Bulletin of the *Transilvania* University of Brasov
Series II: Forestry • Wood Industry • Agricultural Food Engineering • Vol. 18(67) No. 3 – 2025
https://doi.org/10.31926/but.fwiafe.2025.18.67.3.4

ECO-FRIENDLY OBJECTS, FURNITURE AND LIGHTING FIXTURES MADE OF RECYCLED WOOD AIMING AT THE PROMOTION OF ECO-FRIENDLY PRACTICES SUCH AS CLOSED-CYCLE ECONOMY SYSTEMS, WHILE FOCUSING ON THE ENERGY EFFICIENCY OF THE INTERIOR SPACE

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Abstract: *The article presents a theoretical and practical study focused on energy efficiency in interior, urban, and rural spaces through the reuse of recycled wood and the application of innovative and sustainable solutions for designing furniture and lighting objects. The study outlines fundamental concepts and research perspectives regarding the need to reduce the use of primary wood, a process aimed at minimising global deforestation and the degradation of natural ecosystems. The paper also examines eco-friendly objects – furniture and lighting pieces – crafted from recycled wood, which combine both aesthetic and functional values and can be integrated into various types of interior spaces, whether residential or non-residential. These design concepts were developed by architecture students within the Architecture of Interior Space course (fifth year, integrated studies), respecting the principles of the circular economy. The projects aim to reduce waste and extend the lifespan of products, while promoting national and European policies of sustainability and energy efficiency in the architectural field. Furthermore, the article highlights the contexts in which the Republic of Moldova can benefit from the support of the European Union in implementing sustainable development initiatives. These include projects and recommendations targeting environmental protection, energy efficiency, and the promotion of eco-conscious educational practices. The research emphasises the dual role of such initiatives: to provide innovative design solutions and to strengthen environmental responsibility within architectural education and practice.*

Key words: *energy efficiency, recycled wood, sustainable design, circular economy, eco-friendly furniture.*

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1. Introduction

One of the major challenges facing humanity in the 21st century is the need to improve the ecological state of the Earth. The exponential growth of demands for comfort and the rapid development of contemporary society directly influence the excessive use of natural resources, leading to ecosystem degradation, climate change, and rising global temperatures. This concern has become increasingly pronounced and has prompted us to conduct numerous scientific studies [4, 5, 10-15] and educational activities through the development of multiple design and architecture projects focused on environmental protection which, in our view, have become priority objectives not only for the socio-cultural and economic environment but also for higher education institutions in our country. These institutions are centred on promoting ecological principles and integrating them into the professional training process, aligning both with the Education 2030 Development Strategy [2], approved by Government Decision No. 114/2023, which emphasises the importance of education for sustainable development and the integration of circular economy principles into the educational system, and with the National Curriculum Framework [16], which establishes strategic directions for educational development, including the formation of students' competencies regarding sustainability and the circular economy.

It is also important to note that the application of sustainable methods and principles in architecture and design contributes to increased energy efficiency and constitutes one of the fundamental objectives of European Union policies. Furthermore, sustainable design involves interventions in management systems and the implementation of the eco-design concept in the built environment, in accordance with European guidelines and regulations. Based on Directive 2008/98/EC [1] regarding waste, which establishes the legislative framework of the European Union for waste management and promotes the circular economy, and on Regulation (EU) 1157/2024 [18], which regulates cross-border transfers of waste, including recyclable waste, among Member States, our country encourages educational policies oriented towards energy efficiency and the valorisation of eco-design and the circular economy, enhancing collaboration between universities and various professional fields.

In this context, the Guide on European Union Practices [8] in waste recycling and associated technologies provides concrete examples of best practices and technologies to follow, thus supporting the integration of sustainable principles into architectural and furniture design.

The main objective of this study is to analyse the potential of recycled wood used in interior architecture and furniture design, including lighting fixtures, presenting innovative and sustainable solutions developed by architecture students at the Technical University of Moldova. These practices adhere to the principles of the circular economy and energy efficiency, thereby reinforcing the role of education and scientific research in promoting a sustainable and responsible built environment.

