Guest Editorial

MoNGeometrija 2018

This Special Issue of Mongeometrija 2018 publishes papers selected among the others exposed for the 6th International Conference MoNGgeometrija 2018. (The conference was named "MoNGgeometrija" in honor of the French engineer and mathematician Gaspard Monge, the inventor of descriptive geometry. Furthermore, "NG" is the acronym for the term "Nacrtna Geometrija" – descriptive geometry in Serbian language.) The conference was organized and supported by Serbian Society for Geometry and Graphics (SUGIG) and the Faculty of Technical Sciences, University of Novi Sad. Moreover, the 6th International Conference MoNGgeometrija 2018 was under the auspices of Ministry of Education, Science and Technological Development of Republic of Serbia and was held in Novi Sad, Serbia, from 6th to 9th June 2018. Since SUGIG considers geometry and graphics as the universal languages of science, technics and all visual arts, the conference offers a wide range of topics: theoretical graphics and geometry, geometry of curves and surfaces, kinematic geometry, descriptive geometry, projective geometry and perspective, theory of polyhedra, applied geometry and graphics, modeling of objects and processes, application of geometry in science, architecture and engineering, geometry of space structures, paper folding geometry and origami, geometric aspects of art and design, computer animation and games, engineering computer graphics, computer aided design and drafting, computational geometry, geometric and solid modeling, product modeling, image synthesis, computer-generated imagery, scientific and technical visualization, graphics education and teaching methodology, education of descriptive geometry and graphics, education technology research, multimedia educational software development, virtual and augmented reality, educational software development tool, history of geometry, geometry in historical contexts, geometric aspects of historic-cultural monuments, life and work of famous geometricians.

Papers published in this Special Issue have been chosen as the most prominent and scientifically most significant and interesting. Let us disclose briefly the essential subject matter of all selected works.

The first paper, *Graphical Synthesis of 6-bar Dwell Linkage Mechanism*, by Maja Čavić, Marko Penčić, Milan Rackov, Jovan Dorić and Zhenli Lu presents the graphical method for the synthesis of the complex structure mechanisms that contain high class structural groups and has an output link with a period of dwell. At the core of this procedure are simple, easily visible and understandable geometric constructions which are used to form equations suitable for further analysis and optimization.

The second paper, *How platonic and Archimedean solids define natural equilibria of forces for Tensegrity*,

by Martin Friedrich Eichenauer and Daniel Lordick, considering the fact that the Platonic and Archimedean solids define natural equilibria of forces, discloses the solution of the densest packing problem. By expanding this idea by a contrary force, authors obtain the principle of tensegrity and show that regular and half-regular polyhedra can be built up by the interaction of physical forces. Following the fact that every Platonic and Archimedean solid can be converted into a tensegrity structure, authors reveal that a vast variety of shapes defined by multiple solids can be also obtained.

The third paper, *Optimization of Voids in Concrete Ceilings – a Geometrical Approach*, by Kevin Noack, Martin Friedrich Eichenauer and Daniel Lordick, the problem of reduction of the material consumption in the building industry is investigated. Authors propose the original eco-friendly and sustainable solution to this problem by placing especially designed voids in the concrete ceiling. The geometry of voids is optimized by the structure of smoothed crossing channels, modelled with rotating semicircles leading to interconnected tori. The solution is validated by the ANSYS simulation results and confirmed that the proposed structure spreads the stress uniformly and leads to a high load-bearing capacity.

The fourth paper, *Design of a Board game with Augmented Reality,* by Tashko Rizov, Jelena Djokikj and Milan Tasevski presents an example of the design of an AR Board Game, a class of table-top games that combines handheld devices (such as smart phones) with physical game pieces to create a merged physical/virtual game on the table-top. Along with that, the paper describes the process of designing a board game that incorporates AR, along with technical implementation. The comparison of the user experience in the case of using just the board game and the board game with AR is conducted and the results of the conducted comparison are also presented and discussed.

In the fifth paper, *Design of a Street-Style Motorcycle Concept,* Tashko Rizov, Risto Tashevski and Hristijan Najdeski present the design process of a motorcycle with a street-style chassis in compliance with the ergonomic and engineering requests. After selecting the optimized design of the product, authors create a 3D model and visualize it by the using of the photo-realistic rendering.

