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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

GAME AND CREATION – SPATIAL ABILITY TEST AIDED BY 3D MODELS AND AR CELL PHONE APPLICATION

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Abstract*Contemporary computer software tools for 3D modeling opened new possibilities in the design process of spatial ability tests, which contain geometric solids and their orthographic projections. 3D computer environment, which enabled drawing, modeling and manipulation with spatial geometric objects, directly affected visualization processes, very important for all engineering professions. Recently many research topics elaborated some new aspects concerning spatial abilities: testing and improvements. This paper gives an overview and analysis of the design process of particular spatial ability test aimed for engineering students (redesign of the existing test named "Geometry 2D and 3D"). 3D geometric models were created in AutoCAD software. Graphic images in the test were made due to efficient software tool palettes. Alternative solution for creation of graphic images was investigated in cell phone AR (augmented reality) application "Augment". The paper discussed important issues of the spatial ability test design and offered new application of AR into practice.*
Key words: Spatial ability test, 3D AutoCAD geometric models, AR mobile application

INTRODUCTION

Visualization of 3D computer generated models is the topic elaborated in particular courses at technical faculties, important for engineering professions. Prerequisites for being an engineer assume the adequate personal spatial ability skills. These skills are being checked by spatial ability tests, which could be very interesting and fun for consumers varying in age and interests. The common test, where one can enjoy playing in solving its content, is the one with geometric entities - solids and their projections (characteristic views). Classical tests were mostly 2D creations – axonometric views of geometric entities, once drown, without option to make any changes, but starting drawing from the scratch. The complexity of the tests is varying, reminding of to computer games' levels. In some cases, adequate pattern (geometric scheme/grid) is a convenient background for designing of a geometric object (Fig. 1). In such creation a designer is limited by the pattern and any lack of experience could cause some accidental mistakes. In fact, very high level of experience and skills is needed to create satisfactory test (with undoubtable solutions).

The problem in recognition of geometric concept of a solid object could appear if having only its axonometric view (representing the visible part of the object from one point of view). Since some parts of the object are hidden it could happen that there is not enough information about geometry of a complete structure, and only by elimination system one can tell which solution in the test is possible.

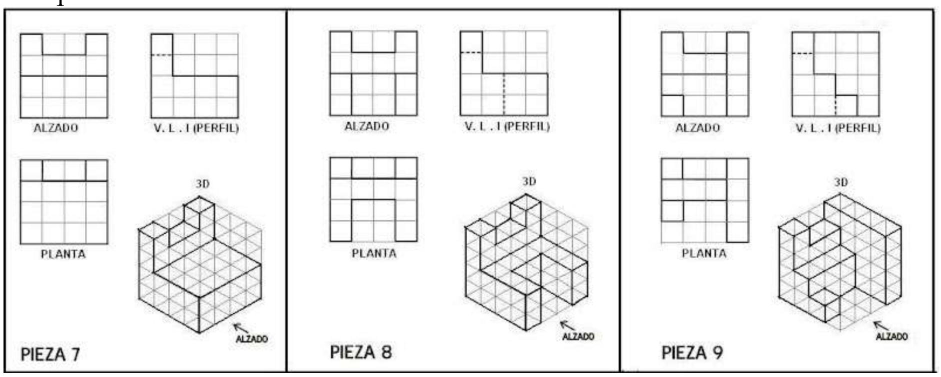


Figure 1: Axonometric view of a geometric object shown in regular greed
http://1.bp.blogspot.com/-VA37fIwJQD4/T5ZBmnkiqAI/AAAAAAAACV0/BLdVV8kN-k/s1600/3d+isom+7a12+RES.JPG

By introducing computer 3D software solutions, and 3D modeling tools, the process of test design is significantly easier and time efficient. A creator generates model in a virtual space (in all three dimensions) and by using manipulation tools (in 3D, or 2D environment) sets the task. Any position of a geometric object can be captured as 2D image in order to be implemented in the test. The new opportunity, brought by 3D software surrounding, is that orthographic projections could be connected to adequate 3D model and afterwards hidden in a layer (Fig. 2a-b). Such possibility minimized mistakes in orthographic views creation.