2. Sustainable Methods in Furniture Architecture

Sustainable furniture, also referred to as eco-furniture, is based on design principles that utilise recycled materials derived from waste, contributing to pollution reduction and the conservation of natural resources. This approach is gaining popularity in interior architecture, both residential and non-residential, by providing alternative solutions for custom-made furniture that ensure both functionality and aesthetic quality within the built environment.

A key aspect of sustainable furniture is its adaptability to different interior and exterior spaces, as well as the flexibility to change its placement or function. Furniture pieces and lighting fixtures made from recyclable materials have been widely integrated since the early 2000s in commercial and public-use spaces, thereby promoting sustainability and ecological responsibility within the community.

Architecture can be seen as a sophisticated interplay of volumes and light, in which new forms are created through processes that can integrate sustainable materials and natural textures. These elements not only enrich the aesthetic experience but also have positive effects on the health of occupants and the quality of the interior environment. Recycled materials can be used for furniture production, interior finishes, masonry or decorative elements, aiming to create and maintain a built environment that is healthier and more environmentally friendly.

In this context, recycling is not merely a contemporary trend but a crucial component of the circular economy, promoting the reuse of resources and the reduction of pollution, while the waste discarded in urban and rural environments has a direct negative impact on human health and ecosystems. Therefore, their recovery through recycling makes it possible to transform them into useful objects with an extended lifespan, thus reducing pressure on natural resources and contributing to their sustainable regeneration. Consequently, the design of sustainable furniture is not limited to aesthetic or functional aspects but becomes an educational and practical tool, encouraging architects, designers, and the community to adopt environmentally responsible behaviours in accordance with the principles of the circular economy and national and international legislation on recycling.

We live in a throwaway society, where many objects are discarded rather than repaired and reused. Thus, arises the principle of sustainability, through recycling and transformation.

3. Sustainability in Design and the Circular Economy

3.1. General Aspects about Sustainability

Sustainability represents a fundamental principle of sustainable development and ecological design, based on the reuse of materials derived from waste. Thus, sustainable development in design involves a harmonious and balanced approach that integrates environmental, social, and economic considerations and entails addressing a wide range of issues regarding the conservation of natural resources and the reduction of negative environmental impacts.

Recycling is not only a process beneficial to the environment but also offers creative opportunities, allowing the transformation of used materials into new, functional, and

aesthetic objects and products. Although recycling involves coordinated actions at a global level, each individual can contribute through concrete practices to waste management and recovery.

An essential criterion in ecological design and planning is the circular economy – a strategy aimed at creating products with an extended lifespan, integrated into a closed loop without generating waste. The circular economy reuses objects that have reached the end of their useful life, repurposing them for new applications and thus prolonging resource use. The linear economy, however, is based on the production of goods which, after reaching the end of their lifespan, are disposed of as waste and completely decompose without further recovery (Figure 1).

