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The First International Students Scientific Conference
"MULTIDISCIPLINARY APPROACH TO CONTEMPORARY RESEARCH"

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PREFACE

The Proceedings includes the selected Papers and Abstracts presented at The First International Student Scientific Conference "Multidisciplinary Approach to Contemporary Research". The Conference was held on 25-26th November 2017. at Central Institute for Conservation, Belgrade, Serbia, Terazije 26. It was organized by Central Institute for Conservation, Belgrade and Scientific Association for the Development and Promotion of New Technologies, Belgrade.

The aim and main idea of the Conference was to present science and scientific way of thinking and working closer to the students, as they will be able, in the future, when they are employed, to connect science and industry. For this reason, the right to participate had only undergraduate and master students, who, with help and monitoring by their teachers and/or colleagues, wrote and prepared papers and presentations.

The aim of this Conference was, also, to provide a Forum for students and researchers from various countries to exchange their ideas and achieved results.
The Conference brought together the participants from Universities, Innovation Centres and Institutes from different countries: Croatia, Romania, Bosnia and Herzegovina, Macedonia, France, Russia, Montenegro, Spain, Republic Srpska, Slovenia and others.

The aim of the conference was, also, to connect different/various fields of science, because we can find many common points between different research areas, and by doing that, to open possibilities of developing new technologies or improving the old ones. Therefore, the Conference covers various topics from the following fields: mechanical science, transport and traffic engineering, material science, metallurgy, electrical engineering and other engineering areas, but all other sciences as well, including for example medical science, which uses different techniques of experimental examination and testing.
Although, the Conference had multidisciplinary character, the participants had very active discussion after the presentations and we hope that it will provoke the further cooperation between them with a new point of view.

The paper presentation was by oral and poster, due to limited time of Conference duration and traffic conditions of participants. The all papers are reviewed. Considering that this was the Students Conference and the age and experience of the first authors, the reviewers *had neglected* language and textual mistakes which were not provoked the ambiguity of the papers.

We would like to thank all authors who have contributed to this Proceedings and also to the Scientific Committee, Organizing Committee, reviewers, speakers, chairpersons, and all the conference participants for their support for a successful scientific meeting.

Editors

CONTENT

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WHERE PHYSICAL AND VIRTUAL MODELS MEET: VISUALIZATION OF 3D GEOMETRIC TASKS

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Abstract: *Visualization skills of 3D space and its elements until recent times were just a matter of ones' natural talents. Today, there are many available technological solutions for improvements and support of 3D visualization. Descriptive geometry as an engineering subject, deals a lot with 3D visualization problems, giving the necessary knowledge base for several engineering professions. Some 3D geometric tasks with geometric entities - Plato's solids were challenging for visualization in an interesting combination of two environments. Cardboard physical model of coordinate planes, along with transparent inclined plane made of plastic folie, was a physical environment for the experiment. 3D computer generated models of geometric solids were imported in augmented reality smartphone application Augment in order to simulate several task settings and solutions. The paper presents the procedures of both 3D models' creation and results of visualization in Augment's environment.*
Keywords: *3D geometric model, visualization of descriptive geometry task, augmented reality application - Augment*

1. INTRODUCTION

Geometric solids and their views are the subjects of research of the significant names related to mathematics and its branch - geometry, such as Plato, Archimedes and Leonardo Da Vinci. Very old Leonardo's drawings are parts of World's cultural heritage today (Fig.1). The visualization of geometric tasks had its development from drawings and physical models - the mock-ups made of various sorts of material (wood, plastic, metal, or cardboard) up to the contemporary graphic software solutions (Fig. 2a-b).