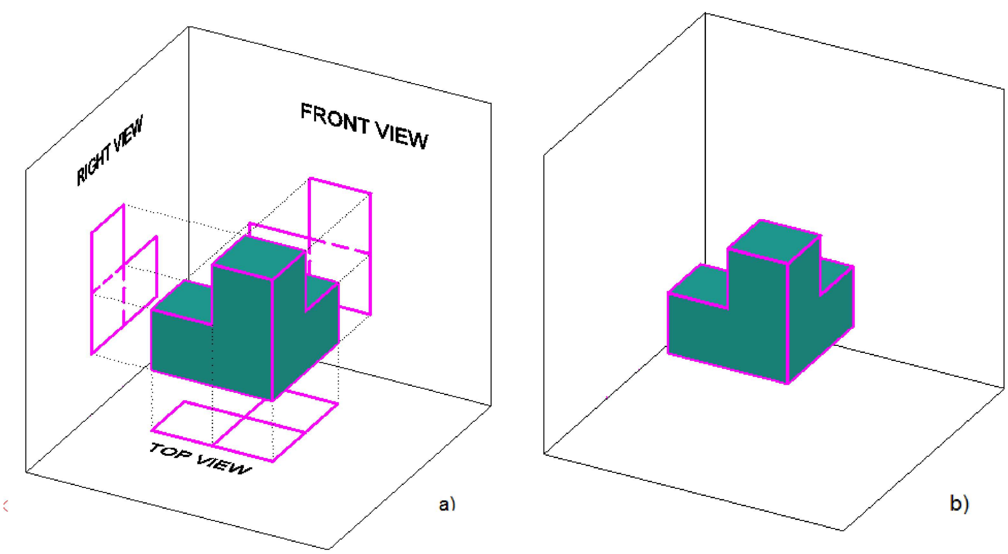


Figure 2: 3D model of geometric figure set in coordinate system: a) 3D model with orthographic projections; b) axonometric view of the model.

Very popular among students and younger population, cell phone applications based on *augmented reality*', enlightened from the new point of view visualization of 3D models. In this paper *Augment* application [1] possibilities were tested. Similar applications were designed for commercial purposes, i.e. market advertizing (applications such as IKEA Place, ViewAR, etc.), where the presentation of goods (piece of furniture) was enabled by photorealistic virtual 3D models. Virtual 3D models can be "inserted" into real environment (apartment, room or natural ambient) and visualized through cell phone camera. Application uses a tracker (activated by a code on Augments web site) original Augments', or created by the user. The example of good practice with *Augment* application is the one where the students of mechanical engineering used the application as efficient help for drawing and comprehension of tasks in technical drawing course at Harran University in Turkey (Fig. 3). This gave motivation impulse for the attempt to include augmented reality environment in spatial ability test experiment [2,3].

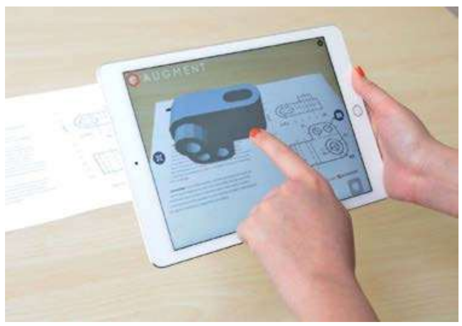


Figure 3: Combined overview of 3D model and its 2D images (technical drawings) in *Augment* application http://www.augment.com/portfolio-items/harran-university/

2. METHODS

Contemporary scientific methods of computer aided geometry here applied are based on 3D modeling principles in AutoCAD software (Obradović, 2015). Presentation of orthographic projections is based on Descriptive geometry and Technical drawings knowledge, necessary for all engineering professions. Actual cell phone applications, as advances in IT, are already standards for contemporary living style. In this paper *Augment* application for android technology based cell phones is applied. Although the application is initially aimed for the other purposes, the attempt to find some new possibilities for its usage was challenging. Visualization of 3D models by an AR application (previously generated in an adequate 3D modeler - software solution), is for sure one of the most interesting and innovative methodologies today. It is certain fact that such methodologies will find their place in educative process of young engineers (Veide, 2014; Veide, 2015).