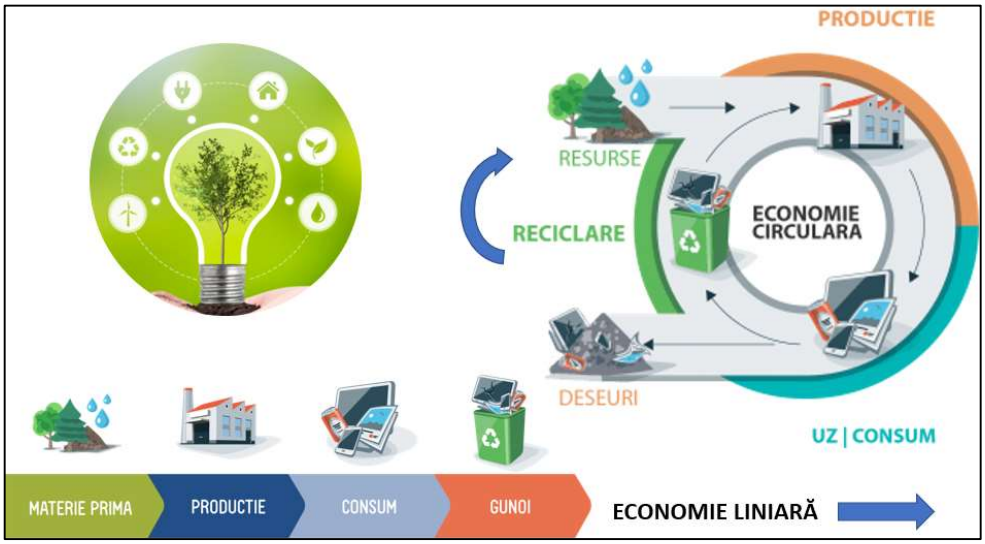

Fig. 1. *The linear and circular economy of a product:*
NATURE is not a place to visit, it is everyone's home and must be protected!

Thus, integrating the principles of the circular economy into sustainable design can represent not only an opportunity to reduce pollution and conserve natural resources but also to foster creativity and the sense of responsibility among professionals in the fields of architecture and interior design.

Today, humanity is facing multiple ecological challenges that endanger not only its own existence but also the balance of Nature as a whole. Global warming, large-scale environmental pollution, the accelerated disappearance of species on Earth, and the devastating floods and wildfires that destroy ecosystems and claim hundreds of thousands of human lives are just a few examples demonstrating that Nature, once an ally, can turn into a relentless adversary when society fails to implement adequate solutions to harmonise the relationship between humans and the environment.

The transformation of waste into reusable resources (raw materials) represents the primary objective of the circular and ecological economy. This approach entails more efficient

management of raw materials, innovation in product design and manufacturing processes to reduce packaging waste, and the implementation of modern methods for waste collection and recovery, thereby protecting the environment and conserving natural resources.

3.2. Wood as a Material – an Essential Resource for Durable Products

Wood sourced from responsibly managed forests (FSC or PEFC certified), processed without toxic chemicals (such as formaldehyde or industrial solvents), and treated by natural methods, is biodegradable, renewable, and ideal for designing healthy and sustainable interior spaces.

In the Republic of Moldova, the predominant forest species are oak (*Quercus robur* L.), beech (*Fagus sylvatica* L.), ash (*Fraxinus excelsior* L.), and field maple (*Acer campestre* L.), all recognised for their durability, high density, and natural aesthetic qualities. Local wood has traditionally been used for furniture, interior finishes, and decorative elements [19].

Wood is an essential resource for human existence, meeting daily needs and ensuring comfort. However, excessive exploitation has led to massive deforestation and significant negative impacts on the environment:

- intensified soil erosion;
- increased frequency of droughts;
- landslides causing severe losses to the national economy;
- degradation of forest stands;
- depletion of forest biodiversity, creating the risk of extinction for certain plant and animal species.

Solutions for the field of architectural design:

- recycling wood and reusing it in construction;
- planting trees simultaneously with logging activities;
- using only timber obtained from tree maintenance and pruning operations;
- utilising wood from trees destroyed or felled by natural disasters.

Wood is a completely organic material and, if used rationally, can remain a renewable resource and a lasting connection to nature without destroying it.

3.3. Forests – the Lungs of the Planet and the Guarantee for Future Generations

Forests in the Republic of Moldova constitute a significant part of the country's natural capital and wood has been a source of human sustenance for centuries. However, in the past, its use was more limited and rational. The development of industries and the growing demand for comfort and quality products have accelerated the exploitation of wood.

In the 21st century, the consequences of overexploitation are reflected in climate change, natural disasters, and population displacement caused by environmental conditions. Studies show that Moldovan forests can absorb over two million tons of carbon dioxide annually; however, uncontrolled deforestation has reduced the country's forest cover to approximately 13% of its total area.

Global, European Union, and Moldovan policies, through the Ministry of Environment's strategy, share a common goal: to halt massive and uncontrolled deforestation by applying policies of reuse, sustainability, afforestation, and the use of

fast-growing industrial tree species.

