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INTRODUCTION

The cooperation partnership project within the ERASMUS+ Program no. 2022-1-RO01-KA220-SCH-000087450 with the title "Sustainable Waste of Textile" (SWOT), carried out in the period 01.09.2022 - 30.09.2024, with a total budget of 250000 euros, had as its general objective to develop in students and teachers in partner schools to act towards reducing the consumption of textile products and the amount of textile waste, to ensure re-use and recycling, to protect natural resources, the environment for energy recovery and to prevent climate change. Recycling of textile wastes can be listed as reducing pollution, energy and water consumption and also the need for chemicals. People should be encouraged to reuse all textiles before recycling, as many times as possible thus reducing carbon footprint.

This project aims teaching students be aware of about not only recycling textile waste but also recycling in all areas. Within the scope of sustainable development principles, waste management should be provided with an integrated approach by making the zero waste principle a living standard in order to control our wastes and leave a clean, developed and livable world to future generations. Increasing the performance and efficiency due to the clean environment and reducing the costs and environmental risks are realized with zero waste practices since waste is prevented with the feeling of "sensitive consumer".

Project coordinator:

- ✓ Liceul Tehnologic Francisc Neuman Arad, România.

Project partners:

- ✓ Universitatea „Aurel Vlaicu” Arad, Romania
- ✓ Sultan Hatun Mesleki VE Teknik Anadolu Lisesi, Sinop Turkey
- ✓ Soares dos Reis School of Arts Porto, Portugal
- ✓ Škola Za Dizajn Tekstila I Kože, Novi Pazar Serbia
- ✓ Istituto Tecnico Statale Economico E Tecnologico "Enrico De Nicola", San Giovanni La Punta (CT), Italy

Starting from the partners' needs and the general objective, the following specific objectives were formulated:

O1-to educate young people to respect environmental issues by involving 25 students/workshop in 5 European learning activities to promote the recovery of textile waste;

O2-to develop in the teaching staff of the partner schools, knowledge and competencies regarding the circular economy and circular product design by organising 2 LTTAs

O3- to enhance the quality and European dimension of teaching process in partners schools;

O4 -to improve the competences in foreign language communication skills for both pupils and teachers by participating in LTTA's and activities on eTwinning;

O5-to explore new possibilities by the use of ICT in learning, developing innovation and creativity at school;

O6-to interconect different systems of education;

O7-to develop key competences such as communication skills, social and civic skills, digital skills, the ability to effectively manage their own learning, both individually and in groups, the ability to appreciate the importance of creative expression. of ideas, experiences and emotions in a variety of environments such as the visual arts.

To achieve these objectives, the following activities were carried out:

- 5 training activities through which students made various clothing products, accessories and decorative items for clothing from textile waste, plastic, wood, etc. inspired by the folk costume of each partner and the costume specific to a representative historical period and study visits

- Collaborative activities between students on eTwinning on recycling, reuse of textile waste

- Creating a collection of clothing items inspired by the folk costume of each partner and the costume specific to a historical period representative for each partner that was presented in the fashion show at the end of the project

- An e-book containing terms specific to the textile industry

- 5 Video materials to promote and disseminate the activities carried out

- three proposed training activities, one online and two onsite, with their main purpose the development of teachers' knowledge, skills and positive attitudes regarding reducing the consumption of textile products and reducing the amount of textile waste, to reduce the amount, to ensure re-use and recycling, to protect natural resources, protect the environment, energy recovery and prevent climate change

- developing a methodological guide to be used in the class of teachers in the current activity, which promotes the recovery of textile waste by educating young people to respect environmental issues, enhance the quality and European dimension of teaching process in partners. schools and develop key competences such as communication skills, social and civic skills, digital skills, the ability to effectively manage their own learning, both individually and in groups, the ability to appreciate the importance of creative expression. of ideas, experiences and emotions in a variety of environments such as the visual arts.

- Dissemination activities

The main results of this project are:

-1 digital vocabulary e-book containing specialized terms in the field of textile and fashion industry in all 5 native languages of the partners and English

- 5 video materials for the promotion and dissemination of the activities carried out

- 5 collections of clothing items inspired by the folk costume of each partner and the costume specific to a historical period representative for each partner that will be presented in the fashion show at the end of the project. A collection will contain at least 10 sets of clothing consisting of clothing products and accessories

- 5 mood boards (1 / partner) for inspiration in making the reinvented folk costume

- 5 mood boards (1 / partner) for inspiration in making the costume specific to a historical period representative for each partner reinvented

- 100 student mobility for skills development regarding environmental issues and the recovery of textile waste, foreign language communication skills, use of ICT in learning and key competencies.

- 100 Europass mobility documents for students participating in training activities

- eTwinning project page for collaboration between students and teachers for digital vocabulary e-book containing specialized terms in the field of textile and fashion industry in all 5 native languages of the partners and English

- minimum 25 teachers participating in the three training activities (1 online and 2 onsite)

- at least 20 activities adapted, applied and proposed to be included in the methodological guide made by the teachers under the scientific coordination and guidance of the UAV Arad partner

- 40 Europass mobility documents granted

- 50 certificates of participation in the training activity granted

- 2 designs for the training program in the field of Design for a circular economy and Recovery of recoverable textile materials

-1 Methodological guide - "Circular product design"

- at least 60 dissemination activities organized by the project partners

- at least 6 multiplication events organized by each partner in which at least 170 teachers, students, decision makers in education, representatives of the local community will participate.

-1000 leaflets / brochures / posters distributed

- 1 project site / platform regularly updated

- 1 Facebook page updated periodically with activities carried out within the project and results obtained with 100 members

- 1 project Twinspace and a project page on the eTwinning platform

- 50 methodological / partner guides distributed in schools in the region

- digital vocabulary brochure

The methodological guide "Circular product design" presents 20 models of activities with and for students, teaching, learning and assessment tools that assist a successful, active and efficient process in the classroom in order to develop to students and teachers a positive attitude towards reducing the consumption of textile products and reducing the amount of textile waste, to reduce the amount, to ensure re-use and recycling, to protect natural resources, protect the environment, energy recovery and prevent climate change.

But the indirect beneficiaries of this guide are in fact students participating in school and extracurricular activities of teachers who apply examples of good practice in direct work with students in the classroom.

The guide summarizes the experience of the partnership and introduces important tools and step-by-step instructions on how it can be implemented and used by classroom teachers, contains innovative and useful lesson models that can be adapted for any level of education

This guide was developed by experts of the coordinator and the partners who in collaboration ensured the implementation of the project:

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By involving teachers in the development of this teaching material, they developed their skills regarding the circular economy and circular product design.

The methodological guide is addressed, first of all, to teaching staff in technological education, the field of the textile industry, but, certainly, it can be used in the process of initial training of teaching staff in higher education, the methodological/didactic courses for various school subjects, becoming a landmark for readers and students.

Also, the inserted content can serve as support in the continuous training of teaching staff in order to make the teaching-learning-evaluation process of school subjects in technological education more efficient. To provide effective support in the educational process for technological education teachers, to allow them to build the organization of contents and ideas, facilitating students' understanding of new information, the application of knowledge, analysis, but also guidance in the creative process, have been developed materials that provide:

- a qualitative, effective and relevant teaching-learning-evaluation process
- student learning, self-learning skills, creativity stimulation;
- Development and implementation of curriculum design.

But the indirect beneficiaries of this guide are the students who participate in school and extracurricular activities of teachers who apply examples of good practice in working directly with students in the classroom. All the activities presented in this guide can be adapted according to the level of education and the characteristics of the students.

The present product gives the reader a complete picture of what was done within the partnership and - above all - concrete suggestions and recommendations for all those teachers who want to integrate PBL (Project Based Learning- Learning based on projects) in the classroom in order to motivate students and teachers to act towards reducing the consumption of textile products and the amount of textile waste, to ensure re-use and recycling, to protect natural resources, the environment for energy recovery and to prevent climate change.

We would like to thank all the students, teachers and schools in Italy, Turkey, Romania, Portugal and Serbia who cooperated with us to collect all this information and present it in this guide. Without their support, contributions and patience the result would not could have been reached. We hope that this guide will prove useful for your school, for your colleagues, but especially for your students.

SWOT Team

THE THEORETICAL PART

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Chapter 1.
Product life cycle, eco-design notions and circular/sustainable fashion principles.

1.1. Explanation of the term linear economy

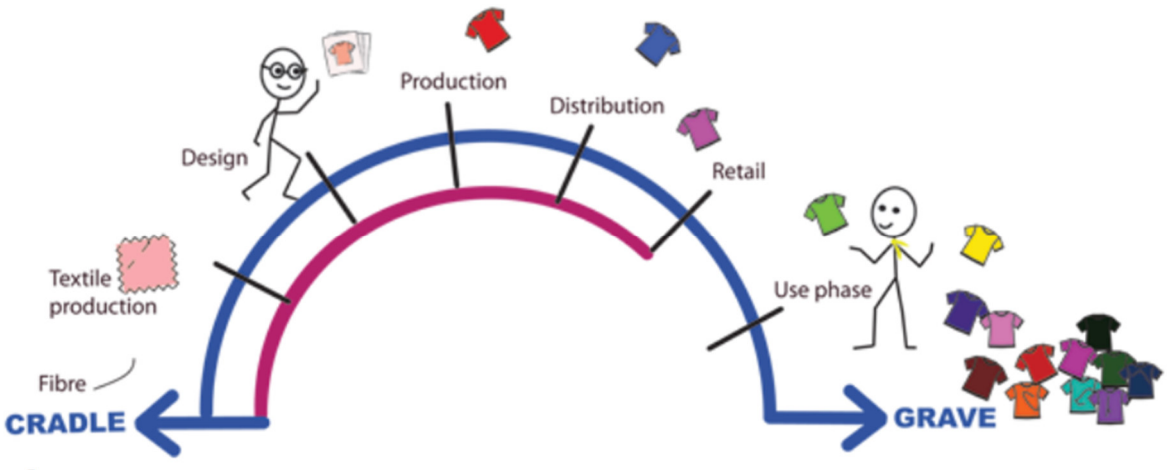
The life cycle of a clothing product is the duration from its launch on the market to its complete removal from production.

The life cycle of a clothing product is valid for both linear and circular economy and is a definition that permanently stimulates the creation of clothing products adapted to the requirements of consumers. Clothing products are born, live and... die.

The life cycle of a clothing product has four stages:

1. Launch (placing on the market) – because "there is only one chance to make a first impression", for a clothing product this stage is decisive. The way a product is launched and accepted on the market can determine its cycle of life. The brand, the price, and the promotion methods are elements that define the place on the market of a clothing product.
2. Growth – is the stage when the optimal ratio between price and profit is sought. It is also at this stage that quality and advertising are invested. Marketing strategies are decisive at this stage.
3. Maturity – is the stage at which it is necessary to adopt a price strategy for the clothing product to be competitive on the market. It is from this stage that the imminent decline of the product occurs. At this stage, price reductions and comparative promotion methods can be practiced.
4. Decline – is the most difficult stage. The product must be reinvented, redesigned, and perhaps, adapted to fashion trends. This stage may end with the sale of the production rights to another company.

Diagram showing the life cycle of a clothing product, with and without recycling.



Source: https://xuenxuenkang.wordpress.com/2018/06/06/research-sustainable-fashion/

Fig. no. 1 Linear economy

The life cycle of a product in current economic conditions is always associated with environmental impact.

Any clothing product is associated with a complex thinking-action that includes the design of the product, the necessary materials for its realization, the type of work done to

obtain the item, the reuse/recycling or the "death" of the product.

This creates the methodology for evaluating the life cycle of a product (LCA) as an operating tool.

The fashion and clothing industries are sectors as beautiful as they are polluting, the present orientation is towards prevention, avoiding to the maximum the polluting technologies for the realization of clothing products, the basic idea being prevention.

In the EU, it has been concluded that product life cycle assessment (LCA) is the most effective method for an integrated product policy. "Thus, in 2003 the EU launched (Integrated Product Policy – IPP). In 2005, an EU-wide platform on product life cycle assessment was developed. In 2010, the International Reference Life Cycle Data System (ILCD) was launched."[1]

LCA (Lyfe Cycle Assessment) is a standardized method, called analysis "from cradle to grave". Life cycle analysis is standardized, ISO14040. The last level tracked during the study of the life cycle of a product is the evaluation of social implications.

In a small context, LCA can be used in environmental performance assessment and improvement to reduce environmental implications.

"The basics of LCA are:

- Identification and quantification of the environmental elements involved in making a product: the nature and origin of the raw materials, the energy and water consumed, the emissions generated, the waste and their management.
- Environmental impact of the elements involved in the realization of the product.
- Analysis of options for minimizing the negative implications on the environment.
- Interpretation of results on resource management and environmental protection."[2, 3]

A study on the life cycle of a product involves costs that are directly correlated with the depth of the study, with the steps taken. To reduce the costs of an LCA, the following shall be envisaged:

- At the design-production level – software for life cycle simulation.
- At the practical level, 3 stages can be considered:
  - Analysis in the sequence of phases, gate to the gate.
  - Analysis of resources, resource transformation, and production.
  - Life cycle analysis as a whole.

The application of the LCA in the clothing and fashion industry will take into account the places where action should be taken to limit the impact on the environment.

[1] https://ec.europa.eu/environment/industry/retail/pdf/issue_paper_5/ENV-2012-00379-00-00-RO-TRA-00.pdf
[2] https://www.eea.europa.eu/help/glossary/eea-glossary/life-cycle-assessment
[3] http://www.uneptie.org/pc/pc/tools/lca.htm

Making the term linear economy explicit

"Anyone who thinks that economic growth can continue indefinitely in a finite world is either a madman or an economist" - Keneth Boulding, quoted in the newspaper Les Echos, nr. of 15 May 2019, p.10.

"A business model is defined by three main elements: value proposition, value creation and offering, and value capture." - Bocken et al. (2014)[4]

The linear economy starts with the natural resources that it transformed into raw materials that form the basis for finished products, and the waste is deposited in the natural environment. In the linear economy, there is no concern for the limited volume of resources, nor for the implications of waste on the environment.

Linear economy is based on three principles: exploitation-production-throwing ("take-make-waste")[5].

The linear economy is based on cheap resources. The design of the products is not related to ecological considerations. The design envisages a programmed life of clothing products so that the sales of companies are high, the products are replaced in the shortest possible time with new ones, and the issue of waste and its implications on the environment is not considered.

In the linear economy when producing garments, natural or chemical raw materials are processed with minimal costs, in a maximum volume, often of doubtful quality and without respecting the principles of environmental protection. Usually, clothing products are produced in Asian countries, where wages in the garment industry are very low, and textiles are finished in poor conditions, with cheap dyes and chemicals that do not comply with environmental standards. In these conditions of production, the clothing items are cheap, they are produced in large quantities, the collections are launched quickly, the discounts are made shortly after the launch of the collection so that the volume of sales is high, the revenues are high, and the turnover of money is fast. This explains why the garment industry is a "rich industry". In these circumstances, the environmental impact on the environment is manifested in a large volume of waste that is incinerated or deposited. This results in greenhouse gases and large periods of hundreds of years for the decomposition of waste that is deposited in landfills.

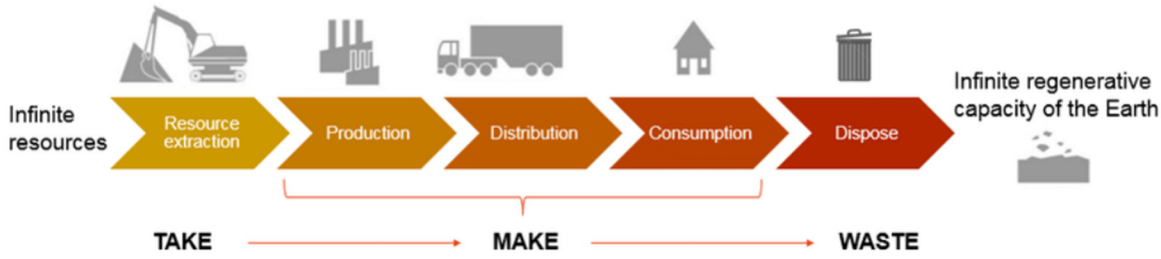
In the linear economy, the starting point is known, which consists of the large volume of resources and the endpoint is the large volume of production. The way forward is minimal, fast production, high sales and maximum profits. There are no effects in this equation related to the environmental impact of the large volume of waste.

The linear economy is an economy with a high loss of raw materials and materials and is polluted by the waste it produces and is not reused.

In a real exemplification, linear economy can be presented as follows, Figure 2:

[4] https://circulartourism.eu/ro/topic/subiectul-1-definirea-modelelor-de-afaceri/

[5] https://azipentrumaine.ro/wp-content/uploads/2021/04/2.-Economia-circulara-vs.-liniara.pdf



Source: https://www.researchgate.net/figure/The-linear-economy-The-take-make-and-waste-approach-ofproduction_fig2_323809440

Fig. no. 2 Exemplification of linear economy

The garment industry uses raw materials:

- Natural or chemical fibers.
- Natural yarn, chemical, natural fibrous mixtures with chemical, two-component, etc…
- Unconventional textiles obtained from fibers and strengthened by various processes.
- Fabrics.
- Knits.

To obtain the color or surface effects on textile materials, the following shall be used:

- Textile dyes.
- Textile chemicals.

At first sight, they seem quite a lot, but the technological flows are relatively short so the time it takes to obtain a finished product is short.

Example of a technological chart, Figure 3:

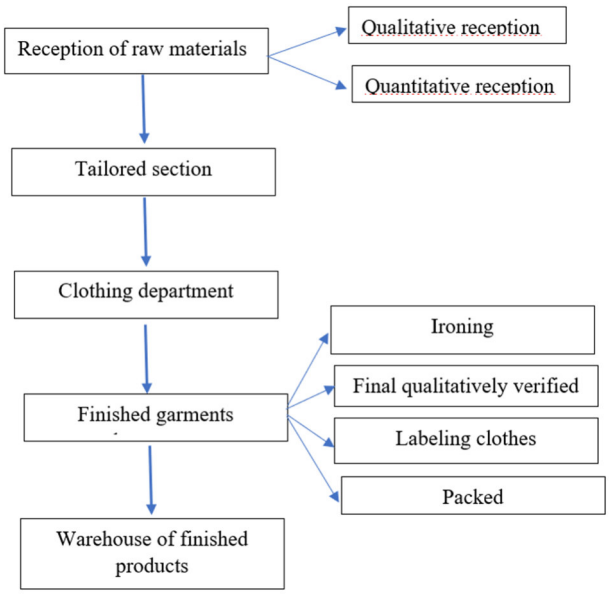


Fig. no. 3 Technological chart

For the garment and fashion industry, the raw materials can be fabrics, knits or unconventional textiles. The reception of raw materials is qualitative and quantitative. The

practical data, obtained by qualitative inspection, usually visual and quantitative, weighing/measuring/counting shall be compared with those in the accompanying documents. After the reception, the materials are deposited in the tailored warehouse, in specific locations, and entered into a computerized database.

The tailored section is the one where the operations are: digging, shaping, vacuuming and cutting by contouring. Modern machines do these operations automatically, and the cutting is done with the cutter, computer guided. Also in this section, the packages are made, that is, all the parts of a product are put together. The size of the packages is dependent on the type of item. Small items, for example underwear, are packed in a large number of pieces, 10-20 pieces/package, and so-called "heavy" items (jackets, coats) are put even a single piece in a package. The packages with tailored parts are deposited in the warehouse of the tailored section.

The garments department is the one in which the embroidery is executed on the cut parts and is assembled by conventional (sewing) or unconventional (welding, gluing) methods. The organization of activities in the clothing department can be organized in flow or modularly, depending on the type of items that are performed, in order for the efficiency to be maximum. In the manufacturing method, the qualitative verification is made by interphase self-control.

The garment finished section consists of four phases: ironing, "sorting", labelled, packaged. Ironing refers to the final ironing of the product on the ironing board, steam ironing press with one or two pillows, and manikin press. Sorting refers to the final quality control of the product. The labelling is done according to the order, with cardboard labels, and the packaging is also made according to the order. Types of packaging can be: folded on cardboard and inserted into the bag individually, several pieces folded and placed in a bag, individually on the hanger and pulled into the biodegradable bag. After packaging, the products are deposited in the warehouse of finished products, in predetermined locations and computerized evidence.

From all stages of the technological flow in a clothing company, waste results, but the highest percentage results from the tailoring of materials. The cost of waste is included in the final price of the product. Thus, the higher the material losses, the higher the price will be. The waste is deposited in landfills to decompose or be incinerated.

Concluding, it can be said that in the linear economy, "***man buys and the payment is made by the planet.***"[6]

It has been found that the price of products from the linear economy is too high, with sometimes serious implications for ecosystems. That is why the circular economy is proposed as a solution.

1.2. Explaining the term circular economy

In the current world economic conditions, economic growth is redefined, starting from a starting base made up of raw materials used, reducing the processing of new, finite

[6] https://dearsociety.net/2021/11/fast-fashion-tu-cumperi-planeta-plateste/

resources and reducing them to a minimum, until the waste is eliminated from the system. This type of economy, which starts from the reuse and recycling of materials, aimed at minimizing, to disposal, of waste, is defined as the circular economy.

The circular economy can be regarded as an ideal system of production-consumption that has the effect of prolonged use of products, reducing waste to disposal and protecting the environment.

The extraction and processing of new raw materials increases the consumption of energy and CO2 emissions, and thus do not fit into current economic policies at the global level.

Principles of the circular economy, Figure 4:

1. Increasing the life of products by keeping the products in use. This keeps the products in circulation for a long time, the orientation being towards durability, reutulization and recycling of products.
2. The reduction to the disposal of waste in the circular economy is achieved by reducing greenhouse gases, reducing water and air pollution, and reducing waste.
3. Renewal and regeneration of natural systems in the circular economy is achieved through the use of used materials as raw materials.

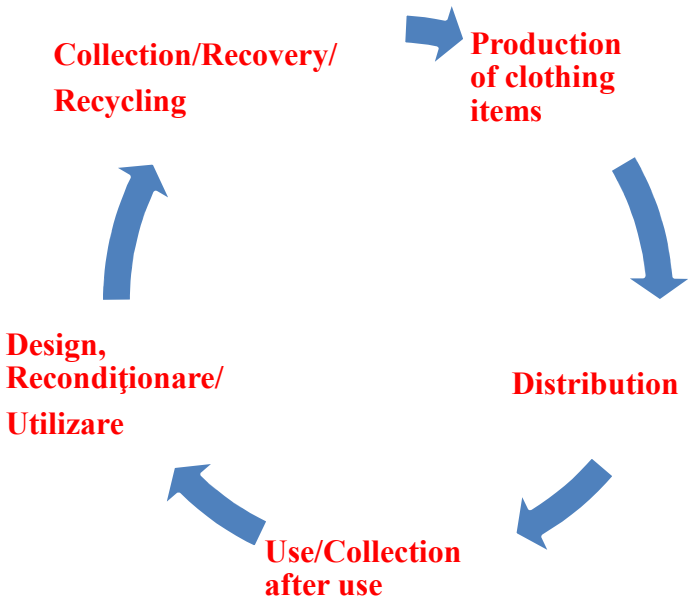


Fig. no. 4 Circular economy

1.3. Ways of moving from the linear towards the circular economy

Extending the life cycle of clothing products is a challenge for the entire planet. This challenge, however, comes with opportunities and threats.

The chances regarding the increase of the life span of the clothing:

- Awareness and understanding of the environmental impact of clothing products.
- Full assessment of supply chains.
- Evaluation of the improvement of clothing products to increase the service life.
- Environmental impact assessment of clothing products throughout the supply chain.
- Promoting quality items that meet the ecological design criteria and implicitly increasing sales.
- Invest in the brand by increasing its reputation and selling quality products with eco-design.
- Investments of firms in eco-design, and use of recycled or low-impact materials on the environment.
- Evaluation of the results after the application of new green technologies.

Threats to increase the life of clothing:

- Incomplete documentation on ecological design and permanent modernization of manufacturing technologies.
- High costs on LCA the higher the product range.
- High costs with accreditations, audits and product standardization, ISO/ILCD (International Life Cycle Data System).
- Variability of quality and reliability of different LCA.

The LCA focuses on environmental aspects, but the solutions must be extrapolated to the level of social standards and economic impact.

For the environmental implications of clothing products, the life-cycle approach is essential.

The information in the LCA regarding the life cycle and supply chains is the most complex document regarding the environmental impact of a product. The information in the LCA should be known and applied by all participants in the supply chains. To be truly useful, the information in the LCA platform must be standardized, ISO and worked on in the ILCD manual and network.

What to do:

- Solving at every stage, from the design to finding solutions regarding the environmental impact on the without transferring the problems from one stage to another.
- Access to clear information and explanations from the LCA.
- Encouraging producers and traders to apply LCA.
- Forecasts of consumer behavior about the life of a clothing product.

- The gradual transition, from a small number to an extensive and well-documented process with clear criteria and precise objectives.
- Development and promotion of standards and traceability for the life cycle of clothing products.
- Develop economic policies on stimulating environmentally friendly technologies for clothing products.
- Elaboration of clear documentation on the eco-labelling of clothing products.

• Supporting producers and traders in implementing the principles of LCA.

Eco-design

The EU aims to reduce electricity consumption by 32% in 2030 compared to consumption in 2007. Increasing energy efficiency is the instrument by which this objective can be achieved.