3. RESULTS

The first idea of the paper was to reconstruct the existing test for spatial abilities - *Geometry 2D* and *3D*, available at https://docs.google.com/forms/d/1yWzioXuVMu8okx_eVwzVIg9mP, which contained relatively simple geometric models (Fig. 4). Test was created in specific working environment, containing several interface lacks: colored arrows without clear meaning, view directions written around circle and the edges of the object overlapped in axonometric representation (Fig. 4).

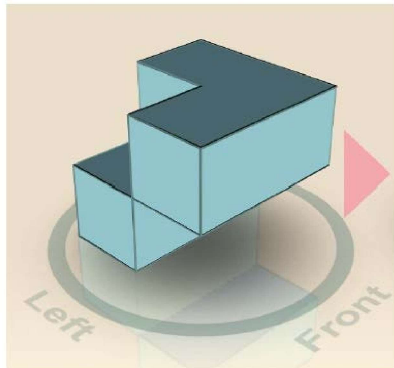


Figure 4: One of the images in the test - 2D and 3D geometry

For the purposes of the experiment, all objects-models from the original test were modelled in 3D AutoCAD's environment, mostly used by engineers (especially, in civil engineering and geodetic professions). It is a common solution that AutoCAD was used for education in Descriptive geometry, or technical drawings courses (Migliari, 2012; Dragović, 2017). Software enables creating serious and complex models of structures, along with materialization, although it is less used than other modelers (3D Max, Maya, Rhinceros, SolidWorks, etc.) for the photorealistic presentation purposes. 3D models from the experiment used a cube (edge size was 4 cm) as a *modul*, which enabled multiplication, "full & empty" combinations, successiveness in variations of models, often statically non-realistic (common edge of two neighbor cubes). The examples of 3D models created in *AutoCAD* software are shown in Fig. 5.

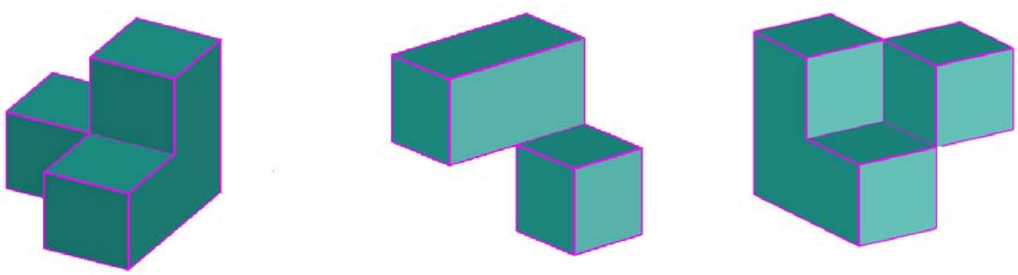
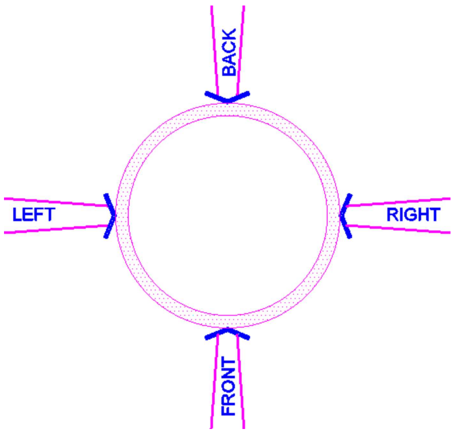


Figure 5: Exemplary 3D models from spatial ability test created in *AutoCAD* software

For the final visual design of the test, orientation matrix with arrows was created (Fig. 6) and each 3D model is set in desired position (Fig. 7), in order to recognize the viewers' site direction.



