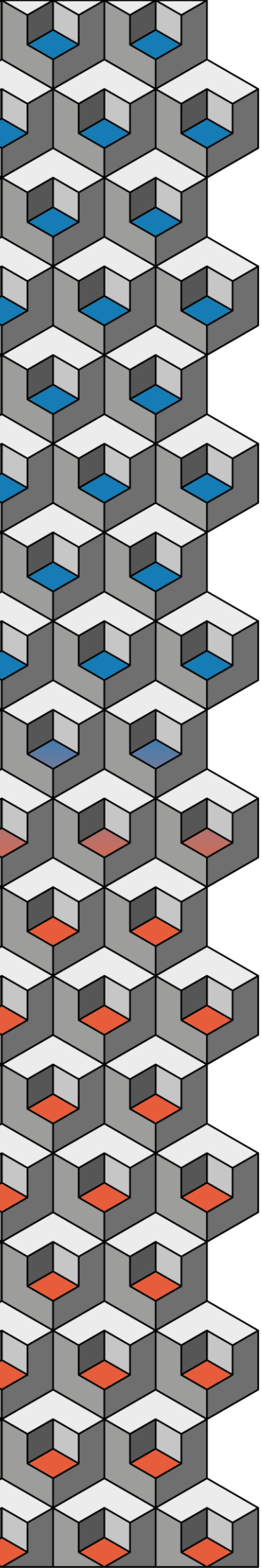

GEOMETRY, GRAPHICS AND DESIGN IN THE DIGITAL AGE

The 9th International Scientific Conference on Geometry and Graphics

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Editors

Ivana Bajšanski

Marko Jovanović

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Novi Sad, May 2023

Ivana Bajšanski and Marko Jovanović

MONG2023 Conference chairs

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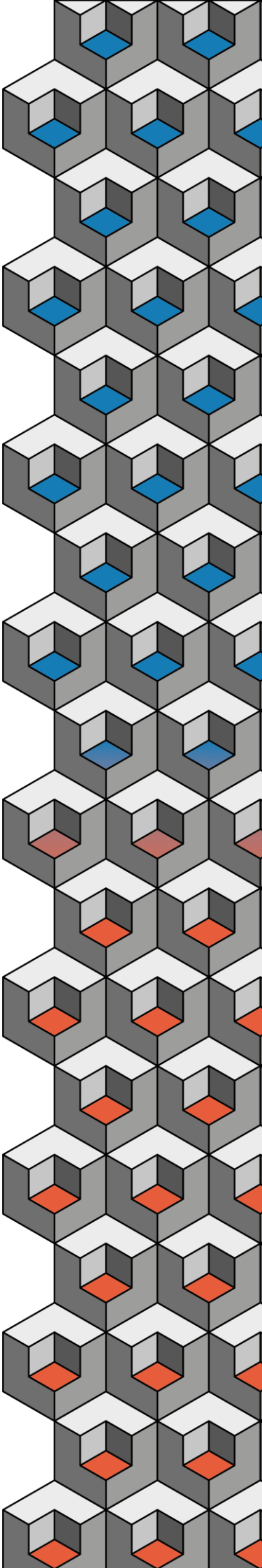

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ON THE OTHER SIDE OF MIRROR – A WORKSHOP ON INCORPORATING GEOMETRY OF MIRRORING IN ARCHITECTURAL PRACTICE AND APPLIED ARTS

Mirjana Devetaković[1*], Djordje Djordjević[2], Nikola Popović[3], Djordje Mitrović[4], Gordana Djukanović[5], Slobodan Mišić[6]

[1]University of Belgrade, Faculty of Architecture (SERBIA), mirjana.devetakovic@arh.bg.ac.rs
[2] University of Belgrade, Faculty of Architecture (SERBIA), djordje@arh.bg.ac.rs
[3] University of Belgrade, Faculty of Architecture (SERBIA), nikola.popovic.bk@arh.bg.ac.rs
[4] University of Belgrade, Faculty of Architecture (SERBIA), djordje.mitrovic@arh.bg.ac.rs
[5] University of Belgrade, Faculty of Forestry (SERBIA), gordana.djukanovic@sfb.bg.ac.rs
[6]University of Arts, Faculty of Applied Arts (SERBIA), slobodan.misic@fpu.bg.ac.rs

Abstract

The magic world of mirrors, their application, integration in interiors and exposure in exteriors, intrigues architectural designers and artists for a long time. Inspired with wide recent usages of mirrors in innovative architectural designs practice, as well as in arts, and grounded our understanding on well-known geometric/optic principles of mirroring, the authors conceptualized a Workshop that was offered to students of architecture, forestry and applied arts, as an extracurricular two-weeks activity.

After briefly introducing a historical/chronological overview of mirrors application in architectural design practice and applied art, relevant theoretical aspects of mirroring were demonstrated on the Workshop. The participating students were offered two possibilities for integration of mirrors in their design-outcomes: to experiment with analogue models and digital/computing ones. For that reason, a large amount of small glass mirror parts was provided. Also, functional parametric families of digital mirrors (planar, concave and convex) were developed especially for the workshop and offered on-line.

Particular foci of this paper are on both: the teaching methodology that was exclusively prepared for the Workshop, and specific usage of experimentation (to trigger unusual ideas and to utilize relevant familiar methods and procedural activities in the new – this context). In the discussion part of this study, a systematized overview of the Workshop results and its analysis from geometric and semantic point of view are given. The results are divided into: first interim critique, second interim critique and final submission. Through a generalization of conclusions, the lessons learned, namely, the level of subject-related geometric knowledge acquired from this unique teaching experience are reviewed, and an analysis of their possible applications in other pedagogic contexts related to geometry-teaching is presented.