The Government of the Republic of Moldova has joined the international community through several decisions in the field of environmental protection and sustainable resource management. Among these is the approval of the National Strategy for Agricultural and Rural Development 2023–2030, section 1.2.3 Sustainable Soil Resource Management in Agriculture [7], which provides for halting deforestation and remediating soil degradation (landslides, wind erosion) through afforestation and large-scale rehabilitation of degraded areas [17].

A study carried out under the project implemented by the International Bank for Reconstruction and Development/World Bank (1818 H Street NW, Washington DC 20433) on the identification of High-Conservation-Value Forests (*HCVF*) in the Republic of Moldova [3] offers a comprehensive overview of the forestry sector and formulates technical and policy recommendations: improving the *HCVF* identification guide, conducting additional research, amending legislation on protected areas, and developing adaptive forest management to ensure future ecosystem services. These provisions allow *HCVF* areas to attract donors and investors to support the forestry sector of the Republic of Moldova (Report Identification of High-Conservation-Value Forests in the Republic of Moldova [19]).

4. Principles of Sustainability in Wooden Objects Applied in Practice by Architecture Students

Wood is one of the most important recyclable materials and one of the most widely used in the industrial and construction sectors, and wooden residues rank second among the largest quantities of recyclable waste generated by construction activities. These residues are often discarded, improperly stored, or left unrecycled, which further encourages tree felling to obtain new raw materials. Although these figures are worrying, compared to other materials, wood remains an under-recycled waste relative to its potential.

Recycling and sustainability are also key concerns for the faculty and students of the Department of Architecture (*DA*) at the Technical University of Moldova (*TUM*), the Faculty of Urbanism and Architecture (*FUA*). Concrete actions are implemented within the *Interior Space Architecture* course and seminar (fifth year, Architecture programme). Architecture students are involved in a sustainability project through the scientific-practical *Eco-design* seminar*,* which reached its eighth edition in 2025. They are trained to recycle and reuse materials for functional interior objects (eco-seminars held at *DA, FUA, UTM*).

Multiple concepts have been materialised into unique interior objects – true works of art combining aesthetic form, originality, and functional design. The purpose of this event is to publicise ecological and sustainability topics within the academic community, to convey information to students and faculty through practical examples, and to raise community awareness about the necessity of recycling and reusing materials for the benefit of the environment and the lives of future generations.

The scientific-practical seminar, implemented through innovation and sustainability in the vision of architecture students, has attracted representatives from various national and international

institutions [9]:

- Faculty of Furniture Design and Wood Processing, Transilvania University of Brasov, coordinated by Assoc. Prof. Dr. Eng. Alin OLĂRESCU (Dean), Prof. Dr. Eng. Marina CIONCA, Prof. Dr. Eng. Mihaela CÂMPEAN, and Lecturer Dr. Eng. Antonela PETRAȘCU-LUNGU;
- the Ecological University of Bucharest;
- members of the National Environmental Center of the Republic of Moldova;
- members of the Environmental Information and Consultancy Center – EcoContact;
- colleagues from the Faculty of Design, UTM – Assoc. Prof. Dr. Valeriu PODBORSCHI (Head of the Department of Industrial and Product Design) and Assoc. Prof. Dr. Cristina EFREMOV;
- media representatives.

Another outcome of transforming recycled wooden materials is the *Coffee Table* – a sustainable hourglass-shaped piece of furniture (authors: HUTSAT Tetiana, JENUNCHI Diana, group ARH-162), created according to Japanese principles using the *Tsugute* technique (Figure 2).

