Figure 4: The exterior of the Bobsleigh track, Trebević
Source; Personal archive / 26th May 2015

As, Slavko Malić, one of the organizers of ZOI 84, emphasizes: "It all boils down to some sort of activities and preparation for the younger generation, the children, to keep them interested. You have, as we say, pushing the bobsleigh. When the time comes, it could be the track where one learns the technique of pushing the bobsleigh, jumping inside it, etc. But it requires hard work. Can you interest someone by only talking about bobsleighing? You must do something for these kids to see, to experience. The situation up there is really sad. If we rebuild the Trebević cable car now, the Bobsleigh track will be even greater, and we have to start rebuilding it as soon as possible."

As learned from the KJP ZOI'84, the track was destroyed during the war, and its reconstruction requires enormous financial resources, which the organization is not able to procure. In accordance with this, the proposed solution consists of the following measures:

- Cleaning the Bobsleigh track and deforestation of the overgrown unnecessary forest species;
- Presenting the Bobsleigh track as a recreation trail through the forest;
- Parts of track/trail covered with the flora specific for this mountain having a role of presenting the natural wealth and creating better visual aesthetics;
- Placing the plant labels around the flora species in order to force its importance and bring attention to it;

Figure 5: A trail of stairs next to the Bobsleigh track, Trebević
Source; Personal archive / 26th May 2015

It is important to highlight that the solution is temporary and with it an attempt is made to bring the landmark back to life with another function and at the same time present the importance of vegetation. This is proposed while having in mind the possibility of restoring the landmark's original function someday. The proposal can work alongside these measures that aim to create a prevailing and short term solution.

Conclusion

Trebević represents an invaluable heritage of the area and needs to be preserved as a contribution to the survival and wealth of people. The place is perfectly fashioned for people who would love to be a part of nature and indulge in it. With all those beautiful flora species planted all over the mountain, you will definitely be at peace with nature. By combining two very important landmarks of this mountain, an approach to a temporary solution reflecting its greatest potentials was provided. If a proper approach is used, the benefits of the mountain can be sensibly exploited and returned to its operating condition in terms of people visiting it again, not only for social, but also for recreational activities. Most importantly, Trebević, recently known as 'a forgotten resort from a fairy-tale', will benefit from another function as well. In the end, Trebević is worth the effort and should be visited. Looking to the future, one can only hope that the authorities will see how important revitalising Trebević is for the city of Sarajevo.

Techno Science
International Scientific Journal of Technical Sciences

Received: April 15, 2017
Accepted: May 20, 2017

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Analiza vangradskog područja: reaktivacija bob staze na Trebeviću

SAŽETAK

"Priroda se može istraživati i voljeti u malim stvarima: u kapi vode, u epruveti, u kavezu. Ali najveća čast i zadovoljstvo istraživanja prirode u velikim i najvećim stvarima je istraživanje velike planine od njenog podnožja do vrha."(Conal Elliott) Ovaj rad predstavlja analizu sarajevske planine Trebević sa posebnim fokusom na bioraznolikost flore koja je krasi. S obzirom na njenu značajnu floru, Trebević se smatra plućima grada Sarajeva. Raskoš flore se ogledao kroz botanički vrt koji je krasio planinu i mnoštvo rijetkog bilja na jednom mjestu, što je privlačilo mnoge posjetitelje. Nažalost, vrt je uništen, a biljkama se više ne posvećuje pažnja. U isto vrijeme, druge aktivnosti su izgubile na važnosti, kao Bob-staza, na prvom mjestu. Rad se sastoji od detaljne analize flore i prijedloga rješenja manje zahtjevnog i jeftinijeg rješenja reaktivacije Bob-staze, koja je jedna od znamenitosti ove planine.

Ključne riječi: Eko-restauracija Trebevića, staništa, flora, landmark.

Techno Science
International Scientific Journal of Technical Sciences

The analysis of Louis Kahn's Salk Institute by means of a critical analysis grid

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ABSTRACT

Research in the field of architecture offers perhaps the most versatile range of topics. However, the methods are sometimes not specifically determined. Therefore, such analysis is usually conducted by means of different value grids / critical analysis grids. Salk Institute is the most prominent building designed by Louis Kahn, often seen as a representative of modern architecture. However, the building has many pre-modern influences visible and despite the initial impression of raw concrete façade, it does have a strong human thread intertwined into all levels of its design. The purpose of this paper is to analyse Louis Kahn's Salk Institute by using the critical analysis grid consisting of 4 key factors: functionality, design, comfort and efficiency and to bring a conclusion that evaluates the validity of the given critical grid.

Keywords: functionality, design, comfort, efficiency, modernism, natural light.

Introduction

The Salk Institute in La Jolla, California, designed by Louis Kahn, was imagined as a home of science by the inventor of the polio vaccine, Jonas Salk. Louis Kahn was chosen by Salk himself, since Kahn was an artist prior to becoming an architect and Salk wanted a masterpiece, "a facility worthy of a visit by Picasso"(Jonas Salk, http://www.salk.edu/about/history-of-salk/). Kahn and Salk tightly cooperated throughout the design process, which resulted in creating a building with a striking exterior – raw concrete, but with a logical, appealing and fascinating concept, as well as the interior. This building remains one of the most fascinating masterpieces of modern architecture. Much like the thought that the only worthy homage to the glorious classical architecture is creating present-day architecture in its own unique way, spirit and values, because everything else could only be a phony imitation, Salk Institute evokes certain universal values, but doubtlessly in its unique way. This facility is a proof that classical values can successfully be not only re-interpreted, but also given a new character, combined into a fusion of different influences where the aim is not mimicking the classical values per se, but creating a greater, completely unique outcome.

Architectural values analysis

A question arises from the above paragraph: can modern architecture then be analysed by the classical architecture grid or not? Can the universal, but somewhat general architectural values applicable in all analyses – utilitatis, firmitatis, venustatis, if applied to THE new-age architecture completely evaluate it? The answer is they are always applicable, yet, more specific value factors can and should be adopted for certain analyses. The question of beauty is perhaps the most un-answered and most raised question, especially in art and architecture. Louis Kahn said: "Design is not making beauty, beauty emerges from selection, affinities, integration, love. What stays unchanged is the fact that architecture is identifier of place; only the means of obtaining that status have changed over time. There is also a question of the architectural critical grid factors validity. How to establish them? Many architects and architecture theoreticians have tried to understand and describe what makes an architectural object successful or unsuccessful, valuable or ordinary. Cristopher Alexander called it a rather hard-to-define value, "A quality without a name". He implied that

this would be a quality everyone would recognize, universal, non-mistaken, and as clear as black and white, alive or dead. It is hard to name it, but it is easily recognized when present. Such thought is agreed upon by many. Yet, there are always disputes on buildings, often whether it is a masterpiece or a controversy that some even call a crime. It is not the case only with modern and contemporary architecture; some great buildings (e.g. Casa Mila by Gaudi) were frowned upon at the time being constructed, to become highly appreciated years later. Therefore, the question whether architectural values are constant or changing remains open in this part of the work and perhaps the analysis and evaluation of the given grid will answer this question in the end. The given architectural values grid for this analysis took in consideration four key values: functionality, design, comfort and efficiency. The analysis includes inspection of available materials used for the facility, including written sources, issues the architect dealt with during construction, renowned critics' opinion, photographs, floor plans, sections, facades, materialization, current use practices and prospects for the future. The summary of the analysis is presented in the table below.

Table 1: Critical analysis grid results, source: Author

VALUE	DESCRIPTION	EVALUATION
FUNCTIONALITY	servant and served spaces; successful problem solving; clear lines; adjustability; flexibility; unmeasurable-measurable-unmeasurable phases of design	High level of functionality obtained
DESIGN	clean space, reduced lines, clear geometry; preserving and reinforcing lines of sight; strong views and vistas; strong linear axis between the entrance and the exit; mirrored structures; silence and contemplation; order and symmetry; monumentality; full-void relation and repetition lead to obtaining specific, peculiar rhythm; simplicity of forms, colours and materials; extruded walls create sense of movement in space opposed to monumentality of the structure and materialization; open views to the Pacific Ocean and the water element; the water "line" serves as a tool for pulling the outer space inside the complex; unity	Unique Symbolic Truthful High aesthetic standards achieved
COMFORT	large amount of natural light in all the interior spaces; floor plans reinforce open views; reliability; convenience; flexibility; different materialization in different zones – easy recognition of the "allowed" and the "foreign" zones	High level of comfort both in the interior and the exterior spaces; ease of communication; simplicity of movement obtained
EFFICIENCY	underground spaces illuminated by light wells; natural lighting used as much as possible; open plan laboratory spaces enable future transformation; the used material will not decay easily and requires minimum maintenance	High level of space usage efficiency, energy efficiency and future transformations possibility obtained

Functionality

The well-known discussion whether form follows function or the architect follows the image and idea first is a topic with still open questions. Yet, the idea that form follows function was becoming more and more recognized by modern architects. One of the best-known is Louis Sullivan: "It is the pervading law of all things organic and inorganic, of all things physical and metaphysical, of all things human and all things superhuman, of all true manifestations of the head, of the heart, of the soul, that the life is recognizable in its expression, that form ever follows function. This is the law." Regardless of the fact that Kahn is a modern architect, these questions will not be discussed here. Instead, it is the Kahn's ingenuity in designing the Salk Institute what matters. The architect literally dismantled numerous different obstacles during the design process. One of them was the question of form and function. Actually, it seems it was not a question for Louis Kahn at all. The final product – Salk Institute reflects an image of a facility created by solving issues on several levels simultaneously and giving equal attention to

all the aspects – function, form, materials, efficiency, comfort... The means by which he accomplished this can be the distinguishing between "servant" and "served" spaces, i.e. those used by humans and mechanical ones, such as pipes or stairwells, with a significant point that utilities go directly through the structure. In conclusion, he was neither strictly modernist, nor formalist, so his design relied on a humanist approach. One word that best explains the whole space concept and functionality in terms of space arrangement is adjustability. The laboratory spaces are clean and can easily be modified in future, which can be characterized as flexibility, a concept crucial in contemporary design.

According to the Visual Dictionary of Architecture, functionality is defined as "being appropriate for natural or proper action for which something is designed, used or exists." In order for the building to be appropriate for that which it is designed for, but also to have the outcome is what many will admire later. Louis Kahn said that the designer must not forget being realistic during the design process.

"A great building, in my opinion, must begin with the unmeasurable, go through measurable means when it is being designed, and in the end must be unmeasurable. The design, the making of things, is a measurable act. At that point, you are like physical nature itself, because in physical nature everything is measurable—even that which is as yet unmeasured. But what is unmeasurable is the psychic spirit. The psyche is expressed by feeling and also thought and I believe will always be unmeasurable.

I sense that the psychic existence-will calls on nature to make it what it wants to be. I think a rose wants to be a rose. Existence-will, man, becomes existence, through nature's laws and evolution. The results are always less than the spirit of existence. In the same way, a building has to start in the unmeasurable aura and go through the measurable to be accomplished. It is the only way you can build. The only way you can get it into being is through the measurable.

You must follow the laws, but in the end, when the building becomes part of the living, it evokes unmeasurable qualities. The design involving quantities of brick, method of construction, engineering is ended and the spirit of its existence takes over. The concept of observing the building through unmeasurable-measurable-unmeasurable phases is perhaps the tool by which both high functionality and aesthetics of the building were obtained.

Design

This point in the value grid is very broad and can be analysed through a number of different sub-points. Through Kahn's opus, his strong sense for preserving and creating lines of sight is visible, which is an important design criterion. Salk Institute is not an exception either. The geometry of the building complex is based on symmetry, which additionally reinforces the views and vistas concept. A strong linear axis between the entrance to the complex and the "exit" (symbolic) to the Ocean exists and enables the direct views.

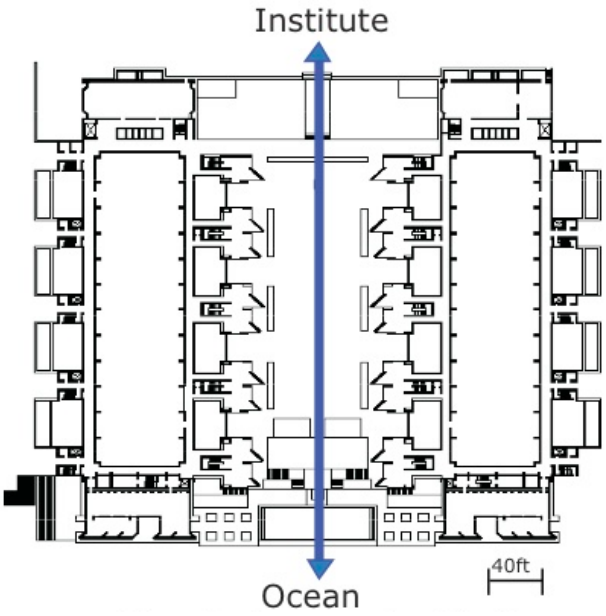

Figure 1: Visual connection through the complex. Source: https://arch220.files.wordpress.com/2012/02/salk-institute-hazal2.jpg, Accessed on 2nd May 2017

The vast and empty plaza in between the mirrored structures reflects the architect's value for silence and contemplation. The mirrored structures embody order and symmetry. Paradoxically, monumentality is obtained through raw concrete. Such use of this material is another proof of Kahn's virtuosity.

According to Leslie, one can see Kahn's "philosophical appeals to such metaphysical values as light, silence, and order". Silence here is expressed through "void" (courtyard) between full spaces – buildings. It is silence both in rhythmical and experience (live) sense. Additionally, there are no trees, just water, the symbol of contemplation. This can additionally be connected to the image of a scientist in our minds – a person who deeply thinks, reflects, contemplates, and observes, often in silence.

Figure 2: Salk Institute, La Jolla California
Source: http://issuu.com/seasirisilp/docs/louis_kahn_final, accessed on 4th May 2017

Rhythm is one of the key determinants of this building (Figure 2). Repetition of the same form in the building plan and facades evokes the repetition of classical columns. The purpose is to enhance the monumentality effect of the building and reinforce the views from the plaza.

Figure 3: Salk Institute, view to the Ocean
Source: http://home.wxs.nl/~jvansant/z_kahn.html, accessed on 4th May 2017

In the simplicity of form, colours, material and peace of environment, the extruded walls suddenly seem to be dancing in space, which is an unexpected and refreshing moment in the whole concept. Their repetition and such rhythm gives a spiritual and almost zestful vibe to the design and space. Another highlight of the design is open view to the Pacific Ocean and the water element which is contrary to the modernist "ornamentation is crime" slogan. Yet, we cannot say that this design is deprived of ornamentation. Kahn stayed far from the ornamentation in its first meaning, but not from that of broad, individual and deeper layers considerations. For example, the water element again; it is the utmost ornamentation purpose element here, in an environment of clean space, reduced lines, clear geometry. For Salk Institute, this element is what extensive sculptural ornamentation is for Baroque.

Furthermore, the water "line" serves as a tool for pulling the outer space inside the complex. Using the site characteristics at its best potential is often difficult, but if proper, always rewarding for the project. "Architecture is more to do with making frames than painting pictures; more a matter of providing an accompaniment to life than the dance itself. (...) It is also possible to compose works of architecture, in townscape or landscape, as if they themselves were objects in a picture, maybe to be seen from a particular point of view or ready to be painted by an artist."

Salk Institute is both of the above. The architect "framed" the fragment of the Ocean view by two mirroring structures and the courtyard. The framing also contributes to the element of silence, both physically and psychologically. Framing seems to be Kahn's speciality; a similar effect can be observed in his National Assembly Building in Dhaka, Bangladesh, where the effect is somewhat widened to "controlling the space", or shaping it.

By designing the Salk Institute, Kahn also composed a picture consisted of several elements: two facilities, vast courtyard, water element in it and its perhaps subtle, but strong psychological relation to the surroundings. Louis Kahn said: "Architecture is the reaching out for the truth."

Now, how much more truthful than they are could the raw-concrete facades be? Such finish (or lack of it) can be correlated to the Georges Pompidou Centre's philosophy. What is, should be seen as such. Even the formwork marks on concrete were left visible. Apart from the maintenance role described in the following paragraphs, such choice of material has other design purposes as well.

As emphasized above, using the site characteristics to their limits, regardless of whether in full compliance, or finding a reasonable contrast to it, but with sense, reinforces both the design and the nature, which so become support one for the other. The Salk Institute case is such, since a rather dull material, concrete with no finish, only emphasizes the beauty of the surrounding nature. Additionally, the building may seem to have followed the "Less is more" slogan.

However, I think that it is the building's character what defined it as it is, not the above mentioned slogan. If we imagine (or see) the building in different environment, under somewhat changed conditions, e.g. at night, the light and shadows are its modifiers and key properties of its design.

At the same time, the courtyard stays as mediator, as the antithesis to the sky above. In conclusion, it is important to emphasize that none of the elements and motifs used are there per se. Each movement has an explanation, cause and consequence, reasoning. For example, the monumentality which the architect himself spoke about might seem to mimic the classical architecture at first sight. On the contrary, it only praises the means by which it was obtained in the past – materials, scale, rhythm (and columns, here obviously left out with reason).

In the past, temples were the most monumental types of buildings. The real reason for creating such atmosphere in the Salk Institute is the Story of the building. It is imagined as a temple, shrine of science where all those seeking knowledge and who can benefit humanity can come and "pray" – learn and produce. Through our formal architectural education, our teachers and assistants have always emphasized the importance of such design approach. Therefore, I highly value it and conclude the Design point of analysis with praise to reasoning in design process that yielded the immeasurable values.

Comfort

Comfort can be observed as a measurable and unmeasurable value. It has its objective, easy to define part and the subjective one, changeable from person to person. The building exterior's key determinant is concrete, which is somewhat brutal and raw, both objectively and subjectively. In contrast, the interior satisfies users' comfort needs; the material used is wood. However, comfort in the exterior space is reflected in a vast courtyard, the water element in it and views to the ocean. Kahn respects the space immensely; the sense for views and vistas is visible in many of his works, perhaps the best being the Four Freedoms Park, where we can see the same element of approaching a distant point in space, as in Salk Institute with the water element in the courtyard. In the interior, comfort for all users is visible in a large amount of natural light in all the spaces of the building. The architect's passion for natural lighting is well-known and present in his many works. However, this case was a real energetic struggle for each beam of sunlight, more described in the following section, Efficiency, both with purpose to save the energy, but also to bring comfort to people, because that is what will bring the people to the building. Furthermore, the floor plans are such that they enable excellent viewpoints to and from the standing points, which offers a sense of reliability and comfort and is convenient for academic purposes buildings.

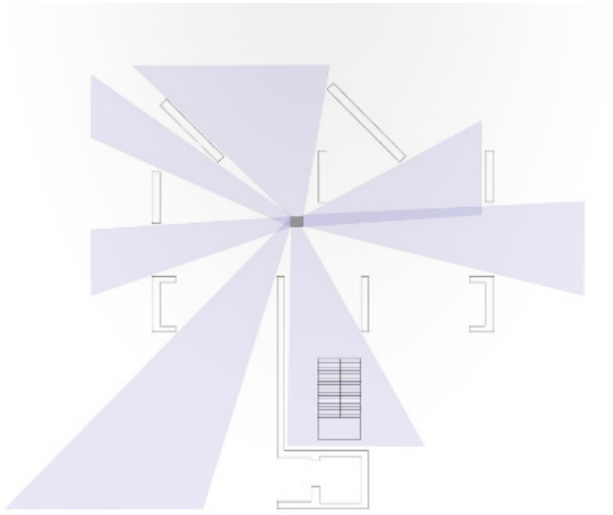

Figure 4: Floor plan 1; viewpoints diagram
Source: http://issuu.com/seasirisilp/docs/louis_kahn_final, accessed on 2nd May 2017

In order to additionally differentiate between served and servant spaces, Kahn used different materials in different zones, which is also helpful for users and visitors, who can easily recognize the "allowed" and "foreign" zones.

Efficiency

It is interesting that the local building height codes implied certain restrictions in terms of number of storeys above ground. As the laboratories and offices required a lot of space, Kahn decided having 2 storeys underground. At the same time, comfort and aesthetic requirements included natural light. Kahn solved this problem efficiently, by introducing light wells that bring a lot of daylight into the underground level laboratories. In terms of efficient use of space with respect to the future, most of the laboratory spaces are open plan, due to the need research laboratories had for change over time.

Efficiency in terms of material maintenance and time flow effects are the best expressed efficiency aspects in this building. The used material will not decay easily and requires minimum maintenance.

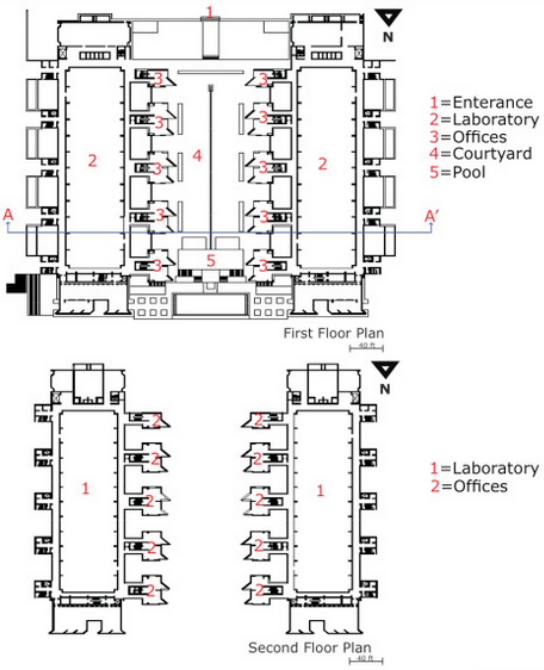

Figure 5: Floor plans, efficiency of space
Source: http://issuu.com/seasirisilp/docs/louis_kahn_final, accessed on 4th May 2017

Such choice is again related to the design and the Story: it is not the building, but what takes place in it that should be admired. Here, the building is yet another tool in service of mankind and choosing concrete reinforces this idea.

Conclusion

Even though represented as a modern architect, Louis Kahn expressed his own, unique style and very strong character in designing the Salk Institute. Pre-modern, even classical architecture influences are present in this masterpiece. Regardless of appearing raw at first sight, perhaps some would see it even as a show-off of modern architecture and frown upon the Institute building, through this analysis, it became very clear that a deep understanding of human behaviour and their needs, as well as an extraordinary sense of space and moulding the visions of future into the present, shapes and forms were the core parts of this design. The building is a complete work, with careful approach that can, after having finished this analysis, I understood, easily satisfy probably any architectural value grid we could set. In terms of the given critical grid itself, the conclusion is that the grid is successfully arranged, since the above described four key points (functionality, design, comfort and efficiency) do summarize the most important aspects of this building's design and do answer key requirements of the nature and purpose of this building.

Received: **April 20, 2017**
Accepted: **May 25, 2017**

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Analiza objekta Salk Instituta (Louis Kahn) putem kritičke analize

SAŽETAK

Istraživanje u oblasti arhitekture obuhvata najraznovrsnije teme. Međutim, metode istraživanja ponekad nisu specifično determinirane. Stoga se nerijetko kao sredstvo istraživanja koriste različite matrice kritičke analize. Salk Institute je najistaknutije djelo Louisa Kahna, često smatrano predstavnikom moderne arhitekture. Uprkos prvoj impresiji korištenog neobrađenog betona, objekat odiše prilagođenošću čovjeku na svim nivoima dizajna. Svrha ovog rada je analizirati Kahnov Salk Institute korištenjem kritičke analize koja se sastoji od četiri osnovna kriterija: funkcionalnost, dizajn, komfor I efikasnost, te u konačnici evaluirati I relevantnost postavljene analitičke matrice.

Ključne riječi: funkcionalnost, dizajn, komfor, efikasnost, modernizam, prirodno osvijetljenje.

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Architectural concepts of contemporary skyscrapers

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ABSTRACT

Nine thousand years of architectural history were marked by human efforts to build tall structures, as evidenced by the remnants of the Egyptian pyramids, the Tower of Babel, pagodas in China and Japan, minarets of mosques in the East, etc. The explosive growth of the urban population has led to the emergence of megalopolises / megacities, large urban agglomerations. Megalopolises have become symbols of our urban age. It is impossible to imagine a megalopolis without its third dimension represented by the skyscrapers. Regardless of their content or primary function, skyscrapers have been named differently throughout history. It is very hard to say why one decides to use one term instead of another: tower, skyscraper, high-rise building, etc. Today, skyscrapers are becoming increasingly popular in rich countries, as well as in the large city centres. They are built not only in order to save space, but are also considered to be symbols of cities, i.e. of the economic power, like temples and palaces were in the past. Skyscrapers are architecturally dominant features, markers in the urban area. They represent their owners' concentration of power and money in today's metropoles. They not only define the horizon, but also help define the city identity. By constructing skyscrapers, the struggle for supremacy and records in achieving heights reaches its peak in the modern, global capitalist society. Today, skyscrapers represent a great achievement of modern technology and cannot be a priori rejected. This article attempts to explore the architectural concepts of modern skyscrapers, the need for high-rise structures, as well as their utilitarian and symbolic aspects.

Keywords: skyscraper, architectural concept, forms.

Introduction

Given the wide range of skyscrapers (towers) usage from their very beginnings until today, it is hard to define them accurately. In addition to the height, as its main characteristics, a high-rise building is denominated according to its construction and typological determinants, according to its use, function, designers, investors, owners, etc. The naming itself is based on the tradition of identifying buildings in architecture and art, spontaneity and acceptance of colloquial identification and recognition. Regardless of their content or primary function, skyscrapers have long since been given different names and it is very difficult to say why one decides to use one term among the others: tower, skyscraper, high-rise building, etc. Some architects believe that a tall building is the building whose main dimension is height and which dominates its surroundings. According to this theory, a church in a village with only two-storey houses which is 18.2 meters (60 ft.) tall, is indeed a tall building, but a 61 meters (200 ft.) tall skyscraper built in a business city centre is not, because it loses one of its essential features - dominating its surroundings among other buildings. Regardless of how we name the skyscrapers today, whether we like them or not, they do cause increasingly frequent controversies and discussions. In addition to the controversy related to the naming of skyscrapers, controversy and discussions on building skyscrapers and living in them emerge. However, regardless of the existence of these polemics, there will always be reasons for and reasons against building skyscrapers.

Historical overview

Construction of the first modern skyscrapers was triggered by the American entrepreneurial spirit and technological achievements (steel structures, elevators). Their instant spread in the city centres is a result of mutual interaction between two factors: the need for a growing concentration of people and a large increase in land prices. Despite the fact that the economic factors and the imperative for a continuing increase in urban density will remain the main actors

in the skyscrapers story, their considerable symbolic potential cannot be neglected. Thousands of workers have been working on the pyramids of ancient Egypt, European cathedrals and countless other towers, all in an effort to create something awe-inspiring.

Ego and grandeur sometimes play a significant role in the building process, just like in the ancient civilizations. People have always aimed to build facilities as tall as the technical possibilities had enabled. A lot of skyscrapers in today's metropoles represent a concentration of power and money belonging to the modern global capitalist society. The first modern tall building originated in Chicago. The architect of the first "skyscraper", the Home Insurance Building, was William Le Baron Jenney.

This was the first building created by means of new possibilities of using steel with the simultaneous invention of the vertical transportation device - the elevator. The Home Insurance Building is an example of the Chicago School of Architecture. At the end of the 19th century, basic prerequisites for the construction of skyscrapers and solving complex technical and static problems were met in America.

Economic interest had inevitably led to construction of taller and taller buildings, since the increase in land prices in the city centres, which the US economic activity was focused on, demanded exploiting every square meter of land parcels and solving problems of high-rise building construction

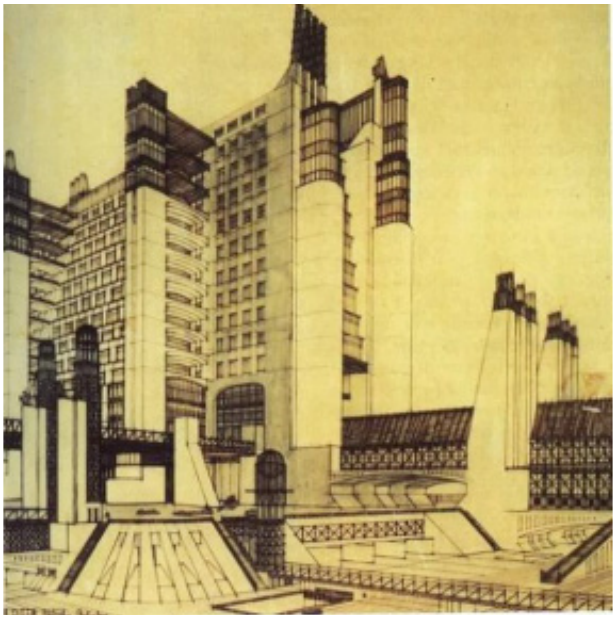


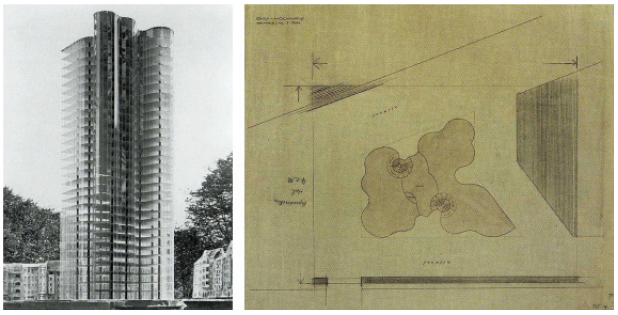
Figure 1: A city according to Antonio Sant'Elia

brought about extraordinarily large amounts of money on the real estate market. On the other hand, there is a considerable reserve towards the construction of skyscrapers in Europe. Although their elegant form can represent a manifestation of optimism, openness and economic vitality, they are usually associated with urban anonymity and uniformity as well. However, the biggest complaints are caused by the environmental insensitivity.