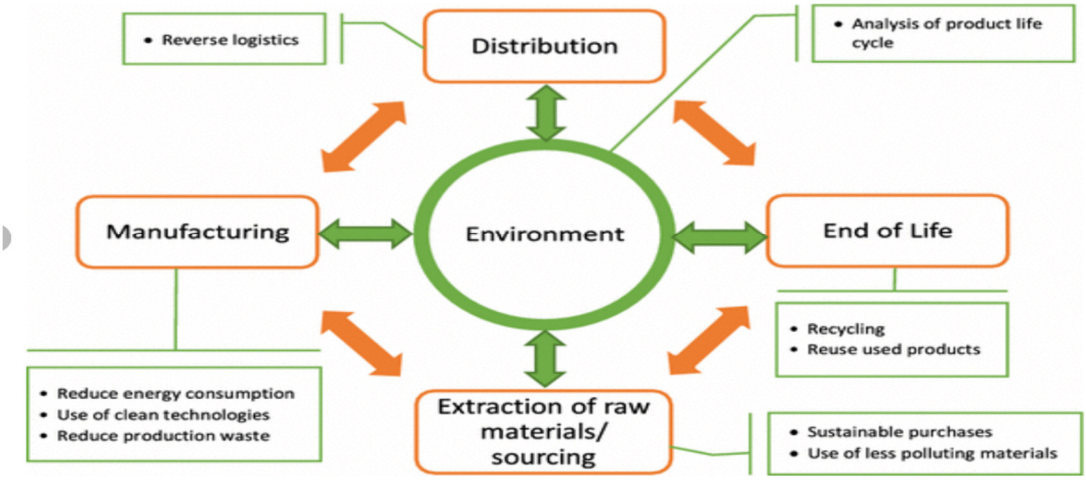
Eco-design is associated with energy labelling.

a. Ways of moving from the linear to the circular economy

The transition from the linear economy to the circular economy involves:

- Use as raw materials in the production process of used items.
- Decrease environmental pressure by extracting or using new, natural raw materials.
- Elimination of syncope's in the supply of raw materials.
- Stimulating creativity through innovative design starting from the raw materials used.
- Accelerating economic growth and increasing the number of jobs.
- The emergence of new occupations such as the ecological design of clothing products to reduce consumption, waste and reuse them (waste) and to eliminate polluting materials from recycling.
- Increasing the life of clothing products and being able to repair them.
- Eliminating "environmental disinformation", the so-called "greenwashing".

There is an impact on the environment in all chains, starting from the sources of raw materials, production/manufacturing, distribution and the "end of life" of products. Schematically, the situation can be presented in Figure 5:



Source: Annals of Operations Research, https://www.researchgate.net/figure/Life-cycle-of-an-apparel-product_fig1_274739073

Fig. no. 5 Environmental impact of production

A circular economy implies a circularity throughout the chain, initially linear, namely: design, production, and use. "Circular fashion means waste design," says Charlotte Turner, manager at Eco-Age, London, UK.

Chapter 2. Principles of eco-design

2.1. Sustainability

Nowadays, there is a widespread recognition of the importance of a sustainable approach to industrial development. Current research on the causes of climate change, a major current matter, validates this concern. The textile industry is one of the most polluting industrial sectors. The primary considerations in textile processing include pollution reduction, consumer safety, and satisfaction. Because water, energy, and raw materials are key production inputs in the textile business, reducing water and energy usage[7].

is one of the top concerns. Reductions in investments and pollution are the main aims of the European industrial strategy.

The United Nations Brundtland Commission described ***sustainability*** in 1987 as "meeting the needs of the present without compromising future generations' ability to meet their own needs." preserving an equilibrium between economic growth, safeguarding the environment, and social welfare [8] To be perceived as sustainable, the industry must meet three main requirements as they are depicted in Figure 6.:

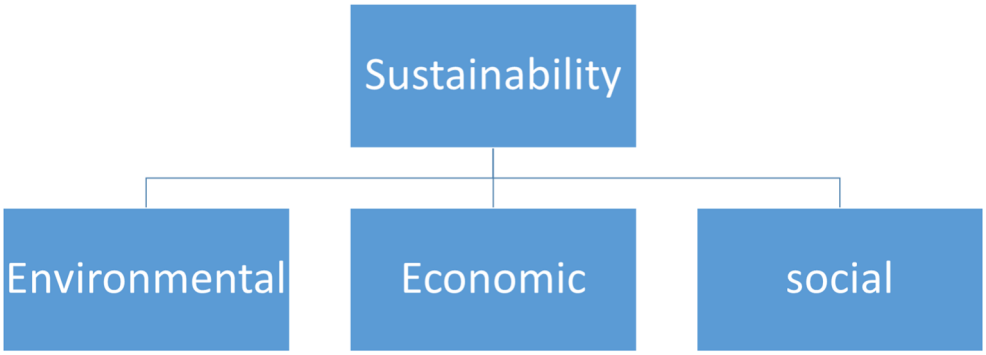


Fig no. 6 Requirements of sustainability

• *Economic survival* involves using natural, financial, and human capital to generate value, wealth, and profits.

• *Environmental compatibility* includes employing cleaner, more eco-efficient products and

[7] A Blueprint to safeguard Europe's water resources, Brussels, 14.11.2012 COM (2012) 673 final. http://ec.europa.eu/environment/water/blueprint/index_en.htm (accessed January 2023)

[8] World Commission on Environment and Development (WCED). *Our common future.* Oxford: Oxford University Press; 1987 p. 43. Available from: http://www.un-documents.net/our- common-future.pdf (accessed 2023)

processes to avoid pollution and exhaustion of natural resources.

• *Social responsibility* includes ethical behavior.

What are ***Sustainable textiles?***

Sustainable textiles are those that are produced in an ethically responsible manner

Sustainable clothing items are manufactured from eco-friendly resources, such as sustainably cultivated fiber crops or recycled materials.

Sustainability encompasses *sustainable production* and *sustainable consumption*.

To be considered sustainable, production has to:

- Maintain the consumption of resources as minimally as feasible
- Minimize environmental impact and protect employees and consumers throughout production and delivery.
- Encourage and improve progress to avoid undesirable social consequences.

Besides, aiming to attain sustainable production, Design, manufacturer, and consumer are all connected. It supposes that every stage of the textile life cycle is confronted along with the

development and assistance for ecologically friendly methods and technology.

Sustainable consumption implies the following:

• To raise knowledge of high-quality, eco-friendly, and socially acceptable clothing items.

• To enhance the lifetime and end-of-life of garments and textile products.

What determines a fabric's sustainability?

Generally, textile sustainability refers to three key criteria. These aspects decide whether clothing is sustainable or unsustainable. They consist of:

- Sources of raw materials
- Material processing
- Lifespan and End-of-Life disposal

It is important to underline that the best eco-friendly fabrics excel in all three categories[9].

Sustainability, the ability to reuse, upgrade and repair products

Textile goods on the EU market must meet a minimum extent of sustainability. Compulsory eco-design criteria for textiles and goods must provide minimum lifetime, durability, reusability, repairability, and recyclability. Regulations also avoid the use of harmful chemicals and minimize microplastics at all stages. They should also increase information communication throughout the value chain.[10]

Better design can increase resource efficiency by encouraging products that are durable, easy to repair, upgrade and remanufacture and recovery of valuable materials and components is enabled at end-of-life.

The Eco-design Directive has so far mostly been used to improve the energy efficiency of products but has strong potential to encourage material resource efficiency. The European Commission issued a request for the development of standards for material efficiency

[9] https://polygiene.com/news/resources/sustainable-textiles/

[10] https://circulareconomy.europa.eu/platform/sites/default/files/ecos-report-how-ecodesign-can-make-our-textiles-circular.pdf

requirements under the directive.[11] The European Commission's action plan for the circular economy covers a wide range of issues including resource efficiency in production processes, collaborative consumption, more circular waste management systems and end-of-waste criteria. The chapter on product design is directly applicable to the eco-design standards..

Within this chapter, it is underlined that "better design can make products more durable or easier to repair, upgrade or remanufacture. It can help recyclers disassemble products to recover valuable materials and components. Overall, it can help to save precious resources"[12]

Thus, design for durability and longer life, ease of reparability and upgrading, and ease of disassembly to enable material recovery, are key elements that should be covered by eco-design requirements for textiles and any other products. Besides, design for the efficiency of recyclability should be augmented by policy standards that constitute a market for secondary materials. As a result, eco-design prerequisites for textiles can include requirements to enhance recycled content in new products.[11] The main themes for the requirements imply durability, reparability, reusability, ease of recyclability and use of recycled content (taking into consideration chemical aspects).

When does design for recyclability only have a positive effect?

1. If the product is directed to a recycler and is not just discarded in a mixed waste stream for the landfill or incinerator
2. If the recycler is conscious of its recyclability features.

The Eco-design Directive allows for two sorts of product group specifications: minimum/maximum thresholds and information requirements.

Several factors influence the active lifetime of a garment or other textile product. Some of these are technical deficiencies in the product itself; others are changes in the wearer's body size or shape; and still others are subjective, relating to style and fashion issues.

What are the reasons for clothing discarding (though not other textiles)?

-changes in the garment (wear and tear issues accounted for 60% of discards);
- size and fit issues;
-functional deficiencies;
- unsuitability due to taste;
- situational factors;
- fashion or style changes etc.[11]

Around eighty per cent of the environmental impact of a good is determined during the design stage.[13] Legislation can and should promote sustainable design for durability,

[11] B. Bauer, D. Watson, A. Gylling, A. Remmen, M. H. Lysemose, C.Hohenthal and A.K. Jönbrink (2018). Potential Ecodesign Requirements for Textiles and Furniture Nordic Council of Ministers 2018, ISBN 978-92-893-5632-9 https://www.norden.org/en/publication/potential-ecodesign-requirements-textiles-and-furniture

[12] European Commission, 2015, https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF

[13] https://ecostandard.org/wp-content/uploads/2021/04/ECOS-REPORT-HOW-ECODESIGN-CAN-MAKE-OUR-TEXTILES-CIRCULAR.pdf

reusability, repairability, and recyclability in textiles. Therefore it is mandatory to set minimum durability requirements for all textiles, along with the desired product lifespan. Consumers should be given consistent information about the expected lifetime of a product.

2.2. Eco-design

According to Johansson *"Eco-design refers to actions taken in product development aimed at minimizing a product's environmental impact during its whole life cycle, without compromising other essential product criteria such as performance and cost."* [14]The eco-design approach attempts to include environmental factors and typical business-oriented ones in product development to mitigate the impact during the entire life cycle [15] Eco-design is the only way to reduce negative environmental consequences and incorporate environmental protection standards throughout a product's life cycle.[16] The concept of design is ubiquitous and forms the fundamental basis for developing a product or service. Eco designing a product or service involves:

- creating a circular system around it to make it appealing to people,
- reduce its environmental impact
- optimize its business impact throughout its life cycle.

How can these aspects be achieved?

The goal of eco-design is to minimize the overall environmental impact of a product or service. It refers to innovative design solutions for products and services that encompass the complete lifespan, from raw material extraction to manufacturing, distribution, and usage, all the way to recycling, "repairability," and disposal. (Figure 7).

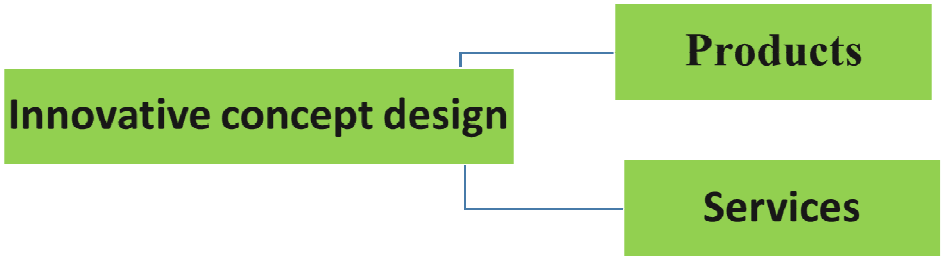


Fig. no 7. Innovative concept design

Throughout the life of the product, pollution reduction is just as important as it is during manufacture. However, ecodesign is a flexible and developing notion that should be regarded as a design strategy rather than a label for environmentally responsible items[17].
Enhancing the useful lifespan of products implies more than just recycling materials. It refers

[14] Johansson, G. (2002), "Success factors for integration of ecodesign in product development: A review of state of the art", *Environmental Management and Health*, Vol. 13 No. 1, pp. 98-107. https://doi.org/10.1108/09566160210417868

[15] Karlsson, R., & Luttropp, C. (2005). EcoDesign: What's happening? An overview of the subject area of EcoDesign and of the papers in this special issue. *Journal of Cleaner Production*, *14*(15-16), 1291-1298. https://doi.org/10.1016/j.jclepro.2005.11.010

[16] Pavko Čuden, A. (2022). Sustainability in functional and technical textiles. *Functional and Technical Textiles*, 779-818. https://doi.org/10.1016/B978-0-323-91593-9.00012-2

[17] https://sustainabilityguide.eu/ecodesign/design/

to retaining a product as similar to its original state as feasible over time, whether through an extended usage period, repair, upgrading, refurbishment or remanufacturing.

Eco-design is a human-centered design approach with a focus on human needs and environmental impact. It defines the problem by looking at the entire system. This approach is based on *circular systems thinking* (lifecycle thinking).

According to the fundamental principle of circular systems thinking everything is interconnected. Eco-designing a product entail making it appealing to people and considering its entire life cycle by applying environmental standards at all stages with the accent of reducing the environmental impact.

The fundamental principles of circular systems thinking encompass:

1. **Design for purpose** by understanding customer demands and habits.
2. **System design** - Consider circular value and supply chains.
3. **Design and innovation – Implies to consider during** product and service design, innovative methods to use and reuse the product.

In this regard, the eco-design wheel is very representative (Figure 8)

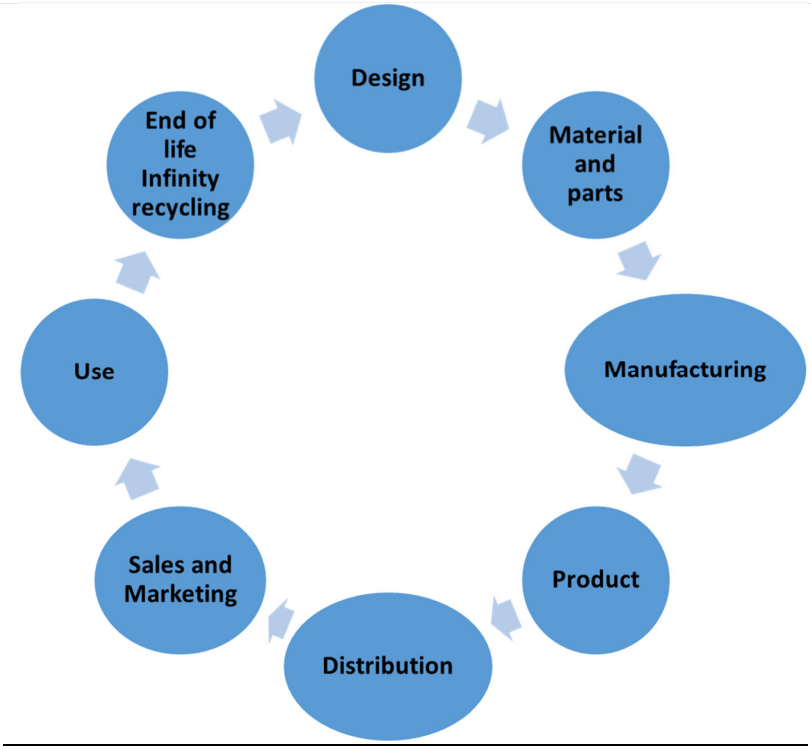


Fig. no. 8 The ecodesign wheel[17]

The eco-design wheel reveals that within the life cycle, the corporation or public body that has decided to implement an eco-conception strategy must pose a few inquiries. The instances envisage concept, materials and parts (weight/volume), manufacturing, product, distribution, sales and marketing, use, optimized life cycle and end of life. [18]

[18] https://www.fashiondata.io/en/eco-conception-in-fashion-towards-the-end-of-fast-fashion/

Eight steps for attaining circularity via Eco-design comprises:

1. Advise clients to select the most appropriate solution for their needs.
2. System-wide, life-cycle perspective.
3. Design for low-impact materials (long-lasting, compact, lightweight, and energy-efficient), and minimize the number of design components and parts.
4. Optimize industrial processes to reduce environmental effects, including energy usage, pollution, waste, and output yield.
5. Design for lifetime sustainability by enhancing a product's lifespan, ease of maintenance and repair, standardization, and modularity for future updates.
6. Design for improved transportation (local distribution system, shift from road to rail, air to sea) and packaging (optimized load, limited air, reduced packing).
7. Design for resource efficiency (low power consumption, easy maintenance) and versatility (upgradable and long-lasting).
8. Design for dismantling, reassembly and recycling of parts.

It is compulsory to pay attention to consumer desires and satisfy those demands (similar to developing goods in general).

Appropriate material use is crucial for circular design. This involves utilizing renewable and sustainable materials from planting to biodegradation (Biological Cycle) and using limited and non-renewable technical materials that can be retrieved and reused in the future (Technical Cycle), rather than continuing to extract scarce resources from our planet._[19]

The Eco-design for Sustainable Products Regulation will work by controlling a definite set of product features and criteria, as depicted in Figure 9.

While these needs can vary greatly depending on the sort of goods, the key eco-design aspects representative of the textile are discussed below.

[19] http://www.idrv.org/wp-content/uploads/Circular-Design-Rules-V-1-IDRV.pdf

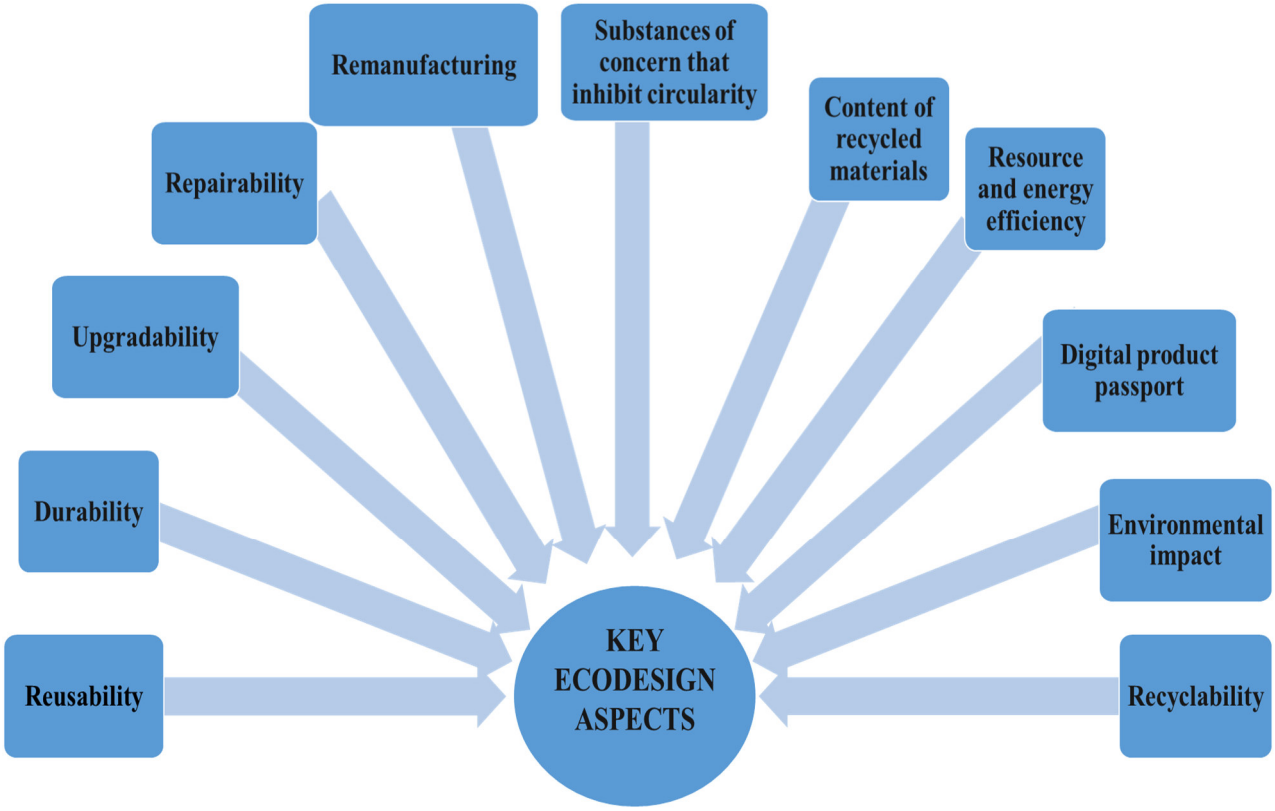


Fig. no. 9 Key Ecodesign aspects

Policymakers have the opportunity to make sustainable textiles the norm. Hence, a set of recommendations shows how this target can be achieved.

2.3. Durability

Durable products are long-lasting, demand minimal maintenance, and preserve their original performance and attributes. Within this context, "durability" refers to improving the quality of textiles, including their reuse and repair possibilities, rather than specific attributes like oil repellence or waterproofing.[20]

Design, production, manufacturing, and use are factors impacting durability. These influence all stages of a product's lifecycle. Emphasis on low-cost, trend-driven fashion without minimal quality standards might result in worse material quality, increased discarding of 'out-of-fashion' clothing, and a more rapid production cycle.

Design options in the production processes like the selection of fibers, their dimensions, thickness, and length, yarn number, twist, and density, fabric binding, weaving and seaming techniques, as well as finishing processes (dyeing, printing), or application of fasteners and accessories and their features, all exert a significant impact on durability. [20]

Besides, various factors influence the active lifetime of a garment or other textile product. Some of these are technical deficiencies in the product itself; others are changes in the

[20] https://ecostandard.org/wp-content/uploads/2021/04/ECOS-REPORT-HOW-ECODESIGN-CAN-MAKE-OUR-TEXTILES-CIRCULAR.pdf

wearer's body size or shape, contextual causes; and still others are subjective, relating to style and fashion issues[11]

According to the literature, approximately 60%[30] of discarded textiles are disposed of due to poor quality or failures in the garment itself (e.g., pillage, colour fastness properties, tear strength, dimension stability, zipper quality, no form-retention after laundering etc.).[11]

How to design products and systems for prolonged lifetimes (with increased durability)?

Extending product and part lifespans represent a solution for shifting to a circular economy. Numerous design techniques are proposed to facilitate durability. To amend product longevity, designers should envisage a set lifespan, considered the optimal choice, rather than expanding it.[21]

Design for durability involves enhancing the physical and technical strength of clothes while also considering their emotional and expressive features for consumers. This may result in prolonged usage and an extended operating cycle. [22]Physical durability refers to the combination of material selection and garment design, including constituent reinforcement, to produce very durable items that can withstand damage and wear over time. Physical durability itself is insufficient. A range of factors, such as timelessness, uniqueness, history, and value, might impact emotional durability.

Emotional durability can be attained by using tactics to enhance and preserve a product's significance and attractiveness to a single or several users throughout time.[23]

The durability of textile products can be attained via the following measures**:**

• Ensure minimal product durability and lifespan prerequisites for all textile goods.

- Determine the intended lifetime of the product in absolute numbers.
- To reduce the environmental impact of clothing, it's important to specify testing techniques that account for long-term wear and washing.

- Determine a clear threshold for adaptive durability in textile products.
  - Establish requirements for fabrics to provide pill resistance, superior color fastness, tear strength, and dimension stability.
  - Define high-quality fabrics and textiles, distinguishing them from low-quality materials.
  - Set durability standards for certain components, especially weak places like seams and zippers.
- Guarantee yarns, spinning, and weaving techniques enhance durability.
  - Different spinning procedures affect woven fabric characteristics, including fiber length, weave type, durability, tensile strength, roughness, softness, and firmness.
- Determine a product's desired stress resistance and longevity using product-specific indicators.

[21] Carlsson, S., Mallalieu, A., Almefelt, L., Malmqvist, J. (2021) 'Design for Longevity - A Framework to Support the Designing of a Product's Optimal Lifetime', in Proceedings of the International Conference on Engineering Design (ICED21), Gothenburg, Sweden, 16-20 August 2021. DOI:10.1017/pds.2021.100

[22] Laitala, K., Boks, C., Grimstad K., I. (2015) Making Clothing Last: A Design Approach for Reducing the Environmental Impacts. International Journal of Design Vol. 9 No. 2, 2015

[23] https://www.ellenmacarthurfoundation.org/articles/designing-products-to-be-used-more-and-for-longer

Provide standard wash and care labelling on all textile items, considering mind durability and minimum lifespan requirements. There is presently no European regulation that controls the usage of symbols for washing guidelines and other areas of textile care.[24]

2.4. Repairability

The design and durability of a product determine its repairability. Garments that are not designed for durability are improbable to be repaired.

Repairability is also impacted by the design of replaceable parts, which may include fasteners. Although spare parts (e.g. fasteners, accessories) are obtainable, there is no easy access mechanism for consumers. Additionally, producers do not assume responsibility for textile repairs. Current fashion trends do not design for repair, even though specific weaknesses might be solved, such as a greater simplicity of disassembly or the ability to access or replace certain parts. Wear, tear, stains, and technological defects contribute to 50-60% of clothing discards, aside from subjective factors like boredom and size variation. Textiles have few failure points, yet fasteners are a significant example of a part that can depreciate in clothes. A simple removal and replacement of fasteners can contribute to more affordable garment repairs. Furthermore, the supply of spare parts (fasteners for example) might be a source of eco-design concerns [24]

Replacement of buttons, and fasteners, including needle and thread for home repair, may be required.