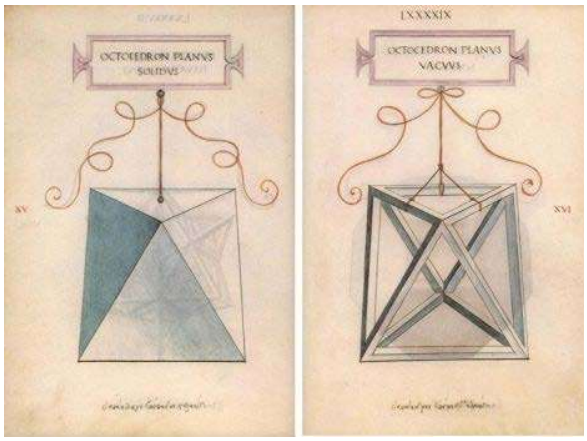

Figure 1: Platonic solids- Leonardo da Vinci's drawings

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Large scale of possibilities in polyhedrons' visualization appeared in last two decades, along with development of mathematical and engineering software solutions. 2D representations or 3D models in adequate graphic environment enabled visual interaction and direct information on their geometric characteristics [1]. Modern graphic solutions - modelers, such as SketchUp, AutoCAD, Rhinoceros, Geogebra and others, allowed creating applicable models in the virtual 3D environment, for various educational purposes. Dynamic software tools made their impact as well (Oldknow 2007; Nagy Kondor, 2010).

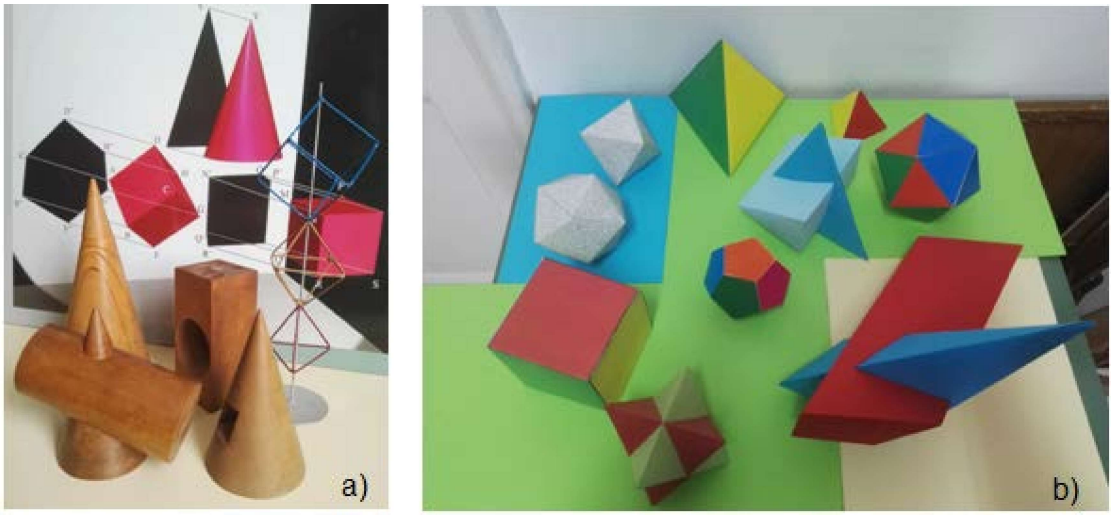

Figure 2: a) Parallel display: wooden and wire-frame models of geometric solids and graphic representation in specialized software for 3D modeling; b) Creative workshop at the Faculty of Civil Engineering - cardboard models representing Platonic solids and intersection of solids.

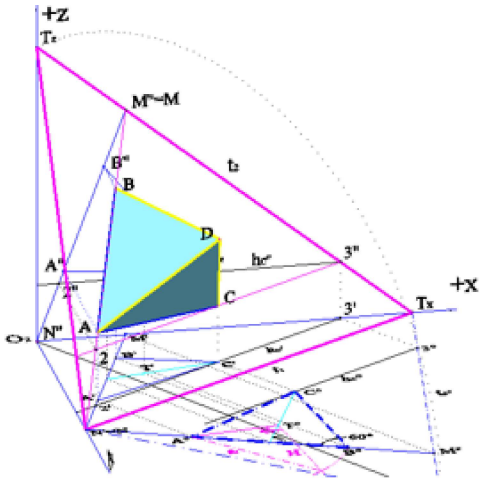

Figure 3: Descriptive geometry task with Platonic solids represented in *AutoCAD* 3D drawing. The task is the part of tasks collection for exercises at the Faculty of Civil Engineering in Belgrade

Until recently, educative approach at the Faculty of Civil Engineering in Belgrade, in visualization of geometric solids was performed by making colored cardboard models, using the principles of drawing the nets and then folding them into adequate models (Fig.2b)
At present, visualization is obtaining by computer presentations in graphic software AutoCAD for 3D drawing and modeling (Fig.3), during which "step by step" guidance through task solving is conducted (Trifunović, 2017).