Although skyscrapers occupy several times less land than low-rise buildings of the same volume, much more energy is spent on their construction and exploitation. The difference between the American and the European type of skyscraper construction is the fact that the American architects had carte blanche, while their colleagues from Europe were always facing bureaucratic "problems" in the design of skyscrapers. Antonio Sant'Elia was among the first ones who thought of high-rise building construction.

In 1914, he dreamt of a concentrated city full of towers linked with traffic infrastructure on several levels. In 1921, Le Corbusier made a project for a city with one million inhabitants, 24 skyscrapers, each having 60 storeys with 95 % of spare land. He justified the introduction of skyscrapers into residential zones with the possibility of preserving large areas of free green spaces.

In 1922, in an unknown location in Berlin (it is considered to be a city square or a traffic roundabout), Ludwig Mies van der Rohe envisioned a skyscraper with a glass facade (Friedrichstraße). The geometry of the "crystal" skyscraper, Friedrichstraße, was a biomorphic plant project with a core and three wings. Given the circumstances and possibilities of building this skyscraper at that time, the project was unmanageable. Since then, and until today, the idea of constructing the vertical city did not die.



Figures 2 and 3: Mies van der Rohe's Friedrichstraße skyscraper's facade and plan

Construction, design and form

Several technological advances, which had occurred in the late nineteenth century, enabled the design and construction of skyscrapers. These include mass production of steel, the invention of a safe and efficient elevator and the development of improved techniques for measuring and analysing structural loads and stresses. During the 1920s and 1930s, the development of high-rise buildings was further improved by the discovery of the electric arc welding device and fluorescent lamps. In the traditional construction method, the building walls supported its structure, while the larger structures required thicker walls.

Sixteen buildings that were constructed in Chicago in 1891 had a wall thickness measuring 1.8 m in the base (ground floor). The need for building thick walls was eliminated by the invention of steel structures (frames), in which the rigid steel skeleton supported the construction's weight. The first building made by using steel structures was the Home Insurance Building, built in Chicago in 1884.
Each skyscraper represents a unique structure designed in accordance with the physical limitations. It is determined by factors such as geology, climate, the needs of the tenants and meeting aesthetic goals of the owners and the architects. Therefore, both the construction and the design of each skyscraper are unique. At the beginning of high-rise building construction, the design was conditioned by the construction of the building itself, while today these relationships are much more flexible.

The emergence of the world's tallest building forms is closely related to the technical advances that had enabled the implementation of creative solutions as architectural landmarks of cities. Since the late nineteenth century to the present day, the development of skyscraper forms has followed the style and development conditions. It resisted the crisis situations and served to achieve the objectives of modern society, following the dynamics of its development. Tied to strict building regulations of cities, these buildings often took shape of land parcels. Yet, some of them were in contrast with land parcel forms, but almost each of these projects carried its own message, a symbolic instance, urban and architectural uniqueness. Taking into account the emergence of skyscraper forms in the past and the trend in rapid growth of land exploitation in the cities, as well as progress in terms of structural design and building materials in the construction industry, we can expect the emergence of unique, freer and architecturally more complex structures in the near future.

Case study 1 – The Home Insurance Building, William Le Baron Jenney, Chicago 1885

Enabled by the discovery of new building techniques and the invention of the elevator, the first skyscraper was built in Chicago, in 1885. The Home Insurance Building was designed by William Le Baron Jenney. The improved steel structure ensured inner support, which meant that, unlike before, the external walls no longer needed to carry the self-weight of the floors. The building had 10 floors, was 42 meters tall and weighed one-third of the weight it would have had, if it was constructed using standard materials, such as stone.

Despite the fact that it rested on the skeleton system as the primary load-bearing structure, later studies discovered that one part of the load had had to be transferred to the external walls and other building elements. The building was demolished in 1931, but it is still considered a pioneer in the development of the world's skyscrapers, because its architecture and structure had triggered a rapid development of ideas about the possibilities of high-rise building construction. From then on, the administrative buildings, business city centres, housing and multifunctional facilities with skyscraper form have become new architectural landmarks of cities.

Primary purpose	The building was made for an insurance company (people and property insurance)
Spatial organization	Square-shaped building plan, vertical communications are placed in the core, office spaces are arranged around the vertical communications
Structural concept / structure	Simple, prism-shaped building was the basis for future skyscraper construction; the skeleton structural system was resting on stone pillars
Architectural and technological aspect	First building made from steel structures and using an elevator

Figure 4: The Home Insurance Building

Case study 2 – The Chrysler Building, William Van Alen, New York, 1930.

We can state that, at the beginning of skyscraper development, buildings used to inherit the stylistic characteristics of movements prevalent in the world at the time. Thus, the Chrysler Building in New York was built in the Art Deco style, which found its inspiration in the archaeological discoveries from Egypt. The form of this building contains various elements that mimic parts of Chrysler cars.

The facade finish contains numerous geometric elements. The shape of the building is prismatic in majority of its mass, from ground level to the top, while only the upper zones are semi-oval shaped, pulled toward the vertical axis of the building, narrowing down to the top, i.e. the car heater – shaped lance. The upper zone windows are triangular-shaped and follow the oval shape with their positioning on the facade. The rhythm on the facade is achieved by coupling windows and grouping them vertically, while the facades are symmetrical.

Figure 5: Spatial diagram, The Home Insurance Building, 42 m

Primary purpose	Car manufacturer company office building
Spatial organization	Square-shaped building plan, vertical communications are placed in the core, office spaces are arranged around the vertical communications
Structural concept / structure	Simple, prism-shaped building with semi-oval surfaces on the top; steel skeleton structure consists of two cores (the inner core made of steel and the outer core made of concrete)
Architectural and technological aspect	Innovative solutions with stainless steel facade surfaces

Figure 6: The Chrysler Building

Figure 7: Spatial diagram, The Chrysler Building, 319 m

Case study 3 – The Seagram Building, Ludwig Mies van der Rohe, New York 1958.

The Seagram Building skyscraper had a great influence on American skyscraper architecture. Alike almost all skyscrapers at that time, it was constructed using skeleton type steel frames with non-structural hanging glass facades. This skyscraper has a distinctive style through which its external structure is articulated. The style is actually a mixture of the functional and decorative structure pertaining to the load-bearing elements. The architect of the Seagram Building, Mies van der Rohe, strived both for the visibility and the decorative role of the structural elements. He wanted to make all steel (load-bearing) frames visible, but the American building regulations did not allow it (steel must be coated with fire -resistant materials – usually concrete). However, he wanted to avoid covering it with concrete at all costs. Therefore, for the first time in the history of skyscraper construction, he used non-structural bronze stressed pillars, visible from the outside. The Seagram Building was the most expensive skyscraper at that time due to the use of expensive, high-quality materials and interior elements.

Primary purpose	Office building
Spatial organization	Square-shaped building plan, vertical communications are placed in the core, office spaces are arranged around the vertical communications
Structural concept / structure	Prism-shaped building, steel frames structure with bronze exterior columns
Architectural and technological aspect	Use of bronze as non-structural exterior facade and space ventilation

Figure 8: The Seagram Building

Case study 4 – The Sears Tower, Skidmore, Owings & Merrill (SOM), Chicago 1974.

A system of connecting several elements into one mass that is much lighter and more stable in comparison to the monolithic structure of the same usable area, was applied in the design of the Sears Tower skyscraper in Chicago. Taking its form into account, we can say that the building was created by subtracting mass from the major, prismatic mass. In this way, a stepped structure narrowing down towards the top was created making its form appear lighter. The materials used for construction are steel covered with black aluminium and glass with an addition of bronze paint, which creates a hot – cool contrast in terms of colour on the facade.

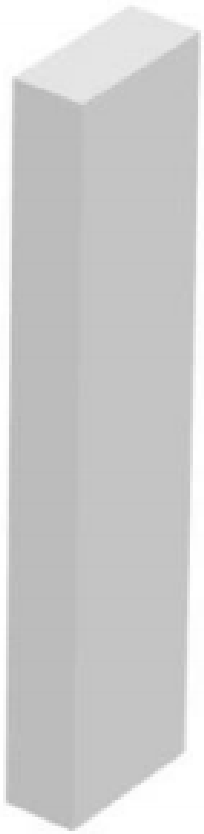


Figure 9: Spatial diagram, The Seagram Building, 157 m

Primary purpose	Large trade corporation office building
Spatial organization	The building plan consists of nine squares with their own communication cores in the middle and office spaces around them
Structural concept / structure	The building was formed by subtracting masses from the main prism-shaped mass; a steel structure covered with black aluminium and glass with an addition of bronze
Architectural and technological aspect	Steel frame with exterior tinted glass coating

Figure 10: The Sears Tower

Figure 11: Spatial diagram, The Sears Tower, 442 m

Case study 5 – Menara Mesiniaga, Kenneth Yeang, Malaysia 1992.

Menara Mesiniaga are the headquarters of IBM in vicinity of Kuala Lumpur. This skyscraper is the result of a ten-year-long research on tall buildings and skyscrapers bioclimatic design principles made by architect Kenneth Yeang. Its structure consists of "green" gardens, ten floors of office space with terraced garden balconies and exterior cooling openings. The skyscraper roof is designed to exploit solar energy (sunroof). A pool through which the solar panels were placed is located on the roof as well. Natural ventilation enabled in the building accounts for its cooling energy savings. Using the environmental design, the architect managed to reduce long-term maintenance costs by reducing the standard energy sources. Apart from large energy savings, Kenneth Yeang managed to keep a high level of the facility aesthetics by designing Menara Mesiniaga skyscraper based on bioclimatic principles. Menara Mesiniaga skyscraper received the Aga Khan Design Award in 1995.

Primary purpose	IBM corporate headquarters
Spatial organization	The building plan is round-shaped; communication core and technical infrastructure are placed along the edge; office spaces are organized in the remaining area
Structural concept / structure	The building is based on two spirals twisted on specific floors to provide shading and visual contrast of steel and aluminium surfaces
Architectural and technological aspect	The world's first bioclimatic skyscraper with a natural cooling system

Figure 12: Menara Mesiniaga

Figure 13: Spatial diagram, Menara Mesiniaga

Case study 6 – The Petronas Towers, Cesar Pelli and Associates, Kuala Lumpur 1998.

The Petronas Towers skyscraper form narrows down towards the top, while the repetition of the horizontal floor module is reduced in number. When analysing the building plan, it is evident that there is analogy with ornaments of Islamic architecture. By analysing the form, we can conclude that the building is symmetrical, balanced and there is a harmony between the individual elements, as well as between the elements and the whole.

Despite being technically well-founded, the form is created with a sense of respect for geometric and mimicking the natural forms. Its plan is developing dynamically along the vertical axis, moving the mass towards the top, so that the building resembles a corncob strongly bonded to the plant stem (i.e. to the ground, in this case).

Primary purpose	The facility was built for the business needs of petro- chemical industry companies
Spatial organization	The building plan consists of two main and two smaller "circles", the central communication core is placed in the middle and other functions are organized around it
Structural concept / structure	The building consists of two main and two smaller towers that resemble a corncob; the basic parts of the structure are steel and concrete with a glass facade which contains elements of Islamic architecture
Architectural and technological aspect	Mastering seismology in skyscraper construction and connecting the two towers at a high altitude

Figure 14: The Petronas Towers

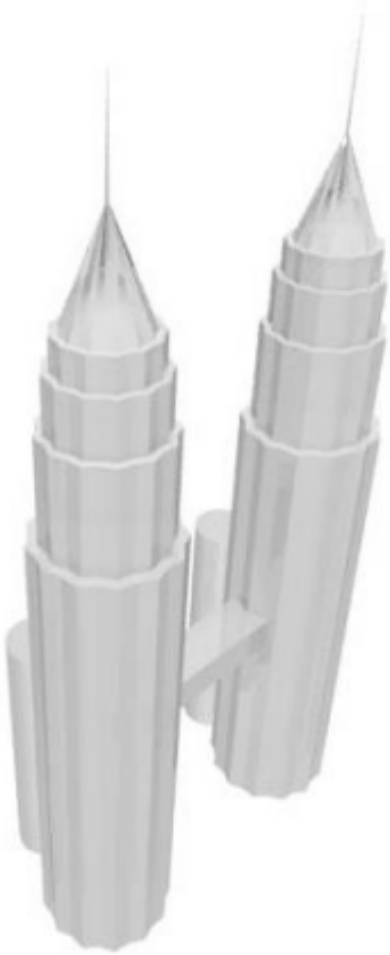


Figure 15: Spatial diagram, The Petronas Towers, 452 m

Conclusion

Whether we like it or not, skyscrapers, regardless of their height, today cause increasingly frequent controversy, polemics and discussions. Despite many existing definitions, it is very difficult to make a general one which would be generally acceptable for skyscrapers, the one that would suit each city, different latitudes, people, etc. Today, skyscrapers represent a great achievement of modern technology and cannot be a priori rejected. During the construction of a skyscraper, factors including specific conditions shaping the design process, social environment and time of construction must be taken into account. Furthermore, we should also note that economic interests have influenced the design of the skyscrapers due to the increase in land price in central parts of cities, which caused exploitation of each square meter of land parcels. The key issue regarding the existence of skyscrapers is the correct choice of location, as well as the appropriate number and arrangement of skyscrapers in the city context. As a symbol, the skyscraper represents a demonstration of power, and is therefore the ideal promoter of the corporate image, as well as a sign of a globalized world economy. In general, we can conclude that the construction of skyscrapers in larger dimensions still seeks the ideal form. However, this search does not include repetition, generally speaking, as each new building adds something new to the history of the skyscraper construction, in technological, aesthetic, or both of these aspects. This article can serve as a starting point for future research on:

- The development of human (green) design of skyscrapers,
- Ideal forms of skyscrapers,
- New designs and new technological developments in the field of skyscraper construction.

Techno Science
International Scientific
Journal of Technical
Sciences

Received: April 25, 2017
Accepted: May 20, 2017

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Arhitektonski koncepti savremenih nebodera

SAŽETAK

Devet hiljada godina arhitektonske historije označene su humanim naporom da se gradi u visinu, što potvrđuju ostaci egipatskih piramida, babilonskih kula, pagode Kine i Japana, munare džamija Istoka. Eksplozivni rast gradskog stanovništva doveo je do pojave megalopolisa/megagradova, velikih gradskih aglomeracija. Megalopolisi su postali simboli našeg urbanog doba. Nemoguće je zamisliti sliku megalopolisa bez njegove treće dimenzije koju predstavljaju neboderi. Neboderi bez obzira na sadržaj ili svoju primarnu funkciju, dobile su seriju naziva i vrlo je teško reći zbog čega se čovjek odlučuje da upotrijebi jedan između ostalih: toranj, neboder, oblakoder, soliter itd. Danas su neboderi sve popularniji u bogatim zemljama kao i u centrima velikih gradova. Oni se grade ne samo za „uštedu" prostora, nego se smatraju simbolom grada, tj. ekonomske moći, kao što su bili hramovi i palače iz prošlosti. Neboderi su arhitektonske dominante, biljezi u urbanom prostoru, oni u Današnjim metropolama predstavljaju koncentraciju moći novca njihovih vlasnika. Oni ne samo da definiraju horizont, nego pomažu definirati i identitet grada. Borba za primat i rekorde u dostizanju visine gradnjom nebodera dostiže svoj vrhunac u savremenom, globalnom kapitalističkom društvu. Neboderi danas predstavljaju veliko dostignuće savremene tehnologije i ne mogu se apriori odbaciti. Ovaj članak će pokušati da istraži arhitektonske koncepte savremenih nebodera, potrebu visoke gradnje, njihove utilitarne i simboličke aspekte.

Ključne riječi: neboder, arhitektonski koncepti, forme.

Techno Science
International Scientific Journal of Technical Sciences

Using QR codes as the target for augmented reality applications

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ABSTRACT

Augmented Reality is a new technology which uses mobile or stable device cameras to enrich the real world with computer-generated content. To make the connection between real and computer-generated world, it is necessary to correctly read the Image Targets and link the coordinate systems of the real (camera recorded) and imaginary computer-generated content. This paper presents a method of using the generated QR codes as Targets for augmented reality applications. The study shows different QR code readability results in various reading angles. The analysis of the results obtained to determine the influence of the type and number of entered characters, QR codes resolution and colour on their readability in augmented reality applications has also been conducted.

Keywords: augmented reality, readability, QR codes.

Introduction

At the beginning of their use, bar codes exclusively served for facilitating the sale of goods, informing quickly about the product price, the situation on the stock and the origin country. Developing technology and the rapid way of life have created the need for a faster and easier way of getting information.The expansion of smart mobile devices has led to an increase in the possibility of using barcodes and their development into the so-called two-dimensional barcodes.

Today, the most popular barcodes in this group are QR codes (Quick response codes) whose application, among other things, found a place in the marketing industry. The most common application of QR codes is that after scanning them, they load a website or a text content if there is no space for it in the area occupied by a single QR code.

Further development of technology brought augmented reality, which can be applied as a form of information for advertising or even in education. Augmented Reality is a technology that uses mobile or stable devices cameras, and enriches the real world by computer-generated content. Combining QR codes and augmented reality gives us different features, but in today's world of smart mobile devices, the combination of these two technologies can be applied in various ways. An example of applying augmented reality in a smart mobile device (Figure 1).

Figure 1: Augmented reality application informing about the contents of the location

Displaying augmented reality is carried out by proper mobile or desktop application which must contain the camera and display. The application works on the principle of detecting markers that are used as the basis for setting up a computer-generated coordinate system through which the augmented reality will appear. This paper explains the use of QR codes for augmented reality tracking markers.

Problem identification

In the experiment, QR codes were applied as augmented reality targets which were scanned with a mobile Android device using the device camera. Then, using the augmented reality application and based upon the target, a 3D cube shape representing the augmented reality content will be formed. The scanning process is performed at different angles and a fixed measuring distance from the QR code being displayed on a computer monitor.

To generate QR codes, a program called Barcode Generator has been used. Once the codes are generated, they are placed on a website called Vuforia developer to test the rate of their applicability for augmented reality targets. A programme called Unity has been used to generate the augmented reality application. Using Unity, a 3D object (cube) has been created and placed at the scene along with the Targets - 2D objects or QR code images in a square shaped .jpg format. The application has a total of 24 targets (QR codes) in many variations, and each is set in such a way that a 3D object (cube) appears in front of each target when read by an (Android device) camera.

Methods and tools

For the purpose of this experiment, a mobile phone Samsung Galaxy S5, computer monitor Samsung SyncMaster T220 and the device for mounting a mobile phone with the ability to adjust the angle in relation to the monitor screen from which the codes are read, were used (Figure 2). The monitor was used to display targets (QR codes).

After mounting the mobile phone in the cradle and placing the monitor in the proper position relative to the phone, the augmented reality application for reading QR codes and generating augmented content has been started.

The measurement of each code was performed in several ways. By continuously rotating the device for adjusting the measurement angle from 90 ° to 180 ° and rotating it from 90 ° to 0°, all the while tracking the point in which the 3D object disappears from the phone display. In addition to this mode, another test, i.e. measuring the appearance of the 3D object when the device is continuously rotated from 0 ° to 90 ° and from 180 ° to 90 °, was conducted. This way of measuring determined the angle degree up to which the app will be able to display the 3D object in relation to the type of QR code. QR code reading in augmented reality application works on the principle of target location memory. If the code has already been scanned, 3D objects will keep running even after the sharp position of the mobile camera causes the loss of target image, or if it is partially covered, because the shape found at the site of the lost code will be treated as the target image for a while.

The 3D object will appear when the camera lens is covered and then uncovered, even though the scanning angle of the camera position in relation to the monitor changed in the meantime and regardless of whether it is just the memory retention of the QR code position, no longer readable under the given angle. The research was conducted in this way to determine the stability of the 3D object generating regardless of the change in angle due to interruption of the visual line between the camera, the target, and readability of the code. It should be noted that the laboratory, where the experiment was conducted, had indirect natural light.

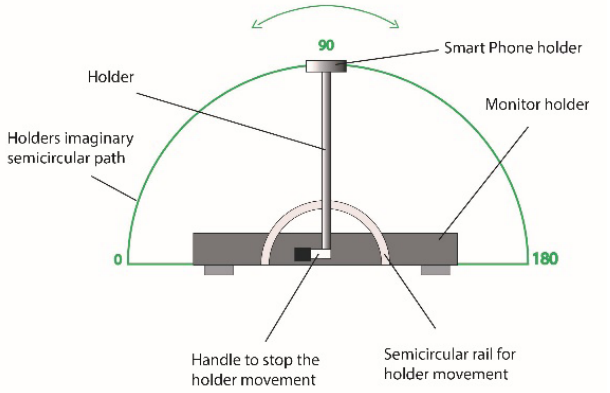

Figure 2: Equipment for mounting the mobile phone with the ability to adjust the angles

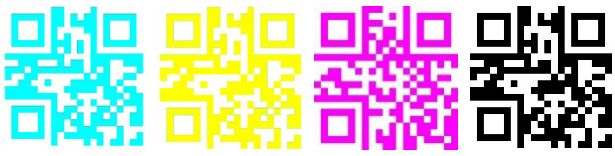

Figure 3: An example of generated QR codes

The tested QR codes are sorted into groups based on the character types (alpha or alpha-numeric), all the codes had the same number of characters (six characters), resolution (200px, 300px, 500px), and the

cyan, magenta, yellow, or black colour. Examples of QR codes generated by the application are shown in Figure 3.

Results

The experiment was carried out on all generated QR codes divided into groups based on a combination of resolution, colour, the number and the type of entered characters. Twenty four QR codes were measured which generated a significant number of results. QR codes were specifically generated at the resolution of 200px, 300px and 500px, in black, cyan, magenta and yellow colour, with six alpha and alpha numeric characters that were entered. Measuring was conducted for 3D object disappearance at an angle less than 90o, 3D object disappearance at an angle greater than 90o, appearance of the object at an angle less than 90o, appearance of the object at and angle greater than 90o, as well as disappearance of the object at angles that are smaller or greater than 90o, due to breaks of the visual line between the camera and the QR code.

Table 1: Research results for QR codes containing six alpha and six alphanumeric characters

QR codes	Disappearance at an angle less than 90°	Disappearance at an angle greater than 90°	Appearance at an angle less than 90°	Appearance at an angle greater than 90°	Covering the lens at an angle less than 90°	Covering the lens at an angle greater than 90°
6 alpha 200px	5	170	55	125	35	150
6 alpha 200px Cyan	10	170	60	122	30	157
6 alpha 200px Magenta	7	170	50	127	30	150
6 alpha 200px Yellow						
6 alpha 300px	5	173	50	127	10	170
6 alpha 300px Cyan	5	173	50	127	7	140
6 alpha 300px Magenta	7	175	50	130	10	140
6 alpha 300px Yellow	7	172			15	165
6 alpha 500px	3	172	50	133	7	170
6 alpha 500px Cyan	5	172	50	117	7	172
6 alpha 500px Magenta	5	172	10	120	5	172
6 alpha 500px Yellow						
6 alphanum 200px	7	172	55	120	25	120
6 alphanum 200px Cyan	10	165	60	120	22	150
6 alphanum 200px Magenta	7	170	55	110	25	150
6 alphanum 200px Yellow	20					
6 alphanum 300px	5	172	47	125	10	167
6 alphanum 300px Cyan	7	172	55	122	10	160
6 alphanum 300px Magenta	5	172	52	120	12	165
6 alphanum 300px Yellow	15	167	90		25	120
6 alphanum 500px	7	172	55	100	7	135
6 alphanum 500px Cyan	7	172	60	120	45	135
6 alphanum 500px Magenta	7	172	68	112	40	135
6 alphanum 500px Yellow						

Table 1 shows the results of measuring QR codes containing six alfa and six alphanumeric characters. Interpretation of the graph is carried out by comparing the height lines representing the specified measuring method have while conducting the experiment. Each line colour represents a different measurement method and does not have the same interpretation. The dark blue line referring to the disappearance of a 3D object at an angle less than 90 ° is observed in such a way that it should be as short as possible, i.e. that it represents small numerical values of the angle. The red line is the disappearance of a 3D object at an angle greater than 90o, and it should be as high as possible to represent greater numerical values of the angle.

Discussion

Figure 4 is formed using table 1 values for the purpose of visual representation and comparison of the measurement results.

The green line represents the return measurement, i.e. reappearance of the 3D object at an angle less than 90 ° and it also has to be as short as possible so as to represent small numerical values of the angle. The purple line represents the return measurement, the reappearance of a 3D object at an angle greater than 90 ° and it is important that it is as high as possible so as to represent the highest possible numerical values of the angle. The light blue line represents the measurement results with visual line interruption between the camera and QR code for angles less than 90°, so it is necessary that these lines are as short as possible and represent the least numerical angle value. The Orange line also presents the results of measurements with the visual line break, for values greater than 90 ° and for this reason it is important that it is as high as possible and that it represents the highest possible numerical values of the angle.

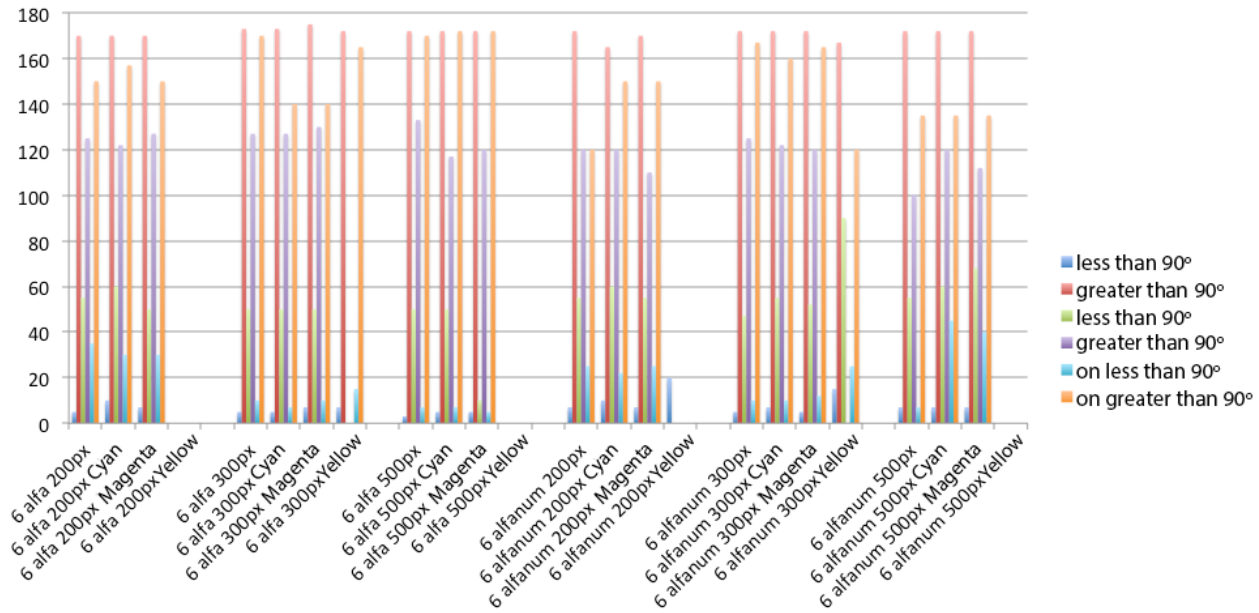

Figure 4: A graphic display of measurement results for QR codes with six alpha and six alphanumeric characters

What can be concluded from the review of the first segment from Figure 4 is that all QR codes are found readable when rotating the camera at angles greater than 90°, or more precisely, all augmented reality content disappeared only when the camera reached the angle greater than 160°. However, attention should be paid to the results of yellow QR codes because they have been found extremely unreadable at each measurement, and the 3D object appeared randomly. In this result division, when measuring the 3D object disappearing at an angle less than 90°, it was found that the QR codes with a resolution of 500px and six alpha character proved to be the clearest and managed to keep displaying the 3D

object under small angles (about 5°). In the reverse measurement, by moving the smartphone camera from zero degrees to 90°, it has been found that the QR code with the resolution of 500px and six alpha characters under the lowest angles generate a 3D object, specifically at angles which range between 40° and 50°.
During the camera return movement from the initial angle of 180° to 90°, the 300px resolution and 6-alpha character QR codes proved the best. The common occurrence of a 3D object was at angles around 130o. During the measurement conducted with the visual line break between the camera and the QR code at an angle less than 90°, the most readable QR codes were those with a resolution of 500px and six alpha characters. They were found readable in these conditions, at an average of 5°.
By measuring the visual line break between the camera and the QR code under an angle greater than 90°, the 500px resolution and six alpha characters QR codes with angles at about 170° proved the best.