The modular design constitutes an important design aspect for various product categories since it allows for easier repairability and functional enhancements.

This might be applied to clothes to allow for the removal and replacement of worn-out components such as elbows and knees.

Yet it can be challenging to imagine eco-design standards that could be accomplished.

This can be ascribed to the absence of policy requirements relating to product stewardship (care) and those linked to design for repairability, which disproves the industry's dominant business model.

How can products be more easily repaired and upgraded?

What strategies may be implemented to facilitate the process of repairing and upgrading products?

- Guarantee repairability and modularity: critical product components should be easily interchangeable, repairable, and upgradeable. Material recovery, value retention, and meaningful future use must all be considered while designing products.
- Easy dismantling of textiles to enable replacement and recycling. The Jeans Redesign Guidelines created by Ellen MacArthur promote the facilitation of effortless

[24] https://circulareconomy.europa.eu/platform/en/knowledge/durable-repairable-and-mainstream-how-ecodesign-can-make-our-textiles-circular-report-ecos

dismantling of any supplementary materials incorporated into the fabric, including accessories, metals, and Radio-Frequency Identification.[25]

- Necessity of disassembly criteria to enable replacement and recycling. For example, opting for stitching rather than gluing can facilitate disassembly and limit the occurrence of harmful compounds in the supply chain.
- Evaluating the two stated requirements is challenging. Therefore, according to ECOS, it is mandatory to set up product-specific criteria to evaluate and compare the simplicity of non-destructive product detachment[23]

2.5. Reusability

Textile reuse extends the useful life of textile items by handing them to new owners, with or without adjustment. [26] Second-hand stores, flea markets, garage sales, internet marketplaces, charities, and garment libraries can assist in renting, trading, exchanging, borrowing, and inheriting of items.[27]

Reusability relies on the availability of durable fabrics in the market. Garments with weak areas, such as seams, closures, or accessories, are less likely to be reused. Additionally, reusing textiles needs a business plan that successfully distributes the products.

Only a small amount of clothing gets reused. According to recent research, reusing textiles has a 70-fold reduced environmental effect, even after considering worldwide reuse exports, which include transportation emissions. Unfortunately, roughly 62% of used clothing and textiles ultimately end up in household debris; hence, quality textiles may be burned or landfilled.[28] *How to make products easier to reuse?*

- Set explicit, ambitious, and time-sensitive reuse and preparation goals to promote reusability.
- Establish product-specific criteria for assessing upgradeability, reusability, and remanufacturing to extend product life. Larger pieces of fabric can be recovered with fewer seams.
- Provide size and dimension information for all textile products.[24]

2.6. Remanufacturing

Remanufacturing of textiles and apparel, named as *Re: textiles*, is the process of restoring used textiles and clothes to their original condition, following the guidelines outlined in the EU Waste Framework Directive. which are defined as *"checking, cleaning, or repairing recovery operations for re-use, and reprocessing waste materials into products, materials, or substances for the initial or other purposes"*

[25] Ellen MacArthur Foundation, The Jeans Redesign: insights from the first two years, 2021; https://emf.thirdlight.com/file/24/Qp81ASxQUnXjs-Qpe_FQhpWxLN/The%20Jeans%20Redesign%20Guidelines%202021.pdf

[26] Sandin, G., Peters, G. M. (2018). Environmental impact of textile reuse and recycling – A review. *Journal of Cleaner Production*, *184*, 353-365.

[27] Fortuna, L. M., Diyamandoglu, V. (2017). Optimization of greenhouse gas emissions in second-hand consumer product recovery through reuse platforms. *Waste Management*, *66*, 178-189. https://doi.org/10.1016/j.wasman.2017.04.032]

[28] https://www.recycling-magazine.com/2023/01/18/new-study-clothing-reuse-has-a-70-times-lower-environmental-impact/

Remanufactured fashion refers to *"fashion clothing that is constructed by using reclaimed fabrics, which can either be post-industrial or post-consumer waste, or a combination of both."* [29] .

Remanufacturing refers to the process of recovering and processing discarded clothes. This process involves implementing reverse logistics systems, such as collecting, as well as developing sorting, disassembly, and production factories. Expanding the availability of remanufactured clothes to the general public enhances the potential for increased sustainability; nevertheless, it also entails certain challenges[29]

Remanufacturing is distinct from the processes of repairing or recycling.

Repairing refers to the process of restoring a broken or damaged product to its functional state.

Recycling transforms materials into a different product with a different purpose.

Figures 10,11,12 encompass different samples of remanufactured products that are created entirely from reclaimed fabrics. (full remanufacturing, semi-remanufactured products, products with no disassembly and minor value addition)

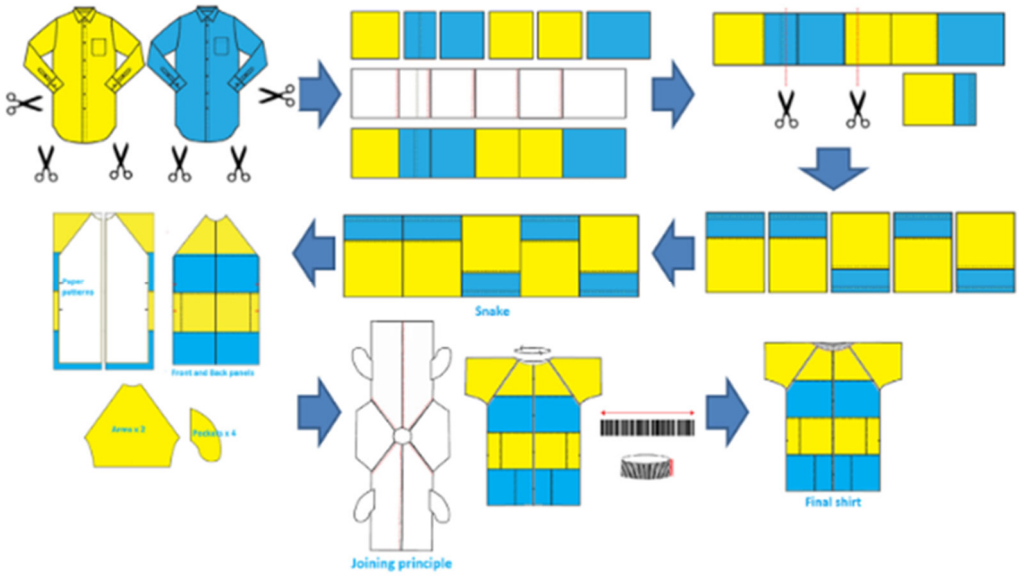


Fig. no. 10 Illustrative "Sewn from scratch" type of remanufactured items[30]

[29] Sinha, P. Dissanayake, G. (2015) An examination of the product development process for fashion remanufacturing. Resources, Conservation and Recycling, 104 (Part A). pp. 94-102. ISSN 0921-3449 https://doi.org/10.1016/j.resconrec.2015.09.008

[30] Pal, R., Samie, Y., & Chizaryfard, A. (2021). Demystifying process-level scalability challenges in fashion remanufacturing: An interdependence perspective. *Journal of Cleaner Production*, *286*, 125498. https://doi.org/10.1016/j.jclepro.2020.125498

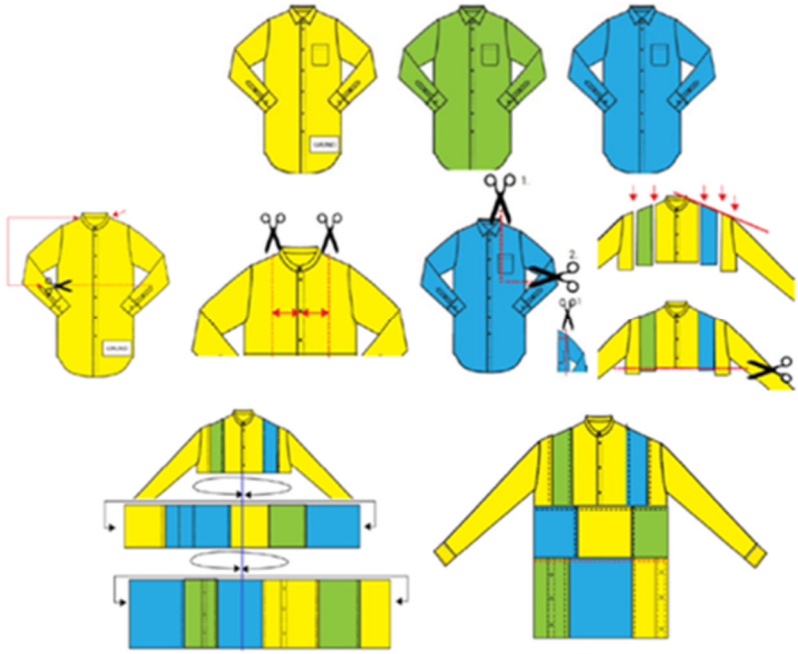


Fig. no. 11 Illustrative "Cut, add and put-together" sort of remanufactured textiles[30]

Fig. no.12 Illustrative "Minor-value adding" type of remanufactured clothing[30] *Advantages of remanufacturing:*

- decreases the need for new resources and is therefore recognized as one of the most effective methods for promoting sustainable manufacturing and waste management.[31]
- The quality of remanufactured clothing is comparable to or surpasses that of new fashion products. The key factors for successful remanufacture were determined to be the quality of the discarded garment and the level of disassembly skill.

[31] Krystofik, M., Wagner, J., & Gaustad, G. (2015). Leveraging intellectual property rights to encourage green product design and remanufacturing for sustainable waste management. Resources, Conservation and Recycling, 97, 44-54. https://doi.org/10.1016/j.resconrec.2015.02.005

- A quality indicator, such as a warranty, is essential for two reasons: to distinguish between a "new" product and a "good as new or better" quality.[32] a potential to develop distinctive, limited-edition products for customers who are prepared to invest more in a single product
- Decreasing textile production reduces the consumption of water, energy, and chemicals, resulting in a decline in greenhouse gas emissions.
- Numerous sustainable fashion designers have acknowledged the potential of fashion remanufacturing as a novel business opportunity.

Regardless of these benefits, this business continues to operate in a niche market. The operation of the reverse logistics process and the process of fashion remanufacturing have been the subject of limited research.

The key steps for achieving the strategic advantage in fashion remanufacturing are considered to be: design, cutting, assembly, modular manufacturing, and quality control.

Remanufacturing encounters obstacles at many stages[33] (Figure 13)

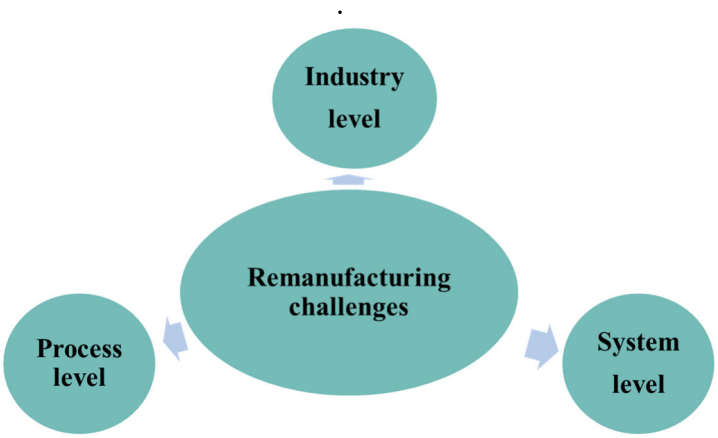


Fig. no. 13 Remanufacturing challenges

Due to the high number of internal and external issues, remanufacturing is complex and challenging to handle.

Internal risks commonly arise from the remanufacturer's internal process difficulties, whilst obstacles beyond the companies' boundaries determine external uncertainties.[34]

How can a successful remanufacturing process be achieved?

[32]Hatcher, G., Ijomah, W., & Windmill, J. (2011). Design for remanufacture: A literature review and future research needs. *Journal of Cleaner Production*, *19*(17-18), 2004-2014. https://doi.org/10.1016/j.jclepro.2011.06.019

[33] Remanufacturing of deadstock and customer claims apparel - Perspectives on business strategy adoption, consumer perceived value, and economic feasibility Authors: Adrian Zethraeus, Ann Vellesalu, 2020, Swedish School of Textile, https://www.diva-portal.org/smash/get/diva2:1666948/FULLTEXT01.pdf

[34] Kurilova-Palisaitiene, J., Sundin, E., & Poksinska, B. (2018). Remanufacturing challenges and possible lean improvements. *Journal of Cleaner Production*, *172*, 3225-3236. https://doi.org/10.1016/j.jclepro.2017.11.023

Addressing all these challenges could lead to a successful remanufacturing process. In addition, an appropriate solution would involve a network of remanufacturing processes, including:

- waste textile collection firms,
- technology providers for cutting-edge pattern-cutting and management software,
- local craft entrepreneurs in target markets for second-hand clothing,
- and manufacturing facilities that supply clothing to major retailers.

2.7. Environmental impact

Household textiles, apparel and footwear are all responsible for landfills, greenhouse gas emissions, and water pollution.

The constant supply of novel trends at low prices, known as fast fashion, has led to an important rise in the total amount of discarded apparel.[35] Resource extraction, production, washing and drying, and waste incineration are the primary sources of greenhouse gas emissions that are generated by the production and consumption of textiles[36] Along with the greenhouse gas emissions, the environmental impact of textiles can be ascribed to: - Water use

- Water pollution
- Textile waste in landfills
- Plastic release into the environment.

The environmental impact of particular activities is evaluated using carbon and ecological footprint measurements.

The categories of actions assessed, and their respective definitions are the key components of the differences between an ecological and a carbon footprint.

The differences between carbon footprints and ecological footprints are depicted in Figure 14.[37]

[35] https://www.europarl.europa.eu/news/en/headlines/society/20201208STO93327/the-impact-of-textile-production-and-waste-on-the-environment-infographic

[36] https://www.eea.europa.eu/publications/textiles-and-the-environment

[37] https://8billiontrees.com/carbon-offsets-credits/carbon-ecological-footprint-calculators/globally-green-environment/

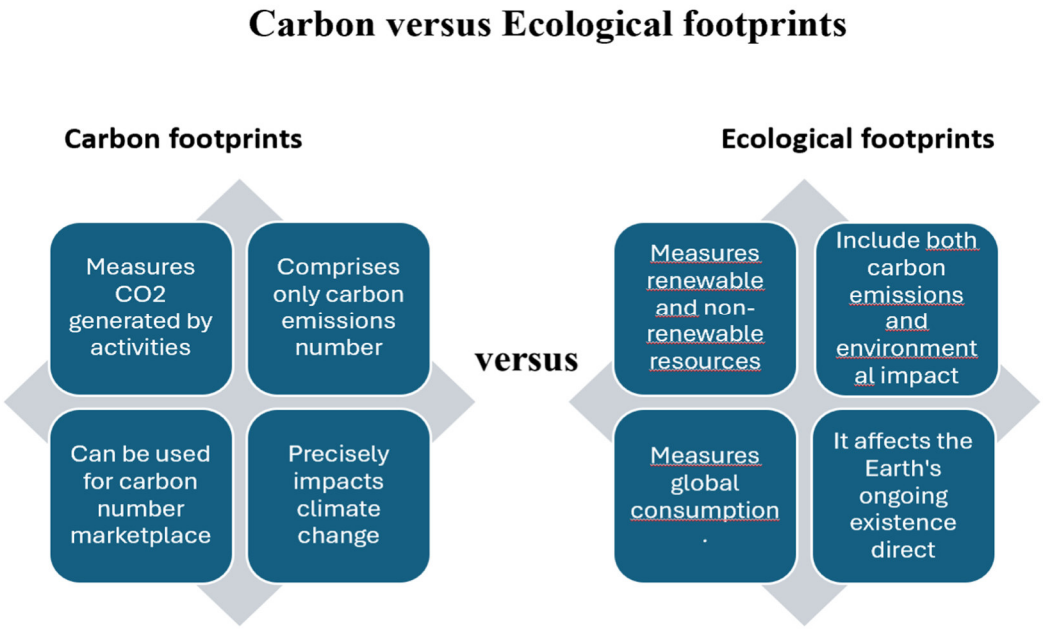


Fig. no.14 Carbon footprints versus ecological footprints

Ecological footprint:

- Include much more than greenhouse gas (GHG) emissions
- Measures the pressure we exert on nature
- It calculates how many natural resources we use and compares that with the availability of these resources.

The calculations also evaluate the energy efficiency of our homes, the materials used to construct them, and their size. The ecological footprint also includes information on the amount of waste we produce, how we travel, how we move, and whether we have access to renewable energy sources[37]

Carbon footprint

- Represents the carbon component of the Ecological Footprint
- Greenhouse Gases (GHGs) are the basis of the assessment of the carbon footprint of various processes, products, and entities.
- Carbon footprint is the term used to evaluate the total emission of GHGs by human activities.

The greenhouse effect is significantly influenced by the presence of six distinct categories of gases Greenhouse Gases in the atmosphere[38]

- Carbon dioxide (CO2)
- Methane (CH4)
- Nitrous oxide (N2O)
- Hydrofluorocarbons (HFCs)

[38] https://css.umich.edu/publications/factsheets/sustainability-indicators/carbon-footprint-factsheet

• Perfluorocarbons (PFCs)
• Sulfur hexafluoride (SF6).

The technical definition of carbon footprint

The concept and connotation of carbon footprints are not currently agreed upon in academic circles. There are three widely accepted perspectives:

- "A carbon footprint is the total greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event or product."
- A measurement of tons of carbon dioxide equivalent, concerning the emission of other greenhouse gases relative to one unit of carbon dioxide. [39] The carbon footprint unit *tons of CO2 equivalent (tCO2e)* or *kg-equivalent-CO2 (kgCO2e)*[40]

For example, in 2020, the production of textile products consumed in the EU resulted in 121 million tons of carbon dioxide equivalent (CO2e) in greenhouse gas emissions, or 270kg CO2e per person.[36]

The textile industry's entire life cycle is extensive. Therefore, the carbon footprint is defined as three phases based on the activities of the textile industry:

I. agricultural stage (cultivation of textile raw materials);
II. industrial stage, (i.e. the production and processing of textiles);
III. sales stage, (transportation and distribution of textiles).

Life Cycle Assessment (LCA) is a conventional approach to system analysis that differs from input-output analysis and bottom-up carbon footprint calculation methods. The stages involved in the evaluation of the LCA method for carbon footprint include:

- the establishment of a product manufacturing flow chart,
- determination of system boundary, collection of data,
- calculation of carbon footprint and test of results.

How to decrease a carbon footprint?

The primary contributor to the carbon footprint is energy- and water-intensive textile processing. Multiple strategies have been suggested to mitigate the carbon footprint of textile manufacturing[41] the most effective way to is to decrease the amount of energy needed for production

- reuse and recycle textiles.
- to decrease the dependence on carbon-emitting fuels.
- use of natural fibers since they have a lower carbon footprint than synthetic ones.

2.8. Digital product passport

[39] Zhang, J., Qian, X. and Feng, J. (2020), "Review of carbon footprint assessment in textile industry", Vol. 1 No. 1, pp. 51-56. https://doi.org/10.1108/EFCC-03-2020-0006

[40]https://textilevaluechain.in/in-depth-analysis/carbon-footprint-in-textile-industry/.

[41] Rana, S., Pichandi, S., Karunamoorthy, S., Bhattacharyya, A., Parveen, S., & Fangueiro, R. (2015). Carbon Footprint of Textile and Clothing Products. In S. Senthilkannan Muthu (Ed.), *Handbook of Sustainable Apparel Production* (1st ed., pp. 141-166). CRC Press. https://doi.org/10.1201/b18428-11

Nowadays it is necessary to develop new technologies, manufacturing processes, materials, and products to adopt the circular economy model. This requires that value chains and material flows become circular, transparent, and traceable.

Nevertheless, the lack of verifiable, accurate data regarding the life cycle, product content, production methods, reuse, and recycling potential may impede the circular economy.[42]

In the linear economy, information regarding the supplier, the components, their origin, and the recycler is at present not widely accessible.

As part of the proposal for an Eco-design for Sustainable Products Regulation (ESPR), the Digital Product Passport (DPP) will enhance the traceability of products, and allow consumers and manufacturers to access all the information concerning a specific product.[43] *What is DPP?*

The European strategy for a sustainable and circular economy seeks to enforce a variety of measures to guarantee that consumers are informed about the environmental impacts of their buying habits and that goods are more reliable, reusable, reparable, resource-efficient, and effortless to repair, refurbish, and recycle. This is one of the measures. European Commission has worked to develop a Digital Product Passport for textiles in 2024[43] The concept of a digital product passport.

"A set of data summarizing a product's components, materials, chemical substances and/or information on repairability, replacement parts and proper disposal".

The European Commission described the DPP as a "product-specific data set" that would organize the disclosure demands for products. It can give details about a product's composition, origin, repair, and disassembly possibilities as well as recycling choices for the individual parts.[44]

A final version proposed by the European Commission defines DPP as:

" DPP is the combination of an identifier, the granularity of which can vary throughout the lifecycle (from a batch to a single product), and data characterizing the product, processes and stakeholders, collected and used by all stakeholders involved in the circularity process".[45]

The level of precision of the product information is determined by *granularity*. It may be a unique identification or a product reference that corresponds to a manufacturing batch or, more broadly, to multiple manufacturing batches with identical characteristics.

DPP is a technological solution for a digital policy instrument that collects information on the value chain, sustainability, raw materials, and product safety in various domains.[46]

This information generates a new level of transparency that improves the interaction between different value chain participants (such as producers and recyclers), increases consumer

[42] https://gceurope.org/digital-product-passport-what-is-it-and-what-does-it-imply-for-the-textile-industry
[43] https://www.europarl.europa.eu/RegData/etudes/STUD/2024/757808/EPRS_STU(2024)757808_EN.pdf
[44] University of Cambridge Institute for Sustainability Leadership (CISL) and the Wuppertal Institute. (2022). Digital Product Passport: the ticket to achieving a climate-neutral and circular European economy? Cambridge, UK: CLG Europe. https://www.corporateleadersgroup.com/files/cisl_digital_products_passport_report_v6.pdf
[45] *Digital product passport for the textile sector.* European Parliamentary Research Service, June 2024, https://www.europarl.europa.eu/RegData/etudes/STUD/2024/757808/EPRS_STU (2024) 757808_EN.pdf
[46] https://www.stjm.fi/wp-content/uploads/2022/10/Digital-Product-Passport-A4-v010.pdf

awareness, and enables more informed decision-making. This essential instrument for disclosure would enable the expansion of circular economy initiatives and the dissemination of information regarding the sustainability characteristics of a product to stakeholders and customers.[42]

The main goals of the policy options on a potential textile DPP include:

- Improved transparency across the complete value chain;
- Greater efficiency and decreased consumption of raw materials;
- Enhanced production of long-lasting products;
- Diminishing waste generation;
- Facilitated competition with fast-fashion actors by promoting product differentiation based on quality.[45]

In the case of textiles, the Digital Product Passport could cover aspects such as:

- Working conditions under which products are manufactured, reused or recycled
- The environmental footprint of the product
- Bill of materials (BOM)
- Presence of hazardous chemicals including substances of concern used in production
- Use of recycled content
- Durability/expected lifetime
- Microplastics release[47] According to the EU Commission, 16 categories of information and concepts could be enclosed in the DPP after the products were endorsed by reference ('unique' or 'batch') and brand [45]The information enclosed in DPP comprises:

1. Product description
2. Composition
3. Supply chain
4. Transport
5. Documentation
6. Environmental impact
7. Social Impact
8. Impact on animals
9. Circularity
10. Health impact
11. Information on the brand
12. Communication/identification media
13. Granularity
14. Quantity
15. Costs
16. After-sale tracking and tracing
17. Customer feedback

[47] https://www.eurofins.vn/en/consumer-product-testing/news/textile-digital-product-passport-for-2024/

Benefits of DPP to European industries; Implication for the textile industry

According to the *Proposal for Ecodesign for Sustainable Products Regulation*, the employment of Digital Product Passports is designed to **increase** several aspects as depicted in Figure 15.[48]

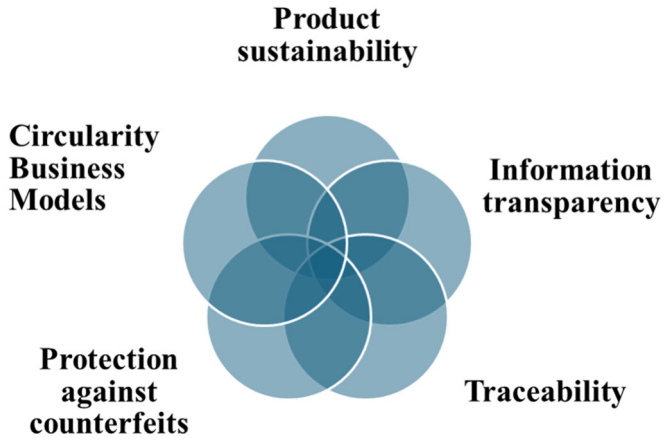


Fig. no.15 Aspects do be increased by DPP

In addition, DPP facilitates the shift to a more sustainable economy by enhancing the sustainability of goods and extending their lifespans.