Regarding the availability of AutoCAD software and knowledge level prerequisites for using such complex environment, the experience at Faculty of Civil Engineering in Belgrade shown that many students did not use the given opportunity for learning and visualization of solved geometric tasks (Trifunović, 2017).
In need to merge physical and virtual experience, and overcome difficulties with complex software, the idea to use augmented reality (AR) surroundings in teaching/learning processes for visualization purposes came out. One of the popular technological platforms which use cell phones and tablets as mediums for visualization was challenging to explore in Descriptive geometry field. Some references have shown its usability (Redondo, 2012). The Augment application as a leader in augmented reality (AR) applications is chosen. This is the application enabling visualization of 3D models in the real environment and at scale. It opened limitless opportunities and improvements in the fields of architecture and construction, marketing, sales increase, and finally in education processes. The aim of the research is to remove barriers that majority of students have when they are facing descriptive geometry problems and 3D visualization in general, and to introduce students with augmented reality benefits.

2. MATERIALS AND METHODS

The leading scientific methods and principles were applied to the experiment in the area of Descriptive Geometry and Computational Geometry (to create models), while methods of presentation were obtained by computer software *Auto CAD* along with cell phone application – *Augment* [2]. In the process of creating physical models and their nets, principles of Descriptive Geometry such as rotation and transformation were applied. *AutoCAD* 3d models were created by a combination of commands and tool palettes supported by computational geometry knowledge. Significant improvements in visualization process were obtained by using possibilities of *view* palette tools (orthographic, axonometric views) and animation tools. As an applicable method of presentation, the possibility of contemporary IT product is applied.

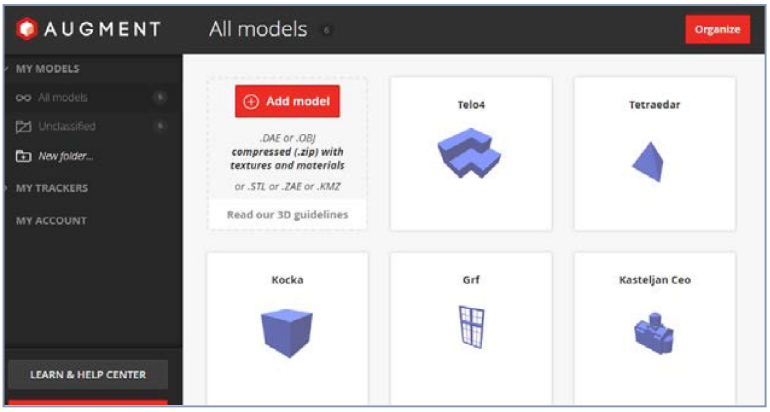

Figure 4: Augments' public storage supplied with models to import in application [2]

Cell phone app *Augment* is used for setting and modification of geometric tasks with Plato's solids in the real environment (physical model), and then captured in specific views. 3D CAD models, previously shared in Augment public storage (Fig.4) and imported in mobile app, could have been used independently without a tracker [2].

Rotation, translation and scaling were efficient for objects' positioning, while final screen shooting was applied for the visualization purposes (Fig.5).