Conclusion

By examining the influence the number and type of characters entered have on QR code readability in the augmented reality application, samples containing six alpha characters and a mixed alphanumeric content, were compared. The impact of the resolution on QR code readability is established by comparing samples that have been generated in 200px, 300px and 500px resolutions. Based on the measurement results, it was concluded that 300px and 500px resolutions are optimal for generating QR codes because they guarantee their proper readability in augmented reality applications. The Samples of 200px resolution QR codes are readable, but the results vary depending on the method used to measure the reading angle, as well as character types. The 300px 500px resolution QR codes have proved to be clearest whether containing six alpha, or alphanumeric characters.

By examining the impact of colour on QR code readability, a basic rule for all the barcodes has been established. There must be a high contrast between the background colour and the colour of the barcode. QR codes can be, not only in black, but also in other colours. However, one should certainly follow the rules of high contrast between the background and the code colour. The examined QR codes are generated in black, cyan, magenta and yellow colours with different resolutions and character types. The comparison was made so as to reach a conclusion on the impact the resolution, type of character and colour have on QR code readability. The comparison of QR codes containing six different types of characters shows that magenta coloured QR codes have the best readability regardless of the resolution and type of character.

Better readability of QR codes was also noted in the cyan and magenta colours with 300px resolution compared to the same colour codes with 200px and 500px resolution. QR codes in yellow colour have proved to be extremely unreadable in the augmented reality application because their measurement results were quite unstable. Only the QR codes of this colour were not read under all the measuring conditions. Unstable measurement results behaviour led to the conclusion that the use of these colours is extremely unfavourable and should be avoided. As already mentioned, the examples of unreadable yellow colour codes show that a low contrast between the white background and yellow QR codes adversely affect the readability.

Acknowledgements

This work was supported by the Serbian Ministry of Science and Technological Development, Grant No. 35027 “The development of a software model for improving knowledge and production in graphic arts industry”.

Techno Science
International Scientific Journal of Technical Sciences

Received: April 25, 2017
Accepted: May 19, 2017

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Upotreba QR kodova kao targeta u aplikacijama proširene stvarnosti

SAŽETAK

Proširena stvarnost predstavlja novu tehnologiju koja putem kamere mobilnog ili stabilnog uređaja realan svet obogaćuje kompjuterski generisanim sadržajem. Kako bi se izvršila veza između realnog i kompjuterski generisanog sveta potrebno je očitati odgovarajuće targete i dovesti u vezu koordinatne sisteme realnog sadržaja zabeleženog kamerom i imaginarnog kompjuterski generisanog sadržaja. U radu je prikazan postupak upotrebe generisanih QR kodova kao targeta za aplikacije proširene stvarnosti. Prikazani su rezultati čitljivosti različitih QR kodova pri različitim uglovima očitavanja. Izvršena je analiza dobijenih rezultata u cilju utvrđivanja uticaja vrste i broja unetih karaktera, rezolucije i boje QR kodova na njihovu čitljivost u aplikacijama proširene stvarnosti.

Ključne riječi: proširena stvarnost, čitljivost, QR kodovi.

Techno Science
International Scientific
Journal of Technical
Sciences

High quality printing – Hi-Fi printing

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ABSTRACT

This paper explains the techniques of Hi-Fi printing, as well as their advantages and disadvantages. Hi-Fi printing, as a group of printing techniques, emerged somewhat recently, at the beginning of this century. It represents a step forward in producing realistic reproductions of the original. Therefore, it enables increased printing quality and entrance into the new era in printing. In addition to the standard C (cyan), M (magenta), Y (yellow) and K (black) colouring agents, the Hi-Fi printing features include the use of additional colorants which provide gamut extensions. This paper is a review paper, based on information available from public sources. The paper also presents several examples of these Hi-Fi printing procedures practical application.

Keywords: High-Fidelity (Hi-Fi) printing, reproduction, gamut.

Introduction

The fundamental purpose of Hi-Fi printing is to achieve the best possible reproduction accuracy. The idea of a Hi-Fi colour reproduction started in 1972 by publishing Harald Kupper's theory described in the "Die Farbenlehre der Fernseh - Foto - und Drucktechnik". It defines the application of basic printing dyes with the addition of red, green and purple-blue. Based on this system, German colour manufacturers soon developed the so-called "Kupper colorant set" (CMYK + RGB), i.e. a set of seven basic colours for colour printing. However, the Hi-Fi printing came to be used as late as the early nineties of the twentieth century, and has not achieved wide commercial use yet. High Fidelity or Hi-Fi printing is defined as the technology of reproduction which increases print quality above the acceptable limits of the classic four-color printing. This includes some changes in comparison with the standard four-colour process that will allow printing in a wider range of colours. Nowadays, the customers expect more from the traditional media. Printing technology must try to catch up with the expectations of its clients. In order to achieve a faithful reproduction, the printing seeks to expand the range of colours that can be reproduced, i.e. an increase in the colour gamut. It is for this reason that the technique called Hi-Fi printing was developed in the first place. Its application increases print quality by spreading the gamut of the output device and thus increasing the authenticity. Hi-Fi printing aims to approach the colour range found in nature. Reproduction of colour tones such as: some orange, violet, specific red, blue, purple and green tones; is not possible with the conventional CMYK printing. It is these tones that represent the focus in Hi-Fi printing reproduction.

Hi-Fi printing

In response to the desire to increase the gamut, i.e. the range of colours that can be reproduced in printing, the Hi-Fi (High-Fidelity) printing was developed. It represents printing with additional dyes, namely, CMYK + additional colorants. Because of the desire to achieve as genuine and as realistic reproduction as possible, this printing was named high-fidelity printing. Additional dyes provide a more realistic representation of the colour spectrum in the print. The term Hi-Fi printing dates from 1972 when it was first described by Harald Kupper in his theory. The Kupper theory represents the extension of gamut usage in printing by applying pigments of greater purity and adding orange, green and blue dyes. The application of Hi-Fi printing begins at the end of the 1990's. The development of High – Fidelity printing in colour began with technological research conducted by experts in labs, in the production (manufacturing) programs. Hi-Fi colour printing is successfully used in creation of new theories and methods and seeks to correct major deficiencies in conventional printing with four basic colours, i.e. to bring the visual effects

of colours closer to the actual scene. A vivid, richer, and more realistic imprint with a stronger three-dimensional effect is obtained.

Figure 1: On the left: standard CMYK printing reproduction,
On the right: Hi-Fi printing method reproduction

The advantages of Hi-Fi printing were quickly accepted by graphic designers, as the expanded Hi-Fi colour gamut enables creation of more realistic and vibrant tones. It is most commonly used in package printing (especially luxury ones), security printing and printing of high quality and luxury graphic merchandise.

Hi-Fi printing techniques

Five to eight colours are used in Hi-Fi printing techniques. It is possible to use several different methods of printing. These are the most commonly used techniques:

- Hexachrome
- Opaltone
- MaxCYM
- Printing with additional lighter dyes
- HP IndiChrome
- Printing with increased concentration of pigment and richness of dyes
- Printing with additional mixed dyes (one or more)

Hexachrome printing

Hexachrome printing represents printing developed by Pantone in 1994. It is printing with six colours, i.e. CMYK + OG, which means four basic colours plus the addition of partially fluorescent orange (O) and green (G). Pantone developed this technique because, at that time, many printing shops had had printing presses with six printing units. Hexachrome is the oldest and one of the most used Hi-Fi printing techniques. The reason originates in the fact that its usage increases orange, green and partly blue parts of gamut, causing significant increase of the print quality for the human eye. Additionally, this technique does not require having more than six printing units and thus belongs to the cheaper versions of Hi-Fi printing, because some of them do require up to 8 printing units.

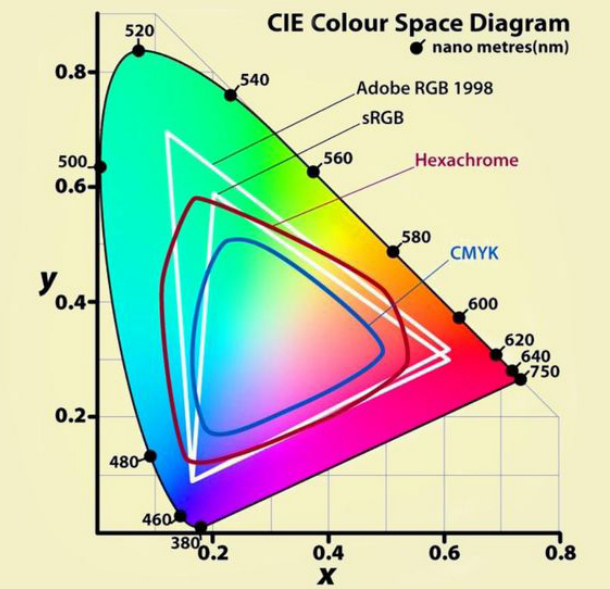

Figure 2: The diagram shows the chromaticity of colours visible to the human eye in which the red line represents the Hexachrome gamut, blue colour represents the CMYK and white represents sRGB (lower) and Adobe RGB (higher)

However, the Hexachrome printing can neither use the standard CMYK dyes, nor the standard or mixed orange or green colours, but more distinguished specially designed Hexachrome colours. CMYK colours for Hexachrome printing are somewhat lighter due to the characteristics of the ICC profile, i.e. the settings, so that fidelity deviations from the original would not occur. Hexachrome printing is used when we want to improve the quality of prints containing green, orange or blue tones, as it does not increase the quality of the prints which do not contain these tones. The application of this technique enables the printing presses to reproduce gamut larger than the gamut of the monitor which penetrates even into fluorescent and pastel areas. In addition, Hexachrome can reproduce 90% of the Pantone Matching System tones, while the standard CMYK printing can reproduce 55% of these tones. To eliminate the

Moiré effect, orange is printed at the same halftone angle as the cyan, while green is printed as magenta. The Hexachrome printing deals with the problem of controlling dye application, because it is impossible to apply 600% of coating due to possible problems in drying, besmearing and fingerprint deformation. This can be controlled via HexWrench software that has three options: normal coating, thin coating and a thick coating.

Opaltone printing

Opaltone printing was developed in 1998 and represents 7 colours printing or CMYK + RGB, four primary colours plus red, green and purple-blue. Less than seven colours can be used as well, if the motif permits so. It is not necessary to use special CMYK colours in this type of Hi-Fi printing, as the printing is possible with the standard CMYK as well. This method is based on Harald Kupper's method in the following manner: we place the colour, resulting from the two CMYK colours overlapping, in the area, where the CMYK colour overlapping occurs. For example, we put green colour in the area where blue and yellow overlap. This is why there are no problems with regulating the coating application of dyes when using this technique. The coating is even thinner than the one used in the four colour printing.

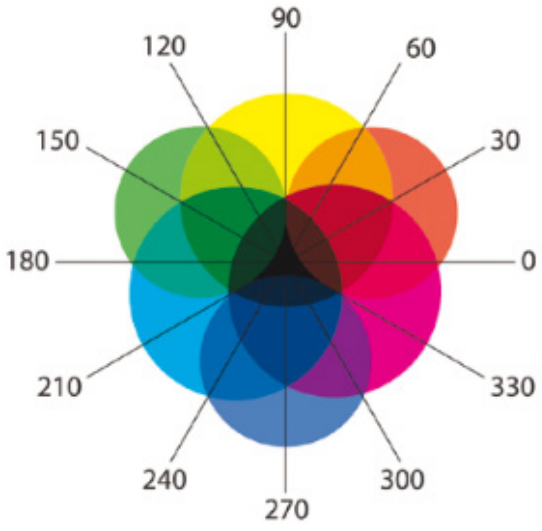

Figure 3: The additional RGB Opaltone dyes perfectly fit into the spaces between the CMYK dyes

This technique allows much easier colour balancing. For example, when using the standard four-color print, even the slightest variance in the percentage of colour, which contains 50% magenta and 50% cyan, results in a tone deviation. In Opaltone print, the 50% magenta and 50% cyan is replaced by purple-blue dye. [6] Opaltone can be used in conventional and digital printing techniques (Opaltone Inkjet). When it comes to the AM halftoning, red has the same angle as cyan, green as magenta and purple-blue as yellow, in order to allay the Moiré effect.

MaxCYM printing

MaxCYM is a Hi-Fi printing method which adds CMYK dyes to the stan¬dard CMYK printing process (CMYK+CMYK). Any CMYK colour can be added, so it represents a 5 to 8 -colour printing. The MaxCYM approach was first used by Royal Zenith. An increase in coating increases the colour gamut and reproduction quality (1-4 colours).

Printing with added lighter dyes

Printing with additional bright dyes is a Hi-Fi printing method which, in addition to the basic CMYK dyes, uses the light cyan (Lc or c), light magenta (Lm or m), representing the CcMmYK abbreviation. Some printing systems use the light key (Lk or k), which then becomes the CcMmYKk printing abbreviation. White pigments are added into these dyes. Using this technique enables a better contrast in reproduction and a less visible raster element, as well as enables smooth transitions from light to dark tones. Today, Inkjet printers for photographic printing use this system with at least six colours, i.e. CMYK + light cyan and light magenta.

Figure 4: CcMmYKk technique of the Hi-Fi printing representation on paper and canvas; the upper part of the Figure shows dye containers

HP IndiChrome printing

HP IndiChrome is a kind of Hi-Fi printing developed by the HP (Hewlett-Packard) company. This is a typical method of Hi-Fi printing used only for the purpose of HP Digital Colour Offset technology. It uses additional spot ink dyes and bright colorants with standard ElectroInk colorants. There are a number of different types of this printing method:

- onPress (CMYK + OV) - standard CMYK printing with added orange (O) and violet (V);
- Plus (CMYK + OVG) - standard CMYK printing with added orange (O), violet (V) and green (G);
- offPress (CMYK + OVG + reflexive-blue, bright yellow, rhodamine red, fluorescent orange).

HP IndiChrome onPress and Plus can reproduce a wide range of Pantone colours without the need to install special spot colours. No additional mixing of spot colours is required. They can be reproduced by using additional colours directly in the machine. This brings dramatic vividness of colour reproduction which is difficult to achieve by regular printing, such as light orange and dark blue. HP IndiChrome offPress is able to reproduce 97% of Pantone colours using up to 11 colours. By using 11 colours, HP IndiChrome offPress is able to produce any of the Pantone spot colours. Thus the reproduction of more than 3.000 Pantone colours becomes possible.

Printing with increased concentration and richness of pigments

This method is actually a method in which additional dyes are not added, but instead, it represents a highly-pigmented CMYK printing. Unlike the classic CMYK colorants, these CMYK dyes have a higher concentration and richness of pigments. At constant imprint thickness, the reproduction has higher colouring density and therefore a greater gamut. The disadvantage is the fact that these dyes are still somewhat more expensive than the standard ones.

Printing with additional mixed dyes (one or more)

This technique is one of the oldest Hi-Fi systems because the lithographers printed multicolour reproductions with 6, 7 or 8 colours using lithography. In addition to the standard CMYK colours, this Hi-Fi technology uses additional colours that are used for increasing the reproduction gamut. Colours can have different effects (metal, fragrant, pearl, fluorescent ...).

Figure 5: A magazine cover photo print with a fluorescent dye

Advantages and disadvantages

Hi-Fi printing has not yet achieved full commercial use, even though the graphic industry companies are slowly beginning to realize its benefits. The slower development of Hi-Fi printing is mainly a consequence of the increased production costs. To perform this type of print with the conventional printing methods, a printing press with 5-8 printing units is required. If the printing shop does not have such a machine, the Hi-Fi print can be achieved through several repetitions of passing the item through the machine. The price of such machines is higher and the larger number of passes (repetitions) increases printing time as well, which also increases the cost of production. The need for additional printing forms and additional software solutions for colour separation also leads to cost increase. Due to the high cost of the final product, Hi-Fi is less used in conventional techniques, but it has increasingly high application with modern digital technologies. The reason is the use of cheaper satellite structures

in which the use of additional printing units can be easily enabled or disabled (with no additional costs or preparation). Another problem is related to AM halftoning and emergence of the Moiré. Apart from the halftoning quality, achieving an extremely precise passer is of the utmost importance because the slightest movement of the passer can lead to major problems with the Moiré.

Apart from using it with satellite constructions, High fidelity printing, can be cheaper than conventional printing methods when used with digital techniques depending on the amount of prints. Very small print amounts are often more cost-effective when printed with digital equipment because there are fewer steps involved in the process. Price per print is the same regardless of the quantity, unlike the conventional printing in which the smaller the amount, the higher the cost per print.

However, the number of printing shops which use Hi-Fi printing technique is gradually increasing. It is a consequence of all of the advantages this type of printing provides, such as: building a reputation, attracting designers and customers, better sales and making regular clients because of the unique offer. In addition, the main advantages of Hi-Fi printing are the gamut expansion, better contrast and colour definition, better reproduction of saturated colours, accurate colorimetric reproduction and thus better quality of the final product.

An example of Hexachrome printing configuration

ICC profiles

The colour management system (CMS) or colour reproduction management is an important segment of colour control in order to obtain as accurate and genuine reproduction as possible via different devices. CMS was developed in order to make high quality reproduction or colour conversion of images, which originated from a variety of sources and are to be reproduced via different devices, with minimum differences. CMS, therefore, represents a system which converts the colour data encoded in a single device (like the RGB scanner) into data for another device (such as CMYK printers) in such a way that the printed reproduction contains the same colours as those in the scan. In cases where the exact colour matching is not possible, the result is supposed to be closer to the original colours.

ICC or the International Colour Consortium is an association / institution established in 1993, by eight leading companies in the field of colour reproduction. These companies are: Adobe, Agfa, Apple, Kodak, Microsoft, Silicon Graphics, Sun Microsystems, Fogra and Taligent. In the meantime, some companies have left the ICC, while a lot of new ones have entered. As a result, the ICC has over 50 members, including some of the strongest companies in the photography industry. The main activity of this institution is creating a standard of files (ICC Profiles), which describes the colour properties of a device. CMS, by means of the ICC (International Colour Consortium), coordinates the data, adjusts and adapts them if necessary. The most important segment of colour management represents the correct setup and use of ICC profiles which describe the specific device.

ICC profiles help us to get accurate colour reproduction when images are imported from a scanner or a camera, displayed on a monitor or printed. They define the relationship between the digital recording device, which receives or transmits, and the standard colour space defined by the ICC, which is based on a system of measurements, internationally defined by the CIE.

In this way, if we have a profile for each of our devices, e.g. scanner, camera, display and printer / printing machine, the fact that it is related to the standard colour space allows us to combine them, so that we get the correct colours when we transfer the images from the scanner or camera and when we print or display them on the computers screen. ICC profile is the profile which matches the specification of the ICC association. By aligning the profiles with these specifications, they can be replaced and properly interpreted by other users. Two main types of profiles are the source (input) and destination (output) profiles and are mainly consisted of data tables. Input profiles describe the devices which, simply put, digitalize the picture - cameras and scanners. Output profiles describe the devices which reproduce the image - primarily monitors and various types of printers / printing machines. When we use the real Hi-Fi ICC profiles, colour separation technology is different and considerably improved in comparison to the default RGB or CMYK conversion into the Hi-Fi colour technology. Separations that are used in the Hi-Fi ICC profile achieve maximum saturation. Therefore, it is currently better to print the reproduction using Hi-Fi ICC output profiles.

Techno Science
International Scientific Journal of Technical Sciences

Received: April 21, 2017
Accepted: May 25, 2017

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Tisak visoke kvalitete - Hi-Fi tisak

SAŽETAK

U ovom radu bit će objašnjene tehnike Hi-Fi tiska te prednosti i mane korištenja ovih vrsta tiska. Hi-Fi tisak kao skup tehnika tiska zaživio je tek početkom ovog stoljeća i predstavlja približavanje što vjernijoj i realnijoj reprodukciji originala, a time i povećanu kvaliteta otiskivanja te ulazak u novu eru tiska. Karakteristika Hi-Fi tiska je da osim standardnih C (cijan), M (magenta), Y (žutog) i K (crnog) bojila koristi i dodatna bojila koja omogućavaju proširenje gamuta. Rad je preglednog tipa, zasnovan na informacijama dostupnim iz javnih izvora. U radu je pred¬loženo i nekoliko primjera praktične primjene nekih od pomenutih postupaka tiska, koji spadaju u Hi-Fi tisak.

Ključne riječi: High-Fidelity (Hi-Fi, visoko-vjeran) tisak, dodatna bojila, reprodukcija, gamut.

Techno Science
International Scientific
Journal of Technical
Sciences

Urban biodiversity and the city – 1. environmental degradation in the City of Pančevo (Serbia)

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ABSTRACT

The most noticeable examples of environmental degradation in Pančevo are associated with the so-called Pančevo South Industrial Zone, where the economic power (=Chemical Industry Pančevo [CIP] "Azotara", CIP "Petrohemija" and Pančevo Oil Refinery) of the Municipality of the City of Pančevo is concentrated in close proximity to residential areas. The construction of these plants in the direction of dominant winds, their outdated technology – used for thirty to fifty years without adequate modernization, illegal construction without the required urban planning permits, constant violations of environmental protection laws, and consequences of NATO bombing in 1999, are considered to be the main sources of environmental degradation in Pančevo. Over the past few decades, the most important environmental concern of inhabitants residing in the City of Pančevo is poor air quality, although serious environmental problems are also detected in other sectors: the water supply, wastewater management, noise pollution reduction, public health protection, soil remediation, conservation of biodiversity, etc. The democratic transition in Serbia (October 5, 2000) in line with its strategic commitment to the process of European integration has led to major reforms in Serbia's environmental laws, necessary for the implementation of modern and more effective environmental protection policies. Given that the (urban) ecosystems in Pančevo have undergone significant degradation – which in turn results in various negative effects on (urban) biological diversity and peoples' livelihoods – immediate attention has to be paid to the complex ecological issues in Pančevo, at all governmental levels in Serbia, especially by the local government in Pančevo.

Keywords: Environmental degradation, urban ecology, Pančevo, Serbia.

Introduction

Pančevo is an industrial city which largely contributes to the economic growth of the Republic of Serbia, not only due to its proximity to the Serbian capital and the most populous Serbian city – Belgrade, but also to the fact that some of the most important energy, petrochemical, and other chemical resources of Serbia are located on its territory (Jelinčić and Djurović, 2009). The Municipality of the City of Pančevo spreads across 755 km2 (75,500 ha) which equals 0.85% of the Republic of Serbia territory (see: The Statistical Office of the Republic of Serbia). The Municipality of the City of Pančevo has 123.414 inhabitants (based on the 2011 Census; see: The Statistical Office of the Republic of Serbia), representing 1.7% of the total population of the Republic of Serbia (see: The Statistical Office of the Republic of Serbia).

Extraordinary quality of available labour in Pančevo, proximity to major Serbian markets, a developed urban infrastructure, and excellent geo-strategic position of Pančevo – with ample roads (The Pan-European Corridor X), railway lines (The Belgrade-Constanta Railway and the Belgrade-Bar Railway), and water transportation options (The Pan-European Corridor VII) – considerably favoured the economic growth of the Municipality of the City of Pančevo in comparison to other Serbian municipalities (not including the Municipality of the City of Belgrade – which is economically the most developed municipality in Serbia) (Mitrović et al., 2013).

The Adria Oil Pipeline (Omišalj-Sisak-Slavonski Brod-Novi Sad-Pančevo) also passes through the city (see: PE Transnafta). Industry and agriculture are still the most prominent growth generators of Pančevo economy (see: The Serbian Business Registers

Agency). Since the early 18th century, Pančevo has had a long tradition of industrial production (Mitrović et al., 2013). The oldest industrial building in Vojvodina – the Pančevo Brewery (est. 1722) – still exists in Pančevo and is located in the city centre. Just a few decades later, the "Jabuka" starch factory as well as the plants for cotton yarn and silk threads manufacturing were also built in Pančevo (Mitrović et al., 2013).

From an economic standpoint, the period between the two world wars in Pančevo resonates powerfully, in many aspects; several manufacturing plants were constructed during that period ("Tesla" light bulb factory – est. 1931; The flat glass factory – est. 1932; "Utva" airplane factory – est. 1937) (Mitrović et al., 2013).

A very important part of the industrialization in Pančevo took place in the 1960's and 1970's, when a large and newly built industrial complex was erected in the so-called Pančevo South Industrial Zone, with several plants belonging to the Chemical Industry Pančevo (CIP) (e.g., CIP "Azotara" – a fertilizer plant, est. 1962; and CIP "Petrohemija" – a petrochemical plant, est. 1979) and the Petroleum Industry of Serbia (Pančevo Oil Refinery, est. 1968) (Mitrović et al., 2013). In the 1980's, factories for metal processing and several food processing and leather dyeing plants were also built on the territory of the Municipality of the City of Pančevo (Mitrović et al., 2013).

A very difficult and critical period for Pančevo's economy and inhabitants started in the 1990's with the break-up of the Socialist Federal Republic of Yugoslavia (SFRY; 1991) and several civil wars that were held in the territory of the SFRY – causing economic sanctions and diplomatic isolation of the Republic of Serbia (1991-2001). It was followed by a massive destruction of Serbian infrastructure and factories during the NATO bombing of the Federal Republic of Yugoslavia (FRY; 1999).

During the air strikes against the FRY, the NATO hit the CIP and Pančevo Oil Refinery during 23 separate days causing 58.500 tons of crude oil / oil derivatives, tons of vinyl chloride monomer and other petrochemical products to be burnt in fire and uncontrollably released into the air, water, and soil (Schmetzer, 1999; Bogojević et al., 2002). The surrounding soil, ground water, and industrial wastewater of Vojlovica's wastewater canal (L = 2 km / W = 76 m; a branch of the river Danube located in Pančevo) – were contaminated with large quantities of toxic substances (e.g., 5.000 tons of crude oil / oil derivatives, 23.000 tons of 1,2-Dichloroethane, 600 tons of HCl, 8 tons of mercury, 3.000 tons of NaOH, 230 tons of ammonia / ammonium hydroxide, etc.) leading to the unseen environmental catastrophe in Pančevo / Serbia / SE Europe (Bogojević et al., 2002).

Environmental degradation in Pančevo

Over the last four decades, Pančevo has been unfortunately recognized as the Serbian "environmental black spot", namely one of the most gravely jeopardized urban industrial areas not only in Serbia, but also in the Southeastern Europe (Jelinčić and Djurović, 2009).

Major environmental degradation in Pančevo began with the municipality's speedy industrialization in the 1960's and intensive processing in the Pančevo South Industrial Zone, which is located in the vicinity of residential areas and in dominating wind directions (Jelinčić and Djurović, 2009).

An outdated technology used in the Pančevo South Industrial Zone – with plants that had been working for decades without modernization, illegal construction in the Pančevo South Industrial Zone – without the required urban planning permits, and everyday violations of environmental protection laws are mapped as the main sources of environmental degradation in Pančevo, besides the diverse environmental issues due to the NATO bombing of the FRY (Jelinčić and Djurović, 2009).

The biggest environmental polluters in Pančevo are also identified a long time ago (CIP "Azotara", CIP "Petrohemija" and Pančevo Oil Refinery) and all are situated in the Pančevo South Industrial Zone, just a few kilometres away from the Pančevo's city centre and two hundred meters from Pančevo's residential neighbourhood – Vojlovica, the most environmentally deprived neighbourhood in the Municipality of the City of Pančevo (see: The City of Pančevo). In addition to the plants of CIP "Azotara", CIP "Petrohemija" and Pančevo Oil Refinery, plants of the "Messer Tehnogas" Company are also located in the Pančevo South Industrial Zone (see: The City of Pančevo). However, the negative effects of

production in this company on the environment and inhabitants of Pančevo is incomparably smaller than the negative effects of business operation from the above mentioned companies in the Pančevo South Industrial Zone (see: The City of Pančevo).

During a decade of sanctions imposed on the FRY, these companies were constantly facing difficulties in purchasing quality raw materials and equipment for their reconstruction and technological modernization and were not able to manufacture under the defined technical and environmentally acceptable conditions (Bogojević et al., 2002). Facing many economical restrictions, these companies were also largely unable to pursue their environmental plans and programs (Bogojević et al., 2002). Moreover, the managements of these companies were not able to organize the implementation of modern / ecologically friendly technologies and basic remediation of existing environmental issues in the vicinity of their plants (and / or somewhere else on the territory of the Municipality of the City of Pančevo) (Bogojević et al., 2002; Jelinčić and Djurović, 2009).

Due to the many environmental issues caused by production in the companies of the Pančevo South Industrial Zone, one of the greatest problems of inhabitants from Pančevo is poor air quality, although serious ecological problems in Pančevo are also detected in other sectors: (1) the water supply system; (2) wastewater management; (3) noise pollution reduction; (4) public health protection; (5) soil remediation; (6) conservation of biodiversity, etc. (Jelinčić and Djurović, 2009).