Recyclers can more precisely quantify a reasonable price and estimate the true value of a product at the end of its lifecycle, opening up new markets for sustainability.

Additionally, the launching of a Digital Product Passport could facilitate market regulation and supervision, thereby improving the EU single market.

Indeed, the DPP must be a tool that is simply accessible and usable by SMEs. It should not be restricted to significant enterprises that own substantial supplies, resources, and capacity.[42]

2.9. Identification of substances that inhibit circularity

The REACH regulation strictly governs the use of chemicals in the textile industry. [49] All European textile manufacturers and importers must consider the REACH regulation.

The substances of very high concern are considered to influence humans and inhibit circularity negatively. The addition of these chemicals of very high concern (SVHC) in the SVHC list, and the requirement to declare their presence in textiles at concentrations greater than 0.1%, should contribute to a decreased application in textiles. But do producers declare these chemicals? Producers want to avoid disclosing these chemicals because it may harm their reputation.

Substances of very high concern (SVHC) encompass those labelled as: Carcinogenic, mutagenic or toxic to reproduction (CMRs),

[48] **https://www.scantrust.com/digital-product-passports-dpp-eu-product-labeling-regulations/**

[49] Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), 1907/2006 of 18 December 2006 and Directive on the Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) 2011/65/EU of 8 June 2011 https://echa.europa.eu/home_en.asp

persistent, Bio accumulative & Toxic (PBTs) Very persistent very bio accumulative (vPvBs)[50]

Chemical content versus ***chemical use***

It is crucial to differentiate between the chemical composition and the use of chemicals.

Certain chemicals should be avoided or used carefully in textile production as they can be found in the final textile goods. One example is azo dyes, which have the potential to release or transform into cancer-causing aromatic amines. Textile products containing these substances are forbidden from being imported into the EU market.

Further substances that are not needed in the finishing stage, such as banned cotton biocides, may not be present in the finished textile product (BPR rule). They are not always identified on the finished textile product since they may be washed out throughout the production phase (e.g., dyeing and finishing). Therefore, the REACH legislation has a limited influence outside of the EU market. In this sense, the focus should be on non-toxic, circular products and materials.

It is also required to limit and substitute chemicals of concern, and to encourage transparency regarding the chemicals found in textile goods and employed in the production process.

Under these circumstances, there are some proposals for requirements

- - Implement eco-design principles to ensure that textile goods are free from pollutants classified as a very high concern (SVHC);
  - Enhance the circularity of the REACH Regulation and specifically target the unique characteristics of textiles, promoting the substitution and the removal of hazardous compounds;
  - Establish mandatory measures to minimize the use of hazardous substances and to track and publish information regarding their usage.

Chemical aspects

Requirements under the Eco-design Directive may not conflict with or duplicate limits and restrictions found in other EU policy instruments, and REACH's life cycle approach already ensures that chemical issues are taken care of in product regulation to a large degree.[49]

The Eco-design Directive can regulate chemical substances (based on their inherent properties) with the specific aim of enhancing the options for recycling textiles, which is different from the aim of REACH.

Labels and certification schemes employed in the textile supply chain, such as OEKO-TEX® standard 100, Blue sign, GOTS, Nordic Swan, and STeP by OEKO-TEX®, are also effective outside the EU. The textile industry uses these labels focusing on textiles to make green claims about chemical usage and chemical content. Furthermore, they serve to demonstrate to stakeholders compliance with regulations such as REACH.[49]

[50] https://echa.europa.eu/home_en.asp

2.10. Content of recycled materials

The environmental impacts of textiles are significantly determined by the type of fiber employed. Applying recycled fibers can greatly diminish energy and resource consumption, resulting in notable environmental and economic advantages, as recycling procedures typically need less energy than new fibers' manufacturing process.

Requiring a minimum recycled content could encourage the collection of used textiles, the development of (new) sorting and recycling technologies, and the design for recycling. Several guidelines use the principle or requirement to obtain fibers or yarn that contain recycled and/or reclaimed content. Imposing a mandatory minimum recycled content may promote the collection of used textiles, the advancement of novel sorting and recycling technology, and the design of easily recyclable products. The minimal thresholds need to be adjusted considering the type of fiber.

Besides, it is imperative to distinguish between the materials recovered from pre-and post-consumer waste, as the last group is more challenging to repurpose but contributes more to the circular economy. (Figure.16)

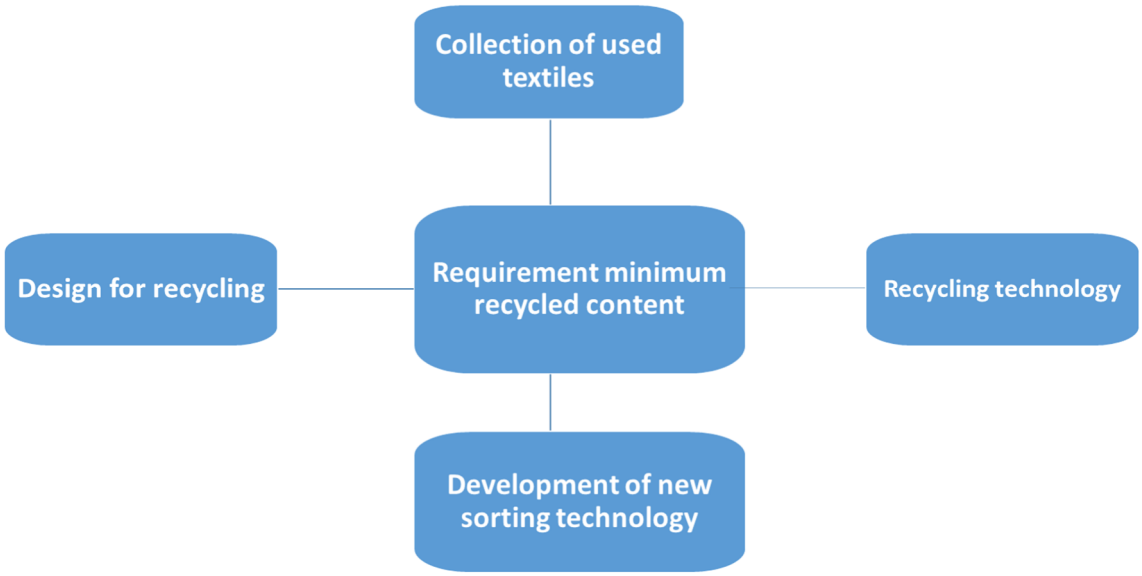


Fig. no.16 Factors affecting the minimum content of recycled fibers

The requirement concerning the use of fibers and yarn with recycled content is envisaged in various guidelines:

Declaration of, and/or minimum threshold for, recycled content as part of Bauer et al. (2018)'s *potential eco-design requirements for textiles* (and furniture): "Textile products must carry a visible label with a declaration of the percentage by weight content of recycled materials and/or Products within (stated fibre group) must contain a minimum of X% recycled material by weight [11]This principle would be appropriate for clothing and home textiles.

1. The Circular Materials Guidelines V1.0 developed by *Fashion Positive* outlines: "Requirement 1A: recycled and/or reclaimed content. The criteria specifically envisage the inclusion of recycled material into fibers.:
    - Optimal performance: 5-74% of recycled material is included in the fiber/yarn composition and/or reclaimed material.
    - Ideal: at least 75% of recycled material integrated into the fiber/yarn composition, including post-consumer waste and/or reclaimed raw materials.[51] The purpose of this requirement encompasses "fiber and fibrous materials production facilities," so applying to all the product categories specified in this report.

Therefore, eco-design criteria for textiles and other items should encompass design considering durability and extended lifespan, simplicity of repair and upgrading, and ease of disassembly to facilitate material recovery. Furthermore, as demonstrated by Watson et al. (2017), incorporating design principles that enhance recycling should be sustained by legislative initiatives providing a market for secondary materials. Hence, ecodesign criteria for textiles may encompass criteria that enhance the proportion of recycled materials in newly developed items.

The following (third-party) initiatives or standards could be used to validate the need to include recycled and/or recovered content:

- Recycled Claim Standard (RCS)
- Global Recycle Standard (GRS)
- QA-CER (Ensures the quality of the recycling process and the use of recycled materials.)
- SCS Recycled Content Certification
- UL Recycled Content Verification.[52]

2.11. Recyclability

Recycling is a fundamental principle of contemporary waste management.
Recycling refers to the process of transforming waste materials into new or reusable items. Textile recyclability is dependent on relevant recycling technologies. Products that were not recyclable ten years ago could be recyclable as technology advances. As a result, requirements in this area will need to account for possible future advancements in some way. Current fashion trends generate a significant amount of textile waste overall. Still, the waste quality is inferior, restricting recycling processes from attaining the intended quality or extracting the desired content.
Many factors impede textile recycling into new textiles. These factors comprise:

- The use of mixed fibers, in which a natural fiber is mixed with a synthetic fiber. Ex. Polyester-cotton fabric blends.

[51] Fashion Positive, 2020https://fashionpositive.org/wp-content/uploads/2020/10/Circular-Materials-Guidelines-v1.0-Final-08202020.pdf
[52] https://circulareconomy.europa.eu/platform/sites/default/files/ecodesign_criteria_for_consumer_textiles.pdf

- The lack of relevant information makes it challenging for recyclers to utilize the appropriate recycling technology.
- Non-removable components, including zips and other fasteners, and labels;
- Persistent functional chemicals, including flame retardants and anti-bacterial finishes, can contaminate recovered fibers and subsequent 2nd generation recycled products and/or be harmful to staff involved in the recycling process.
- Dyes and finishes that obstruct chemical recycling processes[11] Textile collection and sorting for recycling.

How to facilitate the recycling of products?

Textile recycling encounters numerous obstacles. Textile recycling can be improved by tackling certain challenges:

- Limit the types of material combinations, blends, chemicals, dyes, and finishes unsuitable for recycling. To prevent harmful substances from being circulated via recycling, employ only safe chemicals (dyes and finishes).
- Only allow products on the market that have established large-scale recycling technologies.
- Provide specific requirements for effectively extracting hardware, zippers, and trims before recycling. The seconds required to isolate individual components can quantify simple disassembly.
- Specify recycled material participation standards to ensure they are met with material from closed-loop recycling rather than from other waste streams.
- Supply a detailed chemical and material components inventory, including „a bill of materials and a bill of chemicals". Since certain materials and substances in products obstruct circularity, standards can provide templates for informing recyclers about the material and chemical content of products and the appropriate end-of-life treatment techniques for particular waste streams, which will help make use of secondary raw materials.
- Set clear and rigorous 'end-of-waste' requirements for textile waste.[53]

Chapter 3. Principles of Sustainable Circular Fashion

"The circular economy system diagram, known as the butterfly diagram, illustrates the continuous flow of materials in a circular economy. There are two main cycles – the technical cycle and the biological cycle. In the technical cycle, products and materials are maintained in circulation through processes such as reuse, repair, remanufacture and recycling. In the biological cycle, the nutrients from biodegradable materials are returned to the Earth to regenerate nature."[54]

[53] https://www.eea.europa.eu/publications/management-of-used-and-waste-textiles
[54] https://ellenmacarthurfoundation.org/circular-economy-diagram

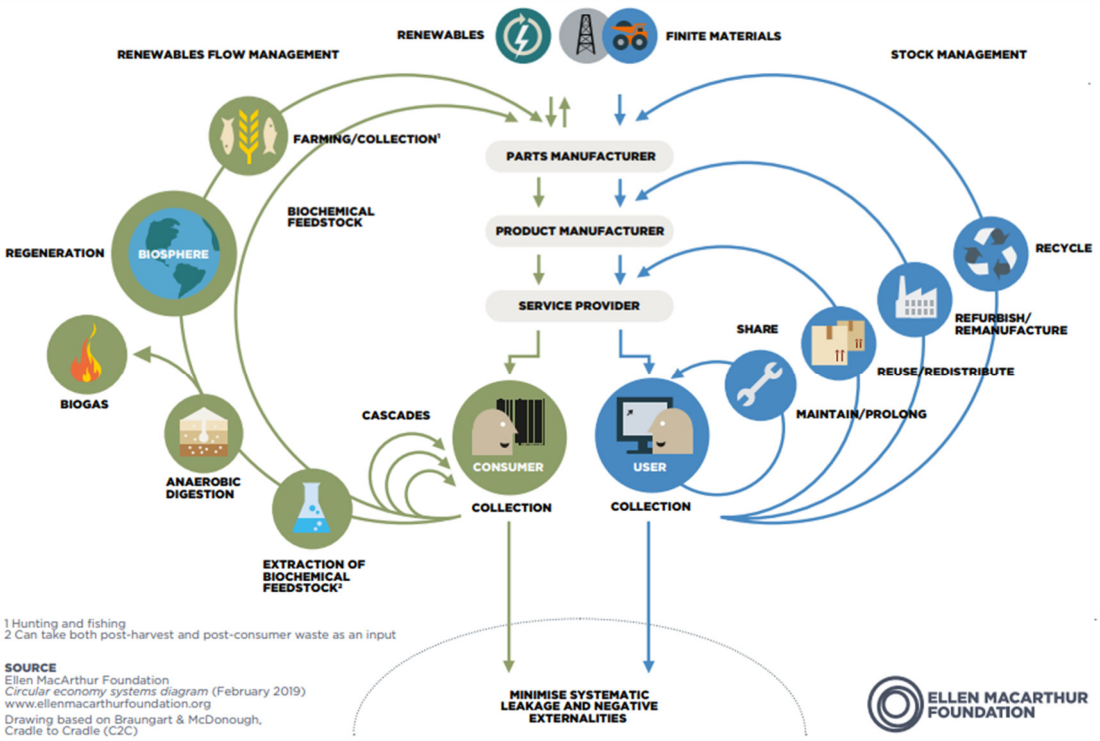


Fig. no. 17 The butterfly diagram

What is fashion? Fashion can be defined as a generalized preference, in a period, and the applicability of fashion is in almost any field.

Fashion is an instinct of people. Fashion defines each of us, it is a state of mind, it is a peculiarity of a group of people at a time. Fashion is part of the "lifestyle", along with sports and healthy nutrition. Sometimes fashion is viewed as a "fad", something "fancy" for a short duration. **Fashion forecasting** is a kind of intuitive research on future trends of buyers, habits and mood. The promotion of a certain kind of clothing to become a "trend" needs the support of a real industry: presentation on stage, taking over in the written press, promotion in TV shows, hanging on banners, and exposure in storefronts. The fashionable prognosis can intuit the life span of a product.

The fashionable forecast is made considering:

1. Study of consumer habits.
2. Setting target groups.
3. Case studies.
4. Interviews in stores, with an informal role.

The trend in fashion is somewhat directed by technological, economic, social factors and last but not least by political ones.

Is there a difference between fashion and style? Yes, there is, style is a term that defines a person, individualizes them and does not overlap with fashion. Coco Chanel said you can't sacrifice style in the name of fashion. Fashion is fleeting, constantly changing, and outfits must be versatile. The style is the one inside, the one related to the soul, it can be said in simple terms that the style is "how you feel". Before they are beautiful, clothes must be comfortable, otherwise they can be passed on to the chapter of beautiful, but unnecessary

things.

"Some styles in clothing:

- **Classic** in which the basic pieces that do not go out of style and are always in fashion trends are highlighted. The classic style highlights the silhouette.
- **Sport** in which the clothes are comfortable, but the silhouette is not always highlighted.
- **Casual or smart casual** is the most used style. Here the freedom to choose the pieces of clothing is maximum, and the combinations of the pieces can give maximum effect. The silhouette can be highlighted or not, but it can be "shaped" to hide imperfections.
- **Office** this style is a classic-elegant one and is most often imposed by companies. In this case, the silhouette is highlighted, the clothes are classic, but comfortable to allow work for at least 8 hours in the same outfit. The office style is specific to the straight skirt up to the knees, the classic trousers, the white shirt, the jacket, the classic topcoat, the classic coat.
- **Baroque** is the style loaded with accessories made of heavy, shiny pieces, dresses with embroidery on large surfaces, with rhinestones and beads.
- **Boho** – chic is a combination of styles that give a relaxing, close to casual and unconventional effect.
- **Romantic** is characterized by dresses and blouses with lace and ruffles, and the coloring is powder pink, blue, pale green, cream, pale purple.
- **Gothic** – is one in dark colors, based on black.
- **Rock** is the style that gives attitude. The leather jacket, jeans and T-shirt are the specific pieces. The accessories are metallic and large.
- **Grunge** – is a nonconformist style specific to the grunge subculture from the 90s. Oversized sweaters and bags, leather jackets and men's hats are specific."[55]

What is a clothing ensemble? A clothing ensemble is a unitary whole, which is specific to a certain style (classic, elegant, office, casual, sports, etc.). A correctly made clothing ensemble is in balance. The excess of beauty creates an imbalance just like the ugly excess. In a harmonious clothing ensemble, the basic pieces and accessories must be correctly chosen, and the attention must fall on a single item that will be "the most beautiful" (example: dress, shoes, purse, hat, watch, etc.).

The design of clothing products is the one that must perfectly correlate the material with the model in order to obtain a "beautiful" clothing product.

Fashion, style and design cannot be separated, they are defining for eras, periods, years and are constantly changing.

Until now, fashion was cyclical and linear, the defining terms being:

RAW MATERIALS → PRODUCTION → USE → WASTE MATERIALS

[55] https://lumeamodei18.weebly.com/stiluri-vestimentare.html

This way of using material resources proves to be a bad one for the environment. Textile waste is in a very large volume, occupying 4th place in the waste hierarchy.

Clothing, as a form of nonverbal communication, has an influence on the state of mind of each person. The notion of "well-dressed" has become one often used nowadays, in the world where it is the image that matters.

A tendency of clothing producers is to produce cotton items from "bio" crops, these items being classified in the "eco" fashion.

"Bio" plant crops are crops that are obtained with fewer chemicals, the chemicals are checked and standardized and comply with all the requirements imposed by the EU. Since items made of "bio" raw materials are produced in small areas, fertilizers are expensive, it follows that clothing will also be expensive compared to similar items from common raw materials. To be part of the 'eco' fashion, the raw materials obtained from 'organic' crops, for example organic cotton, are finished with dyes and chemicals that comply with EU organic standards, so that the final product is one that belongs to the "eco-fashion".[56]

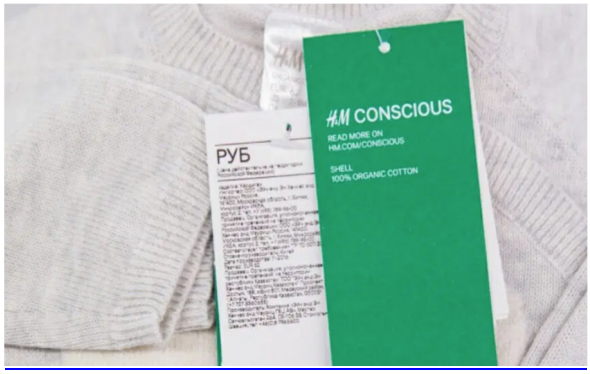
Well-known fashion brands that produce "eco" items

H&M (Hennes & Mauritz - Sweden)

The Swedish brand H&M, founded in 1947 in Sweden, is among the first brands to switch to the "green line", using certified natural materials "bio", dyes and chemicals that meet the environmental standards imposed by the EU. The H&M brand is a brand that does not use natural fur for the production of clothing.

H&M is among the first large clothing brands to produce clothes from recycled raw materials. It is known that used clothes are collected in H&M stores and vouchers are offered as a reward when handing over a package with used, washed, dried and folded clothes.

[56] https://www.renovablesverdes.com/ro/moda-sostenible/



Source: https://www.eco-stylist.com/how-sustainable-is-hm/

Fig. no. 18 H&M labels

C&A

C&A is an international retailer whose origin is in Germany. It was founded in the 17th century and then expanded into the Netherlands and Belgium. The retailer C&A sells brands Clockhouse, Here+There, Avanti, Angelo Literco, Yessica Pure, Yessica, Your Sixth Sense, Rodeo, Palomino.

C&A has a line of bio-cotton items labelled "bio cotton" for articles of underwear, knitted clothing and jeans.

Organic cotton used for clothing production is certified by either GOTS (Global Organic Textile Standard) or OCS (Organic Content Standard).[57]

Source: https://www.c-and-a.com/uk/en/corporate/company/newsroom/featured-stories/2015/ca-is-the-worlds-largest-buyer-of-bio-cotton-again/

Fig. no. 19 C&A labels

Inditex

Inditex is one of the big clothing retailers run by the richest man in Spain. Inditex owns the following brands: Massimo Dutti, Zara, Berska, Pul&Bear, Oysho,

[57] https://www.c-and-a.com/ro/ro/corporate/company/sustenabilitate/bio-cotton/

Stradivarius, Kiddy's Class and Zara Home.

Inditex's policy was to reduce water and energy consumption by 30% for the same production volume, for leed (Leadership in Energy and Environmental Design) certification.

To comply with the recycling criteria, Inditex offers a modest amount, in the form of a voucher, for each unnecessary thing that is brought to the store.

Levi's

Levi's (Levi Strauss) is an American company founded in 1853. Levi's company owns Dockers, Levi's and Signature brands.

Levi's launched the "eco-denim" line with jeans for men and women in 2006. In 2007, the Waterless jeans range was launched to stimulate water reduction for finishing denim fabrics and finishing made jeans.

Mark&Spencer

Mark&Spencer is a brand founded in the UK in 1884 by Michael Marks and Thomas Spencer. The brand sells clothing, home and food products.

Mark&Spencer has implemented technologies to reduce water and energy consumption in the production of clothing items.

GAP

GAP Inc. is a company founded in the U.S. in 1969 by Donald Fischer and Doris Fischer. GAP owns the GAP, Old Navy and Banana Republic brands.

In 2007 gap company was produced T-shirts for men made of knit 100% organic cotton, unpainted. In 2008 GAP launched an organic denim production line, and the packaging of the products was only made of recycled paper.[58]

Principles of sustainable circular fashion

The first indication of the circular economy is the ecolabelling of products.

Ecolabelling

Source:
https://eurlex.europa.eu/legalcontent/RO/TXT/HTML/?uri=CELEX:32010R0066&from=RO

Fig. no. 20 Ecolabel

[58] https://ecology.md/md/page/eco-moda-10-branduri-pentru-produse-organice

What is the Ecolabel?

The EU Ecolabel is a voluntary European label that is awarded for excellence in the field of the environment.[59]

The eco-label was introduced in 1992 and being applied guarantees products with low environmental impact. The ecolabel guarantees a product with low environmental impact throughout its manufacture, distribution and disposal, guaranteeing products with a matte lifetime, easy to repair, reusable and recyclable.

The Ecolabel is an alternative that recommends products with low environmental impact to classic products with a shorter lifespan and that do not meet the standards required by environmental protection.

Ecolabel is a challenge in choosing and promoting sustainable, repairable and recyclable products with respect for environmental protection standards. The Ecolabel is a guarantee, in practice, of the transition from the linear economy to the circular economy.

The EU Ecolabel is in line with the EN ISO 14024 type I standards.

The Ecolabel is a success story that turned 20 years old in October 2022.

Source: https://environment.ec.europa.eu/topics/circular-economy/eu-ecolabel-home/about-eu-ecolabel_en

Fig. no. 21 Ecolabel EN ISO 14024

The Ecolabel is an identification method by which economic operators can market goods and services with low environmental impact.

The Ecolabel is based on two principles:

1. Environmental criteria (minimum implications for soil, air, water).
2. Performance criteria (low risk of allergies, carcinogenic effects, etc.).

[59] https://environment.ec.europa.eu/topics/circular-economy/eu-ecolabel-home_ro

The European Ecolabel is awarded on request and encourages the application of the principles of protecting the environment, protecting public health, and recycling products. Ecolabel is somewhat like an accreditation system

The ecological criteria are valid for a period of 3-5 years, being constantly reviewed and adapted to technical progress.

The Ecolabel is a graphical method of identifying how an item of clothing or packaging on the market complies with environmental criteria. Eco-labels are a means of informing consumers about how a product is scientifically designed to comply with environmental criteria.

The eco-labels shall give information on:

1. Design and traceability of products that comply with ecological conditions throughout their lifetime: design, production, distribution, use, reuse/recycling/disposal.
2. The labels "eco-label" give an indication of the safety in use of an article.
3. "Eco label" labels are a challenge for both manufacturers and users.
4. “Eco label” labels provide certainty regarding the sanogenesis of a clothing product and influence its route to elimination.

Eco-labels are specific to sustainable fashion, which comply with environmental and performance criteria. Clothing products are sometimes cheap because they are finished with chemicals that do not comply with the criteria imposed by the Ecolabel. An example may be black products that are painted with dyes based on aniline, a substance proven carcinogenic. Another aspect would be that of improper fixation of dyes on fibers, for example being "blue-jeans" whose color sometimes remains on the skin when simply proving them.

Buying clothing products becomes a challenge if environmental criteria are taken into account. Underwear and clothing made of natural fibers (cotton, linen) are preferable to chemical ones. Natural fibers can come from certified "organic" crops of known origin and can be painted with dyes that comply with environmental protection criteria. It is well known that cotton does not require special painting conditions, it is easily painted even with walnut leaves. Garments produced and labelled eco-labelled comply with environmental criteria.