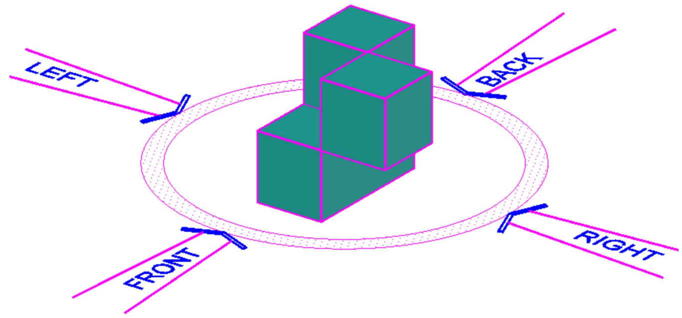


Figure 6: Orientation matrix **Figure 7:** 3D model setting inside the matrix

From the orthogonal projections of the models correct questions/answers were created (*view* palette tools in *AutoCAD*). *"Print screen*" option enabled creation of images, which were additionally processed in *Paint* application (Fig. 8), in order to be organized in the final test. The wrong alternatives were created by rotating/mirroring correct answers and by switching visibility of the edges. Models are colored, with highlighted edges.

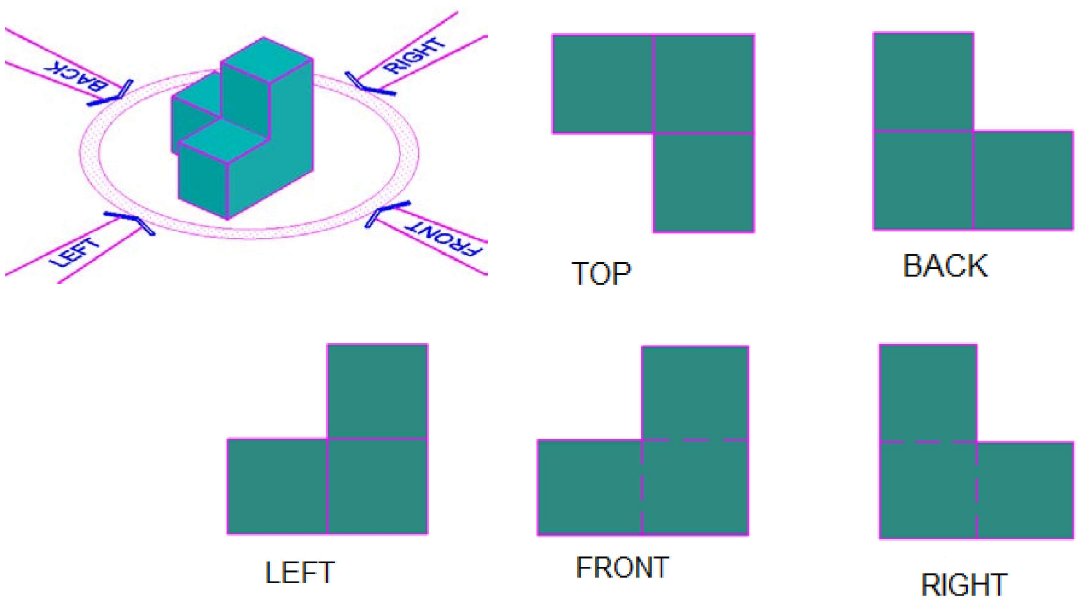
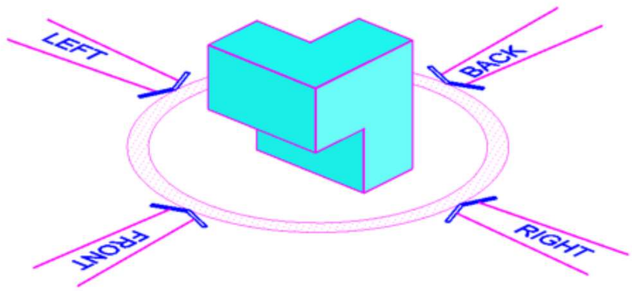


Figure 8: Representation of the 3D model and its characteristic views

Two types of tasks were given in the test: to recognize projection/orthographic view based on the axonometric image (Fig. 9a) and *vice-versa*, to recognize axonometric view based on projection /orthographic view (Fig. 9b).

1. Which of the pictures - 2D projection, matches the representation of the given figure that is composed of five identical cubes if it is viewed from above?



Circle only one of the answers given - 2D pictures from 1 to 4. Keep in mind that the edges that are not visible are presented with dashed line in 2D picture i.e. projection.