The ecological situation in Pančevo is far from being good, but some legal and institutional reforms have been made. To improve certain aspects of environmental degradation in Pančevo, various donors have also invested significant funds, including the Government of the Republic of Italy, the United Nations Development Program, and European Commission Delegation to the Republic of Serbia (Jelinčić and Djurović, 2010).

As many as the top three Pančevo polluters that survived unfavourable economic transition in Serbia, started investing time and money in mitigating effects of the historical pollution in Pančevo, mostly through modernization of manufacturing processes. For example, the Gazprom Neft – a subsidiary of the Petroleum Industry of Serbia – has recently invested 547 million Euros in upgrading and rebuilding the Petroleum Industry of Serbia, including Pančevo Oil Refinery (see: Gazprom Neft completes refinery modernization project at Pančevo). However, there is a long way to go.

The benefits of turning Pančevo and its surroundings from a "black spot" on the eco-map of Serbia (and SE Europe) into an area with a high quality of life are clear. Only with healthy environment and healthy inhabitants all potential advantages of Pančevo location and the heritage of its urban zone might be used completely to propel socio-economic progress of Pančevo itself and its surrounding areas (Jelinčić and Djurović, 2010)

The improvements of environmental quality would also promote public health quality of Pančevo' inhabitants and increase the prices of residential and business real estate, as well as land – which are currently depressed – and therefore would significantly contribute to the general well-being, creating a possibility for Pančevo to become one of elite satellite residential areas of Belgrade and one of the most beautiful small urban spaces in the mid Danube area (Jelinčić and Djurović, 2010). This must be a definite goal for all – present and future – local governments in Pančevo, as well for the governments of the Autonomous Province of Vojvodina and the Republic of Serbia.

Intensive agriculture and (urban) biodiversity loss in Pančevo

Pančevo is also regionally known as the city with centuries of tradition in agricultural production as well as for its famous fertile chernozem soil (Duš et al., 2013). Agriculture still plays a major role in Pančevo's economy (see: The City of Pančevo). According to the available agricultural resources, Pančevo is one of the richest municipalities in the Republic of Serbia, with 63.322 ha of high quality agricultural soil (see: The City of Pančevo).

In addition, there are many different types of soil determined in Pančevo, including carbonated chernozem on loess terrace, carbonated chernozem on loess plateau, chernozem on sandy loess, chernozem on clayish loess, carbonated marshy black soil, non-carbonated marshy black soil, meadow black soil, gleyic vertisol, alluvial soil, and non-carbonated swamp soil (Jelinčić and Djurović, 2009). It is well known that climate and hydrological characteristics of terrain are very important for

agricultural production (Hamjah, 2014). Pančevo has moderate continental climate with warm and dry summers, and short and mild winters (see: Climate data for cities worldwide – Climate – Pancevo).

Hydrological characteristics of territory belonging to the Municipality of the City of Pančevo and its surroundings are also very favourable for intensive agricultural production, as well are the major geomorphological characteristics of the terrain (Hamović et al., 2010).

Territory belonging to the Municipality of the City of Pančevo is an integral part of the Pannonian Basin with further geomorphological units: (1) loess plain (part of the Southern Banat loess plateau); (2) Pančevo loess terrace; and (3) alluvial plains, formed along the banks of the Danube and Tamiš (Hamović et al., 2010).

There is plenty of surface and ground waters in Pančevo (see: The City of Pančevo). Ground waters encompass shallow (phreatic) and deep (artesian) water-bearing layers. Surface waters could be divided into natural ones (rivers: Danube, Tamiš, Nadela, and Ponjavica) or artificial (melioration canals and artificial lakes) (Hamović et al., 2010).

According to the aforementioned facts, the territory belonging to the Municipality of the City of Pančevo has quality arable land and many other agricultural advantages (e.g., a developed system of canals for agricultural irrigation) and thus possesses a great potential for economically efficient and versatile crops and livestock production (see: The City of Pančevo).

On the other hand, it is shown that intensive agricultural production alters hydrological cycles in many (agricultural) areas in the world due to the complex soil preparation (e.g., artificial terrain drainage, irrigation and the like) (Haygarth and Jarvis, 2001).

Agricultural production is also assumed to be one among the main threats to biodiversity (see: The Belgian clearing-house mechanism of the convention on biodiversity). Agriculture and biodiversity are unfortunately often treated separately, even though it has been evidenced that biodiversity underpins much of modern agriculture and that conventional agriculture causes a significant biodiversity loss (Rodrigues et al., 2004; Scherr and McNeely, 2008).

As the biodiversity crisis has become more apparent, a significant increase in the number of protected areas in recent years is monitored world-wide (see: New UNEP report unveils world on track to meet 2020 target for protected areas on land and sea). The global network of protected terrestrial areas covers 15.4% of the world's surface area at the moment, with the majority of these falling within categories I-IV of the IUCN's classification (see: New UNEP report unveils world on track to meet 2020 target for protected areas on land and sea). At the same time, our knowledge regarding the extent of which the current (global) protected natural areas accomplish their goal of protecting biodiversity is still insufficient (Rodrigues et al., 2004).

Conclusion

Since the economists see the future of Pančevo in the context of intensifying agricultural production, especially organic agricultural production of healthy and safe food, of both – plant and animal origin, it is necessary to improve the quality of the environment in Pančevo (Jelinčić and Djurović, 2009; see: The City of Pančevo).

To promote future sustainable land use in areas with significant environmental degradation, well planned restoration of degraded agricultural soil (e.g., soil polluted by heavy metals and other pollutants / toxicants – from various agricultural and / or industrial wastes, etc.) should be considered way before any ecological action is taken.

Besides the urgent investments in soil remediation in Pančevo – in accordance with the highest standards stipulated by the European Union – a sustainable agriculture and complex prevention of biodiversity loss on the entire municipal territory should be considered the key action by the local government in Pančevo (as well as of its counterparts on provincial and national levels) (Duš et al., 2013).

A detailed analysis of relevant documents done by Duš et al. (2013) revealed that during the period 2000-2010, the Municipality of the City of Pančevo initiated only one soil quality examination on its territory (2003/2004), with the aim of preventing future soil degradation and pollution, as well for planning necessary soil remediation procedures / methods. If sporadic efforts in this context are excluded, it may be concluded that a planned soil remediation on the territory of the Municipality of the City of Pančevo was not done during last 4 decades

(Jelinčić and Djurović, 2009; Duš et al., 2013)! The Ministry for Environment, Land and Sea of the Republic of Italy and the Ministry of Environmental Protection of the Republic of Serbia signed, in 2002 in Johannesburg, a Memorandum of Understanding, to which the City of Pančevo acceded in an Annex (Jelinčić and Djurović, 2009; Duš, 2011). Subsequently the project: "Monitoring Environment and Sustainable Requalification of Selected Industrial Zones in the Republic of Serbia: Pilot project Pančevo" – was designed.

In early February 2005, the Italian Ministry opened a local office in Pančevo, and as a part of the Action Plan for Pančevo, the Italian experts drafted, in 2006 and 2007, twelve projects to determine the state of the environment and promote its quality in Pančevo and submitted them to the Pančevo Environmental Protection Secretariat in the form of technical reports and project designs (Jelinčić and Djurović, 2009, 2010; Duš, 2011). Nothing more than project designs and feasibility studies were unfortunately done (Jelinčić and Djurović, 2009, 2010; Duš, 2011).

This devastating information also represents a cross-section of the general state in the environmental protection sector in Serbia, primarily since Pančevo – according to numerous independent estimates – is at the very top of the list of the biggest ecological "black spots" in SE Europe / Europe (Duš et al., 2013). At the same time little has been done to protect and improve the quality of the environment and natural resources / (urban) biodiversity conservation in Pančevo (Jelinčić and Djurović, 2009, 2010; Duš et al., 2013). It also depicts the unawareness regarding the importance of good environmental practices / (urban) biodiversity conservation for the development of sustainable agriculture in Serbia, as well as for the prospective Serbian relevance at the global market of organic food (Duš et al., 2013).

Investing in afforestation and sustainable agriculture sounds like a good model to improve (urban) biodiversity (Scherr and McNeely, 2008). Forests are among the most important repositories of terrestrial biological diversity (see: Biodiversity for a world without hunger). Biological diversity is the basis for a wide array of goods and services provided by forests (see: Biodiversity for a world without hunger).

Unfortunately, only 7% of the total territory belonging to the Municipality of the City of Pančevo is covered by forests – which has been estimated: insufficient (Jelinčić and Djurović, 2009, 2010). According to the Spatial Plan for the Republic of Serbia, adopted in 1996 for the period of 15 years – an optimal afforestation for the Pančevo / South Banat District / is 17.9%. The integration of (urban) biodiversity conservation and sustainable agricultural production goals, therefore, should be the focus of any environmental policy created by the local government in Pančevo. One should bear in mind that (urban) biodiversity conservation and ecological restoration in human dominated ecosystems (=urban ecosystems) should be strengthened through real connections between sustainable agriculture and (urban) biodiversity.

Moreover, the managing landscapes on a multi-functional basis, that combines healthy food production, (urban) biodiversity conservation and the maintenance of (urban) ecosystem services, should be at the forefront of any effort to achieve healthy living in any urban areas in Serbia including the Municipality of the City of Pančevo.

Acknowledgements

This study is partly financed by the European Union through the European Integration Fund, managed by the Delegation of the European Union to the Republic of Serbia and implemented by Press Now (Belgrade, Serbia), through the FOS (Belgrade, Serbia) and the CPES (Belgrade, Serbia) initiatives. The authors are extremely grateful to Mr. Nenad Živković – a journalist and publicist from Pančevo – for being immensely helpful in providing documents and information needed for understanding the complex history of environmental degradation / environmental catastrophe in Pančevo.

Techno Science
International Scientific Journal of Technical Sciences

Received: April 30, 2017
Accepted: May 25, 2017

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Techno Science
International Scientific
Journal of Technical
Sciences

Biodiverzitet urbanih sredina – 1. Degradacija životne sredine u gradu Pančevu (Srbija)

SAŽETAK

Najuočljiviji ekološki problemi u Pančevu povezani su sa proizvodnjom u tzv. Južnoj industrijskoj zoni u kojoj su skoncentrisani najznačajniji ekonomski potencijali Pančeva (=Hemijska industrija Pančevo [HIP] „Azotara", HIP „Petrohemija" i Rafinerija nafte Pančevo) i to nadomak naseljenih mesta. Izgradnja ovih fabrika na pravcu dominantnih vetrova, zastarela tehnologija, koja se u njima koristi već trideset do pedeset godina – bez adekvatne modernizacije, ilegalna (do)gradnja bez poštovanja važećih urbanističkih planova, permanentno kršenje zakona iz domena zaštite životne sredine, kao i posledice NATO bombardovanja tokom 1999. godine, smatraju se glavnim uzrocima degradacije životne sredine u Pančevu. Tokom nekoliko poslednjih decenija, najveći ekološki izazov za Pančevce predstavlja loš kvalitet vazduha, mada su ozbiljni ekološki problemi uočeni i u sektorima vodosnabdevanja, upravljanja otpadnim vodama, zaštite od buke, zaštite javnog zdravlja, remedijacije zemljišta, zaštite biodiverziteta i dr. Demokratska tranzicija Srbije koja se odigrala 5. oktobra 2000. godine, kao i strateško opredeljenje Srbije za proces evropske integracije, doprineli su reformi zakonodavstva u oblasti zaštite životne sredine, neophodnoj za implementaciju modernijih i efikasnijih politika zaštite životne sredine. S obzirom da su (urbani) ekosistemi u Pančevu pretrpeli značajnu degradaciju, koja je višestruko negativno uticala na stanje (urbanog) biodiverziteta i kvalitet života ljudi u ovom gradu, navedenim ekološkim problemima u Pančevu mora se posvetiti posebna pažnja na svim nivoima vlasti u Srbiji, a poglavito u jedinici lokalne samouprave u Pančevu.

Ključne riječi: Degradirana životna sredina, urbana ekologija, Pančevo, Srbija.

Techno Science
International Scientific Journal of Technical Sciences

Urban biodiversity and the city – 2. the importance of conserving urban biodiversity in the City of Pančevo (Serbia)

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ABSTRACT

In the future, it will almost be impossible to conserve biodiversity by applying an approach using isolated protection of critical natural areas. Promotion of biodiversity needs a complex action – globally and locally – focusing on extension of areas available for natural habitats and their interconnectivity. Cities may play a significant role in the conservation of global biodiversity through protection and management of urban biodiversity on their territories. Furthermore, conserving urban biodiversity may be crucial in conserving local and / or regional species. At a time of increasing urbanization, conserving biodiversity in urban areas becomes very important for the well-being and quality of life for future generations. This is especially true for inhabitants living in the cities that face heavy air pollution, environmental degradation, deteriorated infrastructure, etc. Having that in mind, the authors of this paper aimed to explore the extent to which (urban) biodiversity conservation and its promotion across the entire territory of the Municipality of the City of Pančevo has been performed during the review period (2007-2016) by the local government in Pančevo.

Keywords: Urban biodiversity conservation, environmental protection, Pančevo, Serbia.

Introduction

Environmental protection and sustainable development on the territory of the Republic of Serbia is guaranteed by the Constitution of the Republic of Serbia. In Article 74 of the Constitution, it is established that everyone shall have the right to a healthy environment and the right to be timely and fully informed about the environmental conditions of the Republic of Serbia. In addition, Article 74 of the Constitution establishes that sustainable development, continuous protection and improvement of the environment – and flora and fauna as well – shall be regulated and provided by the Republic of Serbia. The competences of the autonomous provinces to organize and provide environmental protection on their territory and in accordance with the law are also defined through the Article 183 of the Constitution. Finally, according to Article 190 of the Constitution, some important competences in the field of environmental protection are given to the municipalities, as local self-governments.

The actual Law on Environmental Protection represents a framework law in the field of environmental protection in the Republic of Serbia, which guarantees an integral system of environmental protection on its territory and ensures the basic human rights for the citizens of the Republic of Serbia to live and develop in a healthy environment, as well as a balanced correlation between economic growth and the environment. In the first chapter of this law, eleven basic principles of environmental protection are defined including the Principle of Nature Conservation / Natural Value Preservation which defines geo- and biodiversity protection, protection of natural goods, landscapes and the like.

According to Article 64 of the Law on Environmental Protection, the planning and management of environmental protection is secured and provided by implementation of the National Environment Protection Program, adopted by the Serbian Government for the period of ten years (March

23, 2010). The Program is aimed to increase environmental and the quality of life for the population in the Republic of Serbia. As a strategic document, the Program stands as an instrument of resolving priority problems in the field of environmental protection in the country.

The fields of biodiversity conservation and nature protection in Serbia are more precisely defined by the Law on Nature Conservation, which precisely regulates the protection and conservation of nature, biological, geological and landscape diversity as an integral part of the environment . In order to improve the field of biodiversity conservation in Serbia, the National Assembly of the Republic of Serbia has also adopted several important by-laws, creating better opportunities for management of protected natural areas / natural resources (e.g., Decree on Ecological Network, Decree on the protection regimes, Code on the content and manner of keeping the register of protected natural areas, Code on the categorization of protected natural areas, Code on conditions to be met by the managing authority of protected area, Code on declaration and protection of strictly protected and protected wild species of plants, animals and fungi, etc.) (see: Institute for Nature Conservation of Serbia).

Several very important strategies and environmental programs have also been recently adopted by the Serbian Government, giving a strategic framework and the management tools for solving problems in biodiversity conservation in Serbia (e.g., National Strategy for Sustainable Use of Natural Goods and Resources, Biodiversity Strategy of the Republic of Serbia for the period 2011-2018, The National Program of Environmental Protection, etc.). A dozen of important international conventions on nature protection were also ratified by Serbian authorities during the last 15 years: The Law on Ratification of the Convention on the Conservation of Migratory Species of Wild Animals, The Law on Ratification of the Convention on the Conservation of European Wild Flora and Fauna and Natural Habitats, The Law on Ratification of the Convention on Biological Diversity, The Law on Ratification of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, etc.

Local governments in Serbia have legal rights to establish protected areas of local significance in their territories, unless the area contains land or objects which are the property of the Republic of Serbia. Local governments also have the right to initiate protection of an area for which the competence of establishment is granted to the Republic of Serbia. Regardless of the protection regime or category of the protected natural area in the procedure of establishment, during the development of the protection study, the Institute for Nature Conservation of Serbia is obliged to cooperate with local governments and communities, as well with the owners and users of the area subject to the protection study (Kujundžić, 2013).

Since the Law on Local Self-Government transfers numerous jurisdictions for implementing environmental protection / biodiversity conservation in the Republic of Serbia, from national and provincial levels to the local governments, it is important to analyse how much has the local government in Pančevo done in order to achieve its objective of nature protection and (urban) biodiversity conservation across the entire territory belonging to the Municipality of the City of Pančevo, while having in mind that the City of Pančevo is one of the most gravely jeopardized urban industrial areas not only in Serbia, but also in the Southeastern Europe.

Materials and methods

The content analysis method for the period of ten years (2007-2016) was employed in this study (Miljević, 2007). In addition to the content analysis, several other research methods were also used in this study, e.g. observation / observational research, narrative inquiry, and comparative analysis of the relevant documents (Miljević, 2007). Since this study investigates one particular ecological / environmental phenomenon within the real-life context, i.e. within one particular local community in Serbia – the Municipality of the City of Pančevo, we may agree the case study methodology was also used in this research (Yin, 1984). The Annual Reports of the City of Pančevo Environmental Protection Secretariat (see: Annual Reports of the City of Pančevo Environmental Protection Secretariat for the year: 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2015; the last Annual Report was issued on June 28, 2016), the Annual Protection Program of the Environmental Protection Fund for the year 2014 (see: Official Gazette of the City of Pančevo, Nos. 3/14, 18/14, and 27/14.), and the Annual Protection Program of the Environmental Protection Fund for the year 2017 (see: Official Gazette of the City of Pančevo, No. 1/17) were given special attention.

Governance of nature protected areas in the City of Pančevo

Based on a detailed content analysis on the Annual Reports of the City of Pančevo Environmental Protection Secretariat, an official website of the Municipality of the City of Pančevo, and other resources as specified, it was found that the Municipality of the City of Pančevo protects five natural areas on its municipal territory, namely: (1) the Nature Park "Ponjavica" (In Serbian: Park prirode „Ponjavica"); (2) the Nature Monument "Ivanovačka Ada" (In Serbian: Spomenik prirode „Ivanovačka ada"); (3) the Nature Monument "Two Ash Trees near Dolovo" (In Serbian: Spomenik prirode „Dva stabla belog jasena kod Dolova"); (4) the Nature Monument "Ćurčin Horse-Chestnut Tree in Pančevo" (in Serbian: Spomenik prirode „Divlji kesten Ćurčina u Pančevu"); and (5) the Nature Monument "Red Leaf European Beech Tree in Omoljica" (in Serbian: Spomenik prirode „Stablo crvenolisne bukve u Omoljici").

The management of these protected nature areas in Pančevo is entrusted to different public enterprises, namely: (1) the Public Water Supply Enterprise "Tamiš-Dunav", Pančevo (→The Nature Park "Ponjavica", until Mid-2015); (2) the Forest Management Unit "Banat", Pančevo (→The Natural Monument "Ivanovačka Ada"); (3) the Public Utility Enterprise "Dolovi", Dolovo / Pančevo (→The Natural Monument "Two Ash Trees near Dolovo"; (4) the Public Utility Enterprise "Zelenilo", Pančevo (→The Natural Monument "Ćurčin Horse-Chestnut Tree in Pančevo" and the Nature Monument "Red Leaf European Beech Tree in Omoljica"; the Nature Park "Ponjavica" is managed since Mid-2015).

Protected natural areas in Serbia have been managed by the government and have thus tended to rely almost exclusively on government coffers. In some Serbian cities, however, these arrangements are changing and new models of financing have emerged. According to the Law on Nature Conservation, different sources are available for financing the protected areas in Serbia, e.g. the state budget, the budget of the autonomous province, the budget of local governments, donations, etc.

In order to appraise, at least roughly, the share of the funds from the budget of the City of Pančevo in financing of the protected natural areas in the Pančevo municipal territory, we analysed the financial aspects of the Annual Protection Program of the Environmental Protection Fund for the year 2014 (see: Official Gazette of the City of Pančevo, Nos. 3/14, 18/14, and 27/14) and the Annual Protection Program of the Environmental Protection Fund for the year 2017 (see: Official Gazette of the City of Pančevo, No. 1/17). In this context, we also analysed the decisions on the budget of the City of Pančevo for the year 2014 / 2017 (see: Official Gazette of the City of Pančevo, No. 29/13 and Official Gazette of the City of Pančevo, No. 37/16).

By virtue of the Decision on the Budget of the City of Pančevo for the year 2014 (see: Official Gazette of the City of Pančevo, No. 29/13), earnings and revenues, including the undrawn amounts carried forward from previous years, have been reported in accordance with the budgetary classification and identified in the total amount of 5,459,901,277.00 Serbian Dinars (44,059,887.64 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia).

Analyses of the Annual Protection Program of the Environmental Protection Fund for the year 2014 (see: Official Gazette of the City of Pančevo, Nos. 3/14, 18/14, and 27/14) show that the Municipality of the City of Pančevo was apportioned only 2,465,000.00 Serbian Dinars (19,891.86 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia) for the needs of co-financing the protection and maintenance of the existing protected natural areas in Pančevo municipal territory in 2014. This exceptionally small amount of money represents only 0.0451% of the total budget of the Municipality of the City of Pančevo for 2014.

This amount of assets, provided by the Municipality of the City of Pančevo for protection and maintenance of the four protected natural areas on its territory, has been distributed as follows: (1) for co-financing of the guard service / nature park keepers in the Nature Park "Ponjavica" – 2,000,000.00 Serbian Dinars (16,139.44 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia); (2) for co-financing of the guard service / natural monument keepers in the Natural Monument "Ivanovačka Ada" – 200,000.00 Serbian Dinars (1,613.94 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia); (3) for maintenance of two ash trees and the environment of the Natural Monument "Two Ash Trees near Dolovo" – 160,000.00 Serbian Dinars (1,291.15 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia); and (4) for maintenance of one horse-chestnut tree and the

environment of the Natural Monument "Ćurčin Horse-Chestnut Tree in Pančevo" – 105,000.00 Serbian Dinars (847.32 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia).

Although this Program had undergone certain amendments and supplements (see: Amendments and Supplements of the Program of Use of the Assets of the Budgetary Environmental Protection Fund of the City of Pančevo for 2014 [see: Official Gazette of the City of Pančevo, No. 1/15]), budget assets for 5.2, 5.3, 5.4 and 5.5 in the Section 5 of the Annual Protection Program of the Environmental Protection Fund for the year 2014 – "Protected Natural Areas" (In Serbian: „Zaštićena prirodna dobra"), were not changed and were worth of 2,465,000.00 Serbian Dinars for 2014 (19,891.86 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia).

By virtue of the Decision on the Budget of the City of Pančevo for the year 2017 (see: Official Gazette of the City of Pančevo, No. 37/16), earnings and revenues, including the undrawn amounts carried forward from previous years, have been reported in accordance with the budgetary classification and identified in the total amount of 5,251,653,113.00 Serbian Dinars (42,379,382.77 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia).

Analyses of the Annual Protection Program of the Environmental Protection Fund for the year 2017 (see: Official Gazette of the City of Pančevo, No. 1/17) show that the Municipality of the City of Pančevo was apportioned 12,700,000.00 Serbian Dinars (102,485.47 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia) for the needs of co-financing the protection and maintenance of the existing protected natural areas in the Pančevo municipal territory in 2017. This extremely small amount of money represents only 0.2418% of the total budget of the Municipality of the City of Pančevo for 2017.

This amount of assets provided by the Municipality of the City of Pančevo for protection and maintenance of the five protected areas in its territory, has been distributed as follows: (1) for co-financing the maintenance of the Nature Park "Ponjavica" – 12,000,000.00 Serbian Dinars (96,836.66 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia); (2) for co-financing the maintenance of the Natural Monument "Ivanovačka Ada" – 100,000.00 Serbian Dinars (806.97 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia); (3) for co-financing the maintenance of the Natural Monument "Two Ash Trees near Dolovo" – 300,000.00 Serbian Dinars (2,420.92 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia); (4) for co-financing the maintenance of the Natural Monument "Ćurčin Horse-Chestnut Tree in Pančevo" – 200,000.00 Serbian Dinars (1,613.94 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia); and (5) for co-financing the maintenance of the Nature Monument "Red Leaf European Beech Tree in Omoljica" – 100,000.00 Serbian Dinars (806.97 Euros / February 17, 2017 Euro exchange rate of the National Bank of Serbia).

These assets (2,465,000.00 Serbian Dinars: 19,891.86 Euros / Year 2014 and 12,700,000.00 Serbian Dinars: 102,485.47 Euros / Year 2017) – intended for protection and maintenance of four / five protected natural areas in Pančevo – are insufficient / minimal. Therefore it is not surprising that in the period observed, the Municipality of the City of Pančevo did not initiate a single specific action dedicated to the complex studies of biodiversity in its territory, monitoring the state of urban biodiversity in already existing protected natural areas in Pančevo (besides a sporadic trunk inspections of protected trees), collecting the necessary information / documents and the like by virtue of which the protection would be planned and implemented in respect of new areas and / or natural structures, which can be deemed significant in terms of conservation of biodiversity in Pančevo (see: Annual Reports of the City of Pančevo Environmental Protection Secretariat for the years 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2015).

The total area of the five protected natural treasures in the territory of the Municipality of the City of Pančevo is roughly 140 ha, meaning that only a small city area is under the protection regime, i.e. 0.19% of the total municipal territory of this city (see: Annual Reports of the City of Pančevo Environmental Protection Secretariat for the years 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2015). If we use the data on the area size of the so-called adjoining protected areas incorporated in this calculation, the total area that is protected in the territory of the City of Pančevo amounts to ca. 204 ha, i.e. 0.27% of the total municipal territory of this city (see: Annual Reports of the City of Pančevo Environmental Protection Secretariat for the years 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2015). It is obvious in both cases that the area of the City of Pančevo under the protection regime is unacceptably low (0.19-0.27% of the total municipal territory) or, in

other words – a so-so protection of urban biodiversity in the territory of the City of Pančevo is being implemented within unacceptably small areas of the protected natural resources.

This fact is all the more upsetting if we consider the evident extent of the environmental disaster in Pančevo (Jelinčić and Djurović, 2009), that lasted for more than 5 decades for the attenuation of which very little has been done by the local, as well as the provincial and national authorities.

This is also supported by the fact that there has been no systematic research on (urban) biodiversity on the territory of the Municipality of the City of Pančevo since January 1, 2004. Moreover, the issues in (urban) biodiversity conservation are not addressed in any of the Annual Reports of the City of Pančevo Environmental Protection Secretariat analysed (see: Annual Reports of the City of Pančevo Environmental Protection Secretariat for the years 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2015).

The Forest Management Unit "Banat", Pančevo, conducted the only concrete analysis of biodiversity in the Special Nature Reserve "Deliblatska Peščara" / "Deliblato Sands" (In Serbian: Specijalni park prirode „Deliblatska peščara"), issuing several publications on the topic. Apart from these publications, there is no further information about the state of biodiversity protection in Pančevo and its surroundings, the activities to preserve wild flora and fauna and about endangered plant and animal species in the territory of the Municipality of the City of Pančevo. All the more so because the Law on Nature Conservation stipulates that the protection of an area or a natural resource may be proposed and initiated by legal entities and individuals. If an area, tree, geological site, natural history collection, that is, all the categories of natural resources determined by the Law, meet the criteria of representation, preservation, authenticity and other determined criteria, it may be referred to the Institute for Nature Conservation of Serbia (Belgrade) with the proposal to establish the grounds for initiating the legal protection procedure (see: Institute for Nature Conservation of Serbia).

There are neither nature parks nor special nature parks on the territory of the Municipality of the City of Pančevo. However, the Special Nature Reserve "Deliblatska Peščara" / "Deliblato Sands" – which is located at the territories of 4 Vojvodinian municipalities (Alibunar, Bela Crkva, Kovin, and Vršac) – is managed by the Forest Management Unit "Banat", Pančevo, the branch of Public Enterprise "Vojvodina Forests", Petrovaradin [In Serbian: JP „Vojvodinašume" Petrovaradin).

Over the past decades, there has been a significant change in the governance of protected areas world-wide, from exclusively state-run protected areas, to those managed by local governments and the private sector (see: IUCN SEE E-Bulletin, Volume 22). A wealth of shared-governance arrangements are also well documented (see: IUCN SEE E-Bulletin, Volume 22).