In the sixth paper, *Web Textbook for Descriptive Geometry,* Sonja Gorjanc and Ema Jurkin, expose the novel educational material for delivering the lectures in descriptive geometry and perspective which is a basis for a web textbook designed for the lectures on geometric subjects. This approach provides the set of highly efficient educational activities and exercises by which students - the future engineers can develop clear and careful spatial reasoning and its graphic representation.

The seventh paper, *Descriptive Geometry in Serbia at the end of the 19th Century, in the Work of Dimitrije Stojanović,* by Katarina Jevtić-Novaković, Olga Timčenko and Marija Divac, reveals the early history of teaching of descriptive geometry in Serbia, concentrating on Dimitrije Stojanović's "Methodology of Descriptive Geometry". The paper is very interesting and extremely significant since it reveals almost forgotten historical facts about Belgrade University and the development process of high education in Serbia. Dimitrije Stojanović, honorable Minister of Construction and Finance, an engineer responsible for the development of the Serbian Railways, should certainly be remembered by the book in which he introduced the most up-to-date knowledge of geometry of those times.

The eighth paper, *Designs of Solar Concentrators*, by Miša Stojićević, Zorana Jeli, Miloš Obradović, Ratko Obradović and Gabriel – Catalin Marinescu, presents, describes and analyzes the basic design characteristics of several types of concentrating solar power systems (CSP) alongside their advantages and disadvantages. Regarding these positive and negative aspects of typical features of various types of CSP, the paper shows how to select the most advantageous and practically applicable CSP. Furthermore and as the most important, authors reveal an example of a novel and original CSP conceptual design. Concerning the fact that the process of making a parabolic mirror is sufficiently complicated to be practical, authors proposes its construction by a pencil of paraboloid circular segments with a common focus which are connected in such a way that they form a mirror. The exposed construction also includes the solution of tracking the sun during the day by the rotating mirror axis. This paper gives the significant contribution to the renewable energy technologies by its innovative, simple and effectively applicable solutions.

The ninth paper, *CAD, CAE and Rapid Prototyping Methods Applied in Long Bones Orthopaedics*, by D.L. Popa, G. Buciu, D.C. Calin, B. Popkonstantinović and F. Poenaru, presents some methods by which human bone joints can be analyzed. Authors describe and discus several CAD methods for the bone virtual reconstruction and reveal the mechanical model of the human normal walking in the motion environment of the SolidWorks application. In particular, the biomechanical system of the human walking is obtained by the creation of the 3D solid model assembly of pelvis, fibula, rotula and foot bones, together with the proper movement constraints. The entire kinematic behavior of each component of the biomechanical system including loads in the tibia is obtained by the results of the SolidWorks motion analysis. Finally, authors perform the FEM analysis of the hip joint under the load of normal human walking and fabricated physical polymers prototypes of bones, different implants and prosthetic elements for the orthopedic applications.

The tenth paper, *Algorithm for image-based architectural element recognition*, by Isidora Đurić, Ratko Obradović, Vera Viana, Lidija Krstanović, Bojan Banjac, Jelena Letić and Nebojša Ralević, presents and explains an image-based semi-automatic algorithm for a shape recognition of an architectural element from an image. This algorithm for the shape recognition is based on the image-processing techniques, and implemented in the C++ programming language, using the OpenCV library. The proposed algorithm is tested and evaluated experimentally on the images of window of two churches, taken with various distances and at different angles. Regarding the experimental results, authors noticed that the performance of the image-based algorithm for the shape recognition of the specific window was mostly influenced by the visual characteristics of the observed architectural element. The shape matching results obtained experimentally, vary in the range from 35% to 100%, which is mainly caused by the degree of the colors homogeneity and textures quality of the surfaces that surround the window. This work is interesting and significant since it reveals the fact that even some aesthetical characteristics can be analyzed and recognized algorithmically.

The eleventh paper, *Teaching of Geometric Surfaces for Architectural Students at the Faculty of Engineering and Design, of Hosei University in Tokyo, Japan*, by Sonja Krasić, Naomi Ando, Petar Pejić and Zlata Tošić, discusses about educational methodology for teaching geometric surfaces applicable in architecture. In particular, the paper exposes and explains in all necessary details the Subject "Geometric Surfaces in Architecture" which was offered to Japanese students at the Department of Architecture, Faculty of Engineering and Design, Hosei University, Japan in III semester, in the academic year of 2017/18. This subject was divided into theoretical and practical course both of which are made by authors of this paper. This educational activities provide students adequate knowledge of geometric surfaces, which they lack due to insufficient teaching of this discipline. Another reason for the introduction of this course in Japan is that the architectural students can gain knowledge that can be applied in the design of their own objects.