The Ecolabel is not only about garments but also about bags and shoes. Currently, there are technologies for finishing the textile surfaces of materials for bags and shoes with the "appearance of leather" that use the remnants from the processing of apples.

Recycled polyester materials are now finished so that the ink of the materials is similar to that of viscose fabrics, a skin-friendly material.

The principles of ecological fashion relate to the **conservation of resources, and the protection of soil, air, and water.**

The carbon footprint is defined as the totality of the greenhouse gases emitted by the company to produce garments. If the scope widens, the carbon footprint is specific to

each organization or person and is due to carbon emissions due to the use of resources to produce material goods.

The carbon footprint is calculated by authorized companies by adding up daily emissions over one year.

Clothing production is one of those with a high carbon footprint, being a very polluting one. The highest degree of pollution is in the case of finishing textile materials (their painting), but also in the case of industrial processing of fibers, yarns, fabrics, knits, and textiles. In the process of making textile materials, in the technological flow of processing, there is the cutting of stage materials resulting in losses (waste) that can be up to 30% of the volume of materials subjected to tailoring. Textile waste can be destroyed, reused or recycled. The decomposition of textile waste results in methane, a powerful environmental pollutant.

Fast fashion items are cheap, but with a short lifespan, so they quickly enter the cycle of reuse or recycling or, in the unfortunate case, are deposited in pits where they decompose.

Sustainable items are more expensive but have a longer life cycle, so they are **less polluting.**

Second-hand items are viewed in the current context as a second chance given to clothing products, increasing the life of products and reducing the carbon footprint that would occur through the rapid recycling of clothes.

Also to reduce the carbon footprint, washing in cold water is recommended. On the detergent labels, it is stated that the enzymes contained are active even at 300C or in cold water. This reduces the consumption of energy needed to heat the water.

Also in the current context, working conditions that respect the environment are imposed for the staff in the productive units (maximum use of natural light, extinguishing of lighting devices in productive sections during meal breaks, etc.).

To survive, the garment and fashion industries are rapidly adapting to new sustainability trends.

How does the fast fashion industry adapt to the sustainable fashion industry?

1. Organizing courses in which information is presented about the current directions of the fashion industry.
2. Organizing festivals and workshops in which the terms of sustainable fashion are presented.
3. Employability programs and the emergence of new occupations.

On the great stages of the world, there are 100% ecological clothing ensembles (Portland Fashion Week, USA) or (The Circular Project Shop, Madrid, Spain). The GREEN TEXTILES Organization promotes products with zero impact on the environment. This organization is in many countries on all continents.

An original experience is that of Heavy Eco, an Estonian fashion brand promoted for professional retraining in prisons in that country.

3.1. Durability, reparability, and recyclability in fashion

What does sustainable fashion mean?

When buying an item of clothing it is important to ask ourselves a few questions:

1. Do we really need that article?
2. Where are we going to wear that item and it fit to a clothing combination in our wardrobe?
3. How many times will we wear that item to justify the purchase?

To join sustainable fashion trends:

- We buy clothes from companies that produce using environmentally friendly technologies and recycled materials.
- Vintage or second-hand fashion offers us unique clothes, some of very good quality.
- Renting clothes for special occasions is a good idea for reducing the consumption of textiles.
- We need to understand the impact of clothes on the environment, especially the fibrous composition. Clothes that contain a large percentage of polyester by throwing it in landfills will be decomposed in a hundred years. It is preferable to wear clothes made of natural materials.
- Reading the labels to see the origin of the clothes. We are asking ourselves whether those who produce them are paid properly or have a decent living.
- It is good to buy clothes from brands that invest in production in compliance with the conditions of environmental protection.

3.2."Fast" fashion will be replaced by "sustainable" fashion

In the current world economic conditions, fast fashion, "fast fashion" will be replaced by the "sustainable" one to reduce the consumption of raw materials, reduce pollution and reduce the volume of textile waste.

Fast fashion "fast fashion" can be somewhat entered into the cycle of "wear and throw". "Fast fashion" is associated with the production of clothes in improper conditions, at the limit of legality, clothes of doubtful quality that are produced with waste of raw materials and energy, with the use of polluting technologies.

The "high-end" clothes, that is, the luxury ones of high quality, is quite difficult to reach because the prices are high for the middle class.

Many times, however, we are put in a position to choose between buying cheaper clothes, or a piece of higher quality. It is a difficult choice in the world in which we live, the one in which often the image is decisive. The choice is even more difficult as social networks can influence shoppers' choices. The younger generations often choose an idol, watch how it is dressed, and buy similar clothes, even if they are of questionable quality.

Middle class brands produce large quantities, which at first, they sell at a high price, and then they make promotions with higher and higher percentages. This type of production is specific to fast fashion, "fast fashion".

Sustainable fashion involves several stages that a clothing product goes through in order to increase its lifespan and reduce environmental pollution.

A few questions can be asked:

1. What will be the trends in sustainable fashion?
2. How will the productive activity be reorganized?
3. What new trades will emerge?
4. What impact will the reuse and recycling of materials have on the climate?
5. What is the energy consumption for material recycling compared to for the production from new raw materials?
6. How will the world's population adapt to the new trends?

3.3. Access to remediation and re-use services

Currently, the stores have a policy of increasing the warranty period of the products sold, precisely to extend their lifetime.

Adapting this policy to the fashion industry will be by increasing the number of garments finishing workshops. Thus, after use, a clothing product can be transformed into something else and used further. This method aims to reduce the volume of textile waste, reduce the volume of production of new items and implicitly reduce environmental pollution. This way of extending the service life is considered economical and environmentally friendly.

The garment repair workshops will be the ones that will give new jobs in the field of fashion industry.

3.4. Responsibility for the capacity for reuse, recycling, storage and waste incineration

The European Union has specific legislation on the separate collection of waste.[60] Separate collection is done in special containers, so that the recycling of materials is as easy as possible.

The incineration of textile waste is a process that runs with carbon emissions that vitiate the environment, and the deposition in the pits of materials with a high content of synthetic fibers or only of synthetic fibers takes hundreds of years for decomposition. In view of this, people need to be aware of the importance of increasing the life of clothing products in order to protect the environment, reduce pollution and reduce the volume of new raw materials.

Clothing trading companies put new collections on the market at intervals of 15-30 days. The clothes are made from new or recycled raw materials.

Under these conditions, there may be a few problems:

1. Where do the material losses occur in the production process?
2. How can materials considered as waste be reused?
3. What can be done with garments at the end of the life cycle?

Industrial textile waste shall be considered to be those resulting from the cutting process and those garments with defects which cannot be marketed. Made-up items with small defects can be capitalized by donating to institutions that care for disadvantaged people.

[60] https://eur-lex.europa.eu/RO/legal-content/summary/eu-waste-management-law.html

The second group of textile wastes are those which are at the end of the product's life cycle, post-consumption.

Efforts are being made at European Union level to adopt uniform measures on textile waste.

Whether recycled or disposed of by decomposition, the textiles used must be collected from consumers.

The collection channels of the clothes used can be:

1. Collection in clothing stores, by the "take-back" method, receiving a voucher for each package with used, washed and dried clothes.
2. Collection in one-way containers of closure-opening, placed on the stand.

3. Collection through NGOs.

Incineration and disposal of waste through landfilling must be the last resort for used textiles. These two methods are the most polluting through the development of greenhouse gases and their long periods of decomposition.

Chapter 4. Sustainable textiles and non-textile

The textile industry is a polluting industry. The production and consumption of textiles have an important impact on the environment and climatic factors.

Classifications can be made in which textile consumption is assessed as environmental impact:

1. **Textile consumption in Europe is the fourth biggest cause of pressure on the environment and climate change**. In the first three places are housing, food and mobility.
2. **Textile consumption is the third largest cause** of land and water use.
3. **Textile consumption is the fifth largest cause** in terms of material resource use and greenhouse gas emissions.

All these aspects form the foundations for the EU Strategy for Sustainable and Circular Textiles.

<u>Discarded clothing products in the EU – what happens to them?</u>

1. A large quantity of used textile products shall be disposed of as waste and subsequently incinerated. Incineration results in energy.
2. Statistics show that on average 38% of textile products are donated for reuse and recycling. The percentage of sales of used clothing is 10% in the country where it was worn, and 10% is sold in other EU countries.
3. The remaining used textile products shall be exported to Africa and Asia.
4. EEA briefing* on 'EU exports of used textiles to Europe's circular economy' **shows that used textile exports have tripled over two decades**, currently standing at 2 million tons/year.

In view of this, EU Member States are obliged to introduce a separate collection of textiles

by 2025, with the objective of reusing a large amount of textile products. There are states where this collection has been done for many years, and in others, it is in its infancy.
*EEA – European Environment Agency

What can be done to reduce the negative impact of textiles on the environment?

Policymakers

Policies to include textiles in the Eco-design Directive, which aims to make textiles safe and more sustainable by design.

Manufacturing companies

Propose manufacturing technologies to improve the quality, sustainability and reparability of textile products so that they can have a longer life.

Consumers

They have the opportunity to buy higher quality textiles at higher prices, or, at lower prices, reused products.

The idea of sorting and coding could be a solution to distinguish textiles intended for reuse from textile waste.

The issue of sustainable products. The role of biological/natural fibers

Biological fibers (natural, plant and animal) are considered the sustainable alternative, but they need to be carefully studied (EEA European Topic Centre on Circular Economy and Resource Use).

Biofibers create different pressures on the environment, through land and water use, associated with agricultural activities and fiber processing for both textile and related industries.

There may be a comparative study regarding the environmental impact of synthetic chemical fibers that come mainly from petroleum and natural and/or artificial fibers, which are obtained from natural polymers (e.g. viscose obtained from wood or reed cellulose, surgical thread / absorbable monofilament sutures – Catgut Plain and Catgut Chrom – obtained from natural collagen). There are also non-absorbable sutures made of synthetic polymers: polyester, polyamides, polypropylene, metallic monofilament. (***As a curiosity***, in modern plastic surgery, minimal scars are obtained by using monofilamentary polypropylene threads.)

EU concerns about countering the negative impact of textiles

The European Commission has proposed a strategy for sustainable products, a plan containing clear regulations for the textile industry.

1. Eco-design of textile products is intended to be a safe and sustainable initiative.
2. Introduction of the digital textile passport to trace traceability.
3. Legislation for the application of extended producer responsibility schemes for textile products.

Consumer fashion. What will happen to it?

"Consumer fashion" is scheduled to expire by 2030.

Currently, the part of quality fashion, which is not consumer, holds a small share. The EU wants the introduction of timeless fashion in terms of design, the introduction of

high-quality, repairable products.

EU initiatives are to shift the textile industry from consumer fashion to a circular and sustainable system.

What are sustainable textiles?

- To define sustainable textiles, we need to understand the phenomenon. In order to be durable, a textile product must be analyzed in terms of raw material, the technology with which it was made (old or current), the service life, and the route after the decision to no longer be worn. This route or loop must be used as long as possible to fit the products into the durable ones.
- The fashion industry is perhaps one of the most spectacular industries, but also one of the most polluting.
- Sustainable textiles are those that make us think twice before buying a clothing product or replacing it, in short, it becomes a way of thinking to change our wardrobe in a responsible way. Currently, clothing companies, large or small, include at least one percent of recycled raw materials in their materials. Sometimes the materials from which clothes are made are 100% recycled.
- The carbon footprint is spoken and "calculated" for any factor considered involved.

Examples of textiles used in clothing production, with which companies reduce their carbon footprint

Organic cotton

Cotton is one of the most widely used raw materials in the textile industry. It is also known that cotton fabrics are nonallergenic and comfortable to wear. Since the demand for cotton fiber is very high, in order for crops to be good, pesticides were used. High environmental toxicity is also found after painting with chemicals that do not respect the environment. These pesticides, over time, have degraded soil and air and created health problems for cotton farmers.

As a result, organic cotton is increasingly being grown, which is a viable alternative to pesticide-stimulated cotton, and fibers or textiles are finished with eco-friendly chemicals. Of course, the volume of production is smaller, but product quality and respect for the environment are undeniable.

Hemp

Hemp for textile use is a plant in the Cannabaceae family, genus Cannabis. Hemp for textiles has no psychotropic effects. Productivity per hectare is higher than organic cotton, and less water is used for textile processing than cotton.

For hemp crops it is worth noting that part of the nutrients are returned to the soil, and part of the carbon emissions are processed in the air.

Hemp belongs to the group of natural, vegetable, cellulose materials with high lignin content. By cottonization (enzyme treatment of hemp fibers) they receive properties similar to linen and cotton, becoming softer, and clothing items will be comfortable to wear.

TENCEL – is a brand, not a material

Under this brand are found Lyocell and Modal fibers/filaments. Both are artificial fibers based on modified cellulose.
Because they are artificial fibers, it is possible to intervene in their production so that they are obtained with predictable properties.
Both Lyocell and Modal can be used on their own or in mixtures with natural or chemical fibers (artificial or synthetic): cotton, linen, wool. PAN, polyesters, polyamides, etc.

PET polyethylene terephthalate

PET – is the common plastic that is mainly used in packaging for the food industry.
Currently, PET is found in fibrous mixtures for fabrics or knitwear intended for outerwear, footwear, leather goods.

Artificial leather

Artificial leather is a fabric of synthetic, ultrafine, microscopic-sized microfibers.
Vegan leather = artificial leather, as terminology.
Artificial leather is an environmentally friendly alternative to genuine leather. Being chemically produced, appearance and functionality can be imposed by production technology.

Features of artificial leather are:

- appearance and touch identical to that of natural leather;
- durability superior to natural leather;
- tensile strength, bending, torsion and friction superior to natural leather;
- good resistance to acids, alkalis, mildew;
- lighter than genuine leather by about 30%;
- cost effective and easy maintenance;
- eco-friendly.

The destinations of artificial leather are varied: clothing, footwear, furniture and car upholstery, accessories (purses, bags, backpacks).

4.1. Non-textiles. What are non-textiles? Can they be useful?

Non-textiles are materials that contain less than 20% textile fibers.
Non-textiles can best be illustrated in pictures.
Non-textiles may be obtained by combining textiles with wood, synthetic or natural leather, or with any material which does not belong to the group of textile materials.
Currently, non-textile materials can be used instead of textiles occasionally, at exhibitions or as accessories/decorations.
Entrepreneurship and new business models for the transition to circular economy
"Entrepreneurship is the process of identifying and tracking a business opportunity in order to capitalize on it. It refers to the process of creating new value (material or spiritual) through committed effort, taking into account the risks involved." Financial Glossary Entrepreneurship

4.2. Stages of the entrepreneurial process

1. "Identifying opportunity - Drucker, in his reference book "Innovation and Entrepreneurship" presents sources of entrepreneurship:

- events triggered by the unexpected success/failure of an activity or idea;
- discrepancies that exist between the current situation and what is desired;
- the possibility of obtaining a good or service faster, more efficiently or of higher quality;
- changes in the structure of a sector or the market as a whole under the action of various factors;
- the trend of demographic changes;
- changes in purchasing and consumption behaviors, lifestyle and perceptions at the level of the target group;
- the emergence of new knowledge and technologies."[61]

2. Motivation of the business concept:

- be unique,
- cover the marketing mix (target variables such as price, promotion, and distribution in addition to the product/service),
- be feasible (timely developable),
- be sustainable (after implementation, the concept must last long enough in the market to generate the target profit).

3. Identification of resources:

- Entrepreneur (health, time, motivation);
- Labor, logistics of distribution channels, raw materials, financial resources, locations, licenses and patents, machinery and equipment, share capital (relationships).

4. Obtaining and harmonizing the necessary resources:

- A fundamental rule for a successful business is not to invest in fixed assets, at first, in order to remain as flexible as possible to respond to risks that are at maximum level at the beginning. The entrepreneur must focus on ensuring the financing of current and long-term activity. As a general rule, entrepreneurs turn especially to four categories of financiers of their new business ideas: family, friends, banks and non-reimbursable funds, the most current and profitable source.
  http://newbiz.ase.ro/despre-antreprenoriat/

5. Business implementation and management

The more efficiently the entrepreneur will know how to use the resources at his disposal to achieve results that differentiate his company, the more protected he will be from competitive attacks. Effective business management involves using the results obtained to develop the business, diversify and attack new markets, sell it at a good price or initiate a new entrepreneurial cycle."

[61] Glosar financiar: Antreprenoriat

Psychological, social and management skills in entrepreneurship

- "Innovation – the ability to think/produce something different that did not exist before;
- Communication skills: collaborators and partners about ideas and vision. Communication skills with subordinates.
- Emotional intelligence – the ability to correctly perceive the emotions of collaborators and to control one's own emotions.
- The ability to value the network of relationships in favor of the business. The network of relationships of an entrepreneur is his share capital. Identifying opportunities and resources increases the larger the network.
- The capacity of perception and influence of partners and employees, in order to induce opinions in favor of an idea;
- Management knowledge and skills, business administration skills, marketing knowledge, IT knowledge, tax knowledge, and legislation. "The ability to identify and mobilize the resources necessary for the development of the activity, especially information resources (about the market, about the environment, legislation), human resources (partners, collaborators, employees), operational resources (equipment, location, machinery) and financial, the ability to obtain financial, social or personal profit."[2]
- The circular economy can be a model of production and consumption based on recycling, remediating, reusing products to increase their lifespan.
- The circular economy reduces dependence on raw materials and recycling reduces supply risks.
- The circular economy leads to the creation of new jobs, can stimulate innovation, research, creation."[62]

4.3. Business models for the transition to the circular economy[63]

1. Closed-loop recycling – waste is the raw material in the production process.
2. Downcycling – is a recycling method by which the resulting products have a lower value than the processed waste.
3. Upcycling - is a recycling method by which the resulting products have a higher value than the processed waste.
4. Industrial symbiosis – refers to the pooling of services and products belonging to different industries to streamline the consumption of raw materials (resources).
5. Separate waste collection
6. Maintenance services for products sold
7. Consumer loyalty by encouraging repeated use of a sustainable product or service.
8. Local production
9. Modular design – designing a product that can be broken down into small parts that can

[62] http://newbiz.ase.ro/despre-antreprenoriat/
[63] https://green-report.ro/10-modele-inovatoare-de-afaceri-care-integreaza-principiile-economiei-circulare/

be easily replaced.
10. Customizing sustainable products or services.

Specifically, for the textile industry in general and the clothing industry in particular, business models

1. **Closed-loop business** – refers to collecting textile waste and selecting it for reuse or recycling.

Some companies collect selectively (for example only from a certain brand) and companies collect textiles of any kind. From this perspective, businesses in the form of second-hand shops or businesses aimed at recycling textiles can result.

2. **Upcycling activities** – are done even non-commercially, at home, by transforming used items of clothing, furniture, and accessories into useful ones. They can be enjoyable and can even be a hobby.

3. Creative recycling activities – these activities require specialized personnel, production equipment and specific spaces. This can also include clothing retouching workshops.

4. Business models for recycling textile fibers – here the technological processes are the same as those already existing, the challenge is to find methods to standardize yarns and materials resulting from the processing.

One barrier that must be overcome is buyers' reluctance to remanufacture products and the predisposition to buy new products, to the detriment of price and environmental impact.

Specifically, for the textile industry, which is a very polluting one due to the fast-fashion phenomenon, solutions are sought for sustainable products, with the longest possible lifespan.

Chapter 5. Recycling of Textile Materials

5.1. Sources/categories of textile waste

The fibrous waste derives from natural and synthetic polymer components, including cotton, wool, silk, polyester, nylon, and polypropylene. Large quantities of these fibers get into us and are discarded. Specialty fibers are designed for specific applications that demand outstanding resilience, thermal stability, and/or chemical resistance.

Polymers and other materials are often blended to create various products, including blended fabrics, carpets, conveyor belts, and composites, among others.[64] **Two groups apply to textile waste.**

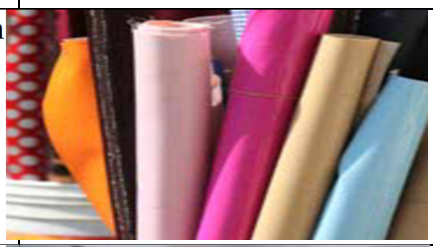
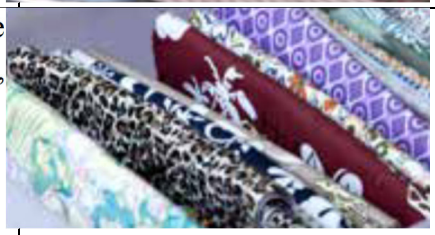
Pre-consumer textile waste **or** ***industrial waste*** **is** generated during the textile manufacturing process or as a result of processing fibers. Pre-consumer textile waste that is 75% recyclable is kept out of landfills and used as raw materials for products like mattresses, insulation, and the automotive industry[65]. According to Redress, pre-consumer textile waste consists of

[64] Wang, Y. Fiber and Textile Waste Utilization. *Waste Biomass Valor* **1**, 135–143 (2010). https://doi.org/10.1007/s12649-009-9005-y

[65] Chen, L., & Burns, L. D. (2006). Environmental Analysis of Textile Products. *Clothing and Textiles Research Journal*. https://doi.org/10.1177/0887302X06293065

various types as presented in Table 1. [66]

Table 1. Classification of pre-consumer textile waste

Textile swatches are extra textile sampling pieces that remain after production	
Cut-and-sew waste refers to textile scraps produced during garment fabrication. Its irregular and tiny forms typically lead to its classification as waste and subsequent disposal.	
End-of-rolls include textiles that are surplus from clothing production	
Unsold garment waste refers to manufactured or unfinished clothing that has not been sold	
Damaged textiles refer to unused textiles that have been damaged, such as by color or print flaws, making them unsuitable	
Sampling yardage refers to the excess waste generated while producing textile samples at a factory.	

[66] Sourcing textile waste: created by redress, https://www.redressdesignaward.com/academy/sourcing

Clothing samples are samples of partially or fully completed clothing produced during design and manufacturing

Post-consumer textile waste

Any textile or domestic item consumers decide they no longer want is considered post-consumer textile waste. Part of this waste is collected and given a second chance at life, usually through recycling or reselling, or it is burned. The complexity and expense of textile-to-textile recycling are increased by including colors, various accessories, and blends of fibers (polyester/cotton, for instance) in the recovered textile**.**

These wastes can be retrieved from the consumer chain by employing distinct urban collection programs or targeted collection efforts, such as those carried out by nonprofit organizations or manufacturers themselves.[65]

Post-consumer textile waste consists of:

- *Secondhand clothing waste* applies to any clothing or fashion accessories possessed and subsequently discarded by consumers, whether used or unused.
- *Secondhand textile waste* implies any finished non-clothing textiles, including curtains and bedding, that have been possessed and subsequently disposed of by consumers (both used and unused)[68]
- With the application of the circular economy or circularity concept, there has been a recent shift away from this unsustainable linear paradigm and toward a more circular one. This is founded on three principles: maintain products and materials in use, regenerate natural systems, and eliminate waste and pollution via design.[67] [68]

Challenges to recycling textile waste

Numerous factors make textile materials difficult to recycle. Technical issues, despite the low levels of collection and sorting, are as follows:

- The great variety of clothing categories
- The diversity of compositions found in individual clothes (such as cotton, leather, metal, silk, etc.)
- The material's flexibility made pre-shredding somewhat more intense than stiff plastics.
- The existence of substantial quantities of pigments and dyes

[67] Ellen Mc Arthur Foundation and Circular Fibers Initiative (2017), A new Textiles Economy., 48

[68] Recycled Textile Fibres and Textile Recycling, (2017) An overview of the Market and its possibilities for Public Procurers in Switzerland

- The intricate constitution of certain fibers (e.g., polycotton is a blend of cotton and PET)
- Numerous fibers exhibit chemical resistance.[69]

A summary of the issues concerning textile recycling and the potential options for policy adoption are included in table 2.[70],[71]

Table 2 Issues concerning textile recycling

Challenges		**The solution to overcome challenges**
Absence of information, motivation, and promotion	**Textile recycling** 	Programs for education and information
olutions to collect textile waste		Availability of containers for collection
Absence of knowledge, affordability, and the fashion push considerable quantity of inferior blends and materials dominate the recycling end market.		Politiche di rimborso per chi raccoglie in modo differenziato i rifiuti tessili
Deficiency of rules and regulations		Tax respite; policies that reward novel technologies and innovations
Diversity of textile fibers and chemicals used in clothing manufacturing		Rewarding technological advancements in the areas of collection, separation, and treatment Awarding initiatives for reusing textile waste and producing in an environmentally friendly manner DPP to offer transparency

Waste management strategies

Efficient implementation of a circular integrated waste management system (CIWMS) is needed. This approach integrates waste and material management methods. In addition to enhancing the economy, the CIWMS system offers the advantages of less environmental

[69] Clark, J. H. (2023). Textile waste – an opportunity as well as a threat. *Green Carbon*, *1*(2), 146-149. https://doi.org/10.1016/j.greenca.2023.10.002

[70] https://www.fibre2fashion.com/industry-article/9777/textile-recycling-techniques-and-challenges

[71] Hole, G., Hole, A.S. (2020). Improving recycling of textiles based on lessons from policies for other recyclable materials: A minireview/ *Sustainable Production and Consumption,* 23 42–51. https://doi.org/10.1016/j.spc.2020.04.005

impact and lower utilization of natural resources.
Waste management legislation and practices must conform to the waste hierarchy outlined in the Waste Framework Directive of the European Parliament[72] Waste prevention lies at the top of the waste hierarchy, succeeded by the preparation for reuse. If preparation for reuse is not feasible, the subsequent stage would involve recycling, followed by energetic recovery[73,77]

5.2. Technology for recycling textile waste

The primary methods of material recycling for textile waste materials are:

a. Mechanical,
b. Thermal,
c. Chemical
d. Enzymatic recycling.

