

THE ART OF ORIGAMI PROMOTED WITHIN THE FRAME OF DESCRIPTIVE GEOMETRY

Abstract: This paper approaches the role of Origami Art role in teaching Descriptive Geometry to students, future builders. Using the Art of Paper Folding in the application classes of Descriptive Geometry, we demonstrate that the acquiring of knowledge and skills in educational practice is complemented by the development of creativity, imagination, Aesthetics and team spirit. Origami turned into a source of inspiration for first-year students majoring in Civil, Industrial and Agricultural Construction to build a demountable assembly made of modular origami elements. The element is a modular triangle, made from a rectangle with a side ratio of $1:\sqrt{2}$ known as the "Harmony Gate". The construction is original and executed on several levels, from white and colored A4 paper, whose density equals 80 g/m^2 . The number of origami elements used is calculated by a mathematical formula.

Key words: Origami, team, project, originality, record.

1. INTRODUCTION

Traditional Japanese arts are a fascination for Westerners. Let's remember: Ikebana – the art of floral arrangements, with the most popular schools of Ikebana Ikebono, Sogetsu and Ohara; Origami – the art of paper folding, chanoyu – the tea ceremony.

Origami (written in Japanese as 折り紙 *origami*, folded paper) is the art of folding colored paper into patterns that express a rich imagination, but also traditional forms with flowers and fauna. [4]

There are many styles of origami, simple compositions with patterns formed from a square of paper without using glue, or complex compositions made up of several origami units. Various types of paper can be used, from thin to thick, as well as magazine tissue or wrapping paper.

Although the Japanese love asymmetry, the art of origami exhibits symmetry.

Etymologically, the word origami (of Japanese origin) is made up of "oru" which means "to fold" and "kami" - "paper", so "folded paper". The notion of origami has been used since 1880, until then the art of paper folding was called orikata. [5]

It is not known exactly where the art of origami started: in China or in Japan. There is a version that in China, immediately after the invention of paper, approximately the first century of our era, the first models of paper folding were made and that this craft was taken to Japan by Buddhist monks. Origami was originally a paper folding technique for various rituals of folding flower offerings to the gods.

The modern art of paper folding owes its existence to the origamist Akira Yoshizawa (1911-2005), considered to be the Master of Origami, the most influential and prolific Japanese origami artist of the 20th century, who created more than 50,000 designs.

The development of the art of origami in the modern era in the West began in 1945.

In Romania, the art of paper folding is found in pedagogical disciplines for skill development, neglecting the spiritual side that it promoted at its origins.

2. EDUCATION THROUGH ORIGAMI

Origami contributes to the development of the individual psychologically and educationally.

Psychologically, it is a creative and comforting activity, even considered art therapy. This art cultivates the aesthetic taste for beauty and symmetry, for utility and creativity. [6]

Among the many benefits brought are: the development of self-confidence - because they realize that they can achieve wonderful things, self-esteem - seeing how beautiful their work turned out, but also patience, communication - because during their work they share various experiences, the development of fine driving skills and last but not least creativity.

Educationally, it is practiced with great pleasure in educational institutions, but it is also practiced with real interest by different people in their free time, as a hobby, who invest time and passion in origami pieces to create real works of art.

In education, origami is used by teachers or educators as a method to develop children's creativity, to relax, to learn new things, to develop skills and competencies and even to stimulate logical thinking, necessary for a harmonious development and development of respect and responsibility towards nature by raising awareness to use paper differently by recycling. [7]

This method used in education will improve the activity of the two cerebral hemispheres and develop memory, imagination, hand-eye coordination, fine motor skills, making an important contribution to the development of those who practice the art of origami.

3. STUDENT PROJECT FOR THE DISCIPLINE DESCRIPTIVE GEOMETRY

3.1 Project theme

The team of student volunteers who participated in this project started in Oct. 2017 proposed the construction of a paper tree folded according to the model used in the art of origami, to compete for the title

of "Tallest paper tree" and to enter this performance in the Guinness World Records.

The students' proposal is considered viable by the teaching staff considering that the art of origami uses the basic elements of Descriptive Geometry, the discipline within which this team project is developed, i.e. points, lines, angles, surfaces. Student volunteers thus develop their ability to construct, observe, formulate, measure, analyze, approximate, verify, calculate, create and enjoy their own work. They also benefit from all the educational and psychological aspects explained above. By participating in this project, students will learn to pay attention to details and improve their orientation in space, precision, dexterity, concentration, and be more disciplined.