Keywords: mirror, geometry, applied arts, architectural design, teaching methodology, multidisciplinary

1 INTRODUCTION

Although mirrors are usual and inevitable objects in our quotidian lives, their feature to reflect reality still intrigues scientists, artists, engineers, as well as ordinary people and kids. The nature itself is full of reflecting surfaces (lakes, ponds for example), representing natural mirrors, and it is really difficult to be sure when first people started to notice their reflective effects. It is estimated, however, that first artificially made mirrors date back in 6000 BC that is to say that the history of mirrors is 8000 years long [1].Nowadays mirrors are equally inspiring artists, cineastes, designers, as well as architects [2]. In media, mirror is used as a metaphor reflecting state of a society (newspapers Spiegel, Daily Mirror…). Mirrors are equally widely present in literature [3] and poetry [4].

1.1 MOTIVATION

In this study is examined an extracurricular Workshop [5] inspired by versatility and application of mirrors in architectural and urban design. The initiative for this Workshop started from the groups of academics teaching geometry of architectural form at University of Belgrade, Faculty of Architecture. Since the

mirroring represent just a small segment of the geometry curriculum, it was intended to enlarge the topic and to perceive it from other viewpoints, namely from the architectural design perspective.

Main goal of the Workshop was articulation of certain intent, i.e. communication of a defined message, by using mirrors in a selected space. The realization of the mentioned was considered possible by changing of perceptive experience of the space, highlighting some of its material and immaterial characteristics, or even usage of mirrors in a metaphoric sense. The students were offered the possibility to choose their own production method and ways of working according to their own affinities (analogue or virtual modelling).

The initial Workshop outcomes included:

a) acquisition of basic geometric knowledge in domain of mirroring

b) stimuli for continuation explorations in the domain

1.2 Research methodology

Methodologically, this research has been created as a qualitative study of the case, where the observed unit has been the realised Workshop. After briefly reviewing available published references, the Workshop has been described and analysed in detail, starting from the pedagogic context, trough the Workshop realization and knowledge acquisition, to the discussion and lessons learned section and conclusions.

The research results from this case study, could be generalized with a high certainty to similar geometry-related pedagogic experiments, combining geometry and design.

2 PEDAGOGIC CONTEXT

In this section we are comprehensively describing and analysing the context in which the Workshop has been realised.

2.1 Preparation and precedent research

The Workshop has been prepared for three years. The precedent research included collecting and processing various references related to:

- geometric aspects of mirroring [6] [7] [8]
- mirror production
- mirror application in art
- mirror application in interior design
- mirror application in architectural design [9] [10] [11]
- mirrors in urban contexts [12] [13]
- mirrors in BIM modelling

The preparation and research stage resulted in a four comprehensive lectures, introducing the participants with the main aspects of mirroring.

2.2 The Workshop approval and announcement

Prior to an announcement to the students, the Workshop program has been approved on all participating institutions, by three academic instances – Vice Dean for education, the Department of Architecture and entire Faculty. After obtaining necessary acceptances from the three bodies, the Workshop was announced on the three Faculties Web sites and students were invited to express their interest in participation.

The Workshop was also announced at the Faculties of Architecture, Forestry and Applied Arts, using analogue posters and mirrors reflecting the poster text and making it readable (Fig. 1).

A number of approximately 60 students send their applications to the Workshop Organizer and participating institutions and all the applications were accepted.

Fig. 1. Example of the Workshop announcement poster, exposed in the lobby of the Faculty of Architecture

2.3 Personal structure of the Workshop

The teaching staff involved in the Workshop consisted of the Workshop creators, supervisors and tutors. The Workshop creators were members of the Chair for descriptive geometry, of the Faculty of Architecture. The invited tutors were young academics from the University of Belgrade - Faculty of Architecture / Department of Architecture and University of Arts - Faculty of Applied Arts / Department of Interior Architecture and Furniture Design / University of Belgrade - Faculty of Forestry / Department of Wood Science and Technology.

The 60 participating students were divided into 10 groups. Majority of groups' members were architecture students, while each group included at least one forestry and one applied arts student. Establishing multidisciplinary groups was an organizing challenge, since the students from different faculties did not know each other. However, after an initial introduction, the students get to better know each others and become very motivated to contribute actively to their groups.

2.4 Technical support

The collaboration within the Workshop and communication with the teaching staff, was technically based on the TEAMS platform, provided by the Faculty of Architecture.