The field of nature conservation in Serbia is regulated by the Law on Nature Conservation, which legislates the protection and conservation of nature, as well as biological, geological and landscape diversity. Providing the natural area with the protection status involves many types of considerations that are ecological, naturalistic, aesthetic, scientific, cultural, political and educational in their nature. The Article 52 of the Law on Nature Conservation prescribes the obligation managers of protected areas in Serbia have so as to adopt effective management plans for the period of 10 years, if the act on protection does not require a different term. However, for these 10-year plans, it is necessary to develop annual implementation plans which are also subject to the approval. Management plans for protected areas established by the Republic of Serbia should be approved by the Ministry of Agriculture and Environmental Protection (Belgrade), and those – for protected areas established by the Autonomous Province of Vojvodina or local governments – should be approved by the competent body for nature protection of the province or local government.

Only the sound management of protected natural areas provided by trained professionals and certain citizen support will ensure the maintenance of these important areas which anchor the success of nature conservation into the 21st century. Unfortunately, the country's economic and political instability for many years, as well as the institutional weaknesses of governmental bodies, agencies and institutions involved in biodiversity conservation in Serbia, cause that certain strategies, laws, by-laws and plans have only been partially implemented.

Ensuring effective management and securing sufficient financial resources are vital for the maintenance of protected natural areas (Phillips, 2000). However, financial resources are often a constraining factor in the effective management of protected areas, falling well short of the needs. Protected natural areas have to compete with

pressing demands from other sectors, such as education, defence, health, etc. For various reasons, these other demands often prove more effective than protected areas at capturing government revenue. The result is that the proportion of public funding going into investment in protected areas is in decline in many countries or is insufficient (Phillips, 2000). Just like biodiversity conservation, protected natural areas are important for other significant reasons. They ensure the continued flow of ecosystem services, such as the provision of clean water and the protection of soil resources (Phillips, 2000). They provide significant economic benefits to surrounding communities and contribute to spiritual, mental and physical well-being. Protected areas also help fulfil an ethical responsibility to respect nature and provide opportunities to learn about nature and the environment. Each of these values pertaining to protected areas are important and should be taken into account in developing a financial plan (Phillips, 2000).

Serbian nature is characterized by a high diversity of flora and fauna, and is an important part of the wealth and diversity of the European natural heritage (see: Institute for Nature Conservation of Serbia).

During the last 6 decades, a region of protected areas in Serbia reached 529,631 ha or 5.99% of the territory of the Republic of Serbia (see: Institute for Nature Conservation of Serbia). According to the Law on Spatial Plan of the Republic of Serbia for the Period 2010-2020, almost 12% of Serbian territory is planned to be protected in some way, by the year 2021 (see: Institute for Nature Conservation of Serbia).

Out of 529,631 ha of the protected territory in Serbia, 20,280 ha is subject to Category I protection (3.83%), which means that any construction and any other human activity are prohibited in that area (except for scientific, research and educational activities). This territory is mostly owned by the state.

If we know that almost three times as much territory is protected in the countries of the European Union, one can simply conclude that Serbia will be faced with a significant work in the field of biodiversity conservation / nature protection on the way to achieve the high standards applied in this sector in the EU (see: New UNEP report unveils world on track to meet 2020 target for protected areas on land and sea and Natura 2000 network).

According to the data of the Institute for Nature Conservation of Serbia (Belgrade), there are 461 natural resources protected in Serbia: 5 national parks, 17 nature parks, 20 landscapes of exceptional features, 68 nature reserves, 3 protected habitats, 310 natural monuments, and 38 areas of cultural and historical significance – that were protected according to the former versions of the Law on Environmental Protection and the Law on Protection of Cultural Heritage. The management of 461 protected natural resources in Serbia is mainly entrusted to public enterprises / state-owned enterprises, but the care of Serbian natural treasures is also given to private companies, tourist and non-governmental organizations, hunting clubs and individuals, including the Serbian Orthodox Church (see: Institute for Nature Conservation of Serbia).

Most of the protected natural resources in Serbia have been entrusted to the management of the Public Enterprise "Serbian Forests" in Belgrade (In Serbian: JP „Srbijašume" Beograd), which takes care of 92 protected natural treasures, having the total area of 244,122 ha of protected areas, representing 46.09% of the total protected area in Serbia. In addition, a large area of protected natural treasures in Serbia is under the administration of the public enterprises established pursuant to the Law on National Parks – "Tara", "Kopaonik", "Djerdap", "Fruška Gora" and "Šar-planina" (see: Institute for Nature Conservation of Serbia).

Besides protected natural resources, 1,760 strictly protected and 868 protected wild species of plants, animals and fungi are also protected in Serbia by the Law on Nature Conservation and in accordance with the Book of Regulations on the Designation and Protection of Strictly Protected and Protected Wild Species of Plants, Animals and Fungi – which contains lists of strictly protected and protected wild species as well as the protection measures. Species in Serbia that may be threatened by overharvesting and uncontrolled gathering from nature are also placed under certain protection (see: Institute for Nature Conservation of Serbia).

Conclusion

Although the legal framework in Serbia gives autonomy to the local government in Pančevo to proclaim protected natural areas on its territory, as well to manage or contribute to the management of protected areas, in practice it seems that the role of local authority in Pančevo is quite limited and based

only on the maintenance co-financing and / or short-term cooperation with higher-ranked authorities on development and adoption of protected natural area management plans, annual implementation plans and the like.

Before anything is done, due to securing necessary funds and building institutional capacities aimed to increase the number / total area of protected natural areas on the territory belonging to the Municipality of the City of Pančevo, a local government in Pančevo should conduct systematic research to foster assessment of (urban) biodiversity on the territory of the Municipality of the City of Pančevo for the purpose of providing more quality and complex biodiversity conservation within the protected natural areas that already exist. This research should be initiated in terms of understanding the impacts of severely degraded environments – like this one in Pančevo – on ecosystems and therefore give valid outputs about – why, how, and where should (urban) biodiversity conservation be organized in Pančevo. Special attention should be given to research initiatives focusing on the effects severe air pollution in Pančevo has on (urban) biodiversity in this city. This data will certainly help in improving the management of protected natural areas in Pančevo, but may be also used for promoting the idea of the importance of (urban) biodiversity conservation and evidencing how (urban) biodiversity and its continuous promotion, support human well-being and the quality of life for future generations.

This information about the state of (urban) biodiversity / biodiversity conservation in Pančevo should be shared with diverse target groups, from students of all levels of education to the policy-makers, and nature lovers. It should help – as it is stated in the EU Biodiversity Strategy to 2020 – in understanding that "biodiversity conservation is not just about protecting species and habitats for their own sake. It is also about maintaining nature's capacity to deliver the goods and services that we all need, and whose loss comes at a high price." (EC, 2011).

Acknowledgements

This study is partly financed by the European Union through the European Integration Fund, managed by the Delegation of the European Union to the Republic of Serbia and implemented by Press Now (Belgrade, Serbia), through the FOS (Belgrade, Serbia) and the CPES (Belgrade, Serbia) initiatives. The authors are extremely grateful to Mr. Nenad Živković – a journalist and publicist from Pančevo – for being immensely helpful in providing documents and information needed for understanding the complex history of environmental degradation / environmental catastrophe in Pančevo.

Received: April 30, 2017
Accepted: May 25, 2017

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Biodiverzitet urbanih sredina – 2. značaj zaštite biodiverziteta u urbanim sredinama grada Pančeva (Srbija)

SAŽETAK

U budućnosti će biti gotovo nemoguće (za)štititi biodiverzitet primenom pristupa kojim se štite isključivo veoma ugrožena područja prirode. Promovisanje zaštite biodiverziteta je više od toga i zahteva sprovođenje složenih mera, na globalnom i lokalnom nivou, s ciljem uvećavanja površina na kojima su sačuvane odlike prirodnih staništa a čiji su delovi ostali međusobno povezani. Gradovi mogu imati značajnu ulogu u zaštiti biodiverziteta i na globalnom nivou unapređivanjem urbanog biodiverziteta na svojim teritorijama. Štaviše, žaštita urbanog biodiverziteta može biti krucijalna za zaštitu vrsta na lokalnom i / ili regionalnom nivou. U vremenu koje karakteriše ubrzana urbanizacija, zaštita biodiverziteta u urbanim područjima od presudnog je značaja za kvalitet života i dobrobit budućih generacija. To se svakako odnosi na stanovnike u gradovima sa izrazitim aerozagađenjem, degradiranom životnom sredinom, narušenom infrastrukturom, itd. Imajući to na umu, u ovom smo radu pokazali koliko je lokalna vlast u gradu Pančevu učinila na polju zaštite (urbanog) biodiverziteta i njegovoj promociji na celoj teritoriji grada Pančeva tokom posmatranog perioda (2007-2016).

Ključne riječi: Degradirana životna sredina, zaštita životne sredine, Pančevo, Srbija.

Techno Science
International Scientific Journal of Technical Sciences

Hydrogeological features of the west Serbian Dinaric Karst

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ABSTRACT

The West Serbian Dinaric karst spreads over the furthest southeastern part of the Dinaric karst area known worldwide. This karst spreads over a significant part of the state's territory and it is marked with approximately 10 large and several smaller mutually isolated masses, made predominantly of karstified limestone from the Middle Triassic period. The limestone has suffered extreme tectonic damages and after that, got transformed in several phases within a karst process. That is the reason why today this karst is characterized by a high level of transmissibility and a high percentage of infiltrated precipitation, as well as by huge groundwater reserves.

Keywords: Hydrogeological features, karst, Dinarides, West Serbia.

Introduction

West Serbia was the subject of regional and basic hydrogeological investigation several times. During the period between 1967 and 1976, Geozavod Belgrade has synthesized a major part of existing data within hydrogeological investigation studies performed in four regions of chosen area. The report itself relies mainly on West Serbian karst investigation data. The investigations were performed by authors of these reports during the period between 2005 and 2007, for the purpose of studies, written in the year 2000 for the Institute for the development of water resources Jaroslav Cerni referring to general water framework directives (Water Framework Directive 2000/60/EC), as well as water supply of West Serbian population and industry. The motive for writing this study is closely linked to the international project Dinaric Arc which lacks data on the furthest southeast part of the Dinaric Arc (West Serbian karst).

Basic geological features of the area and rock categorization based on the degree of water permeability

The furthest southeast part of the Dinaric karst area belongs to Serbia – typical geological units known worldwide for their extremely complex geomorphological and hydrogeological features (Cvijić J, 1900). The discovered karst area in Western Serbia extends from Loznica and Valjevo on the north, over Prijepolje and Sjenica, to the mountain range on the edge of Metohija valley on the south (Fig. 1). In this area which is 260 km long and 40 to 60 km wide, around ten large and several smaller mutually isolated zones (masses) that consist of Middle Triassic limestone are located (Komatina M, 1975). Morphologically, we can distinguish limestone massifs of Maljen, Povljen, Tara, Zvijezda, Zlatibor, Zlatar, Bučja, Jadovnik, Giljeva, Velika

Ninaja, Mokra Gora, Žljeb, Koprivnik, Paštrik and Koritnik (Cvijić J, 1926). That is why the area of the West Serbian Dinaric karst has distinct mountain features with heights AMSL between 110 and 2,700 m. Atmospheric precipitation height during an average wet year varies between 750 and 1200 mm while its average is 910 mm. The West Serbian Dinaric karst area is distinguished by relatively diverse lithostratigraphic structures and complex structural composition. Among numerous geological formations, the most widely spread are the following:

1. Mio-Pliocene Lacustrine sediments complex.
2. Jurassic Diabase-chert formation.
3. Middle and Upper Triassic Limestones, rarely dolomitic limestones.
4. Early Palaeozoic Schist complex.

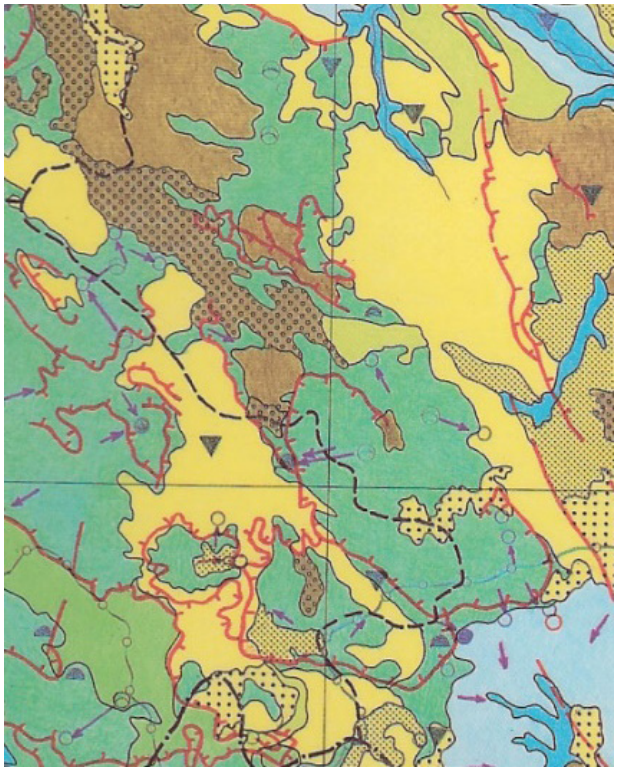

Figure 1: Karst terrains of W. Serbia with adjacent regions (Komatina M., 2016).

Schists forms terrains north of Valjevo and Loznica, the area between the Povlen massif and the line Perućac-Užice. They also form the spacious Dinaric region border zone east of Ivanjica and Novi Pazar. According to rock categorization based on the degree of water permeability, they range from impermeable to low permeable environment. A thin Werfenian-flysh complex lies over the layer of Schists, and after that, a thick series of Middle Triassic limestones (rarely dolomitic limestones), which create the main geological formation of the West Serbian Dinarides. Because of their chemical and mineralogical purity, a high level of suffered tectonic damages and lengthy terrestrial phase, limestone is intensively karstified near surface and in the depths. That is why it is an extremely permeable environment and could contain large reserves of accumulated groundwater.

Here and there, the top layer for limestone is formed by extremely heterogeneous formations like Diabase-chert formation or Peridotite (serpentinite) and Neogene Basin formation. Diabase-chert formation is widely spread in the river basins of Veliki Rzav and Mali Rzav, then in the vicinity of Nova Varoš, Prijepolje and Sjenica. The Zlatibor massif stands out from other Peridotite masses because of its dimensions, and the Metohija basin stands out from other Neogene Basins. The mentioned geological formations, compared to limestone, represent an impermeable environment and an impermeable top layer for precipitation infiltration, as well as a barrier for further movement of groundwater.

As it was already said, this terrain has extremely complex structural composition. Among various larger and smaller folded formations, there are numerous neotectonic structural fractures (fracture zones). Because of that, positional relations between the mentioned geological formations are disturbed, and karst contact springs often occur along the fractures (Katzer F, 1909).

Basic hydrogeological features of the area

From the hydrogeological point of view – first of all – it is important for every karst mass of this area as the reservoir for groundwater to become acquainted with the positional relations between the older geological formations from substratum (Schist, Werfen), and with the younger formations (Diabase-chert formation, serpentinite, Neogene) (Komatina M, 1970). All the important features of limestone aquifer, i.e. the water body accumulated in it, are the result of structural and positional relations within these three packages of rocks with different permeability (groundwater accretion and circulation direction, possibility of accumulation and discharge, pollution saturation, etc.). For aquifers of the Zapadna Morava upper drainage basin, for example, the most convenient circumstance for groundwater accumulation forming is if limestone is

laterally enclosed by an impermeable layer (barrier). But this phenomenon does not occur so often in this area, so groundwater usually flows out directly into the river. On the other hand, the position of karst aquifer and supplementation of corresponding water body can become extremely complex if the top layer is formed out of impermeable rocks, which is characteristic for the West Serbian karst. This feature is particularly expressed in two most important limestone areas: (1) Zlatibor, Zlatar and the drainage basins of Veliki and Mali Rzav, and (2) Pešter plateau and surroundings, where impermeable formations cover between one third and one half of the karst aquifer area. The existence of such top layer certainly makes groundwater balance more difficult but also contributes to the fact that there are no qualitative (chemical) pressures on groundwater accumulation forming process (Komatina M 1964/65).

West Serbian karst water resources belong to the two hydrographic entities – the Black Sea drainage basin and the Adriatic Sea drainage basin, considering only Beli Drim drainage basin within the Adriatic Sea drainage basin (Metohija valley with surrounding mountains). Drainage basins of Drina, Zapadna Morava and Kolubara belong to the Black Sea drainage basin. The following karst areas belong to Drina and its headwater Lim drainage basin: Povlen, Tara – Zvijezda, karst of the Prijepolje surroundings and most of the Pešter plateau karst; Zapadna Morava and its headwater Ibar drainage basin: Zlatibor karst, drainage basins of Veliki and Mali Rzav, Đetina, mountain Ninaja and upper Ibar karst; Kolubara drainage basin: Maljen karst (Lelić karst) (Fig.2).

Groundwater discharge regime depends on the hydrogeological terrain structure and, more or less, has a lower uniformity coefficient. Karst springs, formed on the contact surface between limestone and some kind of barrier, are less uneven, especially if limestone has better retention features. The size of the outflow module subsurface ranges between 5.5 and 17.0 l/s/km2. The groundwater type is calcite hydro-carbonate and it has low mineralization. The quality is very good (mostly I and II drinking water class).

Relatively widely spread occurrences of the thermo-mineral waters suggest a presence of deep-ground circulation through the karst collectors. The following eight thermo-mineral water springs are of great practical significance and have great capacity: Ovčar banja, Vrujci, Petnica, Lađevac, Vrutačko vrelo, Pribojska banja, Crno vrelo and Čedovo near Sjenica.

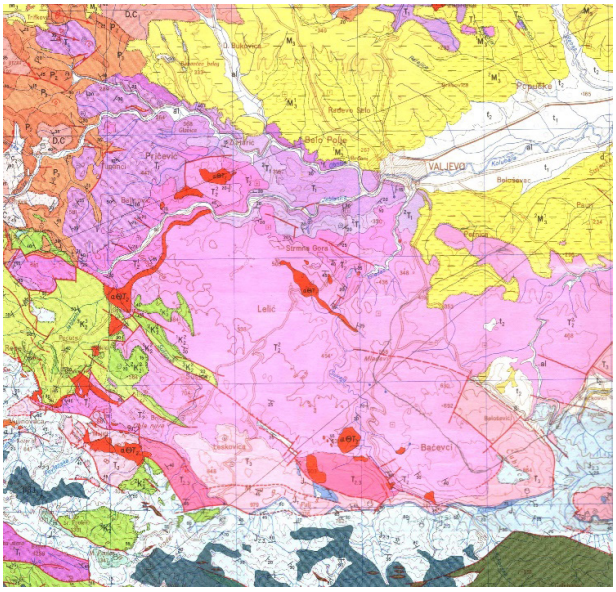

Figure 2: Karst terrains of central and western part of the Lelić area
1. Pink area – karst terrain,
2. Yellow – Neogene,
3. Blue – diabase – chert formation (Komatina M., 2016).

A survey of karst aquifers

1. Mountain Maljen aquifer (Lelić karst)

The mountain region of Maljen is located south of the city of Valjevo and covers an area of almost 280 km2. It is made of Middle Triassic limestone (rarely of dolomite), monoclinally positioned toward the north. Tectonically damaged limestone is much karstified, and that is why this area is marked with numerous lapies, sinkholes, ponors, fissures and shorter dry riverbeds. In literature, this area is known as Lelić karst (J.Cvijić, 1912). The major part of precipitation becomes, concentrated of diffuse, infiltrated into permeable limestone and directed toward the north through the schist substratum.

This groundwater comes across an impermeable barrier made of the Valjevsko-mionički basin sediment and, along the tectonic contact surface between limestone and Neogene, emerges on the surface in the form of several strong contact springs: Paklje (Qmin 150 l/s), Gradačka vrela (Qmin 410 l/s), Petnica (Qmin 45 l/s), Ključka vrela (Qmin 60 l/s), seepage spring Vrujci (Qmin 200 l/s). The only spring among them which has been tapped in order to satisfy the city of Valjevo's needs is exsurgence Paklje and partly Gradačka vrela.

Test drilling in the Valjevsko-mionički basin and in the area north of the basin (Mačva, Posavo-tamnava, Srem) showed that Triassic limestone is widely spread in the north, but also emphasized its practical importance regarding aquifer with large thermal water reserves, and a potential spring located in Mačva. Let us also mention the spring that is formed in Nepričava near Lajkovac – in covered karst aquifer – in order to supply the population of Lajkovac. Its capacity is 120 l/s (Komatina M., 2016).

2. Mountain Povlen aquifers

The mountain Povlen massif extends south from city of Valjevo. Apart from Middle Triassic limestone, the mountain consists of Diabase-chert formation and other impermeable rocks. The two most important geomorphologic formations are: (1) karst area Vinčina voda – Zapolje with long rock area along the southern edge, and (2) wide Palaeozoic shale region, steeply leaned toward the river Drina. This karst area is marked with numerous lapies, sinkholes, ponors and long dry karst valley Široki do – Prekobrdo with a large number of periodically active ponors. Around 60% of precipitation gets infiltrated into limestone. Groundwater gets directed toward the contact area between limestone and the Palaeozoic shale and gets discharged through the Bakića vrelo and Taorsko vrelo. Apart from these two separate water bodies, there is also the limestone massif of Trešnjica whose water gets discharged directly into the Trešnjica river bed. The groundwater discharge regime varies during one budget year, so extreme spring-flow values for Bakića vrelo are 90 and 320 l/s, and for Taorsko vrelo 40 and 160 l/s. Taorsko vrelo has been partially tapped in order to satisfy the city of Kosjerić's needs (Komatina M., 2016).

3. Aquifers of Tara and Zvijezda massifs

Tectonic blocks of mountains - Tara and Zvijezda, west of Užice, are distinctly mutually separated by the regional fault zone of Konjska reka (Fig.3). They are built predominantly out of strongly karstified limestone and partly out of Triassic dolomite limestone. The highest peaks of these mountains are 1675 m (Zvijezda) and 1544 m (Tara), while the river Tara, which partially separates them, runs on the level of about 290 m AMSL.

The mountain Tara has large features of the Quaternary area, it expands through 183 km2 and has an average height of 1200 m. Triassic limestone is predominant in this area, and the edges, as well as central parts, consist of heterogeneous (mostly impermeable) rocks. Mitrovački fault divides the massif in two parts, and the east wing is elevated. The plateau is rich with surface karst formations such as karst uvalas and valleys with sinking rivers and numerous sinkholes. The closed depressions Dobro polje, Ljuto polje and Bogdanovac stand out (Komatina M., 2016).

A major part of Tara groundwater tends toward the drainage base in the north. The leading privileged collector is presented by Mitrovački fault and the biggest natural sink of the karst aquifer is exsurgence Perućac. This groundwater outcrop emerges at the contact area between limestone and Werfenian sediments, and has relatively good retention features (1340:2300:6500 l/s). A very small part of this exsurgence is tapped in order to satisfy the needs of the fish pond. Untapped exsurgences of the rivers Rača (85:250:680 l/s) and Solotuša (75:190:460 l/s), as well as the thermal spring Ladjevac (Qav 50 l/s, water temperature 17,5-20,00C) are located further East, in the same contact area.

Favourable conditions for groundwater accumulation do not exist in the area of mountain Zvijezda, so groundwater discharges directly in the river Drina.

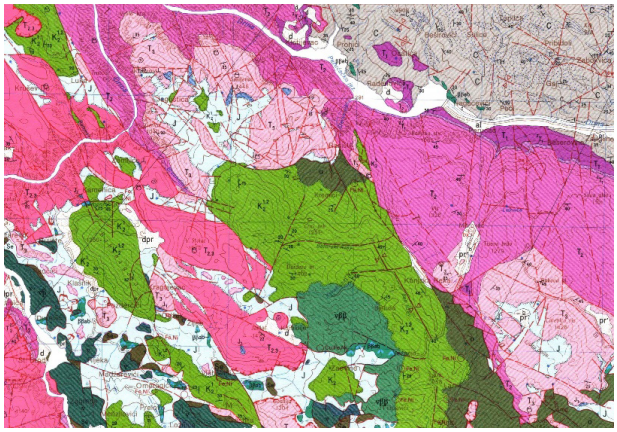

Figure 3: The karst of Tara and Zvijezda mountains
1. Pink – Karst terrains,
2. Others – impermeable rocks (Komatina M., 2016)

4. Aquifers of the mountains Zlatibor and Zlatar and the drainage area of the river Rzav

They are placed within the large karst area between Užice in the north and Sjenica in the south. If we also consider the limestone covered with an impermeable top layer, this area measures around 1520 km2. Here, limestone forms some sort of a discontinuous ring around the peridotite Zlatibor massif. In the limestone substratum, Werfenian formations and Paleozoic shale are located while diabase-chert

rocks form a partly impermeable cover (bedrock). The surface discharge from peridotite and diabase-chert rocks runs to the limestone contact area where groundwater percolates into numerous ponors, and emerges again in the mountain foothill through several exsurgences. There are several exsurgences in the area of mountain Zlatibor (Komatina M., 2016):

1. A group of water bodies from northeastern slopes of the mountain Zlatibor and drainage area of the river Djetina. Groundwater flow accretion comes from percolation of the shorter surface rivers formed on peridotite and direct infiltration of precipitation into limestone. The groundwater moves towards north and northeast and discharges through numerous karst springs in the area of drainage bases – rivers Djetina and West Morava. The biggest are: Sušičko vrelo (Qmin 420 l/s), Vrutačko vrelo - thermal and cold (Qmin 135 l/s) and occurrences in Jelisavčići (Qmin 135 l/s) and Stapari (Qmin 35 l/s). The mentioned occurrences are not tapped.
2. The water body of river Ljubišnica spring. Discovered karst formation near Ljubiš discharges though the river Ljubišnica spring, tapped in order to satisfy the fish pond needs. The spring-flow varies between 70 and 350 l/s. It was already emphasized that a major part of groundwater from this area drains into the rivers Veliki Rzav and Mali Rzav. Today, Veliki Rzav is the regional water supply source.

South of Zlatibor, massifs of mountains Zlatar, Kozomora and Kitonja distinctively stand out within the landforms. They consist, to a great extent, of Middle Triassic limestone. Aquifer is partially covered with diabase-chert formations, especially in the case of mountain Zlatar. Lacustrine formations, from Neogene, partly form the top layer above limestone. Groundwater circulates through distinctly discontinuous karst toward the river Bistrica valley (Lim tributary) as its drainage base. Here emerge numerous outcrops, a.o. Radovića vrelo (Qav around 300 l/s), Crno vrelo (Qav around 200 l/s), Česme (Qav around 70 l/s), Pećine (Qmin 45 l/s) and Vrelo (Qmin 40 l/s). Some of the mentioned occurrences are tapped in order to satisfy the city of Nova Varoš's needs.

In the mountain area north of the Neogene basin of Sjenica, groundwater gets directed toward south and southeast and it emerges in the contact area of limestone and Neogene. Out of the main groundwater outcrop – exsurgences of Zarudina – during the drought period, flow around 250 l/s. Another important exsurgence is Šarsko vrelo (Qav oko 120 l/s). Exsurgence of Zarudina is tapped in order to satisfy the needs of cities of Sjenica and Štavlje.

5. Karst aquifers in the vicinity of the city of Prijepolje

Several karst masses which have large capacity resurgences exist in one part of the drainage area of the river Bistrica, in the vicinity of the city of Prijepolje. Aquifers of Bučja and Jadovnik massifs, as well as those of Brodarevo area, stand out.

The mountain terrain Bučja, west of Prijepolje, is a predominantly open aquifer that consists of Middle Triassic limestone. Through that discontinuously permeable medium, groundwater circulates toward north (toward exsurgence Bučja) and toward east (toward exsurgence Seljišnica), up to the impermeable barrier of diabase-chert rocks and schist. Typical spring-flows are: Seljašnica – Qmin 400 l/s, Qav 1200 l/s; Bučje – Qmin 300 l/s, Qav 1100 l/s. The exsurgence of Seljašnica is tapped in order to satisfy the city of Prijepolje's needs.

The aquifer of Jadovnik i Brodarevo spreads over mountain massifs of Jadovnik and Komoran, southeast from Prijepolje. Almost a quarter of intensively karstified limestone from the Middle Triassic area is covered with impermeable top layer made of diabase-chert rocks. Groundwater circulates towards the main drainage base – river Lim valley, where it discharges through the untapped exsurgence of Sopotnica, with minimal water-yielding capacity that measures almost 300 l/s (Komatina M., 2016).

6. Aquifer of Pešter plateau and its surroundings

Among the Dinaric karst of West Serbia, the karst of Pešter plateau and its surroundings stand out because of its size (Fig.4). That distinct karst area covers around 1900 km2. Among surface karst formations the most important are: Pešter field (40 km2) marked with numerous ponors and a sinking river Borovštica. Borovštica runs from Đerekarsko vrelo, and there are around 140 different registered places where the river percolates along its course.

Besides numerous percolation shafts in the field, long cave exsurgence which is located downstream from the village Đolovići stands out among speleology formations. The area itself has a mountainous character, with Triassic limestone that forms more mountain massifs, surrounded with an impermeable layer like schist, diabase-chert rocks and Neogene

sediments. Additionally, on more than one third of the area, above limestone lie diabase-chert formation rocks and Neogene. That top layer is thickest in the area southeast of Sjenica and southwest of Tutin.