The twelfth paper, *Simulation and motion study of mechanical integrator 3D model, by Branislav Popkonstantinović, Miša Stojićević, Zorana Jeli, Miloš Obradović and Popa Dragos-Laurentiu,* explains the operational principles and discloses the results of the simulation and motion study of the mechanical integrator 3D model assembly. Specifically, 3D models of the input function generator, the ball and disc integrator and the output *x-y* plotter are created and their operations are simulated. As an example, two functions, the first of which is linear and the second one quadratic, are integrated by the mechanical integrator modelled in this paper. This work is significant mainly for education in the fields of solid modelling, mechanism synthesis and scientific visualization of the mechanism motion and operation. In particular, authors present the motion analysis that visualizes and discloses the mutual relationship between the integration calculus as the mathematical operation and the geometrical and kinematical characteristics of one special type of mechanical computing device.

In the thirteenth paper, *Bridging the Gap Between Physical and Digital Sculpting by Application of*

Reverse Engineering Modeling, authors Željko Santoši, Igor Budak, Mario Šokac and Duško Pavletić demonstrate the useful application of 3D technology in the field of plastic arts. In order to do so, one case study is presented showing the way to bridge up the symmetry-related gap between physical and digital sculpting by the applying reverse engineering modeling. By the using of close-range photogrammetry technique, a physical 3D model of a human head, previously manually sculpted in clay, is digitized and, by the using of computer-aided inspection, the symmetry analysis and correction are performed. Presented study is significant because it points out how to implement well known reverse engineering techniques in the field of arts to make the artists ready to meet the complex challenges of present time.

The fourteenth paper, *Implementation of Inverted classroom methodology in 3D modeling course,* by Aleksandra D. Joksimović, Emil A. Veg, Vojislav D. Simonović, Mladen M. Regodić, Goran B. Šiniković and Nenad Gubeljak, presents a novel teaching methodology and shows improving results achieved in the teaching process on course Engineering graphics at the Faculty of Mechanical Engineering at the University of Belgrade (Serbia). By the providing an interesting new material, which is more versatile to younger generation than previously used, authors of this paper achieved the improvement in overall student's grades. This material is presented to the students in the form of video materials, which offers an opportunity of distance learning and preparation for the lesson. Particularly interesting and important is the novel and original set of exercises for 3D solid modelling through which students obtain the advanced skills and knowledge in the field of computer aided design and engineering graphics.

The fifteenth paper, *Point-Clouds as Photogrammetric Representations of Linear Objects Surfaces: The Impact of Extrinsic Shooting Parameters on the Change of Roughness-Quality of Their Textures*, by Đorđe Đorđević, Alina Duta, Gordana Đukanović, Mirjana Devetaković Radojević and Nikola Popović, examines and presents the influence of various shooting parameters regarding change of roughness and quality of surface textures of linear objects when these objects are presented in the form of unstructured photogrammetrically created point-clouds. Authors conclude that the performed photogrammetric digitalization can be declared highly precise and satisfyingly accurate regarding roughness/smoothness and barely prone to object-to-camera distance for a fixed focal length, shooting directions perpendicular to the axis of targeted object, station-points uniformly radially distributed around it and obtained process-quality descriptors values belonging to recommended ranges.

The sixteenth paper, *Interactive change of lighting in the portrait images*, by Srđan Marković, Marija Obradović and Alexandros Demetriades, explains and exposes a method for obtaining an image with variable light source that affects the facial features generated on the bases of the face tracking data acquired from the existing static photograph. This method is based on lighting alteration in portraits photographs through real-time rendering. Thus, authors get a portrait with altered light, as if such a source was present at the actual moment of photographing. The proposed method help us getting dynamic effects from static images with an aim to improve or even change the visual experience when viewing the image, so that its further application corresponds to the given context.