3.2 Establishment of working groups

The activity was continued in 2018, 2019, 2022 and 2023, in the months of October-November by 4 more teams, in total approximately 250 volunteer students, from the CCIA, AR, ITT and TCM specializations from the Faculty of Mechanics in Craiova, Romania.

These teams worked at home or at the college in the Library, lecture halls and in the last year, 2023, when a much larger work surface was required, work was done in the Faculty Exhibition Hall.

The teamwork helped the students to achieve the final goal with the exercise of the specific roles of each member of the team on hierarchical levels [3]. This transversal competence promotes the spirit of initiative, dialogue, cooperation, mutual respect, diversity [2].

Each year, the volunteer student teams were also led by students who got involved in learning and assigning workloads and solving the errors that inevitably occurred.

The workload has increased from year to year. The diversity and variety of solutions created a positive, motivating affective climate. Each member of the team enjoyed the support of the others.

3.3 Organization of work teams

Teamwork stimulated students' creativity, while simultaneously developing other skills essential for success, such as the ability to communicate effectively, solve problems or learn continuously. Although each team member had a well-defined role, the transfer of knowledge and work where needed at a given time was a recommended and effective process within each work team [1].

The teamwork generated a high degree of efficiency in meeting the objectives and ensured the completion of the project on time.

Various informational exchanges took place between the team members, and each student's experience had a valuable contribution to the achievement of the common objective.

Along the way, new students came. They were attracted by the novelty of the activity and were helped to integrate quickly and efficiently.

Communication was essential for the optimal functioning of the work team.

Communication was a priority for both team members and teaching staff, encouraging a positive working environment.

To encourage communication and information exchange, brainstorming sessions and free discussions were initiated, encouraging each student to express his opinion and provide information about any difficulties encountered in the work process.

Although we worked with 5 teams of students, in 5 years, some of the students even worked for 2 years, transmitting from their experience working methods, harmony in the team, the purpose of the project, enthusiasm, ways of developing new skills and knowledge. Everything was based on the interaction between the members of the new team and the old team, on communication, trust in the goal, the desire to learn something new, to pass on knowledge, to turn the complex process of teamwork into a great success. [8]

The organized teams interacted in the following activities: folding the origami elements, joining them in rosettes, building the metal skeleton mounted inside the tree with the base plate, mounting the rosettes one on top of the other and decorating the tree with origami ornaments.

One can see below images from the five years of activity, about 10 months of work, Figure 1 – Figure 6.



Figure 1 The activity developed for the tree in 2017.



Figure 2 The tree in 2017 – 0.80m high.



Figure 4 The tree in 2018 - 1.80m high.

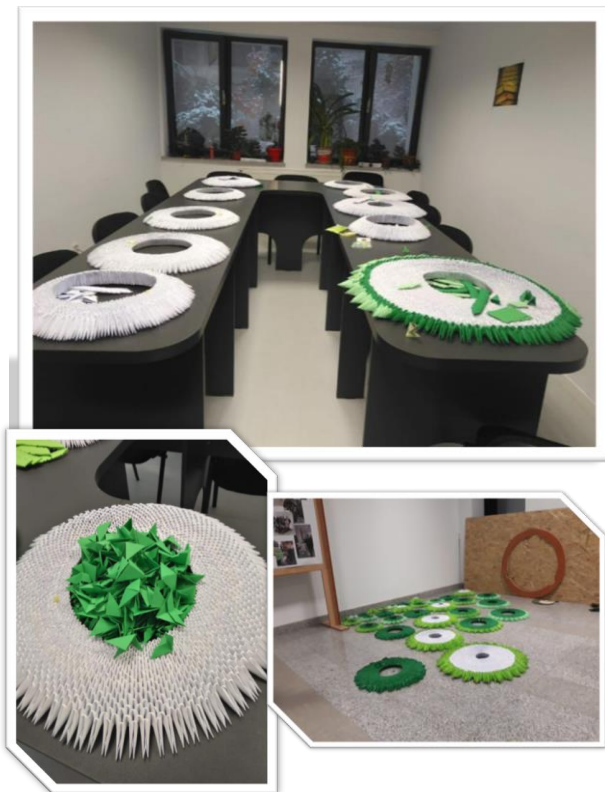


Figure 3 The activity developed for the tree in 2018.