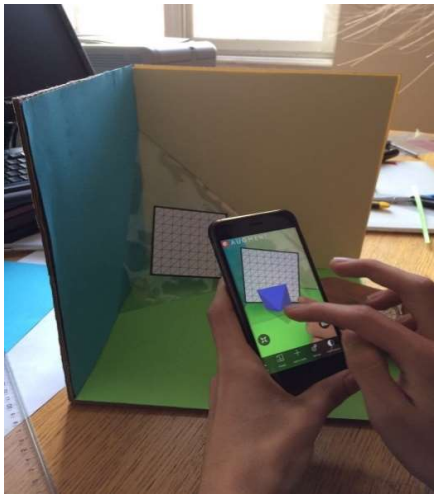

Figure 5: Model manipulating in *Augment* application

2.1 Introduction to "Augment"- cell phone application

Augment is AR platform for configuring, managing and viewing 3D content, which includes three main components:
1. Free application on iPhone, iPad or Android, which we use to bring 3D models into real environment online and offline;
2. Manager - for upload and manage 3D models and trackers (after login and account creation on web site *manager.augment.com*);
3. Desktop – to design and review animations, materials, 3D content and then publish, or share to mobile application;
Application uses a tracker – a pattern with an unique design aimed to bring the 3D model in reality and in a proper scale. There are three groups of trackers such as universal, custom and on-the-fly. They are useful to position models onto 2D image when user wants to visualize and manipulate certain model. Trackerless mode works the best for large models, which should be positioned on the ground.

3. RESULTS

It was challenging idea to bond cardboard physical model (model of coordinate planes along and exemplary transparent inclined plane, made of plastic folie) with virtual models (Platonic solids: cube, octahedron, or tetrahedron) in AR environment. Coordinate system consisting of 3 projection planes (H-horizontal, F-frontal and P-profile) was made of thick cardboard, and used as the physical environment for insertion of virtual 3D models. Substantial elements of the

geometric tasks were highlighted on the transparent plane (the basis of solids and characteristic planar lines) as shown in Fig. 6.

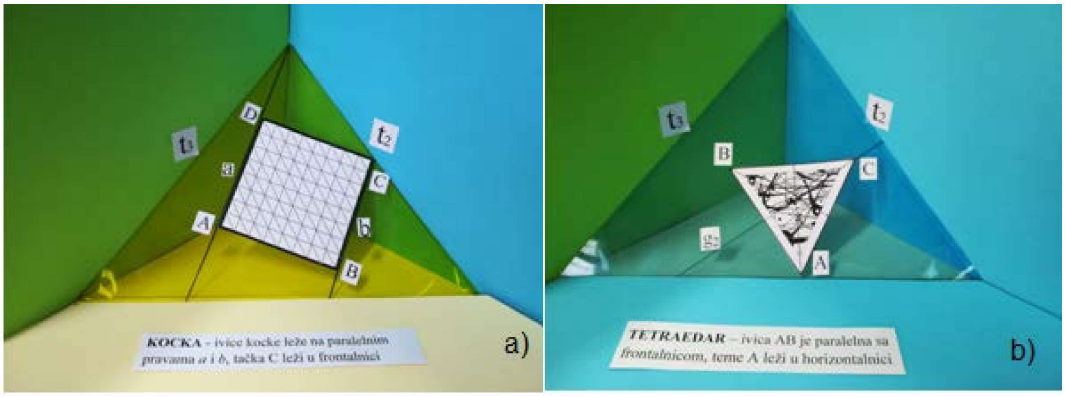

Figure 6: Descriptive geometry task settings on physical models: a) diagonal scheme tracker; b) Augments' reshaped tracker

Two types of the trackers were made: triangular and square shaped with the diagonal scheme (Fig. 6a) and Augments' pattern (reshaped in the form of specific solid base) Fig. 6b. Five diverse cases of the Descriptive geometric tasks with Plato's solids were presented and properly assigned. Three types of polyhedrons (cube, octahedron and tetrahedron) were modeled in *AutoCAD* and added into Augments library. Finally, in Augment app. imported models were positioned in physical environment of the task settings (Fig. 7) by manual manipulation (rotating and scaling).