The, seventeenth paper, T*he man who invented descriptive geometry,* by Ivana D. Cvetković, Miša D. Stojićević, Hellmuth Stachel, Rodoljub G. Milićević and Branislav D. Popkonstantinović, exposes an interesting and significant insight into the life and work of Gaspard Monge, the famous French scientist who was a founder of descriptive geometry. The paper gives biographic data on Monge's life and professional activities, starting from his early age of 16, when his scientific potentials were recognized by the teachers at Collège de la Trinité. Many interesting details from Monge's life, in this paper, are set in the recurrent historical context of political events in France. The authors of the paper carefully adduced Monge's relationships with the ruling structures, and among those, with famous Napoleon Bonaparte as well. The reflection of Monge's work and influence on his students (nowadays also well-known scientists) is also indicated. The main part of the paper is focused on Monge's contributions to the field of geometry and natural phenomena. His geometrical method of representation of a spatial object by the two orthographic projections is emphasized as the most important turnover in obtaining precise graphic description of an object. Among other Monge's geometric contributions, authors presented his interest on generating principles of developable surfaces, as well as his theorem on three arbitrary circles in the same plane and the property of the pairs of their tangent lines.

The eighteen paper, *About the geometry of transition pieces relative to the flat-oval tubing*, by Carmen Mârza, Georgiana Corsiuc and Ana-Maria Graur, presents and explains the geometrical methods for the reduction and enlargement of the flat-oval ducts sections, as well as of the transition pieces between the flat-oval sections and circular or rectangular sections, respectively. By the using of the descriptive geometry methods, the patterns required for the construction of these pieces can be obtained. Authors of this paper exposes the practical application of the descriptive geometry theory of developable surfaces in the design and construction of the ventilation and air conditioning installations.

In the nineteen paper, *Spherical Perspective in Design Education*, author Matthias Kulcke presents the ability of the spherical perspective to serve as a meta-class model of vanishing point perspective systems, giving a teacher the opportunity to present approximations of the straight linear perspective models (with one, two or three vanishing points) all in one system. Spherical perspective as an approximation to human vision, as well as the spherical perspective in the context of augmented reality are discussed in all necessary details. Author emphasizes the importance of freehand drawing since this precious skill hasn't been replaced to the same extent by digital tools and

techniques. Regarding this, the mathematical basis for a spherical grid as a curvilinear approximation to one-eyed human vision and a didactic approach for its integration into the freehand drawing of the design oriented perspective are also explained and presented thoroughly.

The twentieth paper, *3D Analysis of Different Metamaterial Geometry and Simulation of Metamaterial Usage*, by Boris Kosić, Miša Stojićević, Zorana Jeli, Branislav Popkonstantinović, Alina Duta and Aleksandra Dragićević, investigates and presents the influence of different geometrical structures on a new concepts for formation of technical systems. Authors accomplish sixty-four simulations conducted by changing internal structure, thickness and orientation of metamaterials and expose the examination results for each different structure of metamaterials. For each simulation results are presented as stresses and displacements. Additionally, three model of pliers have been simulated, and its results were compared with results from previous simulations. The paper exposes how different structures can handle the same load, and discloses which of these metamaterials will suited the best for the used pliers model.

In the twenty-first paper, *Recalling Ivory's Theorem*, author Hellmuth Stachel presents the novel consideration and revision of the famous Ivory's Theorem and discloses a few important algebraic consequences. Some recently published theorem are reproved in this paper by the using of Ivory's Theorem. Author discloses a new theorem, its proof and distinct cases, and emphasizes some significant remarks and consequences. One of the particularly interesting repercussion of the Ivory's Theorem exposed in this paper is the existence of incircular net of great circles on a sphere which reassembles the spherical model of elliptic geometry and a spherical Poncelet grid! Author introduces the cyclic canonical coordinates and discloses the proof of the novel theorem based on previously proved theorems and corollaries. This paper is interesting and significant for the theory of geometry (Euclidian, planar hyperbolic, spherical and pseudo-Euclidian geometry). Moreover, as is shown in paper, Ivory's Theorem has important algebraic repercussions and can be applied in various branches of Computational geometry.