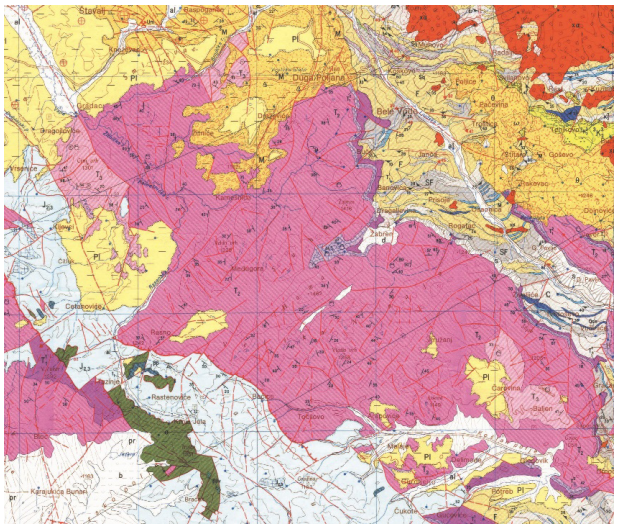

Figure 4: The karst of the northern part of Pester polje (near Sjenica)
1. Pink – Karst terrains,
2. Others – impermeable rocks (Komatina M., 2016)

Within the structure of Pešter aquifer, several water bodies are noticeable – the water body of Sjeničko vrelo, water bodies of Vape and Raška exsurgences, a group of upper Ibar exsurgences by Ribarić and the water body of Bistrica exsurgence.

The water body of Sjeničko vrelo (Grabovica exsurgences) spreads over a relatively small area. It is interesting for the ways of groundwater accretion: in the west part of the drainage area, the river Trijebinska percolates into aquifer – direct precipitation infiltration into aquifer. Inside, the limestone water circulates towards north and discharges through Sjeničko vrelo. Sjeničko vrelo is the exsurgence that emerges on the contact area between Triassic limestone and diabase-chert formation and has very variable water-yielding capacity during one year – from 250 to 2500 l/s. It is tapped in order to satisfy the city of Sjenica's needs (Komatina M., 2016).

The water body of the river Vape exsurgence is located southeast of Sjenica. Similar to the above mentioned water body, groundwater origins partly from the direct precipitation infiltration into limestone, and partly from percolation of the west part drainage area surface water into diabase-chert formation. It should be emphasized that the limestone located in the southwest part of the drainage area is covered with the relatively thick layer of diabase-chert formation. While circulating toward northwest through the limestone, groundwater comes across the barrier made of Neogene sediments and it discharges, almost completely, through one spring - river Vape exsurgence. The water - yielding capacity of this untapped exsurgence varies – from 550 to 9000 l/s.

The water body of the river Raška exsurgence spreads west from the city of Novi Pazar, across the area of about 190 km2. The field is made of Triassic limestone, and it is covered, to a very small extent (along the southwest border of the water body), with the diabase-chert formation rocks. The main massif groundwater – of the mountain Ninaja – circulates toward east. Dynamic reserves of this water body discharge through the exsurgence with the same name, located in the contact area between the limestone and schist, in the vicinity of the monastery Sopoćani. This exsurgence is of siphonic (sinkhole) type and has a water - yielding capacity that varies from 950 to 7600 l/s. One third of the minimal flow is tapped in order to satisfy the needs of the city of Novi Pazar, while the bigger part is used for hydroelectric power plant Ras and for the fish pond.

The water body of upper Ibar is formed within the limestone massifs in the vicinity of Ribarići, and this area measures around 110 km2. Karstified Triassic limestone is open aquifer, excluding around 15% of the area that has a top layer made of diabase-chert formation. Groundwater discharge is concentrated through three following exsurgences: Crno vrelo (Qav around 7500 l/s, Qmax around 4500 l/s), Miljina glava (Qav around 480 l/s) and Vrelo (Qav around 180 l/s, Qmin around 30 l/s). The water body of the Bistrica exsurgence is partly located at the territory of the Republic of Montenegro. It spreads over almost 450 km2. This tectonic damaged and intensively karstified limestone lies with its bigger part exposed to the surface. Exceptionally, on the surface of around 30 km2, an impermeable top layer is made of the diabase-chert formation rocks, while the limestone in the Pešter field is covered with quaternary detritus which is 20 m thick. Hydrogeological relations in this area are very complex. Generally, groundwater flows toward southwest, precisely toward exsurgences of Bijelopoljska Bistrica. Upstream, there is an exsurgence that emerges from the mentioned cave near Đalovići, and its water - yielding capacity varies between 580 and 9000 l/s. This water is partly used in order to satisfy the needs of the city of Bijelo Polje. Downstream, the exsurgence Juriško has similar capacity but is not tapped.

7. Karst aquifers of Metohija's mountain edge

The mountain massifs of the Metohija valley northern area are mostly made of massif Middle and Upper Triassic limestone.

The results of the dye test performed on the ponor Savina voda showed that a major part of the Mokra gora limestone mass groundwater is pointed toward the ravine as its drainage base. Discharging of this water is performed at the contact area between limestone and a barrier made of diabase-chert formation through the exsurgence Istok (Qmin 800 l/s, Qmax around 6600 l/s) and exsurgence Vrelo (Qmin around 150 l/s, Qmax around 2600 l/s). Just a very small part of the exsurgence Istok is tapped, in order to satisfy the needs of the village with the same name.

Limestone of the mountains Maja Rusolija and Žljeb belongs to the drainage area of the richest exsurgence in Serbia – exsurgence of the river Beli Drim. Water discharges at the contact area between limestone and the diabase-chert formation rocks, in the vicinity of the village Radavac (northeast from the city of Peć). Water - yielding capacity varies between 900 and 15500 l/s. This exsurgence is partially tapped in order to satisfy the needs of the city of Peć (Komatina M., 2016). Mountain Paštrik and Koritnik karst water bodies, along the edge of the southern part of Metohija valley, discharge through the several occurrences in the village of Vrbnica, through the exsurgence in the village of Poslište and other groundwater springs in the vicinity of Prizren. The main spring in Vrbnica is located in the contact area between limestone and Paleozoic shale and has water - yielding capacity that ranges between 490 and 3300 l/s. The exsurgence in Poslište is also a contact occurrence and its water - yielding capacity varies between 210 and 1900 l/s.

Conclusion

Geological factors important for karst process development are: chemical purity and limestone texture, the level of the suffered tectonic damage and existence of the fracture structures of a larger scale, hypsometric relations between limestone and the impermeable geological formations, duration of the terrestrial phase, as well as the climate and other conditions during that phase. Modelling of the privileged underground karst formations is primarily directed by position and dimensions of a fracture structure. In the case of the West Serbian karst, however, the impermeable footwall position (most frequently – the Palaeozoic shale within a monocline structure) and hanging footwall (most frequently Neogene lacustrine formations, and diabase-chert formation, locally also peridotite) are very important for the groundwater distribution within a karst aquifer. For the discharge of formed water bodies, however, in the foreground lies the position of the impermeable barrier. That is why karst exsurgences primarily emerge on the contact area between limestone and the side barrier. Karst exsurgences with the largest water – yield capacity are: Perućac, exsurgences of the rivers Vapa, Raška and Beli Drim, exsurgence Istok and Vrbničko vrelo.

The most significant feature of the West Serbian karst is surely the impermeable block made of younger geological formations that significantly cover karst. This is the explanation of the phenomenon that more karst resurgence, practically, don't have sufficient catchment area if the close mass of the open karst which corresponds to the exsurgence capacity is considered. The existence of the impermeable block, as well as very low population density, are the main reasons for absence of qualitative (chemical) pressures on the water bodies, so the major part of the springs has drinking water of excellent quality. An existing trend excludes the possibility of risk increasing during the decades to come.

The following occurrences could deviate from this rule: Ključko vrelo (increased concentration of nitrates), Perućac (momentarily, very brief occurrences of biological pollution arrived through the Mitrovački fault), Sjeničko vrelo (occasional unclearness and bacteriological improperness). In the case of exsurgences of Bijelopoljska Bistrica, potential dangerous points of chemical and microbiological status worsening in the future could be the intermittent river of the Pešter field. Anyway, it is considered that – within the process of setting the sanitary protection zones in the karst – special attention should be payed to the percolation zones and the privileged collectors between ponors and matching groundwater springs. A major part of the West Serbian settlements is using the water of the nearby springs. However, the level of the exploitable karst groundwater reserves usage is generally minimal. The conclusion is that the quantitative status of isolated water bodies is satisfactory, and that could also be forecasted for the future. The general conclusion is that the quantitative and the qualitative influence of groundwater on terrestrial and water ecosystems remains, in the practical sense, unchanged, which means that the previous ecosystem status has not been changed.

Techno Science
International Scientific Journal of Technical Sciences

Received: April 30, 2017
Accepted: May 25, 2017

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Hidrogeološke karakteristike Dinarskog karsta Zapadne Srbije

SAŽETAK

Dinarski karst Zapadne Srbije prostire se preko jugoistočnog dela svetski poznate oblasti Dinarskog karsta. Teren karsta pokriva značajan deo državne teritorije i čini ga deset velikih i nekoliko manjih izolovanih celina, pretežno izgrađenih od karstifikovanog krečnjaka iz perioda srednjeg trijasa. Krečnjak je podvrgnut izrazitim tektonskim oštećenjima i posle toga izmenjen u toku nekoliko faza u okviru procesa karstifikacije. To je razlog što se ovaj karstni teren danas odlikuje visokim nivoom propusnosti i visokim procentom infiltriranih padavina, kao i velikim rezervama podzemnih voda.

Ključne riječi: Hidrogeološke karakteristike, karst, Dinaridi, Zapadna Srbija.

Techno Science
International Scientific
Journal of Technical
Sciences

The concept of local governance in BiH information system development

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ABSTRACT

This paper deals with the implementation of information systems for public administration in BiH. IS implementation is a complex process that involves solving problems such as: a review of IS theoretical aspects, analysis of the current state, selection of the most appropriate methods for IS development, implementation of the IS, post implementation support and measuring the practical benefits of IS implementation.

Keywords: information systems, development, methodology.

Introduction

Several methodologies for the software systems development and design are known in theory and practice. In present conditions, the development and design are realized by forming mixed teams that include: users (analysts of the real system), information system analysts and software system designers. Using modern tools for software systems development and design (CASE - Computer Aided Software Engineering), the project team develops a software system in phases, depending on the chosen methodology.

Today, when asked, the question of how to actually develop and design a software system in the context of information systems related to automating certain functions across all the levels of municipal structures and services presents a highly topical response. However, due to the high complexity of the functions and processes in the system, which needs to develop a software, it is necessary to invest a lot in finding methodologies that will best suit the software systems development needs.

The failure to develop and design complex information-software systems, as well as low productivity of the project teams encourage research dealing with finding new methods.

LIS development concept proposal

Using past experience in working on IS development, and some of the existing methodologies and lessons learned in the application of the methodology, MIRIS is given a concept for OCT development of. The development of IS for the local government in BiH can only be done by a combination of several available methodologies. If we decide to develop the IS from the top down, it is necessary:

- To establish a Government Information Centre for Information Technology (ICVI), at least at the level of entities;
- To define the role of government in development

The main ICVI task is to make a satisfactory computerization of the public administration. Among other things, ICVI would be responsible for:

- the development of application software,
- advising government bodies on planning and implementation of information technology,
- supervising the application software development and implementation,
- guaranteeing adequate quality services and products of information technology,
- methodological and technological coordination in project development.

Enumerated tasks correlate closely with the chosen methodology of information system development. Besides the above listed, the ICVI task is to take care of developing a methodology that would deal with the development of information systems for public administration. Computerisation of public administration will make the state authorities, service users and, in some segments, the purchasers themselves involved in the process. The Government Information Centre for Information Technology would assume the function of the professional coordinator and contractor, who would carry out most of the Performer Affairs. Such a situation leads to the fact that different approaches are used for individual developments, which in turn leads to the emergence of various products (mainly in the analysis and planning phases). Such diversity makes it difficult, if not impossible, to conduct effective supervision and quality assurance, which the Government Information Centre for Information Technology would be in charge of. This further aggravates re-usability of the product development and comparison between various development projects. To make high quality IS, it is necessary to involve the government at the entity level for several reasons:

- the software would be cheaper for municipalities,
- software quality would certainly be much higher because several municipalities would make suggestions in the process of application development,
- a universal system applicable to the whole territory of Bosnia and Herzegovina would be created,
- people would have some standard procedures for dealing with their problems no matter where they are,
- the government would have better control of individual municipalities,
- the Election Commission would receive unique data,
- Departments of Statistics and various departments in charge of municipality development would also provide the necessary data,
- simply stated, all the participants would benefit - the state, municipalities and the end service users as well.

An overview of the methodology for LIS development

The main purpose of the proposed concept for information systems development, the Government Information Centre for Information Technology and, of course, other state authorities can offer:

- assistance in preparing, setting up, coordinating, managing and supervising the projects development, carried out for the needs of the Government Information Centre for Information Technology (joint ventures) and the needs of other state bodies,
- a gradual approach to the development and implementation of information systems for state bodies,
- methodological support in monitoring the projects execution quality involving/regarding the contractor and
- creating positions for the contractors involved in the process.

Table 1: The content of information system development methodologies

Information system development methodology								
Information system structural development methodology			Information system object oriented development methodology			The methodology for the development of "workflow" applications		
Rules and the use of diagramming techniques	Development process	CASE tools	Rules and the use of diagramming techniques	Development process	CASE Tools	WfMC model	Development process	Review BPR and WF tools

Structural Methodology

In structural methodology, where diagrammatic techniques for data and functional modelling are presented and without which it is not possible to imagine a good approach in information system development, the development procedures used for information systems and diagram examples are formed by using the CASE tool, which offers very good support for the teams developing the IS, as well as those who maintain them. Information system structural development methodology arises on the basis of information engineering methodologies Oracle CDM and SSADM.

Rules and diagramming technique usage

Easy-to-understand and in detail defined structural diagrammatic techniques are crucial in the development of information systems. In the development of the information system, close preparation of the people developing the IS (developers, analysts) and IS users is necessary. All of them have a role in the process, from the start of IS development to its implementation and even later maintenance. Diagrammatic techniques are invaluable for the exchange of ideas, and in the final stage, unambiguously guarantee that developers correctly, and in detail, understand the effect and importance of the organization itself.

Due to automation and CASE tools usage, clearly defined diagrammatic techniques become even more important because automation allows translations of syntax, automatic switching between different diagrammatic techniques and automatic translation of diagrams at the logical and physical levels. There are a lot of reasons why the development and maintenance of information systems is not possible to imagine without the use of structured diagramming technique.

Below are a number of diagramming techniques that recommend a structural part of the Methodology for developing information systems and its different stages. Diagrammatic techniques, used in the analysis phase, are used to represent actions and the need an organisational information system (state body) has, or an action area pertaining to an organisation system in a logical level. This does not later serve a physical embodiment of the information system. Diagrammatic techniques, which are used in the planning stage, have already built an application systems reflection plan - developed in the construction phase.

A review of diagramming techniques, which are used in various stages of information system development, can be seen in the table below. The leftmost column lists diagrammatic and other formal techniques, whose use is recommended in the Methodology of information systems development, primarily the listed stages of information systems development. The diagrammatic technique suitable for each phase is placed at the intersection between each phase and diagrammatic technique. The diagrammatic technique is not used at the stage where the cross section is empty.

Table 2: A review of diagramming techniques by stages in the information system development

Development stages of diagrammatic techniques	**Strategic planning**	**Analysis of work areas**	**Planning application systems**
Decomposition diagrams	The organizational chart,	Detailed functional decomposition	Plan of the application system structure
Diagrams data flows	Functional	Detailed functional model	
Diagram entities	Decomposition,	Detailed data model	
Matrix connection	Strategic elements	Matrix connection	
Diagram action		Processes - entities	Process plan
Structure charts			Structural plan of the application system
Structured language			Process plan
Decision making tables and tree			Process plan
Diagram of the transition state			Process plan
Relational scheme			Data structure plan

Development Tools

Modern CASE tools are essential in the development of information systems. In the structural part of the methodology and in the information systems development, the tools used to create diagrams are Oracle Designer / 2000, PowerDesigner, etc. Diagrammatic techniques supported by tools and the type of graphical notation that needs to be described, should be visible from the development of diagrams.

The methodology of developing applications to support the work process

Basic concepts

Tools used to support work processes can roughly be divided into:

- Tools for the analysis and planning of work processes (Business Process Reengineering Tools - Tools BPR) and
- Tools for managing work processes (Workflow Management Systems - WFMS).

Tools for analysing and planning workflows are meant for making shots of existing processes, their future modelling and detailed analysis. With such a tool, the created models of the processes are used for their evaluation, which takes into account cost,

- time (performing, waiting for the whole time) and
- quantity (the number of embodiments in a time interval).

In the results of the evaluation process, models of the reconstructed process are made with the same tool. It is possible (if the tool allows) to check the feasibility and consistency of the models.

Tools that manage workflow allow you to perform work processes before it is possible to perform those required by the model, in the way that they recognise each tool. To avoid repetition, the different tools are necessary to develop guidelines that allow data transfers to a model made for tools used in the analysis and planning processes, as well as tools for managing work processes. Tools for workflow management enable IT supervision and direction through the work process, from one activity to another. In guiding the process, it is necessary to inform users that they must perform a task that guarantees the user appropriate software tool, which will be able to perform the required task, and appropriate information. A tool should also allow the user to see where its requirements are in the context of the entire process, which can contribute to the gradual improvement of the process itself.

Development process

The process of building applications for the support workflows (Workflow Application) is different from the classic approach. Since the work area of such an application can represent all the activities of the organizational system, it is very important to have a developed access to the description of the organizational system. Key elements of such descriptions are organizational chart and description of the work processes. The main reason for the differences between the classic and an approach in developing applications for workflow management is the emphasis on content and not on performance.

Connecting with other methodologies and projects

One of the guidelines given when creating a methodology for information systems development should be that it must be compatible with the existing methodologies, which have already been used, that ICVI benefits from it, and that it could be used for the informatisation of state authorities. Introducing a new methodology incompatible with the existing ones would actually open a lot of questions and dilemmas, and in turn be the opposite of that which we want to achieve.

Thus, for example, the strategic planning methodology can be created on the basis of information engineering methodologies, within which the first phase is not strategic planning. In the strategic planning methodology, the procedures, development and final products of strategic planning should be described. This would serve as the fundamental methodological basis for the execution of projects regarding strategic plans for developing information systems. It will prove to be both the strategic plans for developing a unique public administration information system and the strategic plans for developing an information system pertaining to individual state bodies that are listed in the “products” created by specific projects regarding information systems development and with it, represent one of the foundations for the projects’ products.

The products, which are formed by the strategic planning methodology, as well as one that accepts such results in the information systems methodological development, should be accepted as input data. The project management methodology

in public administration can be prepared on a different basis. It should be described in the project organization and operations management. This methodology can be used for management in all the projects pertaining to the field of information technology and guarantee project quality. By connecting to the target module, it is evident that the following methodologies can be used in projects for information system development:

- An information system methodology, in accordance with which to perform technical activities and preparation of technical products and
- A project management methodology, in accordance with which the course of project management procedures and a guarantee of project quality would be conducted

This means that MVPJU / IT determines that the project should be divided into phases and the new methodology will be used to determine the stage. Further on, the methodology will determine the content of technical activities and the schedule, while MVPJU/IT will determine that activities of preserving quality will be conducted in line with the content of technical activities. This methodology is used for mutual overlapping, so it is sometimes very difficult to determine the area pertaining to one method.

Utilisation of the methodology

Given the purpose of the information systems development methodology, which represents the basis of proposals for creating municipal information systems development methodology, one can predict its usage. If you take into account that one of the project users is actually a leader in charge of developing an information system, which will be used by MIRIS so as to help define an appropriate project design and activities, select a control point as determined by one tool, which will result in process development. The project leader will choose an appropriate approach (structural, object based ...), after which he/she will run its development.

In the part of the methodology, responsible for IS development process, it will result in an output that will be used later on to determine the course of the next stage, which is a part of the project. Of course, the project leader will be able to keep the real situation in mind and on the basis of his experience maintain the recommended phase or even divide it in several phases. The presented division of stages in the methodology should not be taken as absolute, but as an ordinary example, corresponding with the contemporary development projects. The proposed division into phases is not absolute, it was already present in the structural part of the methodology proposal, and it was based on an integrated approach that was presented first and introduced more and reduced access. Apart from the activities being reduced in these phases, in the concise approach, some stages must be combined. Furthermore, the leader of the project in the area where he/she described the steps in the development, has to propose the activities and their sequence within the stage. The activities and their sequence are determined on the basis of experience in working on multiple projects, so it is recommended that the project leader proposes as many benefits as possible, but they could, of course, be individual activities according to his/her judgment for combining or modifying them.

The second part of this chapter presents the way this methodology benefits leaders and team members responsible for establishing the IS. The team leader in charge of achieving satisfactory quality has a really interesting task because the development process is presented here. Among other things, the proposal has, according to the best development project, created each phase, used as input in any part of the phase. Product analysis and planning are crucial in developing the IS. There are hidden traps, VCE and common defects, that can appear in the IS development phase.

Conclusion

In addition to the conclusion one might add that this is a Bosnian E-administrative model, which is based on building the traditions and expert systems, which have influenced the administration in the last decades. The term transformation is also to be understood as ejection, rotation and introduction of new methods used in administration, and in relation to the citizens, and not to throw too much of the old ones. The road is marked by the development of BiH municipalities. It cannot be an extreme development even in relation to the economic efficiency and launching bureaucratic ideals. It is in a grey area between black and white, where all justifications meet, but there is no collective ideal model for when, what and how to achieve it. The pressure the environment plays in the municipality and the rate of ICT development can take part in improving the tendency, seen in comparison with the competition, orientation towards the citizens, responsibility, orientation toward the goal and offer,

as well as participate in the process of moving away from politics as a profit and project based result orientation. The information system development methodology and other methodological materials designed for the needs state administration has and not for a written document (Document: UNDP BH ICT4D - ICTs for Development) will not remain unchanged. It needs to be an orderly way to renew and update. That is why, in the coming years, and based upon practical experience, new needs in the field of information systems related to public administration and new trends in technology will arise and make it necessary to update the materials. The information system development methodology adds another piece to the mosaic that is methodological order in computerisation of public authorities.

Received: May 15, 2017
Accepted: May 28, 2017

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Koncept razvoja informacionih sistema za lokalnu upravu u BiH

SAŽETAK

U ovom radu je obrađena problematika implementacije informacionog sistema u javnoj upravi BiH. Implementacija IS-a je kompleksan process koji podrazumjeva rješavanje problema kao što su: razmatranje teorijskih aspekata izgradnje IS-a, analizu postojećeg stanja, izbor najpogodnije metode izgradnje IS-a, implementaciju IS-a, post implementacijsku podršku, kao i mjerenje praktičnih koristi implementacije IS-a.

Ključne riječi: informacioni sistemi, razvoj, metodologija.

Techno Science
International Scientific
Journal of Technical
Sciences

Using modified HAZOP Methodology for environmental risk assesment in industrial plants

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ABSTRACT

This paper aims at drawing attention to the possibility of a modified HAZOP Methodology when checking environmental risks in the stage of designing new plants and facilities and analyzing environmental risks of the existing plants and facilities. The modified HAZOP Methodology, called Green HAZOP, has been in use for the past ten years intended for checking the relation between the design of plants and facilities in operation and environmental risk. This is a simple and useable tool allowing for a relatively quick assessment of the chemical and energy plants' design from the enviromental aspect. The application of this tool may be extended to other industries with a necessary education and training of HAZOP leaders and a team of designers, that is, process owners. The application of this method to the assessment of Action Plans for receiving an environmental permit and a Study of Environmental Impacts, during an assessment procedure, which lasts unusually long, may be significantly improved and accelerated.

Keywords: Standard BS IEC 61882:2001, HAZOP Methodology, Green HAZOP, HAZOP leader, HAZOP team.

Introduction

The term "sustainable development" has become the key word in designig and operation of chemical and energy plants and facilities. There are several proven successful methodologies already providing improved safety in the design stage. Nowadays, HAZOP Study is most probably the most used methodology for the identification of risks in the processes throughout the world. The British Standard BS IEC 61882:2001 standardized this methodology and, as such, it is widely applied for risk analysis at designing plants of oil and chemical industries. For a majority of developed countries, HAZOP methodology is prescribed by law and is a condition to obtain building permits and bank loans. Over time, this methodology has been amended and adjusted to the requirements of individual processes and thus the following methodologies were developed:

- HAZAN methodology for risk analysis
- HAZID methodology for risk identification
- GENHAZ procedure for biotechnology (Royal Commission on Environmental Pollution (1991).

Positive experiences gained so far in the implementation of HAZOP studies on risk assessment at building energy and processing plants show that this methodology is very useful and efficient at detecting risks of accidents and deviations from safety requirements already in an early design stage. This paper has a purpose of demonstrating the fundamentals of HAZOP methodology application and indicates a possibility of its simple modification and applicability at checking environmental risks in all the phases pertaining to the project realization and in the plant management phase. The use of this simple and efficient tool should be certainly expanded and its performance will be constantly improved through practice. In this work, the process of conducting a HAZOP study is shown in more detail as this is a relatively unknown method here. The basic HAZOP methodology is a structured systematic technique for checking a certain system with a purpose of:

- Identifying potential risks within the system. These risks may include anything which is essentially related to the system observed and in addition, cover a wider area that may have an impact on the system (e.g. environmental risks);

- Identifying a potential problem in system operation (operability) and, in particular, identifying the cause of operable non-compliances and deviations in the production which results in a non - compliant product.

Green HAZOP is an attempt to modify this basic methodology and to adjust it to the environmental risks assessment. Both standards require a documented approach, audit performance and continuous improvements. In the first part of this paper, fundamental requirements of BS IEC 61882:2001 standard are presented and advantages of this methodology identified; further on, the required modifications with a purpose of its simple application to environmental risks are also presented.

Standard BS IEC 61882:2001 hazard and operability studies (HAZOP studies)

In order to view the possibilities for the application of this methodology on environmental risk analysis, we should first (briefly) view what BS IEC 61882:2001 Standard prescribes when it comes to the implementation of HAZOP studies. Standard BS IEC 61882:2001 provides instructions as to the implementation of HAZOP studies, a procedure that uses the methodology of brainstorming and guide words for the identification of major risks and then defines the procedures for a practical implementation of these studies. Fundamental characteristics of HAZOP analysis are, as follows:

- Analysis is a creative process! Analysis is performed systematically by using guide words in order to identify potential deviations.

From the basic design intent regarding safety, such deviations are later used on as triggers to encourage the team members to perceive any potentially weak spots and to define the consequences.

- Analysis is conducted under the leadership of a qualified expert (HAZOP Leader) who is supposed to ensure that the entire system is covered and tested using a logical and analytical approach. A qualified note taker should be assigned to the Leader who will record all risks identified and operable impediments that will have to be resolved and removed later.
- Analysis is conducted in various fields for which appropriate specialists-team members have been assigned who should be well familiar with the problem and have an ability of clear judgment.
- Analysis should be conducted in a positive work

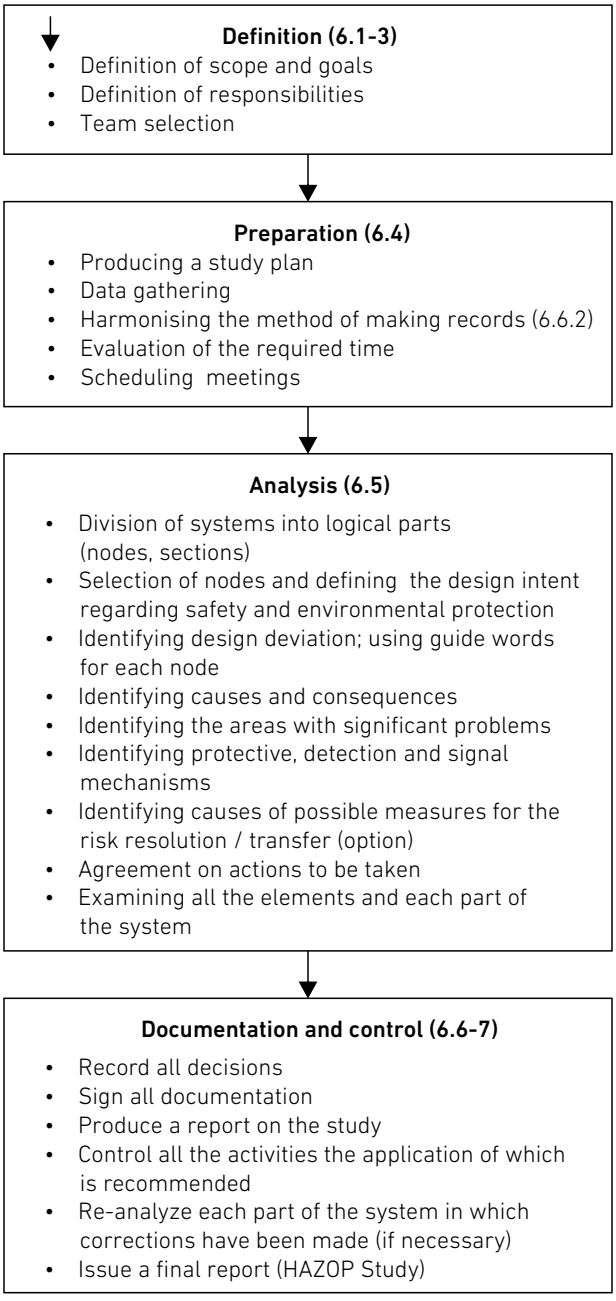

Diagram 1: The process of implementing HAZOP Studies

atmosphere where a positive way of thinking and a well-intended discussion will prevail. Once the problem is identified, it should be recorded so that its difficulty can be assessed later on and a recommendation for the resolution thereof provided.