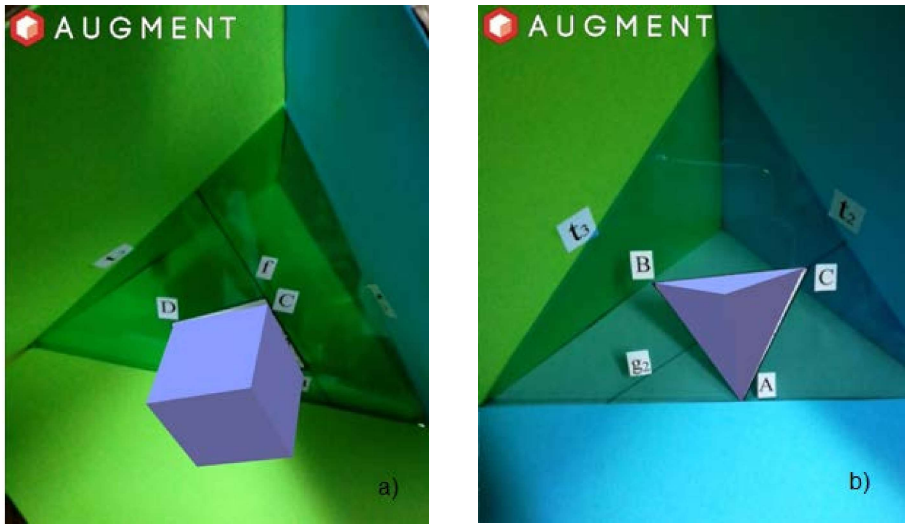

Figure 7: Virtual polyhedrons positioned in geometric task settings: a) cube and b) tetrahedron

4. DISCUSSION

This sort of study where the combination of physical models and virtual ones presented specific geometric tasks gives a certain quality of the experiment and research itself, because students

would be able to visually, without any drawing, interact with solids directly in 3D friendly environment. It is essential in studying to enable plenty of examples – variations of tasks, as sufficient education materials. The main goal of the experiment was to offer design solution which could help students in descriptive geometry learning process in order to improve visualization of specific geometric tasks with Plato's solids. In the paper contemporary augmented reality application possibilities were tested and explored.

The *classical* approach in teaching/learning processes which relayed on complex 2D drawings, not simple to mentally relate with their 3D representations, nowadays is substituted with new one aided by advanced technological tools and solutions. The experience at Mechanical Engineering in Mexico, where students use AR tools as educational support for their projects and classes in engineering drawing course [3], have shown excellent results in efficiency and ease of task solving. *Augmented book applied to Engineering* enabled them to adopt easier geometric knowledge and eliminate comprehension gaps.

There was a practice with generations of students at the Faculty of Civil Engineering in Belgrade, within faculty tasks to solve complex geometric tasks by making physical or virtual models (in modeling software *AutoCAD*). The latest research results (in 2016) of a group of students concerned 3D computer models (in AutoCAD software) as visual support for understanding of desciptive geometry topics – intersection of two second order surfaces (Kilibarda, 2016). Good practise of experimenting with new technologies is now extended by AR aplication.

5. CONCLUSION

With the rapid spread of technology and development of applications for augmented reality, engineers from all professions are able to completely utilize their imagination and ideas and make exceptional projects from that. AR application is growing rapidly due to portability of its technology. Virtual 3D space is very important and necessary in contemporary life style of any kind of professionals, scientists, or educators. In combination with physical models, through concept of AR it can bring new dimensions and results in visualization. The application of augmented reality that is presented in this paper, in the field of teaching/learning Descriptive Geometry has obtained research goals:

- Physical and virtual models of geometric solids qualitatively supported visualization of Descriptive geometry tasks.
- Various task settings gave visual representations of virtual solid models (Plato's solids) in given real surroundings of physical model (coordinate system and defined plane).
- Augmented reality introduction in educative process enabled proper spatial comprehension and visualization of the geometric task, along with amusement of interaction with virtual model.
- Physical model creation (of Plato's solid) is replaced with given virtual model hence a student became only a user of the friendly cell phone application, available in the classroom (if device has an internet connection).
- In accordance with technological streaming, the application is suitable source of important visual information and learning support, but authors recommend both physical model making and Augment application usage, because once gathered both affect on deep understanding of geometric principles.

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