The twenty-second paper, *Perception of 3D Virtual Road Markings - Based on Estimation of Vehicle Speed*, by Aleksandar V. Trifunović, Svetlana J. Čičević, Dragan M. Lazarević, Magdalena S. Dragović, Nataša D. Vidović and Marijana R. Mošić, describes the experiment performed to explore how drivers' perception and behavior are influenced by two virtual 3D shapes' projections – a 3D alternative crosswalk pattern and speed bumps consisted of triangular prisms. By the results of this experiment, authors proves the existence of the fundamental relationship between visual perception and geometry. Authors discuss how drivers' perception and behavior are influenced by virtual 3D shapes projections, drivers' willingness to reduce the traveling speed of 50 km/h and evaluate the degree of realism of the 3D road markings in simulated virtual environment and speed reduction. As the conclusion particularly important for the improvement of the road safety, this paper discloses statistically significant differences between drivers' willingness to reduce vehicle speed as a response to the two types of road markings: the first one with the square shape base (rectangular prism) and the second one with triangular shape base (triangular prism).

The twenty-third paper, *Bespoke Geometric Glazing Design for Building Energy Performance Analysis*, by Nicholas Mario Wardhana, Aikaterini Chatzivasileiadi, Wassim Jabi, Robert Aish and Simon Lannon, describes the procedure for creating a bespoke geometric glazing design on given curved surfaces based on the concept of UV-mapping, which maps points in a 2D space to a 3D surface. Such mechanism facilitates texture designers to easily and intuitively create a texture design in the 2D space, rather than making such design directly on the 3D surface. Authors compared commonly used window-to-wall ratio method for glazing modelling with bespoke geometric glazing design which, while more time consuming, allows a more aesthetically representative and geometrically accurate glazing design, thus minimizing the energy performance gap. At the end of the work, authors propose a few directions which can be considered for the improvement of the exposed solutions.

The twenty-fourth paper, *Employing Mesh Segmentation Algorithms as Fabrication Strategies. Skin Pattern Generation Based on Reaction-Diffusion Mechanism*, by Effimia Giannopoulou, Pablo Baquero, Angad Warang, Affonso Orciuoli, Alberto T. Estévez, and Miguel A. Brun-Usan, analyses how the process of evolution of generative architectural design can apply similar physical and geometrical principles, which govern biological processes that appear during development, to design architectonic free-form shell structures. Authors extend the design workflow considering the collaborative fabrication processes including fabrication tools, material properties, manufacturing simulations and assemble logic. The paper discusses that biological skin patterns and segmentation in fabrication open a new field for interdisciplinary analysis and architectural applications. The outcomes have been used to fabricate a model, using three different materials and three fabrication methods, during the Biodigital Master in Architecture.

The twenty-fifth paper, *Design of solar systems for buildings and use of BIM tools: overview of relevant geometric aspects*, by Mirjana S. Devetaković, Đorđe D. Đorđević, Gordana D. Đukanović, Aleksandra D. Krstić Furundžić, Budimir S. Sudimac and Alessandra Scognamiglio, thoroughly analyses, systematizes and discloses the geometric aspects which are significant for the design of solar systems. After providing detailed explanations of the main elements of solar geometry using the tools of spherical trigonometry, the paper discusses the integration of the presented geometric concepts in the BIM environments, and refers the example of Autodesk Revit software through its sun study tool. Authors analyze the functionalities of all interactive components of the 3D solar path represent-ation and emphasize the importance of knowledge on solar geometry that needs to be acquired during archi-

tectural education, so that architects participating in the BIM working environments, could be prepared for efficient conceptualization of integrated solar systems.

The last, twenty-sixth paper is, *Automation of the Avatar Animation Process in FBX File Format*, by Milica Lazor, Dušan B. Gajić, Dinu Dragan and Alina Duta. In the focus of the paper is optimization of the animation process applicable in gaming and movie industries. Proposed is an innovative programmatic approach to animation and use of a specific file format for storing animated avatars. The paper reports achievement of a significantly higher degree of automation and programmability than other standard animation approaches, and therefore more efficient production process. It refers to resources published by the same authors that overview entire coding corpus and give detailed technical explanations of the process. It also identifies a valuable range of related issues for further solving.

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Guest Editors

Branislav Popkonstantinović
Full Professor
University of Belgrade,
Faculty of Mechanical Engineering
E-mail address: dr.branislav.pop@gmail.com

Ratko Obradović
Full Professor
University of Novi Sad,
Faculty of Technical Sciences
E-mail address: obrad_r@uns.ac.rs

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Figure 1. Participants of the 6th International Conference MoNGgeometrija on a trip - a visit to the Monastery Krušedol on June 9, 2018.