The fiber composition and the chemical structure of the polymers that constitute the fibers play a major role in determining whether an article of clothing is suitable for monomers, polymers, or fibers recycling.[74] *Recycling fibers* refers to retaining the fibers intact after the disintegration of the fabric.

- *Polymer recycling* comprises the dismantling of the fibers while preserving the polymers intact.
- *Monomer recycling* signifies that fibers and polymers are cut down into their chemical building blocks.

Prerequisite for an efficient recycling process

1. Efficient recycling methods require technologies to sort and manage the numerous textile waste streams - identify, classify, and separate constituent elements:
   a. fiber blends
   b. dyes and chemicals from finishing treatments
   c. other components ((i.e. trims, buttons, zippers, threads)
2. Novel recycling technologies - less expensive and harmful, more energy-efficient than traditional methods for producing raw materials
3. Collaborative industry efforts from raw materials, design, collection, and recovery technologies are essential to realizing the environmental, economic, and social benefits of a textile recycling chain.[75] Independent of the chosen waste management strategy or recycling technique, substantial priority must be placed on improving the collecting and sorting techniques for textile waste.

[72] European Parliament and Council of the European Union, 2008 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098
[73] Piribauer, B., & Bartl, A. (2019).Textile recycling processes, state of the art and current developments: A mini-review, *Waste Management & Research,* 37(2) 112–119, https://doi.org/10.1177/0734242X18819277
[74] Harmsen, P., Scheffer, M., Bos, H. (2021)Textiles for Circular Fashion: The Logic behind Recycling Options. *Sustainability*. ; 13(17):9714. https://doi.org/10.3390/su13179714
[75] Le, K. (2018) Textile Recycling Technologies, Colouring and Finishing Methods, https://sustain.ubc.ca/about/resources/textile-recycling-technologies-colouring-and-finishing-methods

To ensure that all textiles are reused at their most appropriate cycle (resale, repair, remanufacture, or recycling) following the Waste Hierarchy criteria,
it is necessary to implement a collection and sorting system.
The setup of a centralized collecting and regional sorting system can facilitate the achievement of this objective. Collaboration among waste managers, collectors, sorters, and second-hand merchants to establish innovative operational strategies is a crucial aspect of this. The initial stage in the recycling process is the sorting of the gathered waste.
Considerable amounts of precious fabric are either discarded as waste or down-cycled through textile recycling processes in the linear economy.

Mechanical recycling

This recycling procedure can be applied usually in an open-loop system.
Mechanical recycling is defined as *"A process, used in a recycling system, based on physical forces, which may be used in isolation for fabric or fiber recycling or as pre-processing for thermo mechanical or chemical and biochemical recycling processes".* [76] This process comprises the cutting of sorted fabrics for use as wiper rags, shredding and pulling textile materials into fibers, and re-bonding or re-spinning into new yarns or fabrics.
This method is appropriate for all kinds of fiber and blends. It does not modify the chemical structure of the fiber. During the shred and tear stages, the textile waste is exposed to significant mechanical stress on the fiber. The obtained fibers are shorter compared to the original ones. As a drawback, dust contamination can be mentioned.
A general scheme comprising the steps to be followed in mechanical recycling is depicted in Figure, 22

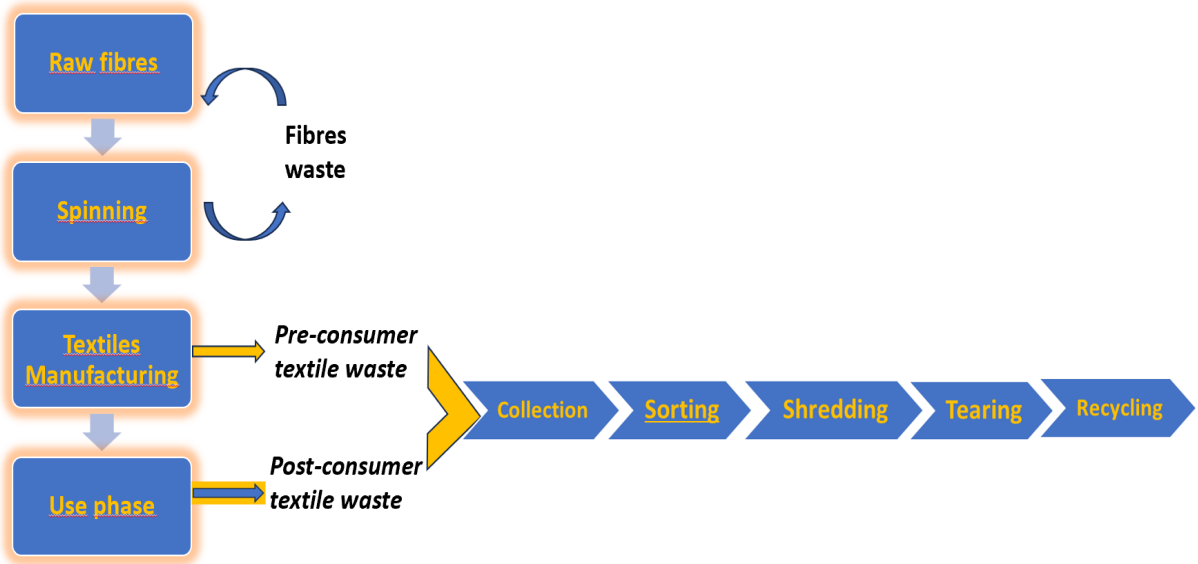


Fig. no. 22 *General scheme of mechanical recycling*

[76] Study on the technical, regulatory, economic and environmental effectiveness of textile fibres recycling, Final report, European Union, (2021), doi: 10.2873/828412, https://op.europa.eu/en/publication-detail/-/publication/739a1cca-6145-11ec-9c6c-01aa75ed71a1

An optimization should envisage improving the mechanical recycling process to be less harmful to the fibers which in turn leads to longer fiber lengths and more equal fiber length distributions and reduces the number of short fibers Besides, the development of mechanical recycling techniques for closed-loop textile recycling of all fiber types is the intended goal.[77]

The input materials suitable for mechanical recycling are illustrated in Figure 23

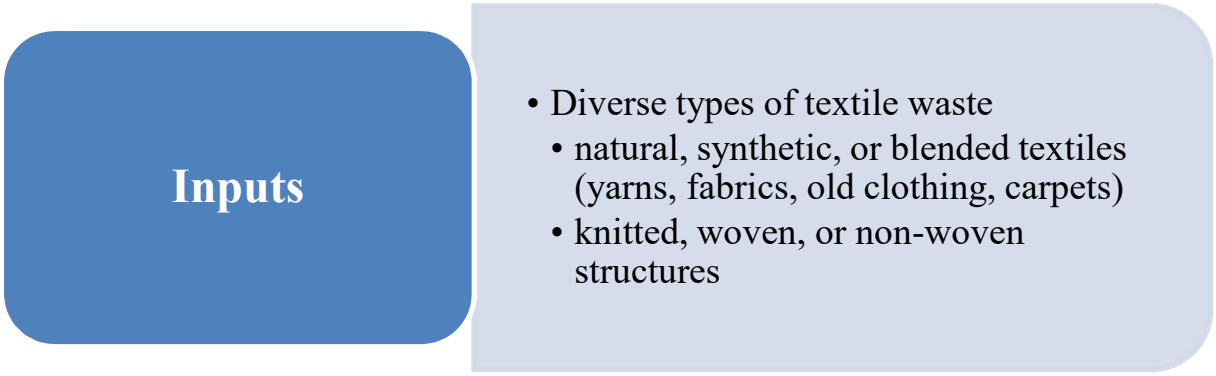


Fig. no. 23 Inputs for mechanical recycling technology

Nevertheless, the fiber type and textile structure exert an influence on the equipment and expected output (Figure 24) [81]

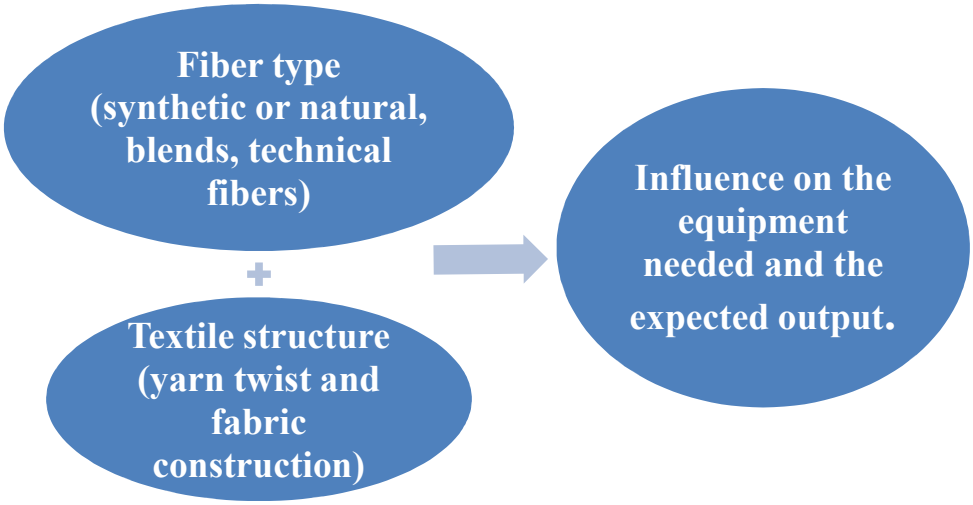


Fig. no. 24 Factors affecting the output of the mechanical recycling

The outputs expected to be obtained via mechanical recycling are illustrated in Figure 25. [82]

[77] Ribul, M., Lanot, A., Tommencioni Pisapia, C., Purnell, P., McQueen-Mason, S. J., & Baurley, S. (2021). Mechanical, chemical, biological: Moving towards closed-loop bio-based recycling in a circular economy of sustainable textiles, *Journal of Cleaner Production*, *326*, 129325. https://doi.org/10.1016/j.jclepro.2021.129325

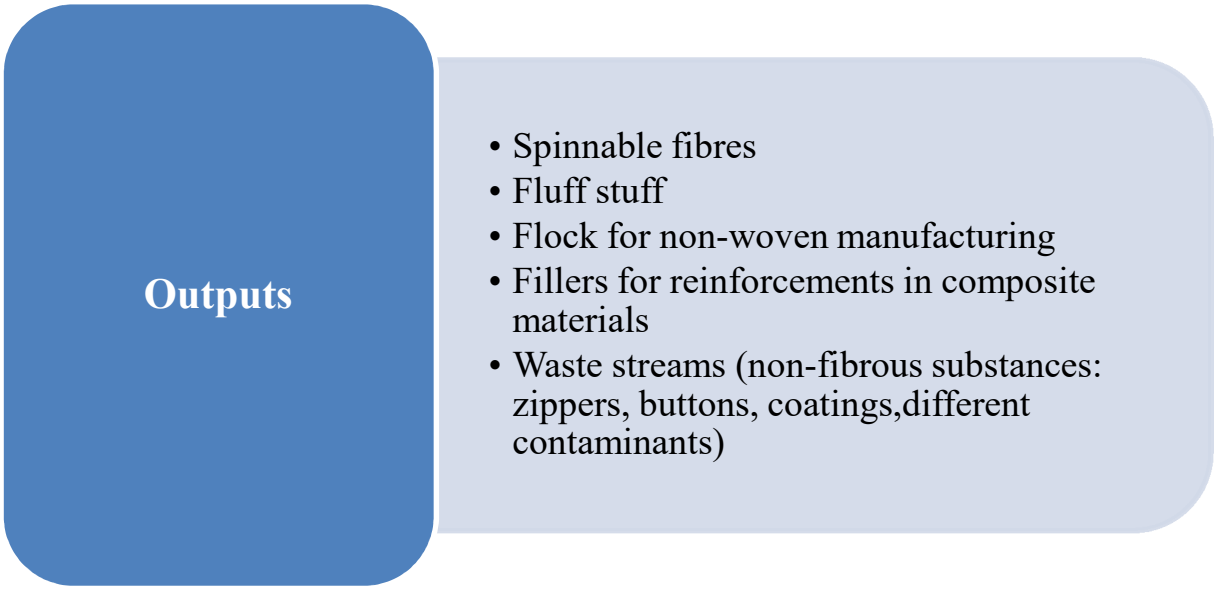


Fig. no. 25 Outputs for mechanical recycling technology

Illustrations of holders of mechanical recycling process technology

Valerius 360

They produced the so-called 360 recycled yarn in various compositions:
Recycled Cotton + Organic Cotton
Recycled + Tencel™ Lyocell
and a novel blend of Recycled Cotton + Seacell™. This yarn is the main output.
Further, they have facilities to produce two output variations: the Recycled JERSEY FABRICS and RECYCLED JERSEY GARMENTS.[78]

Mechanical recycling of Denim waste offcuts

Valorization of Denim waste offcuts into high mechanical three-dimensional denim waste fiber needle-punching composites. The steps to be taken include:

- Opening-carding-needling
- Vacuum-assisted resin transfer molding (VARTM) technology Epoxy - matrix.

[78] https://valerius360.pt/process/

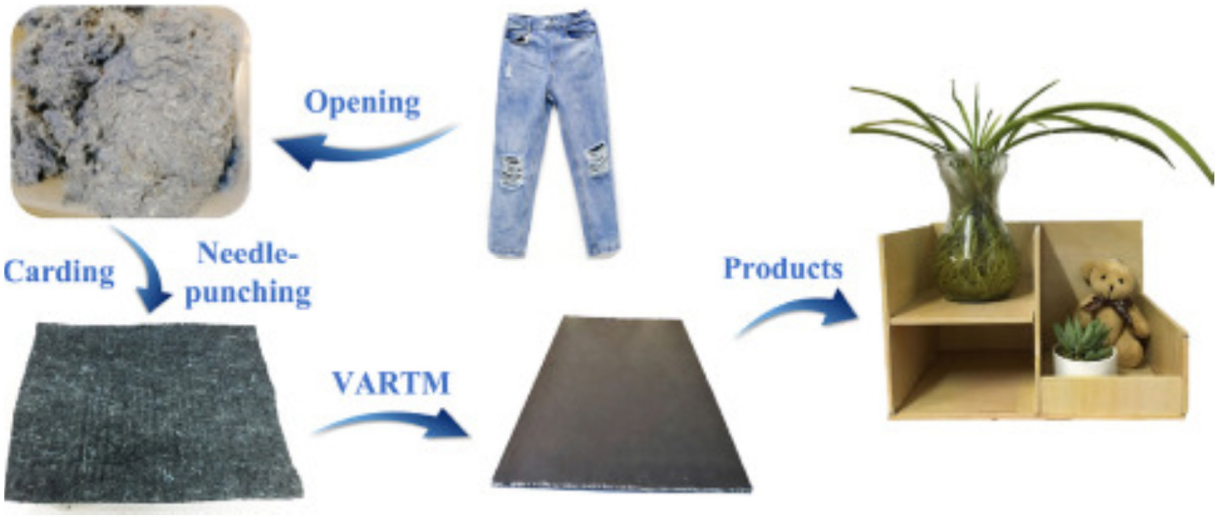


Fig. no. 26 VARTM recycling technology[79]

Fig. no. 27 Mechanical recycling by FabBRICK[80]

Wool employs a closed-loop recycling method that eliminates the requirement to combine virgin fibers when recycling the textile for the first time.

Italian wool producers in the Prato area also refer to fiber-to-fiber recycling for wool as "regenerated wool.[81]

[79] Meng, X., Fan, W., Wan Mahari, W. A., Ge, S., Xia, C., Wu, F., Han, L., Wang, S., Zhang, M., Hu, Z., Ma, N. L., Van Le, Q., & Lam, S. S. (2021). Production of three-dimensional fiber needle-punching composites from denim waste for utilization as furniture materials, *Journal of Cleaner Production*, *281*, 125321. https://doi.org/10.1016/j.jclepro.2020.125321

[80] https://designwanted.com/fabbrick-construction-materials-recycled-textile/

[81] https://comistra.com/circular-economy

A representative model for sustainable fashion could be mentioned Prato (Table 3)

Table 3 Model for sustainable fashion

Technology holder	Type of textile waste	Products
Comistra closed loop	Post-consumer wool waste	Regenerated wool yarn and wool blends
Manteco closed loop	Post-consumer wool waste	Wool fabric

Thermal recycling

Can be applied for:

• Closed-loop or open-loop system for pure synthetic materials.

Defined also as thermo-mechanical recycling involves the melting of synthetic fibers producing regranules and/or new fibers.

This technology is designed for recycling thermoplastic textile waste, e.g. polyester, polyamide, polypropylene.

The thermo-mechanical approach is mainly a re-extrusion process consisting of several steps that can be grouped as follows: cutting, compacting/drying or drying, feeding to extruder, melting, and extrusion (spinneret) (Figure. 28). The obtained Re-granules can be utilized in the manufacturing of staple fibers or the plastics sector.[82] The remelting procedure entails the removal of any contamination in the form of specific surface treatments (flame retardants, prints, coatings) dust, dirt, and wash residues. Besides, this method of recycling is not feasible for polymers that cannot melt, such as elastane and fibre blends (e.g. nylon 6 and Nylon 6.6)[83] The thermoplastic material's molecular weight and intrinsic viscosity are further crucial factors for the thermal recycling procedure.

The steps to be followed in the frame of thermal recycling are comprised in Figure 28

[82] Altun, S., Ulcay, Y. (2004). Improvement of Waste Recycling in PET Fiber Production. *J Environ Polym Degr* **12**, 231–237 https://doi.org/10.1007/s10924-004-8150-4

[83] Roos, S., Sandin, G., Peters, G., Spak, B., Schwarz Bour, L., Perzon, E., & Jönsson, C. (2019). White paper on textile recycling. *Mistra Future Fashion: Stockholm, Sweden*.

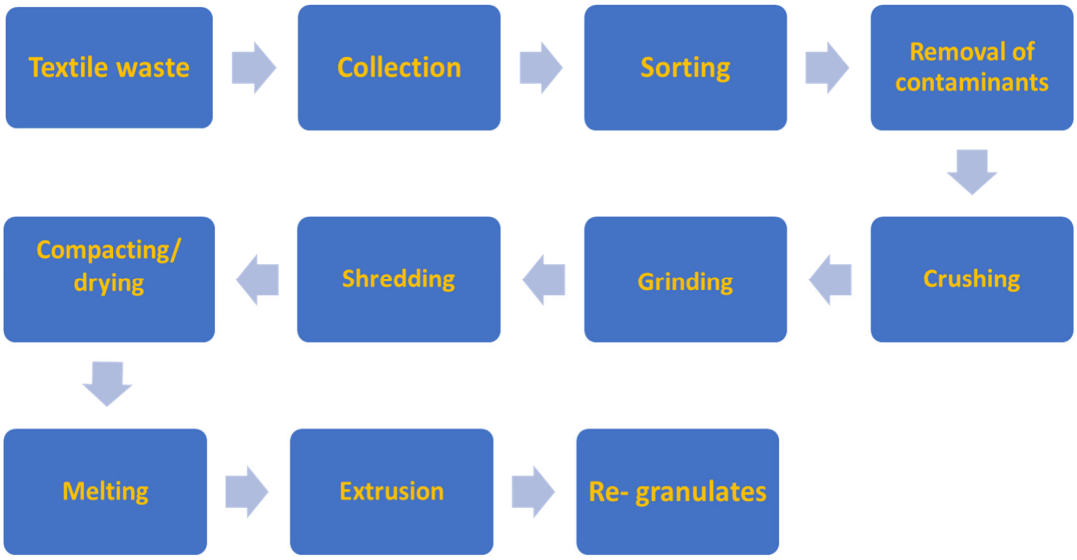


Fig. no. 28 Steps of thermal recycling

The input materials suitable for thermal recycling are mentioned in Figure 29.

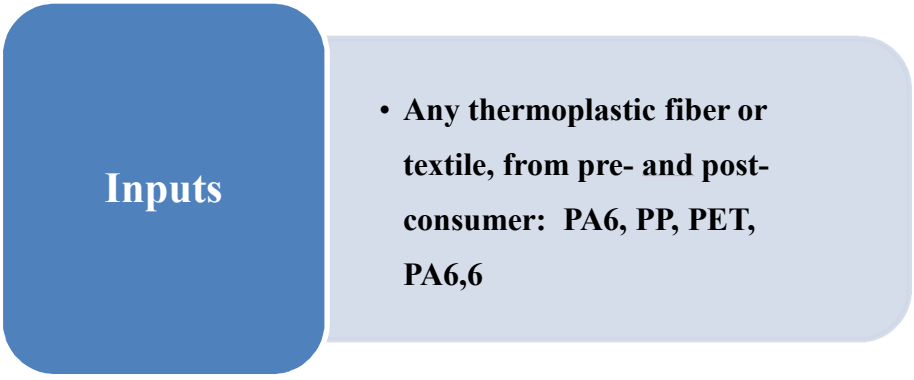


Fig. no. 29 Inputs for thermal recycling technology

Due to the significant potential for contamination, garment waste derived from households or fashion waste is not considered an appropriate source.
Depending on the quality of the input, the output of the thermal recycling can be classified as depicted in Figure 30.[82]

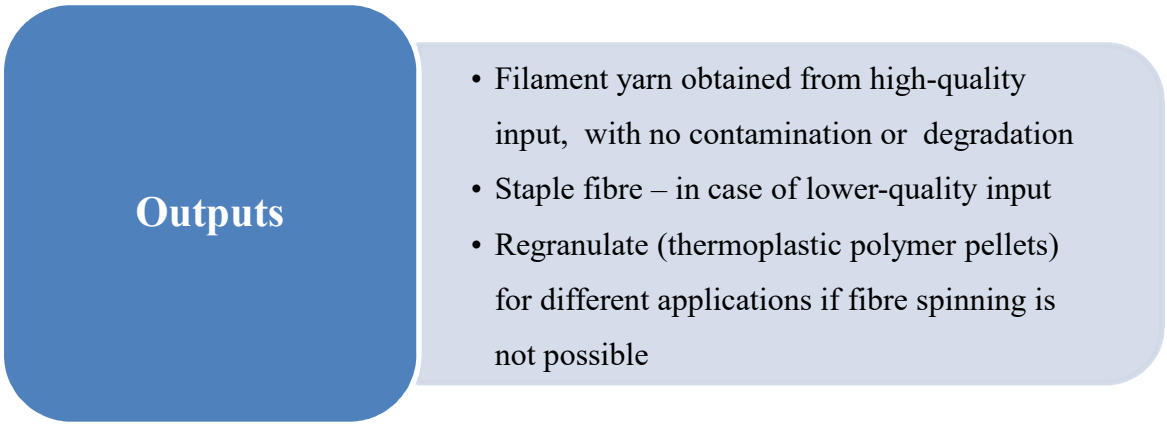


Fig. no. 30 Outputs for thermal recycling technology

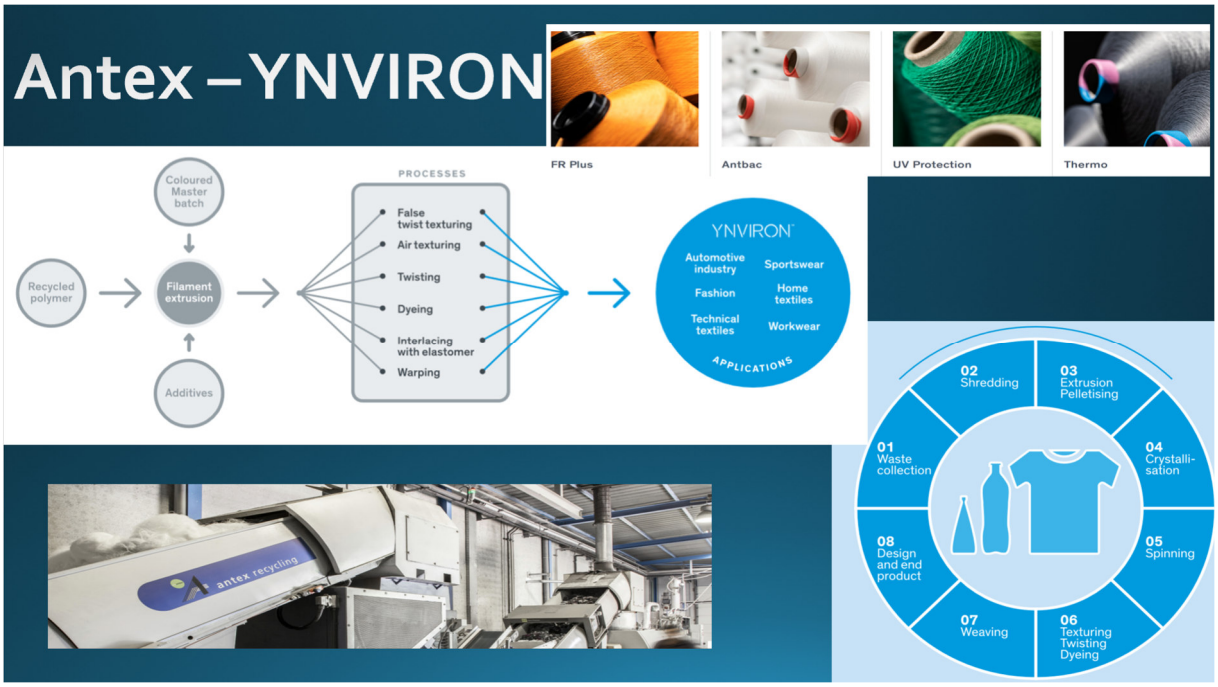


Fig. no. 31 Thermal recycling by Antex[84]

Chemical recycling

This recycling procedure can be accomplished in the following systems:

• Closed-loop or open-loop system for synthetic fibers

• Open-loop system for cotton

Chemical recycling is defined as "*A process using chemical dissolution or chemical reactions which is employed in polymer or monomer recycling. There are several possibilities within this recycling technology*.[82] A general scheme comprising the steps to be followed for the chemical recycling of polyester (PET) and polyamide (PA 6 and PA6,6) is presented in Figure 32

[84] https://antex.net/wp-content/uploads/2021/08/02-23-antex_ynviron_brochure-en-digital.pdf

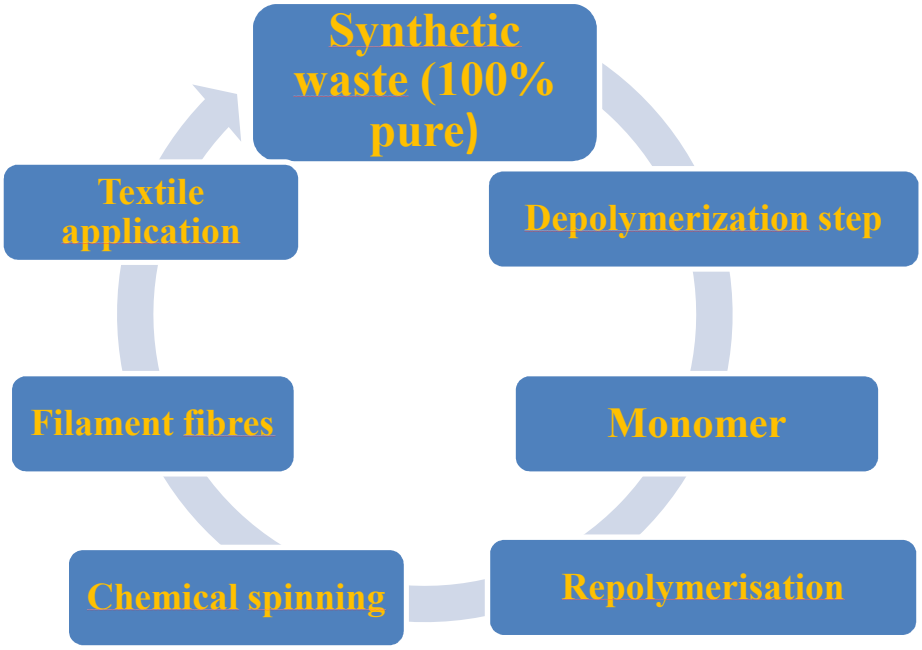


Fig. no. 32 Flowchart of chemical recycling of textile materials

Regardless of what type of fiber is subjected to chemical recycling, the requirement for attaining a definite quality of recycled fiber consists of the purity of the input. Actually, the purer the input material is the more efficient the chemical recycling process becomes.
The inputs and output materials of chemical recycling are presented in table 4.