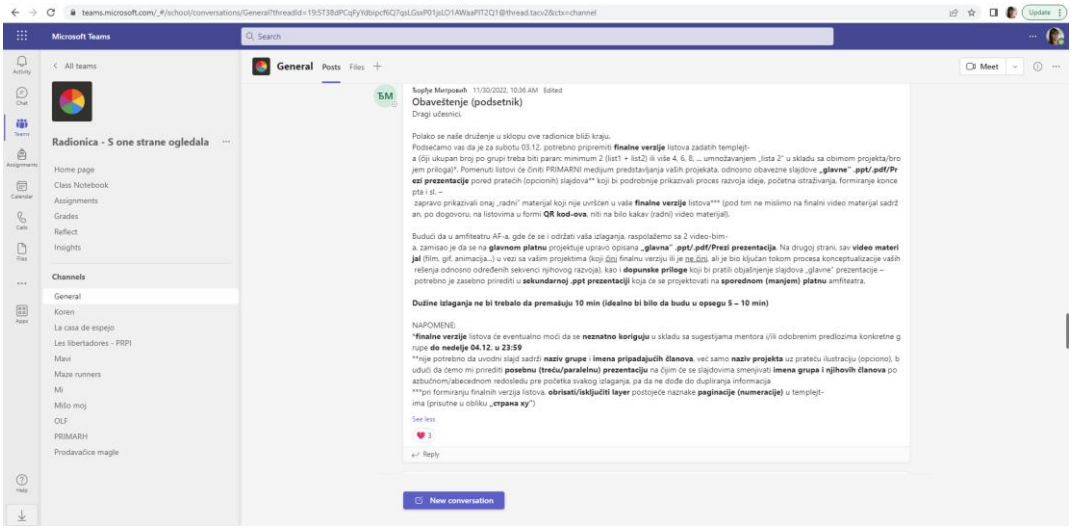

Fig. 2. The TEAMS electronic environment for communication within the Workshop

The TEAMS environment (Fig. 2) consisted of one General channel for communicating information relevant to all participants, and several channels especially created for communicating within the student groups, each of which had a different characteristic name. The general channel, as well as the group channels, had Posts and Files sections. While the Posts section served for exchanging short messages and reactions, the Files sections contained relevant documents.

2.5 Theoretical aspect of the Workshop

The theoretical aspect of the student workshop was provided in the detailed lecture overview of the history and classification of mirrors based on their geometric forms and the effects they produce. Through numerous examples of the use of mirrors in architecture and art, as well as video clips, students had the opportunity to familiarize themselves with flat, concave, and convex mirrors and to analyze them based on their effects. Additionally, the lecture included a review of the application of mirrors over the past twenty years through the analysis of spatial, light, and symbolic effects. The discussion with the students after the lecture stimulated their interest in further research on the topic and the use of mirrors in their future projects.

2.6 Empirical Analogue aspect of the Workshop

For the purpose of analogue modelling, a considerable amount of mirror glasses was obtained. In the initial stage of the Workshop the students were encouraged to test the mirroring effect by quick modelling, using the prepared material (Fig. 3).

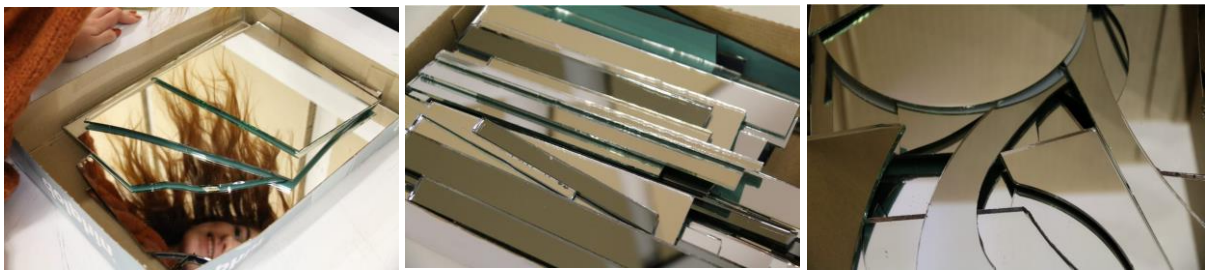

Fig. 3. The pieces of mirror glass prepared for the analogue modelling

After this initial stage, characteristic for the first day of the Workshop, it wasn't sufficient to work with mirror pieces only, and the students started to bring other materials, like cardboard and coloured paper, as well as other 3D objects, with aim to examine the effect of their reflection.

2.7 Empirical Digital / BIM aspect of the Workshop

The virtual modelling option was supported by a number of parametrized BIM families, modelled for the REVIT software. The students had opportunity to examine effects of concave and convex mirrors, parametrically changing their offset from the floor and radius. A range of flat mirrors were also provided, where the students could parametrically control offset from the floor, slope of the mirror, depth and width of the mirror frame, and other features.

Fig. 4. BIM family of concave mirrors. Examining different relations of the object and mirror

2.8 Photo documenting

All stages of the Workshop have been carefully and persistently photo-documented. The participating students signed their acceptance to be photographed and the photographs to be later used for the various Workshop reports, as well as for the final Workshop publication. The aim of the photo/documenting process was to illustrate the working atmosphere during the Workshop, as well as to record the creative processes that occurred within the student groups (Fig. 5).