- To resolve the identified problems is not a primary task of HAZOP analysis; they get recorded in order to be resolved later on by those responsible for the design. The HAZOP Studies implementation consists of the basic steps shown in Diagram 1.

Principles of the analysis

The basis of HAZOP is "guide words" with the help of which deviations from the core design intent are identified. The system is divided into parts the size of which depends on the system complexity and the size of potential risks and one should adhere, wherever possible, to a natural division determined by the design itself. It is necessary to define the elements participating in that part of the system and the characteristics and quantities thereof (e.g. materials, temperature, pressure, flow, etc.) The choice of guide words should encourage inventive thinking and allow for the implementation of a complete and comprehensive analysis. The following table provides some guide words with the explanation of their meaning.

Table 1: Basic guide words and their generic meaning

Guide word	Meaning
NO (NOT, NONE)	Complete negation of the design intent
MORE	Quantity is increased
LESS	Quantity is decreased
AS WELL AS	Quality modification/increase
PART OF	Quality modification/decrease
REVERSE	Logical opposite of the design intent occurs
OTHER THAN	Complete substitution

Apart from the above, additional "complementary guide words" are in use required to define the time for any sequence observed.

Table 2: Guide words related to the temporal progression of activities (timetable)

Guide word	Meaning
EARLY	Related to the timing
LATE	Related to the timing
BEFORE	Related to the order or sequence
AFTER	Related to the order or sequence

There are many possibilities for interpreting the guide words specified in Table 1 so that additional guide words are used to direct the train of thought properly, in order to identify the deviation more easily. Guide words need to be chosen prior to the analysis commencement.Each guide word should be applicable to each element within the node with a view of detecting a prospective possibility of the design deviating from the desired intent or required safety conditions.

The application of guide words to certain components is outlined as a matrix, so that guide words are in rows whilst the analyzed elements are placed in columns. In order to perform an applicable risk identification, it is necessary to cover individual elements and their accompanying characteristics with all the relevant design aspects and guide words signifying certain deviations from the designer's intent.

It is necessary to clarify the term "design intent" more thoroughly. The designer develops a system design (basic or detailed design) on the basis of input and desired outcomes specified in advance. By developing the system, the designer starts with desired functions often anticipating that in the course of the system's life cycle and its long-term operation, certain undesired work conditions may occur and the system may undergo radically different work conditions (caused by human or technical error). This would mean that his "initial design intent" when assembling the elements into a system has not been met, that is, the system consisting of a large number of parts nodes contain would not operate any more as originally conceived. This is particularly important from the aspect of risk as designers are mainly preoccupied with technical and economic issues and tend to "forget" about the safety degree and a possibility that it may happen that the system works under completely irregular circumstances.

Managing HAZOP studies

Fields of application

Originally, the HAZOP procedure was developed for the system in processing industries (oil and chemical) including liquid media and their flows through processes. In time, due to its simplicity and practicability, the methodology was spread to almost all the fields of human activities. It may be applied in the phase of design, more detailed designing, trial operation and at regular operation and maintenance of plants.

Launching the study

The study is launched by the person responsible for the project (Project Manager). He / she shall determine when and for which purpose the study is being produced, summon the Leader and provide conditions for the study, Together with the Leader, the Project Manager defines the scope and goals and produces the study plan. The scope and goals are interdependent and cannot be defined independently and separately. It is necessary to clearly define:

- System borders and its interfaces with other systems and the environment
- Any initial wanderings of the team and wasting time on secondary problems need to be avoided; the team needs to be focused on relevant matters.

Defining the study goals

It is necessary to define the study goals and delegate responsibilities for individual entities and to determine as to how the study results will be used. Apart from this, the following elements should be defined:

- The life cycle phase that will be covered by the study
- Persons, i.e. assets exposed to risk, environment and neighborhood
- Problems of operability that may affect the product quality
- Standards that should be applied to the system from the aspects of operability and safety

Responsibilities and competencies

Roles of the team members, their responsibilities and competencies have to be clearly defined prior to the commencement of their work. The Leader is the one who should be thoroughly acquainted with the design and should assign roles and responsibilities to the team members. He should also ensure that there are qualified and educated team members by certain fields of expertise. The HAZOP study is teamwork and as such it requires each team member to do his part of work:

- The Study Leader should be thoroughly acquainted with the design and be familiar with the process of conducting a HAZOP study. He is bound to ensure a constant flow of communication between the project management and HAZOP team. He plans tasks and co-ordinates the selection of team members. His responsibility is to propose guide words and clarify their appropriate interpretation to team members. He leads the team through the entire study and makes sure conclusions are appropriately entered into the minutes and is also responsible for the creation of final documents.
- Note taker (Secretary) is bound to follow the entire procedure in records. He processes all the study documents, helps with the formulation and definition of conclusions and has other administrative tasks.
- The Designer should explain the design and measures foreseen within the system as prevention or risk response.
- Project beneficiary and maintenance personnel are tasked with management and maintenance, i.e. any problem that may be expected in the course of operation.
- Specialists, including quality and environment managers make sure that any problem is viewed from the expert's point of view, prospective environment risks evaluated and risk reduction measures recommended (not obligatory, though).

Application of guide words and deviations

Guide words need to be carefully selected to trigger a discussion in the right direction and to limit it to specific problems. They should not encourage team members to have ideas not in compliance with the study goals. The Leader has a great deal of responsibility, based on his experience, to propose those guide words that will yield efficient result. Table 3 gives an example of some process deviations and the application of guide words to them.

Table 3: Process deviations and application of guide words

Type of deviation	Guide word	Example for the application in processing industries
Negative	NO	Intent not achieved (e.g. no flow)
Change of quantity	MORE	Quantity is increased (e.g. higher temperature)
	LESS	Quantity is decreased (e.g. Lower temperature)
Change of quantity	AS WELL AS	Impurities present Some other operation / step occurring in parallel
	PART OF	Only one part of the required has been achieved (e.g. fluids do not come in the required quantity)
Replacement	REVERSE	Covers the reverse flow in the pipeline and reverse chemical reactions
	OTHER THAN	Results are different from what should have been achieved (e.g. wrong material added)
Time	EARLIER	Something happened earlier than it should have happened regarding the timing (e.g. cooling, filtering).
	LATER	Something happened later than it should have happened regarding the timing (e.g. cooling)
Order or sequence in process	BEFORE	Something happened too early as a sequence (e.g. mixing or heating)
	AFTER	Something happened too late as a sequence (e.g. mixing or heating).

It should be noted, however, that the guide words may be completely differently interpreted when analyzing another system. Sometimes it may happen that the application of certain guide words will not give a sensible result.

Also, sometimes there will be several different interpretations, but all of them should be analyzed and recorded. The flow of analysis with the application of guide words is depicted in Diagram 2.

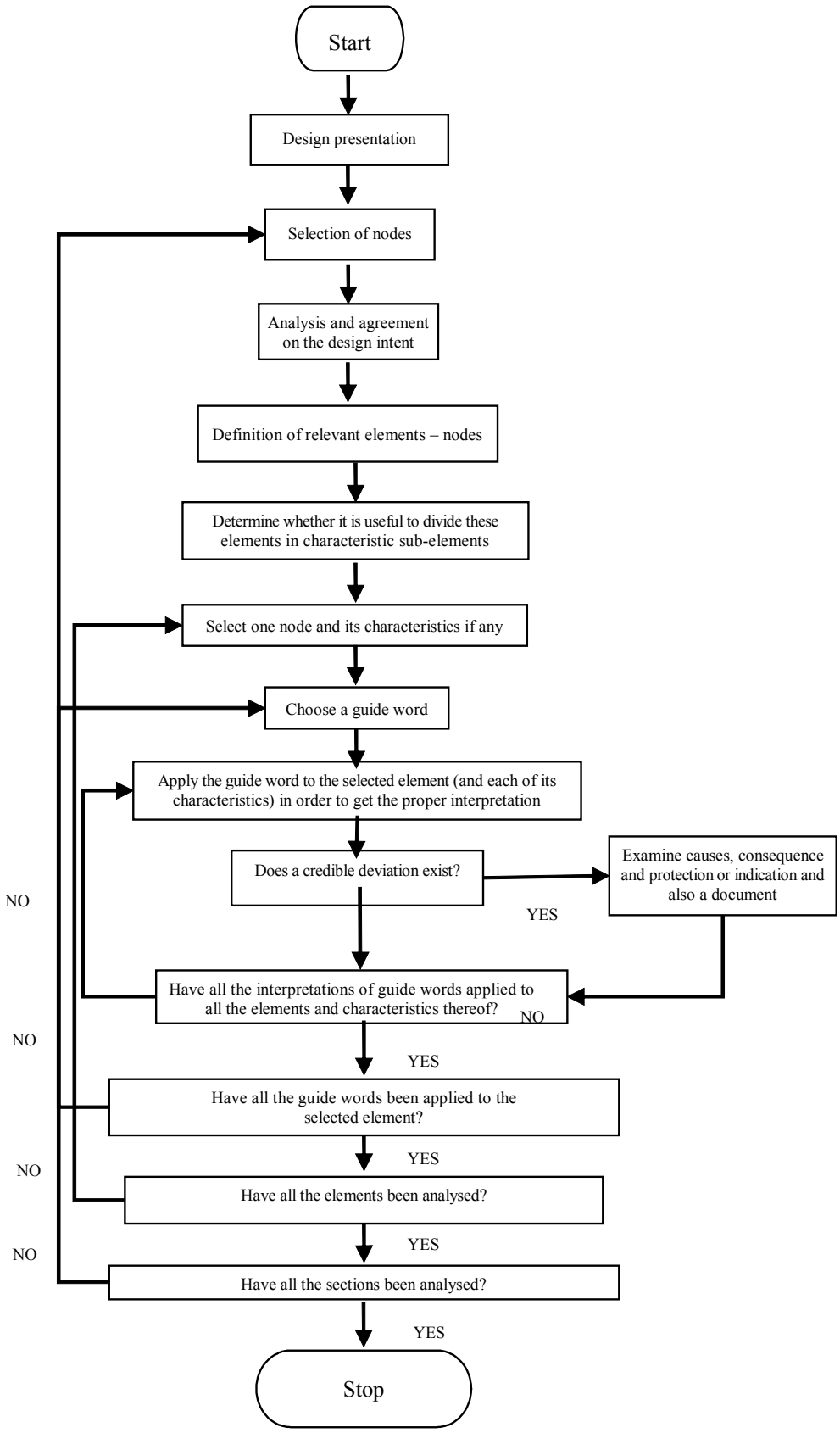

Diagram 2: A diagram of the procedure flow for HAZOP — application of guide words

Documentation

The main strength of HAZOP lies in the fact that it is a systematic, disciplined and documented procedure. In order to obtain the proper result, HAZOP needs to be completely documented. The Leader is bound to ensure that there are quality records from the team sessions. The Note taker (Secretary) needs to be a qualified and experienced person with a good knowledge of the working language. There are two acceptable methods of recording:

- Make complete records on everything said during the application of guide words to individual elements of the system which meets all the audit requirements and provides a detailed overview of the session.
- Make a note of deviations, identified risks and operating problems along with actions recommended only. In this case, the document is smaller and easier for processing it later though less useful during a subsequent audit.

The study result should be a detailed report containing the following:

- Details of all the identified risks and operable problems together with the details for their resolution or transfer;
- Recommendations for the future analyses of specific aspects of the design using different techniques if necessary,
- Actions required to address identified uncertainties,
- Recommendations for the transfer of identified problems based on the team's knowledge and experience,
- Records and especially perceived spots that may cause problems for the plant and maintenance,
- List of team members.

Such documentation should ensure the discovery and interconnection among all the identified risks with the system elements. Each of the recorded risks and operable problems should be separately recorded and marked and each question posed should be traced to the name and surname of the person posing it. Each problem and resolution thereto has to have a possibility of a single - meaning identification. Finally, all the documents have to be agreed on, accepted and signed.

Control and responsibilities

HAZOP study's aim is not to redesign the system, nor does the Leader have such authority to ensure the implementation of the recommended for removal or transfer of risks and operable problems. The project manager is responsible for the implementation of the study recommendations. In some cases, the Project Manager may authorize the team to have such recommendations implemented. In this case, the team should request the following additional tasks to be conducted:

- Agreement on the definition of major problems identified should be reached, the design, all work and maintenance procedures should be modified accordingly;
- The team should verify all such modifications, present them to the Project Manager and obtain the approval thereof;
- A HAZOP study procedure for the reviewed design including the system interfaces should be carried out again.

Audit

The program and results of the HAZOP study may be checked by means of performing an internal audit by thus authorized persons form the company. The criteria and contents of such an audit should be prescribed by the company's procedures.
The audit may include the following: staff, procedure, documentation and supervision of the implementation.

Example

Put simply, the entire procedure may be viewed through an example. Picture 1 provides a very simplified example from the processing industry. Material A is transported without stoppage by means of Pump E'3 from Reservoir E-1 and other Material B by the means of Pump E-4 from Reservoir E'2. Both materials go to Reactor E-5 where these are mixed and subject to a chemical reaction with a view of obtaining material C. Let us assume that at all times, there should be much more of Material A in order to evade a threat of a possible explosion in the Reactor. The real design contains much more details about pressure, speed of mixing, time of reaction, etc.; however, these will be disregarded in this example and only a simplified overview is taken.

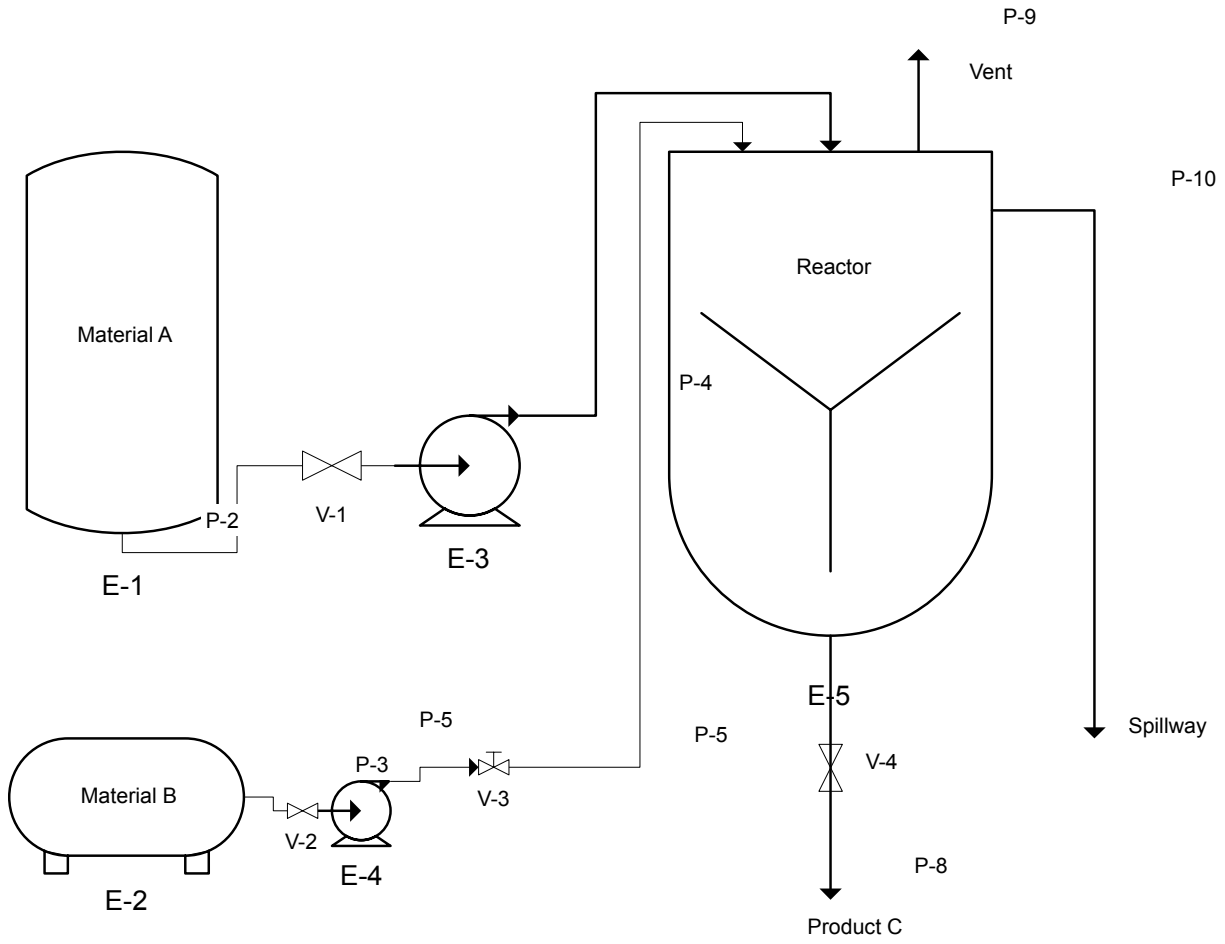

Figure 1: A Simple Process and Instrumentation Diagrams (P&IDs)

The part we are analyzing is that line from the Reservoir of Material A to the Reactor including Pump E'3. The intent of the design was to provide the delivery of Material A in a greater quantity than that of Material B. This can be shown in Table 4.

Table 4: Path from the Reservoir of Material A to the Reactor

Material	Activity	Source	Destination
Material A	Transport (in the quantity >B)	Reservoir of Material A	Reactor

Each guide word from Table 1 (and all those adopted by the team in the session beginning) was applied to each element and everything was recorded in HAZOP records shown on the next page. The style of recording used here is that with analysis results only.

HAZOP Methodology and guide words

As explained earlier, the HAZOP Methodology is related to brainstorming. Brainstorming is a very powerful technique, but it is quite difficult to ensure this technique to be serious enough when it comes to the problems of safety and operability. One of the aforementioned requirements applies to the size and ability of the team. Another requirement applies to an appropriate set of guide words that should be applied to all the relevant parameters and identify all deviations from and deficiencies of the design, from the aspects of safety and operability. The standard recommends seven guide words as a basis. There is a problem with completeness contained in the identification of key parameters to which guide words should be applied. The method applied by almost everyone organizing HAZOP studies is that they ask the team what are the key parameters and then they

add to the list of guide words. In practice conducted by chemical and oil industries, a set of 20 words is mainly in use. The Leader has to check the list of guide words he believes are sufficient and then re-check it with the team. When it comes to some non-standard equipment or special processes depending on the human factor, it is necessary to organize a special training in order to get that set of appropriate guide words.

Completeness and appropriateness of guide words is the key factor in creating an appropriate scenario and a basis for the HAZOP study success.
It is decisive for the quality of HAZOP studies to select a sufficient number of guide words that will be corresponding to the system analyzed and check all the scenarios relevant for safety. The list of words recommended by BS IEC 61882:2001 Standard is not adequate for the quality performance of the Study; however, a list of guide words recommended by experienced consultancy companies (Den Norske Veritas) is provided for oil and chemical industries.

Completness and coverage

All the above recommended procedural steps have to be taken even prior to viewing all the contents to be covered by the study. It may happen that some of the P/ID drawings or some sections thereof are missed. Also, it may happen that out of date and invalid documentation without the latest updated design modifications is analyzed. The HAZOP procedures should prescribe the production of all valid P&ID drawings. To omit the analyses of individual drawings shall be permitted only if the entire team agrees on this, which will require a thorough justification in writing. The Leader has to make sure that all the equipment on the drawing observed is analyzed.

In order to monitor this he should mark, on the master drawing, each piece that has been completed and to transfer it to the list of documentation and drawings. Therefore, there should be a document proving that the complete drawing has been analyzed by the team.

When it comes to the existing plant for which the Leader has not received the current P/ID drawings (and the team members have warned him of this), it is necessary for him to put such drawings aside until such time they are marked or made current. He cannot allow the team members to mark the drawings. To check physically on the very spot is of essence.

Assesment criteria

Prior to giving its recommendations for changes, the HAZOP team has to decide whether the current situation is acceptable. Nothing is gained if the team is very productive in giving recommendations of doubtful quality. The process of decision-making is quite often the most difficult one as assessment / evaluation criteria have not been determined.
A question is posed from the safety aspect as to whether this consequence will be too serious to be tolerated, to which it may be answered quite simply.

However, the next question "is a probability too high to be tolerated" is much harder to answer. This is the area where the safety specialist and environment manager may help the team define appropriate criteria. To use the risk index may be of help sometimes, but it requires quite a lot of time which we do not have too often. It is much easier for operability to establish criteria as they are based on cost-benefit principles. It is much easier for the team to make recommendations to management if such recommendations generate profits for the company.

Classification of recommendations

Goals are clearly defined so that the HAZOP Leader may expect that recommendations given by the team will have influence, especially so if they are related to the aspect of safety. In many cases, it is the team who identifies adverse effects on environment, which is also important for the decision-making.

The procedure should lead to a properly evaluated difficulty of consequences not reducing the relevance of environmental aspects so that management may accept and implement the recommendations given. It is also required from the HAZOP Leader to make a separate checking with a view of comparing goals and recommendations.

Testing recommendations against goals

Although this is a task of the entire team, the Leader and Secretary should, in the course of the entire study, check each recommendation and compare it with its corresponding basic goal in order to reduce risks to an acceptable level. It means that, after each HAZOP session, the leader and Secretary should check on all the recommendations and if some are identified as inappropriate, this should be resolved in the next session.

Conclusion

There is a need to develop tools that would be of help in the process designing, project evaluation and implementation of project solutions using the criteria of ecological engineering. Green HAZOP is a systematic tool based on the HAZOP studies for incorporation of ecological engineering, starting with the stage of detailed designing and then through the technical acceptance and operational plants. The implementation of such Green HAZOP analysis is aimed at identifying deviations of the design, construction and running of the plant that may be harmful to the environment and occur in every stage of the project implementation in equipment, the works and material. Such deviations may result in negative effects on the environment and sustainable development. Green HAZOP essentially connects the steps of identifying environmental risks and provides an opportunity for preventive actions; therefore, it may be concluded that it could be very useful at assessing the quality of environmental protection and prevention of environmental risks, both for plants to be built and those already in operation. It would be of particular interest to apply it to the analysis of Action Plans and Studies of Environmental Impact which could improve and accelerate the assessment procedure significantly. It is certainly necessary to further develop and elaborate on this methodology in practice in order to obtain a useful tool for the project evaluation from the aspect of environmental risks. However, considering its simplicity and a wide application, the effort will surely pay off.

Received: May 20, 2017
Accepted: May 26, 2017

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Korištenje modificirane HAZOP metodologije za provjeru rizika na okoliš u industrijskim pogonima

SAŽETAK

U ovom radu želi se ukazati na mogućnost izmijenjene metodologije HAZOP-a prilikom provjere postojanja rizika na okoliš u fazi projektiranja novih postrojenja i objekata te analizu ekoloških rizika postojećih postrojenja i objekata. Modificirana metodologija HAZOP-a, zvanog green HAZOP-a, već je proteklih deset godina u upotrebi za provjeru funkcije dizajna pogona i objekata u odnosu na rizik po okoliš. Ovo je jednostavan i upotrebljiv alat koji omogućuje relativno brzu procjenu dizajna kemijskih i energetskih postrojenja s ekološkog aspekta. Primjena ovog alata može se proširiti i na druge industrijske djelatnosti uz potrebna obrazovanja i osposobljavanje voditelja HAZOP-a i dizajnerskih timova, tj. nosilaca ovih procesa. Primjena ove metode je značajna u postupcima izrade akcijskih planova u svrhu dobijanja okolišne dozvole, kao i u aktivnostima prilikom procjene utjecaja na okoliš, koje uobičajeno traju dugo, a ovom metodom se mogu značajno poboljšati i ubrzati.

Ključne riječi: Standard BS IEC 61882: 2001, HAZOP metodologija, zeleni HAZOP, HAZOP lider, HAZOP tim.

Techno Science
International Scientific Journal of Technical Sciences

Application of nanotechnology in improving the properties of textile fibres

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ABSTRACT

As an everyday need, textile requires the process of creation from raw materials to usable structures to be taken care of. As a foundation of textile, fibre, both natural and synthetic, is versatile and has to fulfil the physical, chemical, aesthetic, cultural and other FABRIC properties. Contemporary findings provide an opportunity to affect the properties during the fibre formation process, colouring and finally weaving and tailoring. The aim of this paper is to present one of the possibilities where fibre can be affected on a nanodimensional level. The process where electrified particles, electrons and ions, affect the fibre provides new dimensions to its surface. Therefore, our aim was to describe the process where ions affect the fibre quality.

Keywords: fiber, plasma, nanotechnology.

Introduction

As an everyday need, textile requires the process of creation from raw materials to usable structures to be taken care of. As a foundation of textile, fibre, both natural and synthetic, is versatile and has to fulfil the physical, chemical, aesthetic, cultural and other FABRIC properties. Contemporary findings provide an opportunity to affect the properties during the fibre formation process, colouring and finally weaving and tailoring. Here, the goal is to conduct processes reduced to nanodimensions, i.e. nanotechnology used to form the fibre surface. The inside of the fibre interacts with the environment using its surface. We will talk about the impact plasma has, as a phase of emerging substance in nature, on wool fibre. At a time where ecology has more stringent demands on textile industry, the importance of plasma and application of its technology gains greater importance. However, introducing plasma technology in the processes used in textile technology is still being researched and its implementation in the production process will require ecological awareness on the side of textile producers and end users. Reaching the desired effects and corresponding modifications in the properties of textile materials during plasma processing will require the knowledge of plasma processing parameters used in the process of producing materials. I shall either find a way (to success) or make one!

Plasma

Plasma (from Greek πλάσμα: moulding, forming) is a completely ionised matter - SUBSTANCE. Due to different properties in relation to the SOLID STATE OF MATTER, liquids and gases, it is common to consider it a special state of matter. Ionised gas has at least one electron separate from a part of its atoms or molecules.

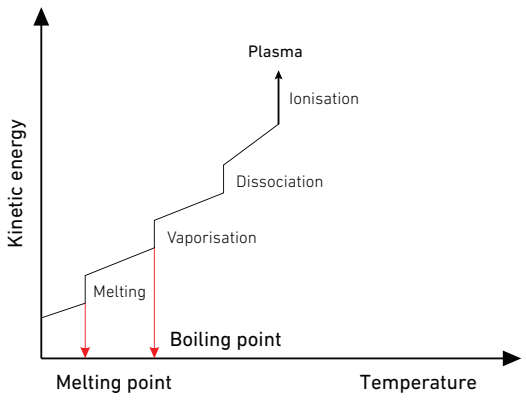

Figure 1. The concept of state of matter

In fact, by separating the negative electron from the atom or a group of atoms in a molecule one gains particles called ELECTRONS on the one and IONS on the other side. The process itself is called IONISATION which results from the energy used for the separation. Owing to the free charged particles (ions and electrons), plasma represents a good conductor for electric current and strongly responds to electric and magnetic fields.

With an increase in temperature to a several thousand degrees, the collision of atoms becomes stronger and intensifies, which in turn results in electron release from the atom structure and creates particles carrying charge; negatively charged electrons and positively charged ions. When they move, charged particles create electric and magnetic fields which results in energy necessary for further atom ionisation, i.e. a state of almost completely ionised matter - plasma. Gas is more or less ionised, at least to a small degree, but not all ionised gas is called plasma. Plasma is said to be a quasi-neutral gas composed of neutral and charged particles. From a macroscopic point of view, quasi-neutral gas is neutral, but its elements are electrically charged. Like gas, plasma does not have s specific form or volume, unless placed in a container, while under the influence of a magnetic field plasma can assume the desired form, for example a fibrous structure. Plasma exists, it can be found near conductors - wires tied to the pole of an electrode's electric source. Therefore, the ion concentration around this type of conductor is determined by the source's pole potential.