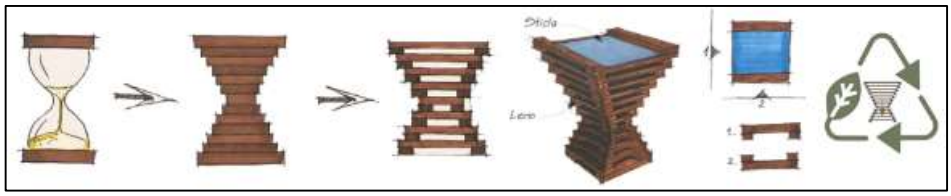

Fig. 2. *Hourglass-shaped coffee table created using the Tsugute technique*

Fig. 3. *Contemporary interior with the imprint of Japanese style and the Tsugute technique*

In Japan, woodworking is considered a distinct art form. The renowned Japanese carpenter Husao Hanafusa states that the traditional carpenter does not regard wood as dead but believes he gives it a new life – something visible in the contractions and relaxations of the wood even after it becomes furniture [20].

Just like in an hourglass, time is irreversible – time to save the home we all share. This time can only be extended through awareness: reuse, reduction, and recycling to protect nature and the lives of future generations. This symbol – the result of responsible thinking and an example realised through recycling and reusing – Is embodied in this interior object. Its aesthetic and stylistic harmony reflects Japanese minimalism, while the application of the *Tsugute* joinery technique creates a piece that can complement any interior space (Figure 3).

5. Recycling is Not Just an Action – It Is the Preservation of the World and Its Resources

Another source of inspiration drawn from nature is the work *Orange Armchair*, created by fifth year students *GHELAN Iana* and *COVACI Dorina* from group ARH-181. The concept of the piece – *recycle, reuse, live* – starts from recycled materials such as plywood and cardboard tubes, all consolidated into an attractive furniture item distinguished by its shape and colour, perfectly suited for spaces dedicated to children's activities and play (Figure 3). (The scientific-practical seminar entitled *Sustainable Furniture in Architectural Space* [6] – Figures 4 and 5).

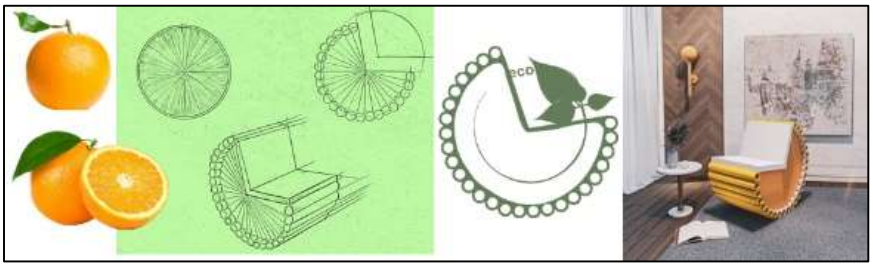

Fig. 4. *The Orange Armchair, work, inspired by natural forms created by students GHELAN Iana and COVACI Dorina from group ARH-181*

Fig. 5. *Works from the scientific-practical seminar entitled Sustainable furniture in the architectural space*

The responsibilities of society can be achieved through methods, models, and principles of recycling and reuse, by presenting and discussing good practices with as many people, institutions, and media outlets as possible, which will lead to concrete actions (*By throwing away, we become accomplices to pollution – Sustainable practices – By reusing, we give objects a second chance; Things we no longer need – Harnessing creative spirit – Opportunities to redecorate the home,* Figure 6).