Table 4 Examples of inputs and outputs for chemical recycling

Inputs	Outputs
Cellulose waste PES waste PA6: mainly post-consumer waste PA6 from carpets, fishing nets Industrial waste (oligomers + plastic waste generated by polymer industries) cotton	Cellulose pulp for reprocessing of man-made cellulosic fibers Regeneration of base monomers for polyester caprolactam which can be repolymerized to virgin grade PA6

The chemical recycling of cotton waste into regenerated fibers represents a promising solution.
A closed-loop upcycling process employs the conversion of discarded cotton garments into pulp, followed by its dissolution in a solvent and subsequent spinning into fibers.

Renewcell

Fig. no. 33 Renewcell [85]

Worn Again Technologies

Worn Again Technologies is a company located in the UK. The chemical recycling technology developed by the company enables the separation, decontamination, and polyester and cellulose extraction from blended textile waste. It intends to build up a circular resource network to connect textile waste suppliers, recyclers and producers.

Fig. no. 34 Worn Again Technologies [86]

Aquafil -ECONYL® REGENERATED NYLON

[85] https://www.renewcell.com/en/circulose/
[86] https://wornagain.co.uk/about-us/#technology

Econy ® REGENERATED NYLON by Aquafil represents a novel nylon produced by an innovative chemical recycling procedure that transforms nylon waste.
In contrast to conventional mechanical processes, this method enables ECONYL® regenerated nylon to maintain 100% of the qualities of new nylon while decreasing the environmental impact of conventional oil-based nylon [87]

Fig. no. 35 Aquafil technology[91]

Future of textile recycling

Textile recycling represents a crucial and feasible remedy to the substantial waste problem faced by the fashion industry. Sustainable practices have the potential to conserve natural resources, mitigate greenhouse gas emissions, foster job creation, and produce income. Nevertheless, textile recycling encounters some obstacles and uncertainties that must be addressed to achieve maximum capacity. The solution to overcome the challenges relies on the following possibilities:

- Conceiving a design for recycling technologies
- Enhancing efficient reverse logistics network
- Cutting-edge sorting and grading of textile waste
- Development of economically viable technology for separating heterogeneous textile waste
- Collaboration among supply chain stakeholders
- The implementation of government policies. [88]

[87] https://www.aquafil.com/sustainability/econyl/
[88] https://thetextilethinktank.org/textile-recycling-latest-trends-challenges-and-opportunities/

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3. Lesson plans

Lesson no. 1.

A. TITLE: Clothing accessories-From inspiration to creation

AUTHOR/AUTHORS Cioltean Florentina

AGE GROUP: 16-17

GRADE: 10th Grade - Technological Education (Specialization: Fashion Designer Technician)

DURATION OF THE ACTIVITY: 6 hours

SUBJECTS

- Textile recycling,
- Creative recycling,
- Art,
- Textile design,
- Up-cycling

The activity was implemented in the form of an extracurricular activity, in the form of workshops in close correlation with the skills acquired in the modules related to the specialization - fashion designer technician, existing specialization within our high school, which lead to the creative recycling of a variety of materials, mainly textiles.

LEARNING OBJECTIVES:

LO1: To develop skills regarding the recycling of textile;
LO2: To identify and develop creative, technical and artistic potential;
LO3: To develop an interest in handmade creations;
LO4: To develop technical and artistic skills and competences;
LO5: Identify and apply the correlation of textile material/garment sketch/garment accessories/finished product.

B. NECESSARY RESOURCES

MATERIALS USED

-Laptop with internet access;
-Simple sewing machine;
-Overlock sewing machine;
-Adjustable mannequin;
- Specialized magazines (fashion)
- Recyclable textile materials (different colors, textures and nature),

- Tailoring centimeter
- Auxiliary textile materials (sewing thread, lace, felt, lace, corners);
-Sewing needles, knitting needles, scissors, knitting needles, beads, watercolors, etc.
-Other supplies and fittings.
- Drawing pad, colored pencils.

METHODS

- incursion into the world of fashion through the sphere of handmade, fashion design and clothing creation (presentations);
- examples of handmade creations;
-exercise to train creative imagination;
- individual exercises on learning manual work techniques;
-individual practical activities for making clothing accessories;

FORMS OF ORGANIZATION

- individual,
- frontal

C.DESCRIPTION OF THE ACTIVITY

No. students: 10

Time	Activity	Teacher role
60 min	Thematic presentations with handmade creations, creative ideas for clothing accessories using different categories of recyclable materials (woven, non-woven textiles, leather, etc.);	Presents, describes, suggests to students variants of possible accessories;
60 min	Exercise to train the creative imagination of the students involved	Ask students to sketch two clothing accessories that can be made from the materials provided
180 min	Practical exercises for making handmade creations based on the previously made sketch.	Provides support to students in selecting the materials needed for new creations and putting them into practice. Exemplifies the steps of making an accessory (sketch-pattern-sewing-assembly).
60	Presenting the accessories made next to an outfit to match in a mini fashion show in front of classmates.	Make available to the students in the target group the outfits for which the accessories have been created for the final presentation.

D. Evaluation of student activity and results

The activity is completed through a portfolio in which each participant of the target group will have as a final product: a clothing accessory (bag, bracelet, necklace).

In evaluating the work of the students, the following criteria will be taken into account:

- Respecting the criteria regarding the correct selection of the necessary materials, matching them and the color tones with those of the clothing for which they were created;

- The fidelity with which the sketch of the accessory was respected, the order of the execution phases, the accuracy of the stitches made, the correct association of colors;

- The personal and novelty elements brought to the finished product;

E. RESULTS DESCRIPTION

The activity, being directly correlated with the established objectives, aims to raise students' awareness of the importance of environmental issues, the valorization of textile waste, increase the graduation rate with certification of professional skills in the field of fashion design, motivate students with technical and artistic inclinations for performance and the best possible insertion on the labor market for upper secondary school students.

F. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	**Measures/Solutions**
Unfinished products	Reorganization of the activity with the student's consent.
Poor quality products	Remediation of non-conforming qualitative aspects.

G. BIBLIOGRAPHY

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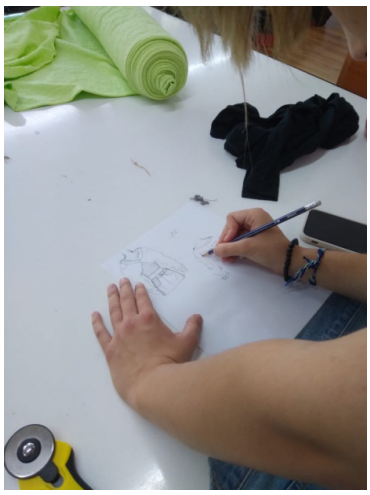

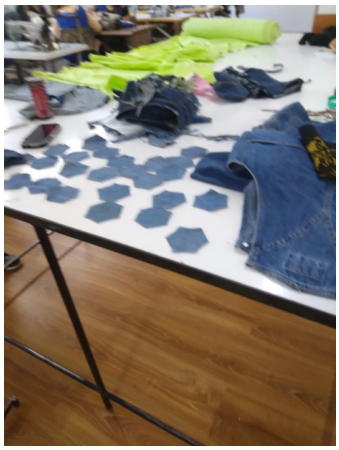

Lesson no. 2.

A. TITLE: Interdisciplinary project-Creativity in the study of cellulose

AUTHORS
Lupei Anca Marilena
Brișan Doina

AGE GROUP: 16-17

GRADE: 10th grade technological high school

DURATIONOFTHEACTIVITY:

2 months

SUBJECTS

- Counseling and Guidance,
- Chemistry,
- Textile Technologies,
- Design,
- ICT

LEARNING OBJECTIVES:

Counseling and guidance

LO1- To practice the management skills of a quality lifestyle

Chemistry

LO2- To explain phenomena, processes, procedures encountered in everyday life.
LO3- To describe the behavior of cellulose, cellulosic fibers and natural organic dyes
LO4- To process written information, data, concepts for their use in project activities
LO5- To systematically use specific terminology in various communication contexts
LO6- To justify the importance of cellulose, cellulosic fibers and natural organic dyes

Textile Technologies:

LO 7- To use design elements to create products specific to the textile and leather sector
LO 8- To carry out simple technological operations for the realization of a product specific to the field of textiles and leather.
LO 9- To use equipment from the textile and leather sector to carry out technological operations
LO 10- To self-evaluate the correctness of the technological operations performed based on the evaluation sheet
LO 11- -To independently identify semi-finished products to obtain finished products

LO 12- To collaborate with the members of the work team, in order to fulfill the tasks at the workplace

Information and communication technology
LO 13- To develop products that develop innovative spirit and creativity
LO 14- To make a presentation
LO 15- -To apply basic elements in text processing
LO 16- To practice the management skills of a quality lifestyle

B.NECESSARY RESOURCES

MATERIALS USED
- tablets or smartphones,
- notebook,
- interactive whiteboard,
- computer,
- scanner,
- printer,
- internet
- chemistry textbook cls. the tenth,
- the experimental activity sheet,
- audio-video presentation,
- ppt presentation (Cellulose)
- various fabrics and knitwear from natural and synthetic textile fibers,
- hammer,
- plants from the school garden (leaves and flowers),
- mordant (white vinegar),
- plastic foils,
- solid work surface,
- gloves,
- electric stove,
- 5 l pot.
- "Flowers from the school garden" collage/mood board,
- pencils, colored pencils,
- watercolors,
- brushes,
- glasses of water,
- drawing pad
- crucible in which textile materials are burned.
- tongs or tweezers to grip the textile materials,
- laboratory gas bulb/lighting, match/lighter,
-experimental activity sheet- Identifying the composition of textile materials,

- samples of textile materials,
- old/second hand clothing products
- Padlet https://padlet.com/amlupei/stilul-meu-de-via-s-n-tos-86sfk383j3xcpt91, video materials In search of sustainability | Cami Gui | TEDxCluj - https://www.youtube.com/watch?v=hTt9wolS_os,
- Carbon footprint calculator (https://www.footprintcalculator.org/en/results/0/summary)

METHODS

- interdisciplinary projects-based learning
- heuristic conversation,
- explanation,
- analysis,
- brainstorming
- directed discovery,
- documentation,
-laboratory experiment,
- experiment,
- demonstration,
- practical activity

FORMSOFORGANIZATION

- individual,
- in groups of 2-3 students
- frontal

C.DESCRIPTION OF THE ACTIVITY

No. students: 19

Time	Activity	Teacher role
60 min	**A1- Subject/Module: Counseling and Guidance** The teacher directs the questions: What does a quality lifestyle mean? Present the Padlet https://padlet.com/amlupei/stilul-meu-de-via-s-n-tos-86sfk383j3xcpt91 and ask students to fill in one idea for each section: • What I eat • What I wear • How I take care of myself Students watch the video In search of sustainability | Cami Gui | TEDxCluj - https://www.youtube.com/watch?v=hTt9wolS_os Students are asked to access the link	Address questions Presents the materials Guides students to discover the importance of sustainable lifestyle Presents the content of the interdisciplinary project Creates the groups Explain the process of developing the project Give homework and

	https://www.footprintcalculator.org/en/results/0/summary using their tablets or phones to calculate their carbon footprint. At the end of the quiz, the results are discussed. It is noted that this activity is part of an interdisciplinary project involving several disciplines, namely: Counseling and guidance, Chemistry, Design elements, Technological operations in the textile and leather industry and Information and communication technology The theme of the interdisciplinary project is presented: "Creativity in the study of cellulose" The class is divided into teams of 2 students who will have to complete a project with the following structure by the end of May: 1. Argument 2. Notions about cellulose (an experimental activity and uses) 3. Natural organic dyes of vegetable origin that can be used for dyeing/printing textiles (description, enumeration and collage with flowers from the school garden) 4. Sketches of clothing ensembles inspired by the collage representing flowers from the school garden 5. Natural cellulosic fibers (classification) 6. The choice of textile materials for the realization of the proposed products (an activity of organoleptic identification and burning of textile materials and testing using the Hapa Zome technique) 7. Printing technological process 8. Conclusions Each team of 2-3 students will have to create a ppt project at the end in which to present the activities carried out. The completed works will be publicly presented during the National Technical Symposium for "EXPECTATIVE" students Homework: Compile a 1-page structured essay answering the following questions: - What is 3R	explain the content of it

	- What is the difference between Slow fashion and Fast fashion? - Why a positive attitude towards climate change is important - Three actions you can take to reduce your carbon footprint Note: This essay represents the project argument	
60 min	**A2- Subject/Module: Chemistry** The activity takes place in the classroom (chemistry laboratory). At the end of the class, the students receive a Documentation sheet- Physico-chemical properties of cellulose and they are asked to prepare an interdisciplinary report, which will focus on the importance of cellulose in everyday life and which will include the conclusions of the experiments carried out in class to determine the dissolution of cellulose in the Schweizer reagent . They will be attached to the report according to the Experimental Activity Sheet	- handout materials, experimental activity sheets, documentation sheets - guide the students during activity - give feedback when needed - evaluate the work done by students - appreciate the successful works -explain the way of preparing the interdisciplinary report
120 min	**A3- Subject/Module: Chemistry** The activity takes place during the green week, in the chemistry or textiles laboratory. The students receive the documentation sheet– Examples of natural dyes and pigments obtained from vegetable sources) which they go through together with the class teacher. The work sheet - ECO printing is distributed and the necessary materials are divided into teams of 2 and they make various prints on various textile materials, with different compositions. At the end of the first hour, each team presents their creations, and they are asked to answer the following questions: - *Why did the color adhere to some materials by pressing and not others?* - *From what materials should a clothing ensemble be*	- handout materials, experimental activity sheets, documentation sheets - present local printings using the Hapa Zome technique - guide the students during activity - give feedback when needed - evaluate the work done by students - appreciate the successful works

	made to be able to use this technique? In the second hour, the students are invited to the school garden to identify flowers and plants they used for ECO printing, to take pictures of them, to find their scientific names on the Internet. Back in the classroom, the students are asked to make a collage/mood board with the title "Flowers from the school garden". This collage/mood board will be used as a source of inspiration for making sketches and clothing products in the following classes.	
180 min	**A4- Subject/Module: Design** Each student makes three sketches inspired by the "Flowers from the school garden" collage made in Chemistry class. When they are completed, all the drawings are displayed on the classroom walls or blackboard. Students are invited to visit the gallery and stick a post-it note on the sketch they like best and think is the most creative. Sketches with the most likes are scored. For those with the least appreciation, students are asked to mention what made them not choose the presented model and what they would do to improve it.	- guide the students during activity - give feedback when needed - evaluate the work done by students - appreciate the successful works
60 min	**A5- Subject/Module: Chemistry** The students are divided into groups of 2. The students are given documentation sheets - Identification of textile materials and are asked, under the careful observation of the teacher and the laboratory technician, to perform the burning and organoleptic tests and to complete the experimental activity sheet - Identification of textile materials. At the end of the tests, each team presents the types of textile materials identified and motivates, taking into account the results of the tests of this activity but also of activity A3, the choice of materials for making the clothing ensembles sketched in activity A4. A completed model of the experimental sheet is presented and students are asked to self-assess and rethink the choice of materials, where appropriate.	- handout materials, experimental activity sheets, documentation sheets - guide the students during activity - give feedback when needed - evaluate the work done by students - present a model of filled experimental sheet -conduct discussions regarding the choosing of materials for eco printing

360 min	**A6-Subject/Module: Technological processes for finishing textile products** The activity takes place in the textile workshop. The students receive the documentation sheet, the work sheet - ECO printing and make local printing using the Hapa Zome technique on the clothing products chosen according to the results and evaluations in activity A3 and A5 and the sketches made in activity A4. The clothing products made available come from collecting old clothes made at the school level by students and teachers. At the end of the activity, each team presents its final outfit.	- guide the students during activity - give feedback when needed - evaluate the work done by students - appreciate the successful works
360 min	**A7- Subject/Module: ICT** The activity is carried out in the IT laboratory for a period of 3 weeks, 2 hours/week. The students gather all the materials made during the activities in the project, arrange them in the logical order of the activities and insert them into a ppt presentation containing at least 15 slides. The completed presentation is sent to the ICT teacher for evaluation. The final presentation is presented in front of a commission composed of the teachers who were involved in the project (Counseling and Guidance, Chemistry, Textile Technologies, Design, ICT)	- guide the students during activity - give feedback when needed - evaluate the work done by students - appreciate the successful works

D. Evaluation of student activity and results

Continuous assessment is carried out through practical tests, systematic observation of students, homework in class, investigation, report, self-evaluation

The summative assessment was carried out for each discipline, according to the national curriculum, by the classroom teachers based on the specially designed evaluation sheet (see Annex)

In order to evaluate the degree of satisfaction of the students regarding the way in which the project activities were carried out, they will have to answer a specially designed satisfaction questionnaire, with questions related to the project activities, the degree of personal involvement as well as that of colleagues, the support provided by teachers.

E. RESULTSDESCRIPTION

Needs analysis

An interdisciplinary project exploring creativity in the study of cellulose is not only a valuable educational opportunity, but also an initiative with real impact on society and the

environment. This type of project promotes a deep understanding of the interconnections between science, technology, art and culture, while developing essential skills for future fashion designers. By combining theoretical knowledge with practical applicability, students will be better prepared to face global challenges and contribute positively to their communities.

Target groups

- 10^{th}grade students in technological high schools.
- Educators are looking for an innovative and multidisciplinary approach to teaching practical training and environmental awareness.

Elements of innovation

Interdisciplinary competence is important for both employability and sustainable development. However, to date, there are no specific interdisciplinary education models and, naturally, no empirical studies to assess them. Since project-based learning (PjBL) is a learning approaches that emphasize students' collaboration, it seems suitable to enhance students' interdisciplinary competence. Based on the principle of constructive alignment and four instructional principles on interdisciplinary learning, students profit more from interdisciplinary PjBL (iPjBL).

Expected impact

Interdisciplinarity in education not only enriches students' learning, but also prepares them for the real world by developing essential skills and promoting a deep and holistic understanding of knowledge. By integrating knowledge from multiple fields, students become better prepared to meet the challenges and opportunities of an ever-changing and interconnected world.

By inviting students to participate in real-life challenges instead of a required assignment, we enable them to become skilled learners ready to explore and discover as they initiate their learning through the inquiry process inherent in an open program. Through an open challenge, our learners have the opportunity to develop a whole new set of attributes such as agility, awareness, curiosity, collaborativeness, flexibility, initiative, imagination, motivation, attention, which many teenagers are accused of lacking. More importantly, as we design and co-design, with our students and colleagues, authentic learning opportunities relevant to them, we empower them to effect positive change.

Transferability potential

The project can be taken over and adapted for students between the ages of 11 and 14 from secondary school, respectively 15-19 high school students, regardless of qualification for technological education classes in secondary school or for making various decorative items during the week” The green school" in secondary school or high school.

F. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
Lack of involvement of all students in the proposed activities	Adaptation of the proposed tasks according to the abilities of each individual student Encourage to work using various materials and methods
Conflicts in groups.	Assign roles in groups and emphasize the importance of each student.
There may be a risk that students misunderstand or oversimplify the environmental message in their work	Encourage discussions and critical thinking about the environmental message throughout the lesson. Provide resources and examples that illustrate the importance of environmental conservation and sustainability.
When discussing environmental issues, there is a risk of inadvertently causing distress or anxiety in some students.	Approach environmental topics with sensitivity, emphasizing positive actions and solutions. Create a safe and open environment where students can express their thoughts and feelings about environmental concerns.

G. BIBLIOGRAPHY/WEBOGRAPHY

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EVALUATION SHEET
of the project and the oral presentation
INTERDISCIPLINARY PROJECT "CREATIVITY IN THE STUDY OF CELLULOSE"

1. Start date of project implementation activities:

2. Establishing the candidate's individual activities plan for the project:
— Date:
— Signature of the candidate:
— Supervisor's signature:

3. Establishing the project implementation plan:
— period:
— revised:
— the date on which the final form of the project is accepted by the supervisor:

4. Meetings for monitoring the project (at least 5 meetings):

No crt	**Remarks**	**Student's signature**	**Teacher's signature**
1	Establishing the bibliography and contents		
2	Checking the materials made for the Chemistry subject		
3	Checking the materials made for the Design subject		
4	Checking the materials made for the discipline Technological operations in the textile and leather industry		
5	Checking the materials made for the ICT discipline		
6	Handing over the project/portfolio		

Part II: Assessment of the quality of the student's activity and the quality of the project

Subject/Module / **Criterion**	Maximum score	Counseling and guidance	Chemistry	Design	Technological processes in the textile industry	ICT
		Awarded score	Awarded score	Awarded score	Awarded score	Awarded score
1. The practical activities undertaken within the project are adequately related to the project theme	5 p					
2. The project theme was approached from a personal perspective, with the candidate demonstrating critical reflection	5 p					
3. The practical activities were undertaken under the supervision of the project supervisor and/or authorized persons	3 p					
4. The accomplishment of the tasks established by the project plan was done according to the initial planning	3 p					
5. The documentation for the project was done with the support and under the supervision of the project supervisor	3 p					
6. The identification and use of the recommended bibliography for the writing of the written part of the project have been completed in full	2 p					
7. The bibliographic references used in writing the written part of the project were taken and presented in a personal way and are not a compilation of quotations	4 p					
8. The solutions for the problem situations that the candidate faced during the execution of the project are personal and were found with the help of the project guide	5 p					
9. In carrying out the work tasks within the project, the candidate demonstrated personal involvement and commitment, the originality	5 p					

of the proposed solutions, imagination and creativity in approaching and fulfilling the tasks						
10. The solutions found by the candidate to solve practical problems are also applicable in other work contexts	5 p					
11. The Project/Product is valid in relation to the theme, purpose, objectives and methodology addressed	3 p					
12. The Project/Product demonstrates completeness and satisfactory coverage in relation to the chosen topic	3 p					
13. The development of the project and the writing of the written part of the project were done in a consistent and simultaneous way, according to the planning	2 p					
14. The candidate's option for using certain resources is well justified and argued in the context of the project	3 p					
15. The drafting of the written part of the project demonstrates a good internal consistency	2 p					
16. The written presentation of the project is logical and demonstrates a good argumentation of the ideas	3 p					
17. The Project/Product represents, in itself, a personal practical solution, with elements of originality in finding solutions	4 p					
18. The Project/Product can have practical applicability outside the school as well	4 p					
19. The realization of the project / product required the activation of a significant number of competence units, according to the professional training standard for the respective qualification	4 p					
20. The drafting of the written part of the project complies with the structure requirements imposed	2 p					
21 In the final presentation of the project, the student achieved a clear, coherent and fluent oral communication	6 p					

22. The presentation was structured in a balanced manner in relation to the project theme and its objectives	6 p					
23. The student demonstrated the ability to synthesize and adapt the presentation to the examination situation	6 p					
24. The student supported his views and opinions in a personal and well-argued way	6 p					
25. In order to make information accessible and increase the attractiveness of the presentation, the student used effective strategies and appropriate means of communication in the presentation: practical demonstrations, graphic elements, models, applications, audiovisual facilities of information and communication technology, etc.	6 p					
Total score Part II	**100 p**					

It is completed by the classroom teacher at the end of the monitoring activity. The criteria refer both to the project development process and to the drafting and presentation of the project.