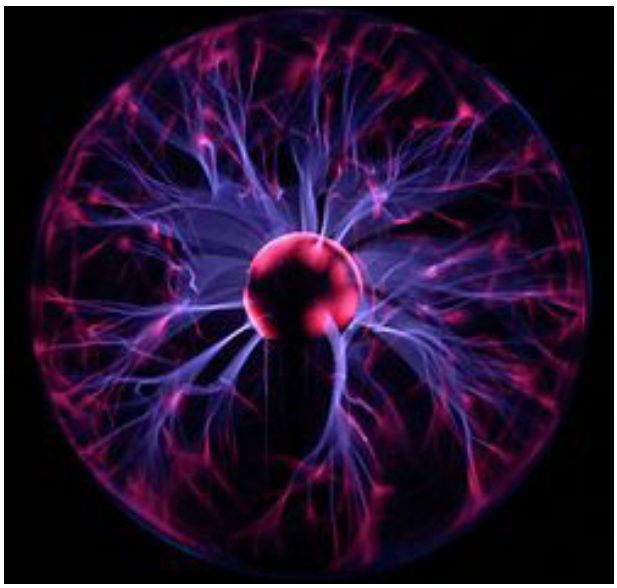

Figure 2. A plasma globe filled with a mixture of various gases with an electrode in the centre of the sphere

Plasma quality is determined using the electrode's potential (alternating-and its frequency), type of nearby gas and its pressure around the electrode. To reach the desired effects and corresponding modifications in the properties of textile materials during plasma processing, it is important to be familiar with the plasma processing parameters used in the process of producing materials. These parameters are: operating frequency, processing time, type of gas, gas flow, pressure (regulated with a vacuum pump in case of low-pressure plasma), the number of electrodes, as well as the distance between the electrode and surface of the substrate.

Textile-fibre and the metioned plasma parameters are interrelated

Research can be directed to a great number of materials-fibres and plasma parameters representing the subject of future research. In this paper, we will analyse the changes incurred in properties of wool fabrics after the preliminary treatment of samples using oxygen plasma, by applying standardised methods and procedures for evaluating the impact plasma has on modifications made in the properties of wool. Atoms and molecules are ionised, fragmented and stimulated, making a very reactive mixture of gasses that, in the production process, react with the sample both physically and chemically. Of course, the obtained effects, i.e. changes in the properties of the processed material's surface primarily depend upon the process gas and its physical and chemical properties and substrate characteristics, as well as upon the processing conditions. Cold plasma, both low and atmospheric-pressure plasma, can be used for textiles (the electron temperature is considerably higher than the ion temperature).

Low-pressure plasma system contains a vacuum chamber with an electrode, as well as carriers dependent upon the type of material and the sample which is being processed, because the way materials are processed is not continuous. The sample size is determined by the carrier size. To reach the low pressure, it is necessary to use a vacuum pump which, in a short period of time, has to ensure the pressure level ranging from 0.01 to 1 mbar.

The electromagnetic field in the system stimulates (at low pressure inside the vacuum chamber) the gas structure and causes acceleration of the free electrons resulting in the creation of plasma when their kinetic energy is high enough to make a plasma reaction (matter ionisation, fragmentation and stimulation). Creating plasma is visible because a light of different intensity appears (ranging from light blue to purple colour).

Figure 3. Creating plasma from light blue to purple colour

Modifying the surface of wool materials using plasma

Wool is a fibre consisting of the protein called keratin. Its molecular chain structure is highly complex and the morphological characteristics of the fibres are rather specific. The outer surface of fibres is covered in scales which is the main reason for wool being prone to felting. The shape of scales and the way they cover the fibre surface, as well as its tendency to felting can be considerably different due to the fibre fineness and the sheep's breed which results in a difference between fine and rough wool. The interior of the wool fibre consists of spindly cells creating the elementary wool substance cortex; rough fibres can have a hollow in the middle, the so called core or medulla.

Research conducted at the University of Zagreb, Faculty of Textile Technology have shown that oxygen plasma affects the quality of the wool substrate. That interaction in Plasma processing contributes to removing the hydrophobic layer from the surface of wool fibre, slight ablation of scales, and probably activates the surface chemically, which results in better molecular binding of colourants, significantly improves the depth to which the colour penetrates the wool sample and a better bath usage. Sorption properties have also been improved without any reduction of fracture force or fracture strain, but an increase, which probably manifests in the change of surface and better traction between the fibres, is recorded. Flexural rigidity as an indirect indicator of decline, tactile, aesthetic and utilisation characteristics is slightly increased which was expected after plasma processing in line with the results of research conducted by other authors.

It is known that plasma solely affects the surface layer on the nanoscale (until reaching the depth of around 100 nm in total), so the reaction between active chemical substances, plasma and substrates is expected to have such physical and chemical transformations, related to changes in the surface layer, affecting the changes of physical, chemical and mechanical substrate properties. Nanotechnology is present since the processes are conducted on a nanodimensional level.

Figure 4. Low-pressure plasma system apparatus

Plasma processing is primarily used for surface processing of materials because it only modifies the surface properties of textile materials while the elementary properties remain almost unchanged. Plasma functioning mechanism is monitored through several processes appearing when it interacts with the surface of materials, while distinguishing the following procedures:

- surface cleaning,
- surface etching,
- surface ablation,
- activation, plasma modification,
- deposition process,
- plasma polymerisation and the like...

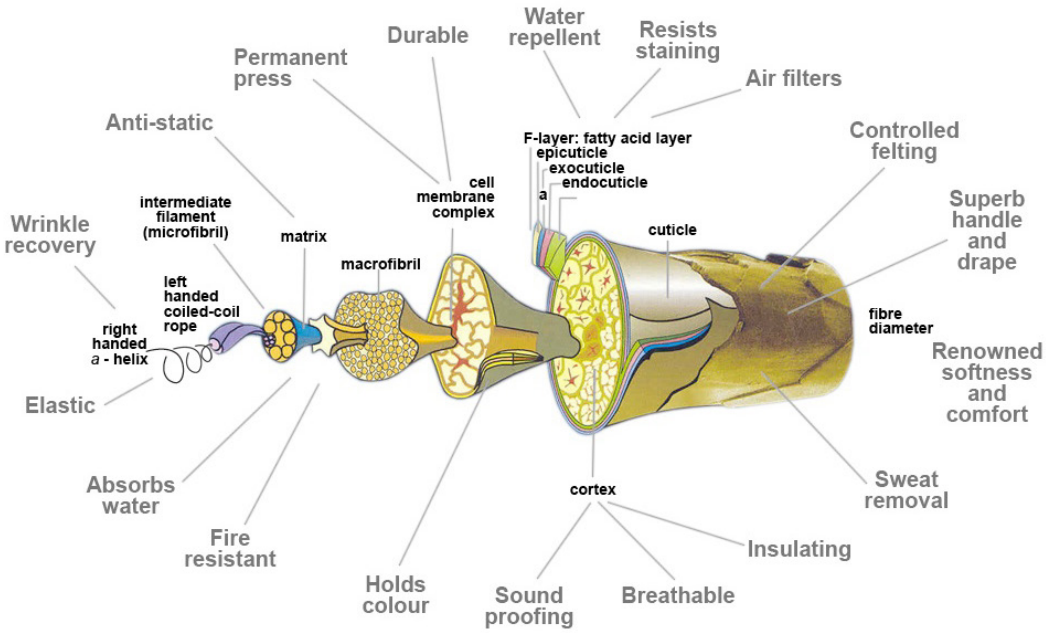

Figure 5: Wool fibre - morphological characteristics of fibre

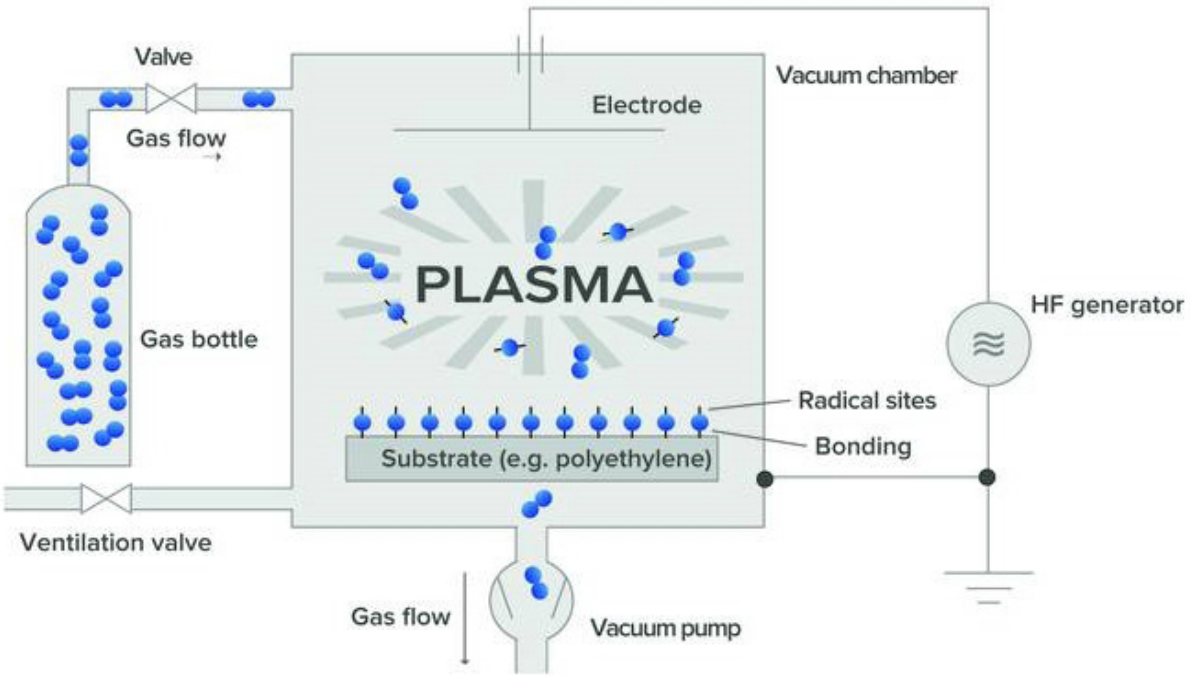

Figure 6: 40 kHz frequency low-pressure plasma system chart

Conclusion

Using plasma processing we make the desired changes, i.e. substrate surface modifications with the goal of obtaining a value-added product with the desired functional properties. During the process of production, plasma interacts with the substrate while physical and chemical changes occur in the processed material surface layer. At the same time, processing parameters have to be optimised: type of gas, force, gas flow, pressure, operating frequency, sample size and the number of electrodes. The aim of this paper is to explore the influence of low-pressure oxygen plasma on physical and chemical properties of the wool substrate. The samples were processed at a force of 300 and 500 W and during different time intervals without changing the values of gas flow, type of gas, operating frequency and sample size. The micromorphology analysis of the wool fibre structure has been conducted using a scanning electron microscope Tescan MIRA\\LMU to determine the changes at the surface of wool fibres by cleaning the fibre surface, changing the appearance and shape of scales, damaging the fibres by scoring, and the like.

Unprocessed fibres have a proper scale surface. Upon plasma processing the cuticle has visible changes, especially when processed at 500 W, which can be seen in the damage incurred on the tips (after a minute of processing) and visible damage fully incurred on the scale after 5 minutes of processing. A greater amount of cuticle residue is visible at the fibre surface due to damaged scales. Hydrophilic properties of wool have been tested by using a vertical test according to the HRN EN ISO 9073-6:2003. standard and a qualitative and quantitative evaluation of wool hydrophilicity (wetting). At the same time, the height h [mm] of vertical water column front flowing through fabric was tested. The results show an increase in hydrophilicity after 30 seconds of plasma processing in relation to the unprocessed sample that is completely hydrophobic. In this way the fibre/textile material properties can be specifically modified. For example, reaching a better wetting ability which contributes to a better usage of colourants during the process of dyeing (printing). Besides that, plasma affects the adhesive properties and methods of cleaning materials without using harmful chemicals and without damage to the elementary properties (primarily non-mechanical) of materials processed in such a way.

Received: April 21, 2017
Accepted: May 25, 2016

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Nano tehnologija u poboljšanju svojstava tekstila

SAŽETAK

Tekstil kao potreba u svakodnevnici traži brigu o procesu nastanka od sirovine do upotrebljive strukture. Vlakno kao osnova za tekstil je raznoliko, kako prirodno tako i sintetičko i trebaju zadovoljiti fizikalna, hemijska, estetska, kulturološka i druga svojstva TKANINE. Savremena saznanja daju mogučnost utjecaja na svojstva kako u procesu formiranja vlakna, bojenja i najzad tkanja pa i krojenja. Cilj ovoga rada je da se iznese jedna od mogučnosti utjecaja na vlakno na nivou nanodimenzija. Proces djelovanja naelektrisanih čestica elektrona i jona na vlakno daje nove dimenzije površine vlakna. Dakle, cilj nam je bio da opišemo proces uticaja jona na kvalitet vlakna.

Ključne riječi: vlakna, plazma, nano tehnologija.

Techno Science
International Scientific
Journal of Technical
Sciences

Natural sciences creation role

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ABSTRACT

The phenomenal world has always been and remains a research intrigue, both in the natural and in the social sciences. The human ability to recognize laws in the phenomenal world and to direct them towards the area of practical application of science leads to technical creativity. From the historical point of view, natural sciences were only classified as sciences that dealt with material things of inanimate nature. However, the natural sciences are sciences dealing with the animate and inanimate nature. Traditional areas of natural sciences –physics, chemistry, biology and geology – are still marked by a widespread general idea regarding natural sciences. The aim of this work is to contribute to identifying the area of natural science education impact on human inventiveness and creativity in the field of human activity.

Keywords: natural sciences, creation, aplicattion, examples.

Introduction

The phenomenal world has always been and remains a research intrigue, both in the natural and in the social sciences. The human ability to recognize laws in the phenomenal world and to direct them towards the area of practical application of science leads to technical creativity. From the historical point of view, natural sciences were only classified as sciences that dealt with material things of inanimate nature. By existing in the phenomenal world, the qualities impact the environment. As a measure of resistance to change, mass has a gravitational effect on the environment. Alongside mass, the quality present in elementary particles: charge, electric charge, appears in two forms, plus-minus pairs. Thus, in the process of separating electrification, they are neither created, nor destroyed, but moved from one place to another.

All the while, the overall electrification remains a constant. In that regard, one can say there is a universal law in nature that can be formulated as follows: The overall (system) electrification is constant in all the processes. Universe is neutral. In order to separate electrification, energy has to be applied. Quantitative domination of one, affects the environment - the electric field. Natural sciences, primarily physics study the two mentioned fields. But, by analysing the phenomenal world we detect quality that is usually called life. The presence of this quality in the material world also affects the environment, which is expressed in the analysis of human behaviour. The field of love... The quality and quantity of this expression including relations are attributed to social sciences. The knowledge belonging to the material world reaches human beings in a greater or lesser degree. The way and quantity of this knowledge a human adjusts to humane living depends upon the individual's or ingenuity of the group, i.e. the quantity of creation they introduce based upon the familiar natural laws is up to the human.

Natural sciences

Natural sciences reflect knowledge in the phenomenal world of nature through description, apprehension of natural phenomena based upon observation, as well as empirical evidence. By establishing laws in a mathematical way, the flow of natural processes can be foreseen. Therefore, first comes the phenomenon hypothesis and then the experiment refuting or supporting the hypothesis on the process, i.e. laws of the natural process. To put it precisely, repetition of the observation results during an experiment can ensure the validity of scientific discovery.

Simply divided, natural sciences can be viewed as life and physical sciences with "still life" being the latter's object of study. Physical science can be divided into branches, including physics, astronomy, chemistry and geoscience. Of course, the division does not

end there. Natural sciences are branched out into specialised scientific fields of study. Technique is the practical application of science. Owing to the progress natural sciences have made, human lifespan has increased, life is more pleasant, it is safer and more beautiful due to creations made by human ingenuity. Creation has arisen through knowledge about the laws of nature. In fact, in the last letter he wrote to his mother, Nikola Tesla states "...mother, until all the lightbulbs in the senate shone, I thought I had created electricity, but then I realised it existed beyond and before me... It was only "given" to me to publish it to humanity... Technology offers the process beginning with science and technique and ending with a knowledge applicable in practice.

These three factors; science, technique and technology provide a comfortable life to a society through ingenuity of humans and their creations. There are laws - science, their application is technique and the way they are demonstrated - technology.

Creation

Creation or creativity is the ability to produce something new by way of imagination, whether it is a new solution, method... This term is usually related to the abundance of ideas and original thinking, as well as the practical application of the work done. Broadly speaking, creation or creativity is seen in a human's ability to think and behave through which they make changes in this world, as well as change themselves. Creation or creativity is generally seen in a human's ability to self-actualise in the surrounding world through constructive and productive reasoning and behaviour by way of making changes in the world and changing themselves. Creation and creativity are significant levers in the general development of a society. Technical creation makes a special contribution to the development of a society. It is reflected through practical application of physical laws on technical advances.

Examples of technical solutions

A great number of technical creations represent a consequence of discovering physical processes and laws regarding them during physics lectures.

Temperature based body geometry

Through constructive ingenuity and finding that body geometry depends on its temperature and the thermal properties analysis of different materials, the person who attends the lecture arrives at the constructive material called reinforced concrete. The concrete itself has defined mechanical properties which could be improved by using additional construction. But, to make a material compatible, one must look into its thermal properties. The table shows that concrete and iron have the same thermal expansion coefficient. There is no shearing when the temperature is changed. Reinforced concrete is the idea!

Table 1: Solid and liquid materials' coefficient of thermal expansion

	Coefficient of Thermal Expansion $(C°)^{-1}$	
Substance	Linear (α)	Volume (β)
Solids		
Aluminum	23×10^{-6}	69×10^{-6}
Brass	19×10^{-6}	57×10^{-6}
Concrete	12×10^{-6}	36×10^{-6}
Copper	17×10^{-6}	51×10^{-6}
Glass (common)	8.5×10^{-6}	26×10^{-6}
Glass (Pyrcx)	3.3×10^{-6}	9.9×10^{-6}
Gold	14×10^{-6}	42×10^{-6}
Iron or steel	12×10^{-6}	36×10^{-6}
Lead	29×10^{-6}	87×10^{-6}
Nickel	13×10^{-6}	39×10^{-6}
Quartz (fused)	0.50×10^{-6}	1.5×10^{-6}
Silver	19×10^{-6}	57×10^{-6}
Liquids		
Benzene	—	1240×10^{-6}
Carbon tetrachloride	—	1240×10^{-6}
Ethyl alcohol	—	1120×10^{-6}
Gasoline	—	950×10^{-6}
Mercury	—	182×10^{-6}
Methyl alcohol	—	1200×10^{-6}
Water	—	207×10^{-6}

Refraction of light

When light propagates through two mediums with different optical densities, the direction in which it spreads out is changed - a phenomenon known as refraction of light. This phenomenon occurs at the boundary between the mediums as a consequence of the change in the speed of light. The incident and refracting waves, as well as the perpendicular to the boundary surface are at the same level.

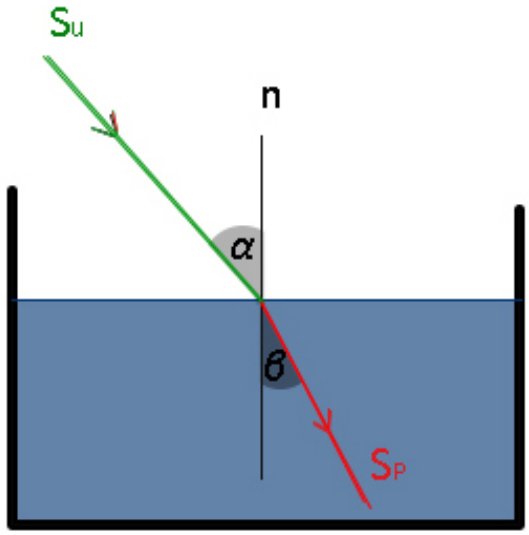

Figure 1: Refraction of light "towards the normal" when passing from an optically less dense to a more dense medium

If the light propagates from an optically less dense to a more dense medium (for example from air into water), the incidence is larger than the refraction angle - light refracts towards the normal. Optical density provides information regarding the speed of light and is determined by a refractive index. The refractive index shows how much greater the speed of light is in a vacuum as opposed to the observed medium (n is always greater than 1, which shows that the speed is greatest in a vacuum).

The change in direction is shown through the law of refraction (sine of incidence / sine of refraction is the same as the other medium index ratio in relation to the first one n_2/n_1). The refractive index describes the optical properties of the substance. It is concluded that, by propagating from a medium with a higher refractive index, lesser speed, and greater optical density into a medium with a lower refractive index, greater speed and rarer optical density one can create a condition in which the light returns to the same medium. Total internal reflection!

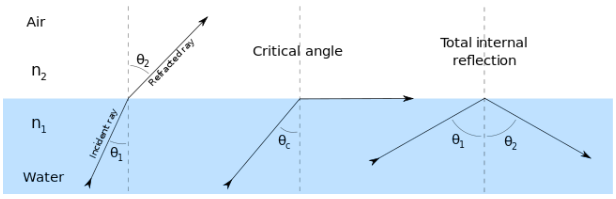

Figure 2: Alongside the notion of total internal reflection

Therefore, when light propagates from a medium with a lesser speed into a medium with a greater speed the conditions of the total internal reflection phenomenon will be fulfilled. Optical fibre idea! An optical fibre is usually made out of glass or plastic and serves for transmitting information by using light. Optical fibres are placed in an optical fibre cable. As a medium, optical fibres are much faster, more reliable and safer than copper conduits because they do not transfer electrical, but light signals. That is why it is impossible to have an unauthorised access to the network via radio frequency interference (RFI) and electromagnetic (EMI) interference. The core is optically denser (a higher refractive index; lesser speed of light), and the cladding is optically rarer (a lower refractive index; greater speed).

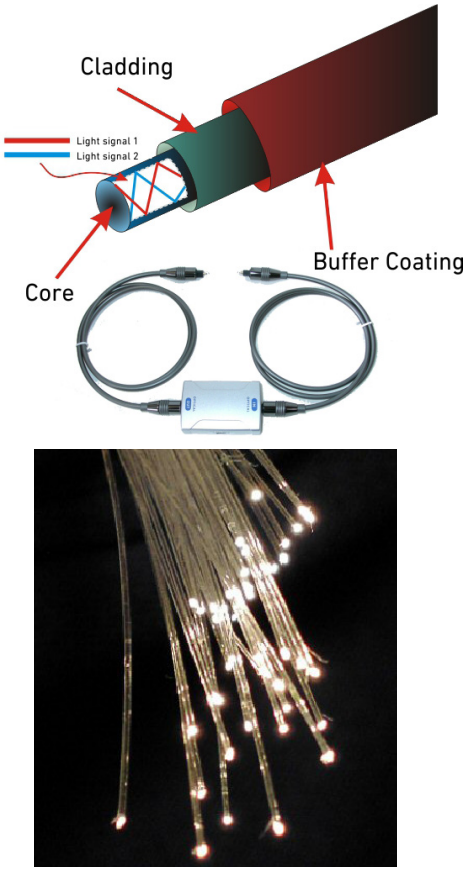

Figure 3: A data transmission optical fibre

Photoelectric effect

The photoelectric effect is the emission of electrons from metals under the effect of light. It was accidentally discovered by Hertz in 1887. Before Einstein physicists were confused by the fact that more light emanates more electrons but does not change their energy. Colour (wave length), not light intensity, affects the energy of electrons. Therefore, light energy separates the negative from the positive electric charges! Einstein solved all the dilemmas in 1905 by hypothesising that light is composed of particles, i.e. it is spread through quanta called photons. More photons emanate more electrons, but the electron energy can only grow if the photon energy grows too. Einstein's hypothesis was so radical that even Planck, the originator of quantum theory, opposed it. In 1921 Einstein was awarded the Nobel Prize in Physics for explaining the photoelectric effect $hf = A_i + E_k$.

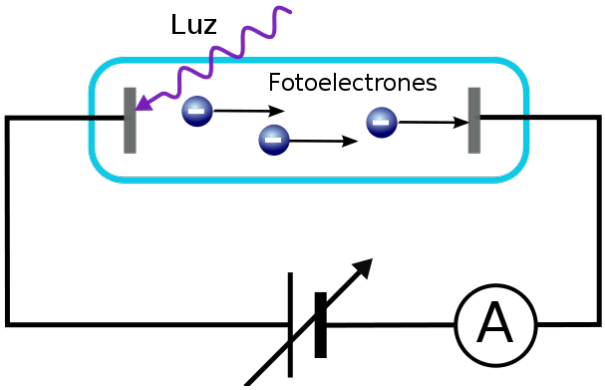

Figure 4: The phenomenon of photoelectric effect

The interaction of photons and materials resulted in inventing photovoltaic cells! In other words, light energy creates electrical energy! The possibility to transform free solar energy into elegantly usable electrical energy arose...

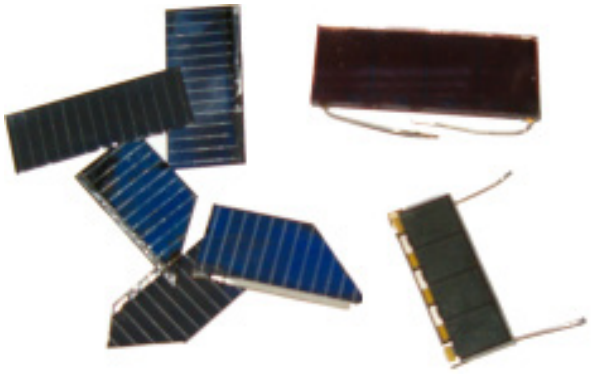

Figure 5: Idea of a photoelectric cell

Frictional electrification

When rubbed, a body becomes electrified and attracts small particles. The mechanical energy is transmitted into electrified bodies by friction. This knowledge developed a thought regarding its usage.

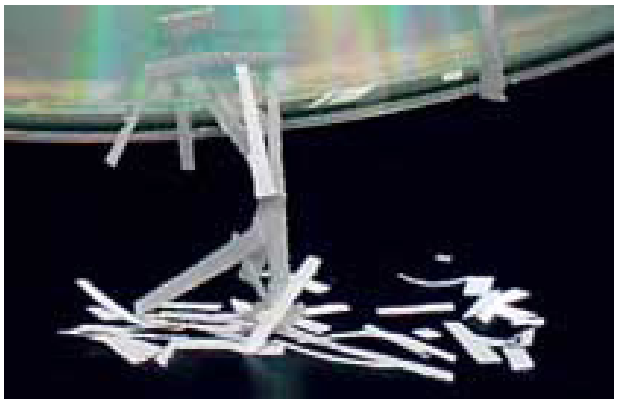

Figure 6: When rubbed, a CD attracts paper, dust, etc.

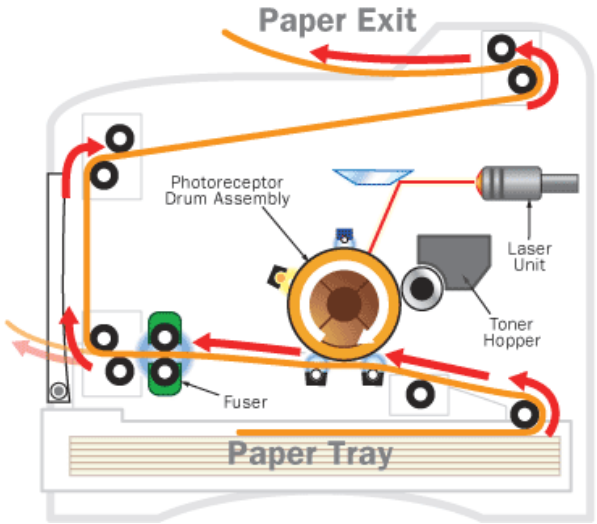

Figure 7: The photocopier structure

Ingenuity gave us the photocopier! It could take a long time to list all the examples of technical creations produced by learning about the laws of physics.

Techno Science
International Scientific Journal of Technical Sciences

Received: April 21, 2017
Accepted: May 25, 2016

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Uloga prirodnih nauka u stvaralaštvu

SAŽETAK

Pojavni svijet je od uvijek bio i ostaje intriga za istraživanje, kako u području prirodnih tako i u području društvenih nauka. Sposobnost čovjeka da spozna zakonitosti iz pojavnog svijeta i da ih usmjeri u područje praktične primjene nauke, vodi ka tehničkom stvaralaštvu.U prirodne nauke svrstavane su, istorijski gledano, samo nauke koje su se bavile materijalnim stvarima nežive prirode. Međutim, prirodne nauke su nauke koje se bave i živom i neživom prirodom. Tradicionalna područja prirodnih nauka – fizika, hemija, biologija i geologija – još i danas obilježavaju opštu široko rasprostranjenu predodžbu o prirodnim naukama.Rad ima za cilj da doprinese uočavanju utjecaja edukacije u području prirodnih nauka na inventivnost čovjeka i stvaralaštvu u području ljudske djelatnosti.

Ključne riječi: prirodne nauke, stvaralaštvo, primjena, primjeri.

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Zaha Hadid unpublished designs

During the london festival of architecture 2017, Zaha Hadid gallery opens its doors to showcase 'ZHA unbuilt', a series of exhibitions featuring a selection of the practice's unrealized designs. from never-before-seen tower renders to intricate stadia models, the gallery illustrates Zaha Hadid architect's continuous design investigation, which is devoted to experimentation and evolution.

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