Figure 5 The activity developed for the tree in 2019.



Figure 6 The tree in 2019 – 3.40m high.

3.4. Completion of the student project "The tallest paper tree" for Guinness World Records

The year 2023 marked the inauguration of the UCV (University of Craiova) brand tree, when students from the Faculty of Mechanics in Craiova installed it in the Aula Magna hall of the faculty, Figure 7.



Figure 7 The tree in 2023 - 4,4m high and 1,44 m diameter.

The activity submitted by the students in 2023 is highlighted in Figure 8.



Figure 8 The activity developed for the tree in 2023.

Aspects of the stages of raising the tree are shown in Figure 9.

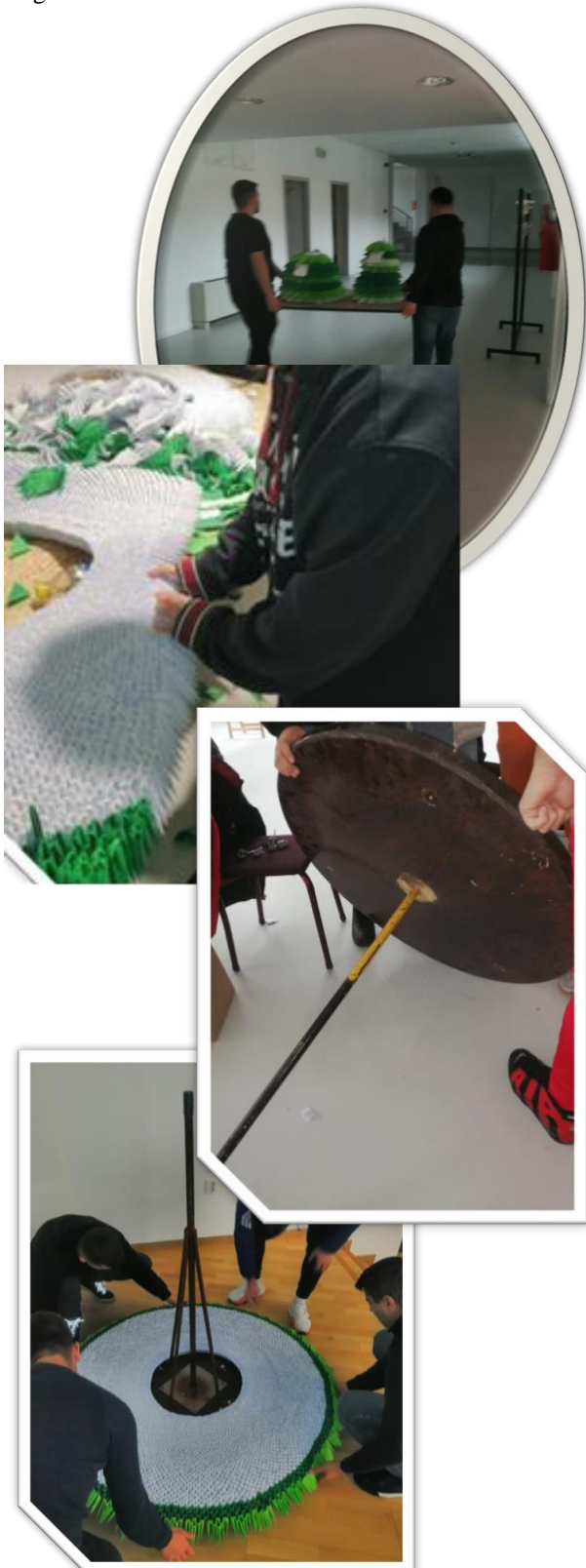


Figure 9 Phases of the execution of the tree, 2023.

Description of this assembly:

- Folded paper tree made of modular origami elements, Figure 10.