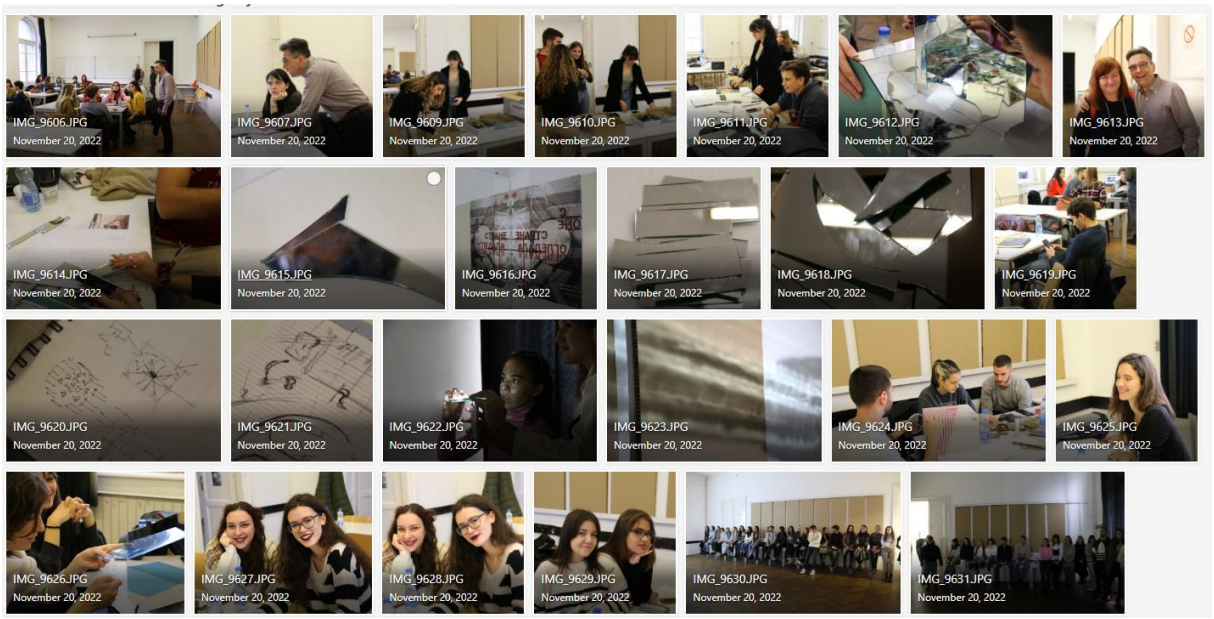

Fig. 5. Part of the photo documentation created during the Workshop

3 DYNAMICS OF THE WORKSHOP

The Workshop was planned to take two working weeks and three weekends, placed in the second half of the winter semester. The live sessions were organized during the three weekends, while the online working parts based on the TEAMS platform, took place during the work days.

In the dynamics of the Workshop it is possible to distinguish the following milestones:

- Introduction to the Workshop
- First interim critique
- Second interim critique
- Final presentation

3.1 Introduction to the Workshop

At the very beginning of the Workshop, all the participating students and the teaching staff gathered in the lecture space and the Workshop programme was introduced by the organizers. Then, an intro lecture was given, aimed at refreshing the students' geometric knowledge on mirroring and at giving new perspectives of mirror usage, predominantly in architectural design. Following fragment from the lecture illustrates the typology of mirrors, where it is possible to identify planar, concave and convex ones (Fig. 6). The presented typology is illustrated by various examples of mirrors applied in contemporary architectural practice.

Fig. 6. Fragment from the intro lecture – Typology of mirrors: planar, concave and convex, illustrated with the examples from contemporary architectural practice

Especially valuable and informative in the introductory part, was a chronological overview of mirror usage in architecture built in last two decades (Fig. 7).

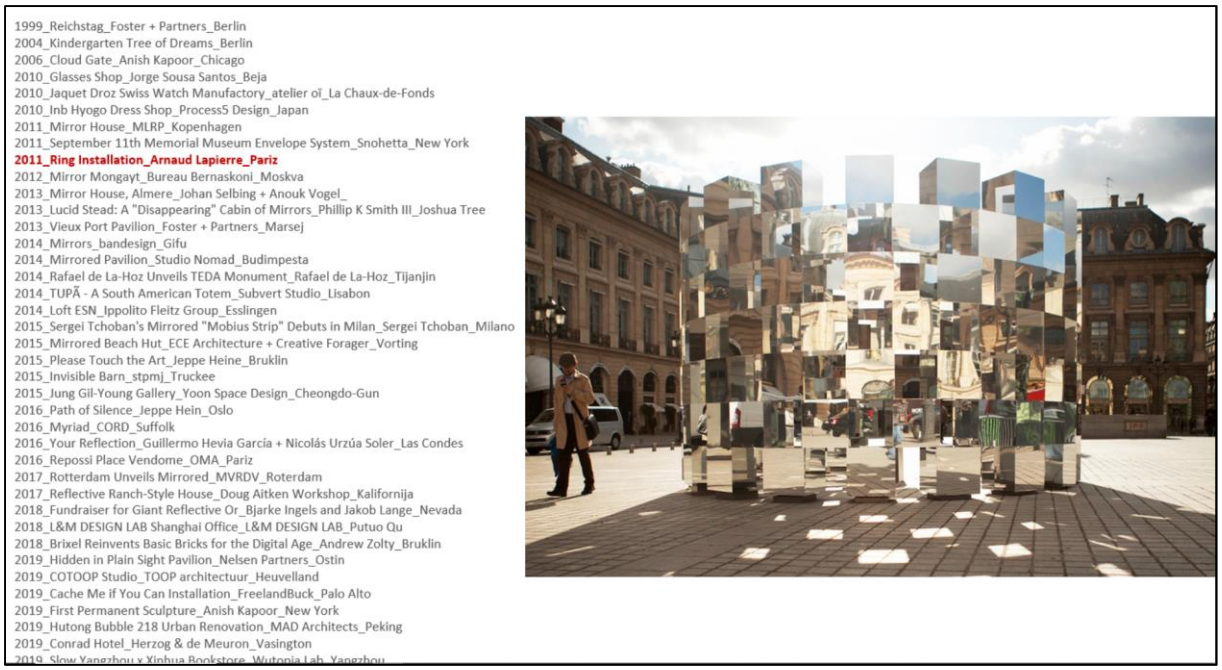

Fig. 7. Fragment from the intro lecture – A comprehensive chronology of architectural objects with mirror effects, in last two decades

After the intro presentation and a lecture on mirroring in architecture, urbanism and arts, the students went to the studio space where the groups were constituted. A requirements for a group constitution was to include students from at least two participating faculties, ideally all the three.