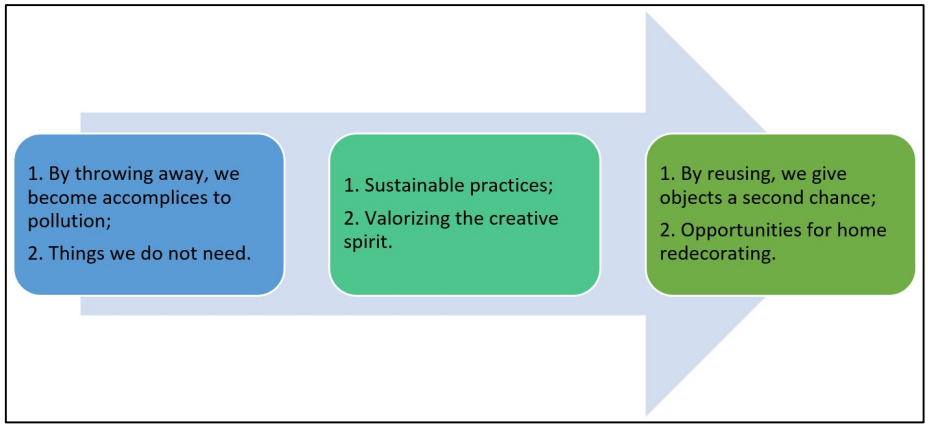

Fig. 6. *Responsible principles of sustainability through recycling and reuse*

Reduce, reuse, recycle was the guiding theme adopted by the architecture students involved in this experiment, which resulted in a beautiful and functional outcome. Inspired by David Attenborough's statement – *Surely, we have a responsibility to leave future generations a planet that is healthy and habitable for all species* – the concern for the natural environment, the interior space, and the traditions of the Romanian people led to the creation of new concepts for functional and personalised interior objects, grounded in philosophical and professional principles.

Accordingly, artificial lighting in interior spaces is of great importance across various typologies, with table lighting being a particularly significant aspect for any event or celebration. Choosing the right lighting fixture can add a touch of elegance and refinement to the entire interior environment. In this sense, an interesting and inspiring idea could be a table lamp based on the coded forms of *The Endless Column* by the great Constantin Brâncuși, thus merging Romanian traditions with modern art.

The Endless Column, a masterpiece of modern sculpture and one of the most renowned works of the Romanian genius Constantin Brâncuși, symbolises continuity and unity. Its simple and elegant form, based on the concept of an ever-growing spiral, can be successfully transposed into a table lamp with impressive effects. Moreover, by employing this iconic form, we can highlight the close link between Romanian culture, art, and creativity, offering a distinctive and original element

for the concept work.

The lamp can be crafted from various materials; however, in this project, wooden metal composites and hardwood objects capable of transformation were selected. The lighting of this fixture within an interior space can create a pleasant, welcoming, and warm atmosphere, suitable for any area of a home or public environment.

6. Sustainability Is More Than an Environmental Goal, It Is an Ethical Value

Leonardo Boff – a table lamp inspired by the forms of *The Endless Column* by Constantin Brâncuși can bring added elegance, originality, and cultural value to our events. This approach honours Romanian traditions while creating a unique experience. Traditional style is characterised above all by simplicity, refinement, and good taste, defined by the warmth of family life and a strong connection to the past, which in turn creates an ambience that links the home to nature.

The diamond shape in Romanian culture symbolises balance and harmony, unity, beginnings and endings. In some folk traditions, the diamond is seen as a symbol of transformation, of the passage from one state to another. The diamond and the infinite are two symbols often associated with profound and mystical meanings in Romanian culture. This emblematic element was precisely what inspired the concept for the lamp designed by student *RUSU Mariana,* from group ARH-181, who incorporated the piece into the interior space to convey messages of continuity, transcendence, and divinity, while also referencing various artistic, religious, or folk contexts (Figure 7).

This work was highly appreciated and awarded an *Honorary Diploma* by the jury members: *Prof. Dr. CIOCEANU Avraham Marian,* President of Bio-Romania at the Ecological University of Bucharest, Romania, and *Ms. NISTORICĂ Tatiana,* President of Bio-Moldova.

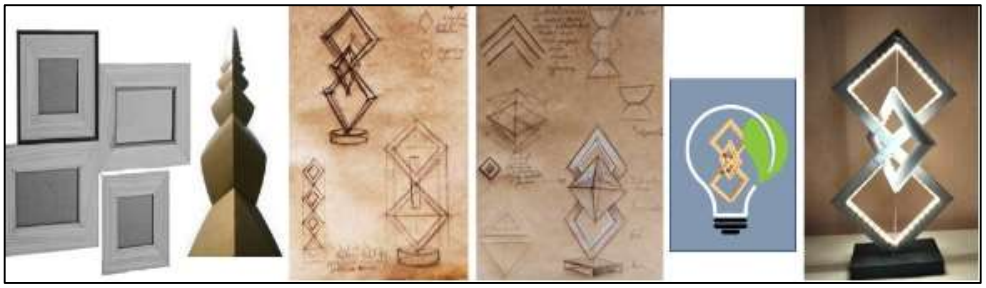

Fig. 7. *Sustainable lighting fixture* designed by student *RUSU Mariana from group ARH-181*

At the same time, *creative sustainability* represents the outcomes of eco-friendly objects, including furniture and lighting fixtures made from recycled wood, designed as concept pieces. These were created by architecture students to promote the principles of the circular economy, focusing on energy efficiency in the design of interior spaces (Figure 8).