Figure 10 Modular origami element used in the project [5]

- Demountable assembly (no glue was used)
- Fir tree height with top: 4.40 m.
- Total number of elements: 269.208 (61.284 small elements - 8 rectangular elements were cut from an A4 format and 207.924 large elements - 4 rectangular elements were constructed from an A4 format). All the elements were precisely cut with a laser.
- The element is a modular triangle, made from a rectangle with a side ratio of $1:\sqrt{2}$ known as the "harmony gate". The steps of folding the modular triangle are shown in Figure 11.

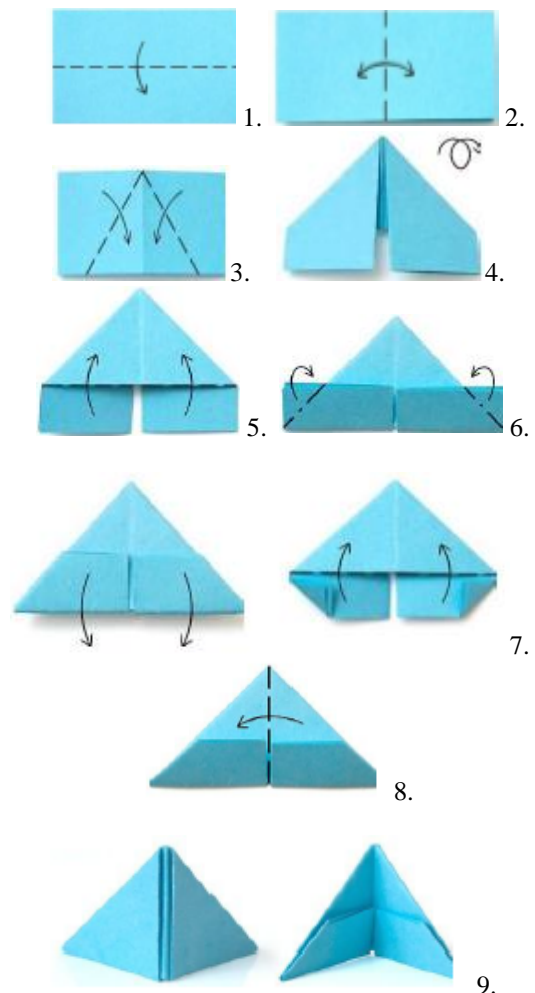


Figure 11 The stages of folding the modular triangle. [5]

- Material: white/coloured, new/recycled paper with a density of 80 g/m^2
- Total number of A4 paper tops: 119.283
- Total paper surface: $3,719.84 \text{ m}^2$
- Total paper weight: 297.587 kg

- Total number of rosettes: 102. The rosette represents each floor of the tree built by demountable joining of modular origami elements.
- Number of modular origami elements for each "i" rosette, calculated with the mathematical formula:

$$N_i = 3(i + 2)^2 + 9(i + 2) + 6 \quad (1)$$

where "i+2" represents the number of rows on the rosette.

- Total number of modular origami elements for "m" rosettes N_{Tm} is calculated with the mathematical formula:

$$N_{Tm} = \sum_{i=1}^m N_i \quad (2)$$

- The smallest rosette has 60 small origami elements and a diameter of 0,01m
- The largest rosette has 7.956 large origami elements and a diameter of 1,44m
- Unique. "The current record for the tallest origami Christmas tree is held by Singapore, with a creation 2,18m high and 1,77m in diameter." Figure 12 [9].



Figure 12 Current World Record. [9]

4. CONCLUSIONS

- Origami offers mental and emotional benefits; it is a therapy through art being a method of relaxation; strengthens the power of concentration; develops logical thinking and creativity; improves hand-eye coordination and sense of beauty; stimulates motor skills.
- Volunteer students of the Faculty of Mechanics at the University of Craiova, built a paper tree, which surpasses the current tree considered the world's height record.
- Construction is a project that promotes the art of origami in the Descriptive Geometry discipline.
- The project was carried out through teamwork, which created a friendly work environment with high productivity.
- The final result could not have been achieved by individual effort.

- The art of paper folding is part of the pedagogical disciplines that develop the skill, but it also has a spiritual side.
- "In Japan, it is considered that the object made of paper, unlike the one made of stone, is perishable and cannot serve eternity. The life of paper with the shape it wears is fleeting, it creates only a moment of aesthetic joy, beyond which only the memory of the essences is preserved. What the art of paper folding loses in duration, it gains in the intensity of aesthetic experience." [10]

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