The creative process started almost instantly, since the students were curious to examine the mirroring effects using the analogue pieces of mirrors provided by organizers. After initial play with the material given, the students were asked to begin conceptualization of their projects in which they had to apply mirroring effect.

The stage of conceptualization was find critical in the process of obtaining later results, so this stage was guided by tutors and supervisors with a particular care.

3.2 First interim critique

The first interim critique took place at the end of first Workshop weekend. At that point students were encouraged to externalize their initial thoughts and ideas.

The interim critique was organized in the lecture space, in a plenary way. The students presented as groups and were quite excited and motivated to persuade audience of their follow colleagues in the creativity, technical aspect and social engagement of their initial ideas. During the presentation, on a way, they inspired each other.

For the Workshop organizers and supervisors this point was very important in terms of predicting further steps to achieve successful results of the entire project.

3.3 Second interim critique

After the success of the first interim critique, the organizers and supervisors decided to run an interim critique during the second weekend gathering. The second interim critique pointed out well developed students ideas and the projects in progress. The students demonstrated a well-developed motivation to succeed with their projects. The student groups that initially had several different concepts, in this stage have chosen one idea to transpose into a final project.

During the second interim critique, the tutors had an opportunity to give a range of constructive suggestions to the student groups and to encourage them to be even more productive in the final stage,

After this critique, the students documented their results and uploaded various documents on the TEAMS platform.

3.4 Final presentations

The final presentations occurred the last weekend of the Workshop. The students demonstrated a high motivation and a strong excitement while presenting their final projects. Despite the fact that all the time they were guided and supervised by their assigned tutors, the final presentations of their particular projects were, on a way, positive surprizes for the entire teaching team.

The presentations were based on final submissions, for which the students were given a specially prepared template. This method of the Workshop knowledge codification helped a lot in the process of gathering and final publishing the obtained results (Fig. 8).

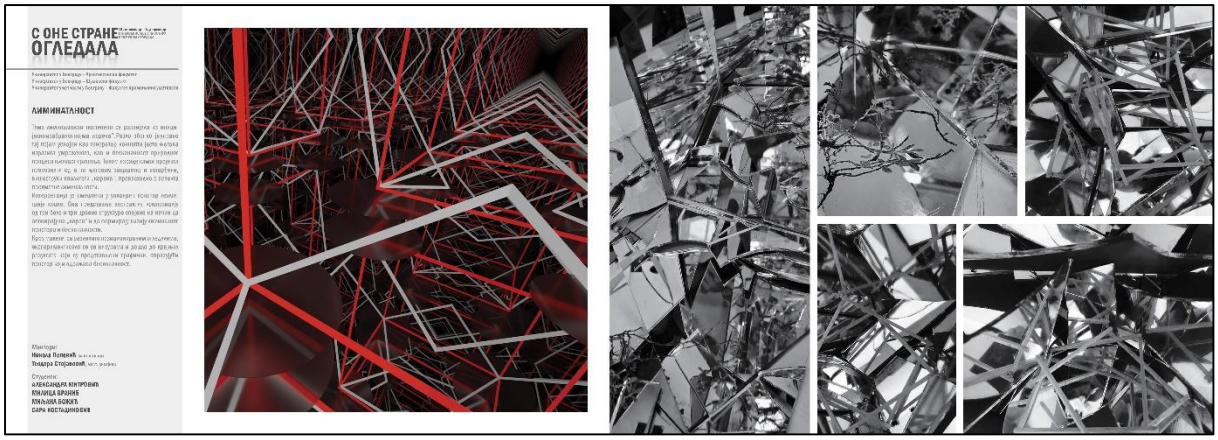

Fig. 8. The project titled "Liminality" – final submission, fragments

4 DISCUSSION OF THE WORKSHOP RESULTS

Prior to the realization of the presented Workshop, a serious and deep initial explorations were performed. They resulted in the carefully prepared series of lectures that introduced the students to the geometric aspects and comprehensive problematics of mirrors application in architectural design.

The Workshop attracted a significant number of students, very motivated to dedicate extra time and to work effortlessly during the extensive Workshop period. The intention of organizers to stimulate creation of multidisciplinary groups gave excellent results. After the first working weekend the groups demonstrated considerable coherency and creative spirit.