An armchair made from recycled wood,

featuring the initials of the Faculty of Urbanism and Architecture in its design concept, created by students *RUSU Mariana* and *CIOBANU Ana* from group ARH-181 (Figure 9).

Ecological and responsible design in interior architecture represents a modern and conscientious approach, emphasising the creation of harmonious living spaces where aesthetics are intertwined with environmental care through the use of sustainable objects. In this context, furniture made from recycled and sustainable materials plays a crucial role, providing a creative and eco-friendly alternative to conventional pieces manufactured from new resources with a higher environmental impact.

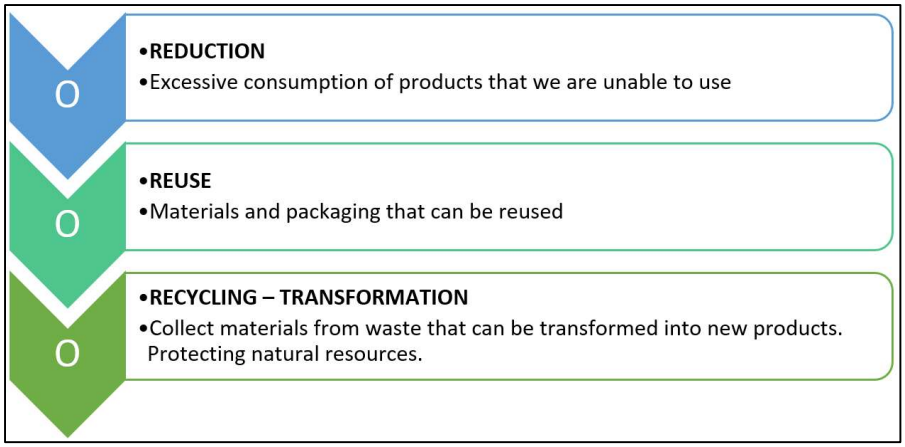

Fig. 8. *Results of creative sustainability*

Fig. 9. *Armchair made from recycled wood with the initials FUA, by RUSU Mariana and CIOBANU Ana from group ARH-181*

An additional important factor is the *EU Eco-design Directive*, adopted in 2009. This directive establishes a legal framework for implementing eco-design requirements for energy-related products and other products connected to energy use within the European Union. The directive focuses on setting specific energy efficiency requirements for products that consume energy. Accordingly, products must meet certain standards and efficiency criteria throughout their entire life cycle – from manufacturing and usage to final disposal. The goal is to promote products that are more energy-efficient, less polluting, and more sustainable in terms of resource utilisation.

7. Conclusion

In conclusion, we mention that eco-sustainable design brings the effects of energy efficiency to the architecture of interior space, through recycled and reused materials. This sustainable process of transforming waste into useful materials, finishes, and objects is an essential strategy for sustainable development at a global level, as well as for higher education institutions, where specialists in various fields are trained.

Acknowledgments

We would like to thank the administration of Transilvania University of Brasov, Prof. Dr. Eng. Ioan Vasile ABRUDAN, Rector, Prof. Dr. Alin OLARESCU, Dean, the professors from the Faculty of Furniture Design and Wood Engineering, Prof. Dr. Hab. Mihaela CÂMPEAN, for the opportunity to share our experience, that of the professors from the Technical University of Moldova. The work is part of the institutional research project, with the number 020406 *Models, systems and technologies for energy efficiency, decarbonization and digitalization of processes in energy, industry, construction and transport.*

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