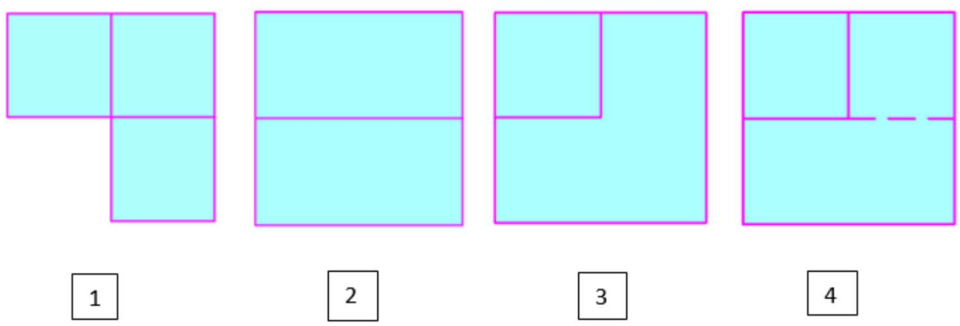


Figure 9a: Representation of the task: recognition of image (2D projection) based on its axonometric view (3D)

2. Which figure of the four given (1-4) fits the 2D picture shown. The figure is viewed from the left.

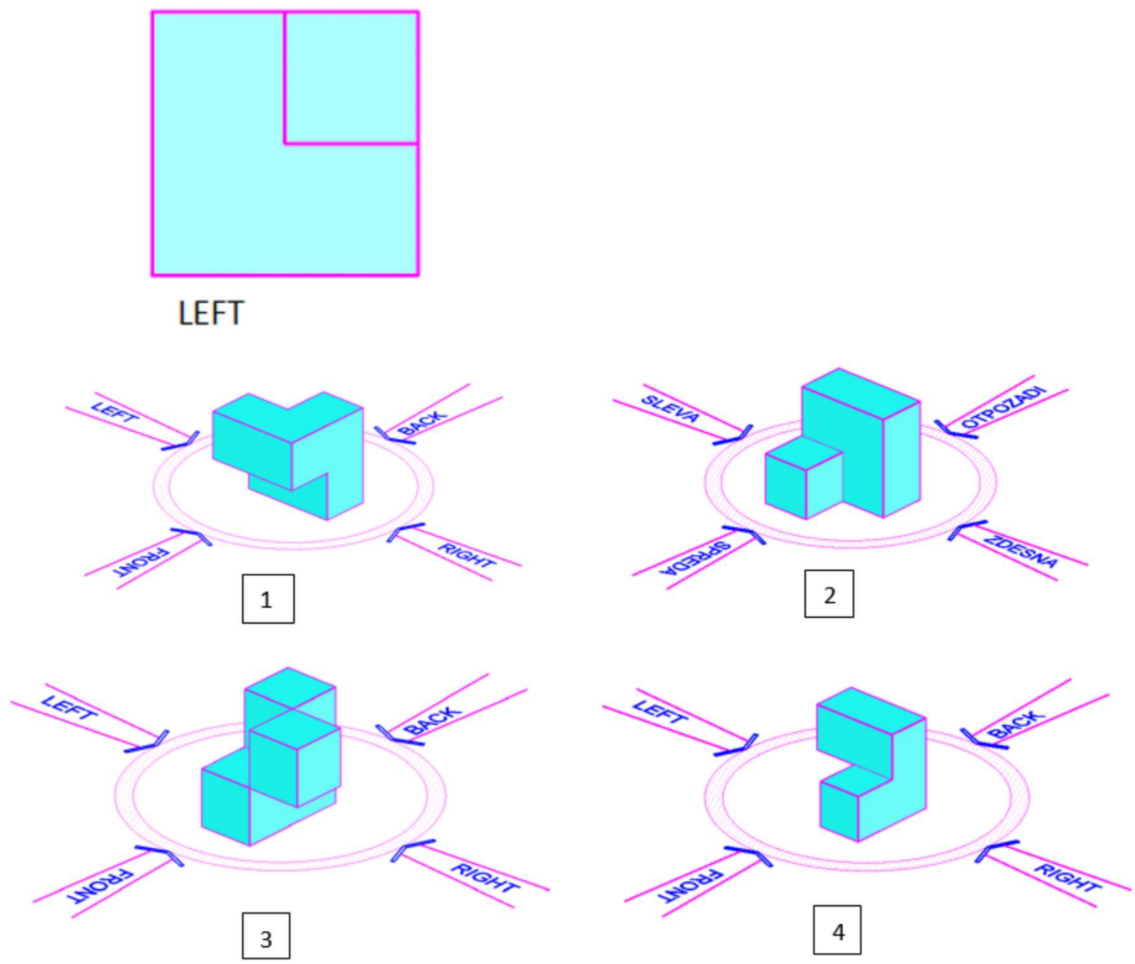


Figure 9b: Representation of the task: recognition of axonometric view (3D) based on its projection (2D)

The second idea was directed to visualization goals. 3D models generated in AutoCAD were meant to be imported in *Augment* application and examined the possibilities of an alternative presentation in the spatial ability test (by taking shoots of the models inside the application). 3D models were saved in appropriate file format (*.stl) in the modeler (*AutoCAD*) and than added to the library of models at Augments' web site. Application imports the model into real space where user can manipulate (rotate, move and scale) and view from different angles (Fig. 10). Photographs taken by cell phone camera could be used just for so-called "spatial" preview, because camera works in perspective regime. Any trial of getting orthographic projection is impossible, as shown in Figs.10b-c.

For an adequate usage in the spatial ability test, orientation matrix and the proper tracker was needed. During trial, the best results appeared when tracker had original Augment's design. Hence, inside the orientation matrix circular shape of the original tracker was inserted. (Fig.10)

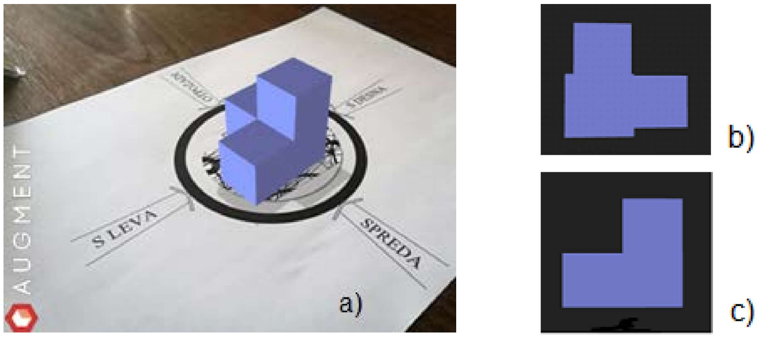


Figure 10: Photographs of the model in *Augment* application: a) perspective view, b) back view and c) front view

4. DISCUSSION