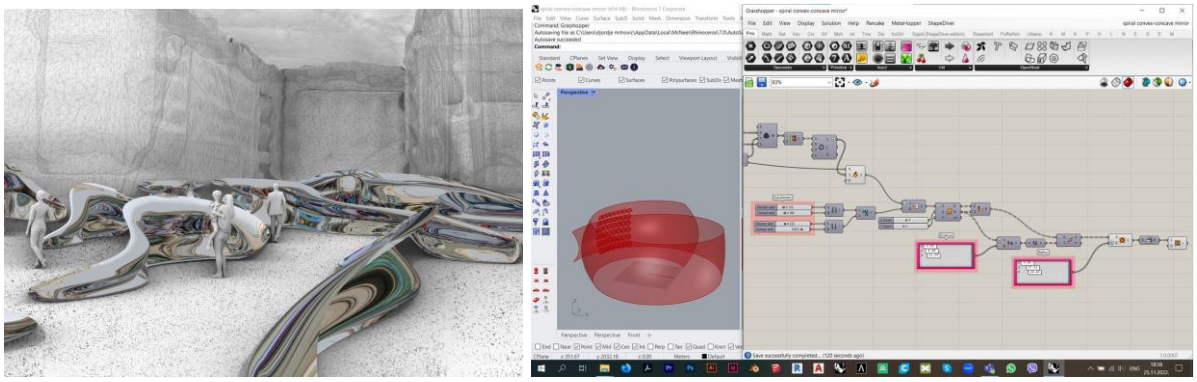

Fig. 9. The project titled "Personality Outline" – working documents

The preparation activity that included providing analogue mirror pieces, has been found especially effective, since it improved a tactile feeling of the material. In addition to the mirror pieces, the students included many other additional materials and objects, with aim to explore the mirror reflective features.

4.1 Review of final projects

The Workshop resulted in eleven projects (Fig. 8 – 17), varying in design approaches, understanding of mirror usage, presentation technique, even social and environmental protection engagement.

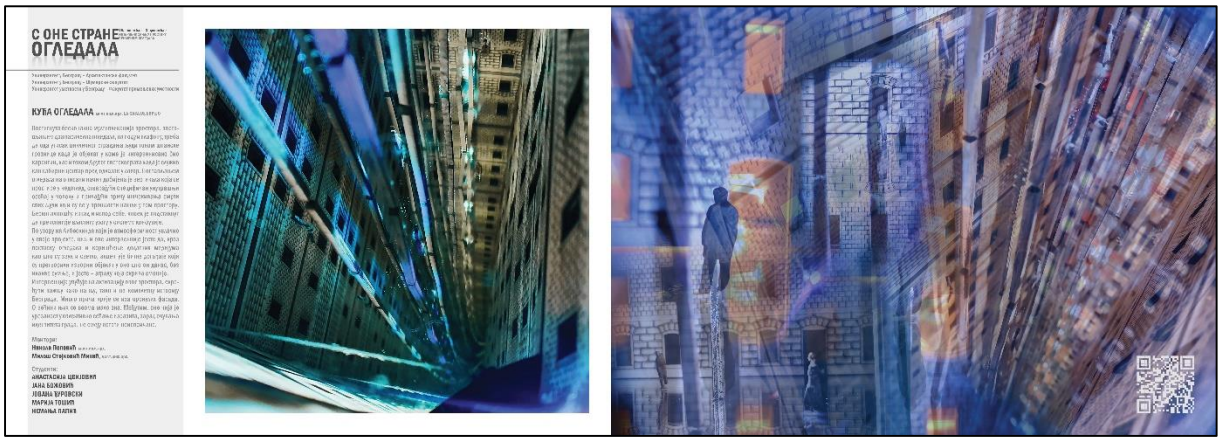

Fig. 10. The project titled "La casa de espejo" (The house of mirrors) – final submission (fragments)

Many of the projects considered the cityscape of Belgrade, as the environment to be reflected by the designed mirror installations (Fig. 9, Fig. 10, Fig. 13, Fig. 14). It is indicative that students who decided to install the mirrors on the selected points of the city, spent some extra time out of the classroom, exploring the best positions for their mirror-installations. Some of the projects aimed at improving the cityscape relied on parametric freeform design (Fig. 9), while the others applied large flat mirrors, reflecting particular ambient of buildings (Fig. 10).

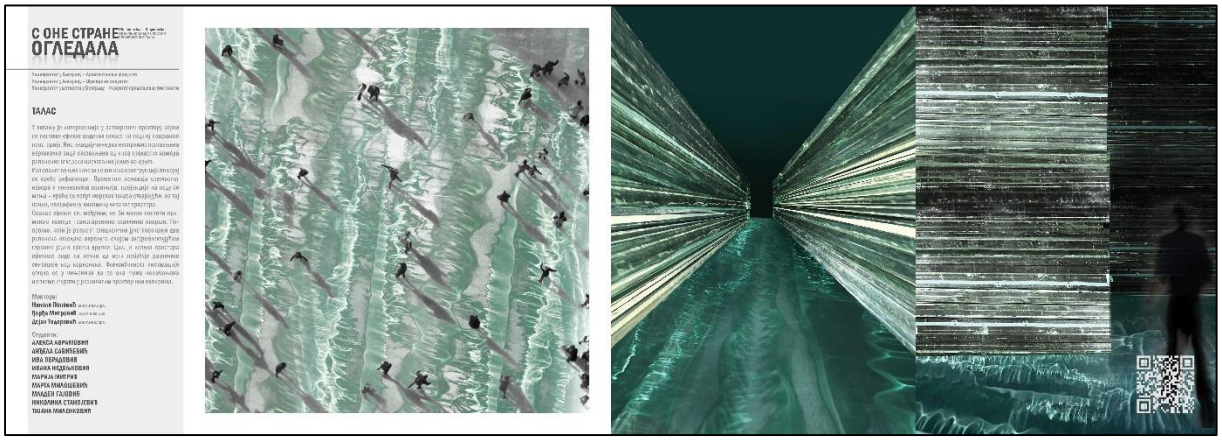

Fig. 11. The projects titled "Wave" and "Wave.ext" – final submissions (fragments)

The projects like the ones at the Fig. 11, titled "Wave" and "Wave.ext", relied entirely on the analogue pieces of mirrors and additional material, superimposed to the mirrors. Presentation of such a project relied partly on video sequences examining reflections of light in space, and partly on analogue model.

Fig. 12. The project titled "Adventures in the Wonderland" – final submission (fragments)

In the project above (Fig. 12) authors created whole little virtual world, inspired by the usage of mirrors in literature and computing games. The project was entirely computer modelled.

Fig. 13. The project titled "On which side if the mirror?" – final submission (fragments)

The students from the group called Mi (Fig. 13) decided to intervene in the plain centre of Belgrade, proposing a spherical mirror installation, interacting equally with the well-known urban environment and passing by people. The technique applied in the project was computer modelling.

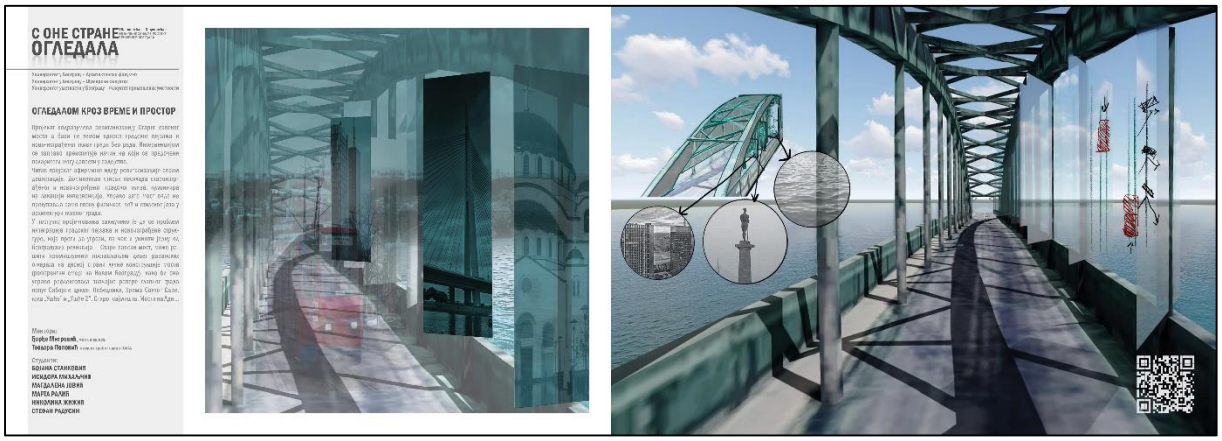

Fig. 14. The project titled "By mirror through time and space" – final submission (fragments)

The group proposing the project titled "By mirror through time and space", decided to use huge urban mirrors, to draw public attention to the viewpoints of the city from the old bridge, and that way to protect the bridge from the intended dislocation (Fig. 14).

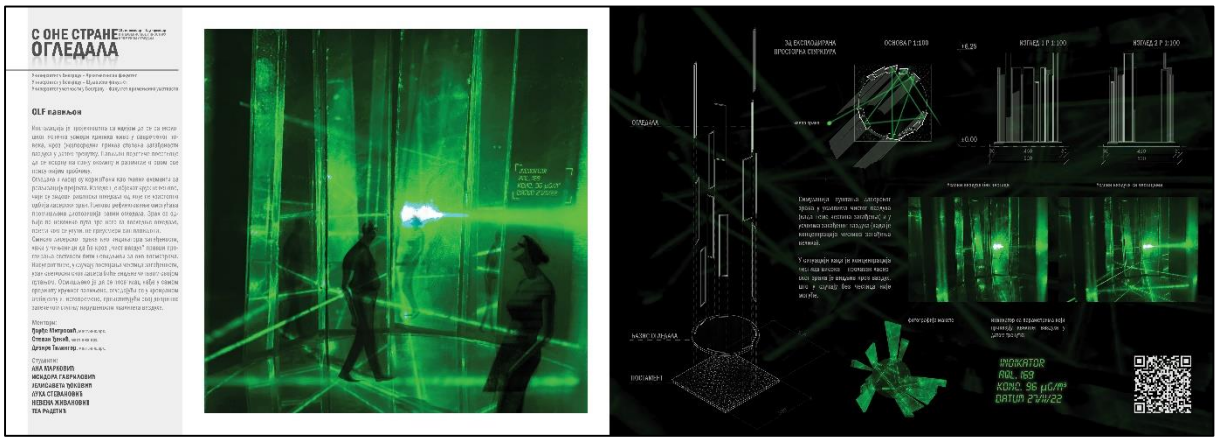

Fig. 15. The project titled "The Olf Pavilion" – final submission (fragments)

The project signed by the group OLF (Fig. 15) represent the space consisting of multiple mirrors in which a person experiences its many reflections and particular lighting effects.