During redesign of existing spatial ability test in 3D computer graphic environment and its processing by contemporary tools and methods, discussion on the question: "What things have to be considered during design of a spatial ability test?" appeared. Several suggestions regarding investigation – test design focused attention to:
- graphic information of the software interface : only essential information should be given;
- setting of 3D model in axonometric preview;
a) non coplanar edges of the model should not overlap;
b) invisible parts of the model should not affect the right solution;
c) successive elimination of given solutions should give the right answer – one possible solution;
- neighbor surfaces should be in different color, or shaded;
- the edges should be accentuated;
- clear and exact instructions should be given in the textual part of the test; if necessary notes should be added.

5. CONCLUSION

Contemporary software solutions for 3D modeling significantly contributed the ease of spatial ability test creation. Tools for manipulation and characteristic views – projections enable efficient setting of 3D models. Simple commands with *layers* (switching off and on) allow efficient changes of an image appearance. Hence, methods and principles applied in presented paper could be recommended for future test designs.

The experience of working with *Augment* cell phone application was valuable and significant one. Some interventions on legibility of trackers should be done. Although the application is limited only to perspective views, it should be tested on its' potentials in improvement of visualization skills, as well as of spatial reasoning. In such context, the presumption is that adequate 3D library (storage) of geometric models, for educational purposes (especially for engineering students) could affect better adoption of geometric knowledge.

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