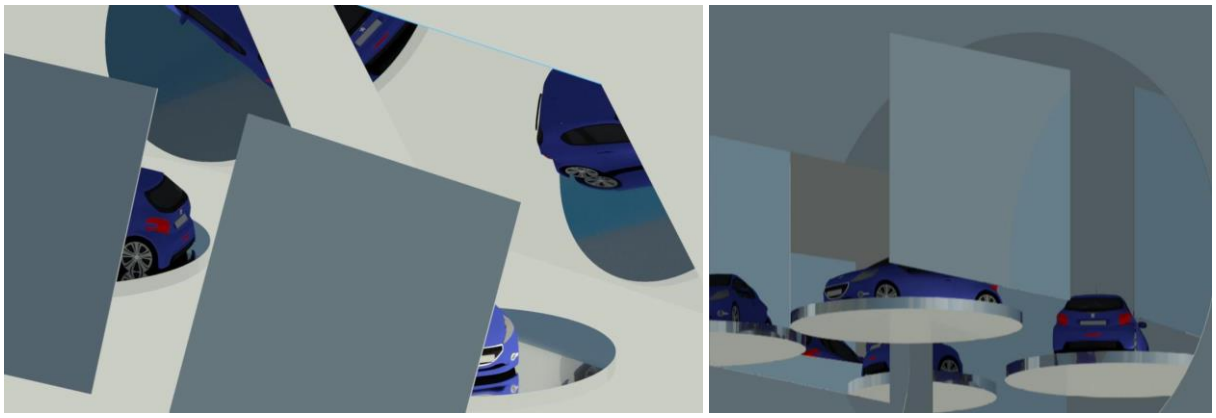

Fig. 16. The project titled "Primarh" – working documents

The space designed in the project titled "Primarh" (Fig. 16) is another computer generated ambient, aimed at being used in commercial auto industry. Equipped by several carefully positioned flat mirrors, it allows a customer to admire the desired car from many unexpected perspectives.

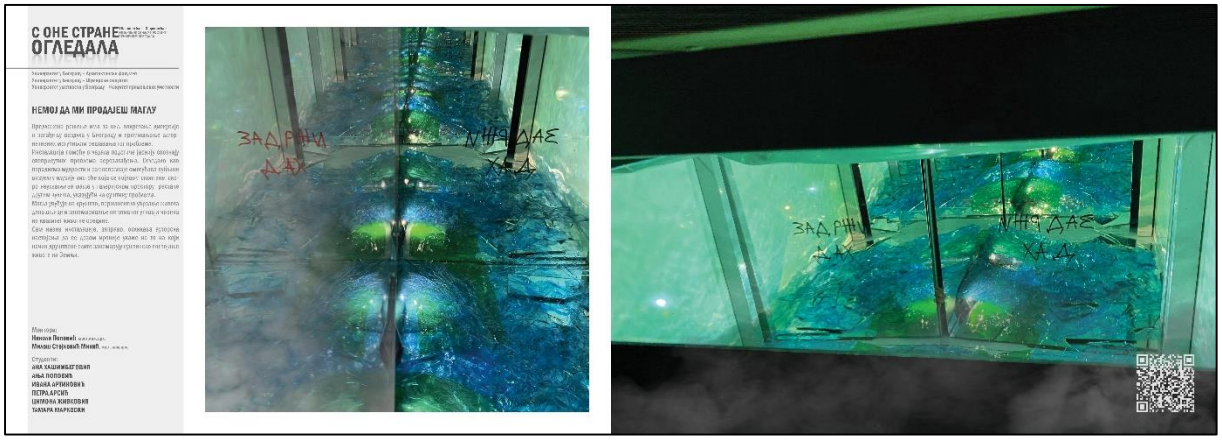

Fig. 17. The project titled "Don't sell me the fog" – final submission (fragments)

The project proposed by the group Fog Sellers (Fig. 17) uses mirrors to draw a social attention to the problems of air pollution. This project has been done as entirely analogue, photographing mirrors superimposed to other relevant materials.

4.2 Application of multimedia

Apart from producing documents according to Workshop requirements, the students unexpectedly demonstrated significant skills in video production, resulted in video material supporting the final submissions. In the case of some groups, using video materials were primary field of explorations, in both initial design stages and final submissions. All the final video-material is made available to the audience via creation of QR codes of links to the YouTube addresses, which have been included in the final graphical submissions organized according to the given Workshop template (Fig. 14, Fig. 15, Fig. 17).

4.3 Electronic publication

Finally, an electronic publication containing all relevant Workshop data and all final submissions is prepared by the organizers. Existence of such publication and inclusion of all students' projects, will be a huge reward for all participants, equally organizers, supervisors, tutors, students, as well as to participating institutions. Advantages of electronic publications are numerous, like low production costs, unlimited number of pages, quick and easy sharing through institutional Web sites and social networks, as well as efficient access by potential national and international audience.

4.4 Lessons learned

Many important lessons have been learned from the presented case. The Workshops need to be carefully prepared and planned. The milestones, like interim critiques, need to be set and for each Workshop stage the participants need to be asked to externalize (document) actual stage of their project. Supporting virtual environments need to be well structured and easily accessible to all participants. A form of the final submission needs to be precisely defined and designed. After the Workshop duration, a considerable amount of time and energy is needed for reporting and a finalization of the Workshop results. Lastly, a questionnaire needs to be prepared for the participants, to give them a chance to evaluate overall project and to express their opinions.

5 CONCLUSIONS

Based on the presented case study it is possible to conclude and generalize that organization of extracurricular activities for senior students, is very demanding, yet extremely rewarding activity. Firstly, a topic selected need to be inspiring enough for the teaching staff and attractive for participants. Secondly, a solid base of knowledge on a selected topic needs to be collected prior to such activity is announced to the potential participants.

The examined educational experiment clearly indicates that, based on well selected geometrical topics, it is possible to obtain a wide variety of valuable results. In this case the results range from pure design implementation of mirrors, to reflecting serious sustainable issues, from business advertising usages, to urban mirroring installations.

An analysis of the electronic learning environment applied, suggests that the knowledge externalized during the Workshop, could be more codified, i.e. structured and organized, so that it better serve as a Workshop archive, long time after the experiment took place.

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