Evaluators (surname, first name and signature):

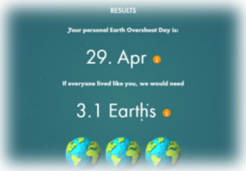
Evaluator 1: ……..

Evaluator 2: ....

Evaluator 3: ....

Evaluator 4: ....

Evaluator 5: .... Date: .....


RESULTS
Your personal Earth Overshoot Day is:
29. Apr
If everyone lived like you, we would need
3.1 Earths

Lesson no. 3.

A. TITLE: Mechanical seams

AUTHOR/AUTHORS
Ștefaniu George

AGE GROUP:
15-17

GRADE: 10th

DURATION OF THE ACTIVITY: 6 hours

SUBJECTS:
- practical training in textile industry domain,
- textile recycling,
- up-cycling

LEARNING OBJECTIVES:
LO1: To produce decorative pillow covers from recycled textile materials using patchwork method
LO2: To identify and select the textile raw materials (recycled /reused textile materials)
LO3: To use the tools and utensils necessary for the work during the practical training in a correct way
LO4: To adjust sewing machines according to the type of stitch
LO5: To cut the materials according to the pattern
LO6: To execute all types of seams respecting health and safety rules at work
LO7: To respect the environmental issues by using secondhand clothing in order to upcycle

B. NECESSARY RESOURCES

MATERIALS USED
- used fabrics, curtains, bed linen, old clothing
- sewing thread, buttons/zipper
-textile industry domain tools and equipment

METHODS (teaching methods!)
-Learning through discovering
-Conversation
-Practical activities -individual work

- Exercise
-Exposure

FORMS OF ORGANIZATION

- individual,
- in pairs
- frontal

C.DESCRIPTION OF THE ACTIVITY

No. students: 20

Time	Activity	Teacher role
1 hour	Checking the students' attire and state of health to properly carry out the practical activity Presenting the purpose of the lesson The necessary materials are distributed and the practical work to be performed is presented and demonstrated	- To ensure a pleasant atmosphere in the workshop - To present the types of mechanical stitches. -To compare and present different types of stitches. - To present different models of patchworks and the way of producing pillows using this method - To show how the materials are cut according to the pattern - To show how to perform simple stitching using the sewing machine -To explain how to perform stitches. - To perform the adjustment of the sewing machine in order to sew. - To demonstrate in slow motion, in a staggered sequence, in a logical rhythm, the execution of stitches.
4 hours	The class divided in groups of 2-3 students discusses what they intend to make from the materials provided The students design the patchwork and create the pattern, choose materials to be used Each group cut materials, pins the pieces and sews pieces according to the requirement given by the teacher.	-To guide the students during activity -To give feedback when needed
1 hour	Presenting and assessing the work done by students	-To evaluate the work done by students -To give feedback -To appreciate the successful works -To explain the causes that led to possible mistakes

D. Evaluation of student activity and results

Continuous evaluation is carried out throughout the activity through systematic observation

The final evaluation is carried out at the end of the activity according to the evaluation sheet

Evaluation and marking grid (according to the evaluation standard associated with the unit of learning outcomes).

Evaluation criteria	Maximum score per criteria	Evaluation indicators	Score on indicator.	
			Maximum	Granted
1. Receiving and planning the workload.	**30 points**	1.1.Selection and preparation of sewing patterns and materials.	**4 points**	
		1.2.Preparing the machines for processing operations (checking the technical condition of the sewing machine, adjusting the stitch pitch, sewing test, thread tension adjustment).	**10 points**	
		1.3.Interpretation of the technical documentation in order to execute the technological operation (seam technical sheet). 1.4.Identification of the type of seam to be executed - from the technical sheet of the seam and the standard sample.	**10 points**	
		1.5.Ensuring the conditions for the application of specific	**6 points**	

		rules regarding health and safety at work and the environment.		
2. Accomplishing the workload.	**40 points**	2.1. Serving the machines and changing the color of the threads as required by the workload (threading the needle, winding the bobbins, introducing the bobbins into the shuttle).	**20 points**	
		2.2. Execution of seams in accordance with the technical sheet, sample time norms.	**10 points**	
		2.3. Execution of thermal processing operations	**4 points**	
		2.4. Compliance with occupational health and safety rules when processing items (sewing, ironing).	**6 points**	
3. Presentation of the workload.	**30 points**	3.1. Self-evaluation of technological operations performed.	**10 points**	
		3.2. Correct use of the specific terminology for reporting task performance.	**20 points**	
4. Total score	**100 points**		**100 points**	

E. RESULTS DESCRIPTION

Needs analysis

The lesson project was carried out in accordance with the school curriculum for 10th grade students in technological education, specializing in Fashion Designer Technician for the development of specific professional skills but also to develop their environmental awareness

Target groups,

- 10^{th} grade students in technological high schools.
- Educators are looking for an innovative and multidisciplinary approach to teaching practical training and environmental awareness.

Elements of innovation

By making decorative items from recyclable textile materials, we develop in students, in addition to the professional skills provided in the professional training standards, also skills to protect the environment by making them aware of the importance of reusing end-of-use textile materials.

Expected impact

- Enhanced Professional Skills: The lesson plan is expected to improve students' professional skills by engaging them in practical and creative activities.
- Increased Environmental Awareness: Through the creation of decorative items using secondhand clothing or used/old curtains/drapes/bed linen, students are encouraged to reflect on the importance of nature and sustainable living, fostering a sense of environmental responsibility.
- Improved Collaboration and Communication: Group activities promote teamwork and communication skills among students.

Transferability potential

The project can be taken over and adapted for students between the ages of 11 and 14 from secondary school, respectively 15-19 high school students, regardless of qualification for technological education classes in secondary school or for making various decorative items during the week" The green school" in secondary school or high school.

F.ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	**Measures/Solutions**
Non-involvement of all students in the proposed activities	Adaptation of the proposed tasks according to the abilities of each individual student Encourage to work using various materials and methods
Conflicts in groups.	Assign roles in groups and emphasize the importance of each student.
There may be a risk that students misunderstand or oversimplify the environmental message in their work	Encourage discussions and critical thinking about the environmental message throughout the lesson. Provide resources and examples that illustrate the importance of environmental conservation and sustainability.
When discussing environmental issues, there is a risk of inadvertently causing distress or anxiety in some students.	Approach environmental topics with sensitivity, emphasizing positive actions and solutions. Create a safe and open environment where students can express their thoughts and feelings about environmental concerns.

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Lesson no. 4.

A. **TITLE:** Creating clothing ensemble inspired by a historical part representative for our country using old/ used denim

AUTHOR/AUTHORS: Ștefaniu George, Lupei Anca Marilena, Hlihor Ramona, Toderici Carmen, Brișan Doina, Julan Cosmin

AGE GROUP: 17 - 19

GRADE: XII – (4-th year of technological High school)

DURATION OF THE ACTIVITY: January - April

SUBJECTS: Upcycling, History, TIC, Technologies, Fashion, Design

LEARNING OBJECTIVES:

LO1: To create sketches of clothing products and accessories
LO2: To develop the manufacturing technological process
LO3: To identify and select the textile raw materials (used denim)
LO4: To respect safety rules of work
LO5: To identify the characteristics of the historical period
LO6: To use ICT tools to create the mood board, presentation, and search information
LO7: To respect environmental issues by using second-hand clothing upcycle

B. NECESSARY RESOURCES

MATERIALS USED
- old denim clothing, second-hand clothing
- textile accessories
- computer
- textile domain tools and equipment

METHODS
- learning through discovering
- conversation
- practical activities – individual work
- exercise
- case study

- project-based learning individual

FORMS OF ORGANIZATION

- individual
- in pairs

C. DESCRIPTION OF THE ACTIVITY

No. students: 19

Classroom mirror: NOT THE CASE

Time	Activity	Teacher role
1st week	Project theme presentation establishing the steps to be taken Setting the table of contents establishing the bibliography establishes deadlines	The teacher presents the theme, deadlines and bibliography, homework
	Homework – documenting the historical period	Establish personal input to avoid plagiarism
2nd week **180 min**	Homework check Study the trend special to the selected period	Teacher's feedback
	In school, IT laboratory Create 2 mood boards and decide the final one	The IT teacher's support and textile technologies lead design
3rd week **180 min**	Create a minimum 5 sketches using different techniques	The design teacher leads, supports and coordinates
4th week **180 min**	Select old clothing, accessories, etc According to the sketches selected	Practical training teachers offer feedback and support
5th week to 9th week **900 min**	To manufacture the products To describe the technological process	Practical training teachers offer feedback and support
10th week **180 min**	Presenting the products and the technological process	Practical training Teacher offer feedback
	Customized remediation plan developing	Practical training The teacher establishes through conversation the steps needed to finalize the products and the technological process description
11th week **180 min**	Creating the presentation (ppt, canvas, padlet, lino,	IT teachers support the students in creating the presentation and offer feedback

	etc)	
12th week 210 min	Final assessment	The teachers involved evaluate the work done

D. Evaluation of student activity and results

- continuous and final

E. RESULTS DESCRIPTION

NEEDS

- The students created sketches that developed the manufacturing technological process;
- Identified and selected materials;
- Respected safety rules;
- Used ICT tools in different stages of the product development and presentation;
- Identified the characteristics of the historical period and trends according to the learning objectives.

TARGET GROUP – 19 students 4th year

ELEMENTS OF INNOVATION

- Multidisciplinary;
- Evaluation made for 5 subject teachers.

IMPACT

- Students aware of the importance of environmental issues and recovery of textile waste

TRANSFERABILITY

- Secondary school students in technological education subjects
- Extracurricular activities
- Initial training for future teachers of technologies

F.ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/ Solutions
Not complying with deadlines	Reorganization of the activities, with the student's agreement

G. BIBLIOGRAPHY

- Manuals
- Internet links used
- Photos

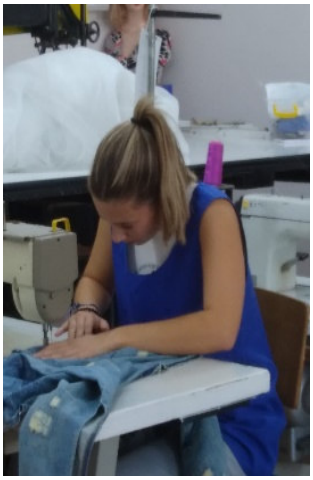












Lesson no. 5.

A. TITLE: MAKING HAND PUPPETS FROM TEXTILE PRODUCTS

AUTHOR/AUTHORS: Textile, history, Pedagogy teachers

AGE GROUP: 16-17 yrs.

GRADE: 11th -12th

DURATION OF THE ACTIVITY: A 3-week study is planned with 6 classes per week. Total 18 classes.

SUBJECTS: History, geography, pedagogy, textile recycling, up-cycling.

LEARNING OBJECTIVES:

LO1: Students will learn basic sewing techniques to create hand puppets from old textile materials.
LO2: Students will develop their creativity and imagination by designing and decorating their hand puppets.
LO3: Students will gain awareness of sustainable practices by repurposing textile waste into functional and artistic creations.
LO4: Students will explore ways to overcome challenges in working with recycled materials and adapt their designs accordingly.

B. NECESSARY RESOURCES

-Interactive board/projection, computer, printer/scanner, computer-aided pattern preparation programs, drawing materials.

MATERIALS USED

- Recycled textile waste (fabric, felt, yarn, etc.)
- Sewing needles and thread
- Scissors
- Fabric glue
- Markers or fabric paint
- Optional embellishments (buttons, ribbons, etc.)

METHODS (teaching methods!)

- Narration
-Doing by showing
-Question and answer,
-Group work
-Practical work
-Brainstorming
-Principle of efficiency

FORMS OF ORGANIZATION: In groups of 6-7 people

C.DESCRIPTION OF THE ACTIVITY

No. students: 12
Classroom mirror: SS will work in groups of 6-7.

Time	Activity - MAKING HAND PUPPETS FROM TEXTILE PRODUCTS	Teacher role
1st week	**Understanding Textile Consumption and Its Environmental Impact**	-providing guidance, support, and resources. - Showing techniques and providing hands-on assistance during practical sessions.
6 lessons	*Lesson 1: Introduction to Hand Puppets and Sustainability (2 hours)* - Introduction to the concept of hand puppets and discussion for the importance of sustainability in crafting. - Discussion on carbon footprint and its significance. - Showing examples of hand puppets made from recycled materials. - Group discussion on the benefits of using recycled materials and brainstorming session on puppet ideas. *Lesson 2: Basic Sewing Skills (2 hours)* - Demonstrating basic hand-sewing techniques such as running stitch, backstitch, and whipstitch. - Practicing sewing on fabric scraps or felt pieces to master the basic stitches. *Lesson 3: Designing Hand Puppets (2 hours)* - Guiding students in sketching their puppet designs and planning the use of recycled materials. - Students create sketches of their puppet designs, considering different shapes, sizes, and features.	
2nd week	**Fabric Selection and Creating products**	- Showing techniques and providing hands-on assistance during practical sessions. - Encouraging creativity, critical
6 lessons	*Lesson 4: Fabric Selection and Preparation (2 hours)* - Assisting students in selecting the right textiles for their puppet designs and preparing them for the next stage of the process. - Students choose fabrics and gather necessary materials for their hand puppets. *Lesson 5: Creating Hand Puppets (2 hours)* - Providing step-by-step instructions on how to create hand puppets using sewing and/or fabric glue. - Students begin making their hand puppets, following the design plans created in the previous class.	

	Lesson 6: Creating Hand Puppets (2 hours) - Guiding and supporting students to work on completing their hand puppets. - Students focus on finishing and designing their puppets.	thinking, and problem-solving skills.
3rd week	**Decoration and Presentation**	
6 lessons	*Lesson 7: Decorating and Making Hand Puppets (2 hours)* - Encouraging students to decorate their hand puppets using markers, fabric paint, and optional embellishments. - Students can express their creativity by adding colors, patterns and features to their puppets. *Lesson 8: Practice Puppet Performances (2 hours)* - Students can rehearse puppet performances with their classmates. - Students work in pairs or small groups to create short puppet shows or scenes, focusing on puppet manipulation and storytelling. *Lesson 9: Finalization of New Products (2 hours)* - Organizing a puppet show where students show their hand puppets and perform their puppet skits for the class. - Students reflect on their puppet-making experience, discussing what they learned, challenges they faced, and how they can apply their skills in the future.	- Monitoring progress and providing constructive feedback on student projects. -Fostering a collaborative and supportive learning environment.

D. Evaluation of student activity and results

- Students will be graded on their sewing technique, creativity in designing puppets, incorporation of recycled materials, problem-solving skills, and presentation of their hand puppets.

- Additionally, they will be evaluated on their understanding of sustainable practices and specifically their ability to explain the benefits of up-cycling textile waste.

Overall, this lesson plan aims to not only teach practical skills in textile transformation but also instill awareness and responsibility towards sustainable consumption and environmental protection among students**.**

E. RESULTS DESCRIPTION

- Students successfully created hand puppets using old textile materials, showcasing their sewing skills and creativity in design.

- Students demonstrated an understanding of sustainable practices by repurposing textile waste into functional and artistic creations.

- Students overcome challenges in working with recycled materials, adapting their designs and

problem-solving effectively.

-Students presented their hand puppets in the class, highlighting the process and inspiration behind each design and promoting awareness of up-cycling practices.

F. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
Quality Issues: The quality of the transformed product may not meet expectations, leading to dissatisfaction among students or participants.	Implement quality control measures throughout the transformation process to ensure the final product meets the desired standards.
Technical and material Challenges*: Students/Participants* may have difficulties in the transformation process, such as sewing techniques or material handling.	Provide adequate guidance and support from experienced instructors or mentors to help students/participants overcome technical challenges and learn new skills effectively.
Safety Concerns: Handling tools and machinery can pose safety risks, particularly for inexperienced participants.	Prioritize safety by providing proper training on equipment usage and enforcing safety protocols in the workshop. Provide personal protective equipment (PPE) as necessary.

Lesson no. 6.

A. **TITLE:** Making costumes from textile products

AUTHOR/AUTHORS: Textile and pedagogy teachers

AGE GROUP: 15-16 yrs.

GRADE: 10th – 11th
DURATION OF THE ACTIVITY: A 4-week study is planned with 4 lessons a day per week. Total 16 lessons.

SUBJECTS: Drama, pedagogy, textile design, textile recycling, up-cycling

LEARNING OBJECTIVES:
LO1: To understand the basics of textile design and its application in costume making.
LO2: To develop skills in creating costumes from textile products.
LO3: To apply problem-solving skills in designing and creating costumes.
LO4: To demonstrate an understanding of the role of costumes in drama and performance.

B. NECESSARY RESOURCES

- Textile materials (fabrics, threads, yarns, etc.)
- Sewing machines or needles
- Scissors, glue, and other crafting tools
- Measuring tapes and rulers
- Costume design software or drawing tools
- Access to a computer or tablet with an internet connection
- Whiteboard and markers
- Decorations

MATERIALS USED

- Various textile materials (cotton, polyester, silk, etc.)
- Fabric paint, dye or markers
- Sewing threads and yarns
- Zippers, buttons, and other fasteners
- Interfacing and stabilizing materials
- Costume design templates or patterns

METHODS (teaching methods!)

- Introduction and demonstration of textile design and costume making techniques.

(e.g. animated films and costume designs)

- Discussion.
- Group work.
- Question and answer.
- Guided practice and experimentation with textile materials and techniques.
- Independent project work, where students design and create their own costumes.
- Peer feedback and self-assessment.

FORMS OF ORGANIZATION: In groups of 5 students

C.DESCRIPTION OF THE ACTIVITY

No. students: 10-12

Time	Activity	Teacher role
1st week	**INTRODUCTION AND CONCEPTS (160 Minutes)**	
4 lessons	*Introduction and explanation of objectives (40 minutes) *Discussing and identifying examples on the relationship between drama class and costume design (40 minutes) *Students determine their own costumes (40 minutes) *Creating costume and accessory ideas and drawing first drafts in groups (Guided practice of textile design techniques). (40 minutes)	-providing guidance, support, and resources. - Showing techniques and providing hands-on assistance during practical sessions.
2nd week	**COSTUME DESIGN (160 minutes)**	
4 lessons	*Reviewing the previous week's work and receiving feedback (40 minutes) *Teaching material selection and basic sewing techniques for costume design (60 minutes) *Creation and development of students' costume prototypes (60 minutes)	- Showing techniques and providing hands-on assistance during practical sessions.
3rd week	**ACCESSORY DESIGN (160 minutes)**	

4 lessons	*Reviewing the previous week's work and receiving feedback (40 minutes) *Material selection and practical applications for accessory design (80 minutes) *Discussion on creating accessory prototypes and their compatibility with the characters (40 minutes)	- Monitoring progress and providing constructive feedback on student projects
4th week	**PRESENTATION AND EVALUATION**	
4 lessons	*Students complete their costumes and accessories and make the final touches (40 minutes) *Costume and accessory presentations in groups and receiving feedback from other students (80 minutes) *Evaluation of the lesson and discussion of the results (40 minutes)	- Emphasizing the importance of sustainability and environmental consciousness in textile practices.

G. Evaluation of student activity and results

- Participation and engagement in class activities (20%)
- Quality of costume design and creation (40%)
- Written reflection and self-assessment (20%)
- Presentation and display of final costume (20%)

H. RESULTS DESCRIPTION

- Students will have a comprehensive understanding of textile design and its application in costume making.
- Students will be able to create their own costumes using textile materials and techniques.
- Students will demonstrate an understanding of the role of costumes in drama and performance.

I. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
• Lack of desired product	• Encourage students to explore a variety of sources
• Potential safety hazards	• Educating students about proper handling and safety precautions
• Students may struggle with sewing and construction techniques.	• Provide additional guidance and support, offer one-on-one tutorials.

J. BIBLIOGRAPHY

Internet sources.

SOME PHOTOS

Lesson no. 7.

A. TITLE: *A STORY OF TRANSFORMATION*- Transforming Knitwear

AUTHOR/AUTHORS: Literature, textile teachers

AGE GROUP: 15-18 yrs.

GRADE: 9th, 10th, 11th, 12th

DURATION OF THE ACTIVITY: 5 lessons are planned. Each lesson is 40 minutes. Total 200 minutes.

SUBJECTS: Literature, Creative Writing , Textile Recycling , Up-cycling

LEARNING OBJECTIVES:

LO1: Students will develop creative storytelling skills by creating a character inspired by an old knitwear item.
LO2: Students will understand and discuss the environmental impact of textile waste.
LO3: Students will gain practical skills in textile up-cycling and design.
LO4: Students will foster awareness and appreciation of recycling through a creative project.

B. NECESSARY RESOURCES

- Writing materials (paper, pens/pencils)
- Old knitwear and other textile materials (provided by students or collected beforehand)
- Access to a computer, tablets or smart phones for research (optional)
- Presentation materials (poster boards, PowerPoint slides, etc.)

MATERIALS USED

- Old knitwear items for transformation
- Writing materials (notebooks, pens)
- Art supplies (markers, colored pencils, paints)

METHODS

- Discussion
- Group work
- Presentation

FORMS OF ORGANIZATION: whole class

C.DESCRIPTION OF THE ACTIVITY

No. students: 12

Time	Activity	Teacher role
1st week	***A STORY OF TRANSFORMATION*- Transforming Knitwear**	
5 lessons	***LESSON 1 - Introduction to Transformation and Storytelling*** **Introduction (15 minutes)** ➢ Begin the lesson by discussing the concept of sustainability and the environmental impact of textile waste. ➢ Show examples of creative projects or products made from reused knitwear or other textiles to inspire students. **Brainstorming Session (25 minutes)** ➢ Have students brainstorm individually or in small groups by asking: *What kind of story can be developed around reused textile materials or old clothes? *How can characters, settings, or plot elements reflect a sustainable lifestyle? ➢ Encourage them to consider different genres (e.g., science fiction, fantasy, realistic fiction) and how each could incorporate reuse. **Homework:** Bring an old piece of knitwear to the next class!	-providing guidance, support, and resources. - Showing techniques and providing hands-on assistance during practical sessions.
	LESSON 2 - Character Creation and Story Development **Choosing Materials (15 minutes)** ➢ Provide students with old knitwear and other textile materials.(tell them to bring materials beforehand.) ➢ Allow time for students to examine the materials, noting textures, colors, and potential uses in their stories. ➢ Encourage them to think creatively about how these	

	materials can influence their storytelling. **Storyboarding (15 minutes)** ➢ Ask students to create a simple storyboard outlining their story idea: o Main characters o Setting o Conflict or problem related to reuse of textiles/clothes **Homework Assignment (10 minutes)** ➢ Assign students to write a rough draft of their short story based on their storyboard. Emphasize the use of reused textile materials or old clothes to the plot.	
	LESSON 3 - Understanding Textile Recycling and Up-cycling **Writing Session (40 minutes)** ➢ Give brief information on the environmental impact of textile waste and benefits of recycling. ➢ Instruct students to write their short stories based on their rough drafts. ➢ Encourage them to describe the reused textile materials or old clothes and their significance to the characters or plot. **Homework:** Finalize project plans and gather any additional materials needed.	
	LESSON 4 Finalizing the project **Final Draft (20 minutes)** ➢ Give students time to revise their stories based on peer feedback. ➢ Encourage them to refine their narratives, ensuring the reuse of textile materials or old clothes enhances the storytelling. **Presentation Preparation (20 minutes)** ➢ Instruct students to prepare a presentation of their story to share with the class: o Create visuals (poster boards, PowerPoint slides, etc.) that highlight key aspects of their story and the reused materials. o Practice delivering their presentation to ensure clarity and engagement.	

	LESSON 5- Presentation ***and Reflection*** **Presentation (25 minutes): Reflection Discussion (15 minutes):** **(5 or 10 minutes per student depending on the number of the class.)** ➢ Students present their upcycled knitwear characters and read their stories. ➢ Discuss what was learned about transformation, recycling, and the creative process.	

K. Evaluation of student activity and results

- Student projects will be evaluated based on creativity, originality, and the incorporation of up-cycling techniques.
- Creative writing pieces will be assessed for depth of understanding of the transformation theme and literary elements.

L. RESULTS DESCRIPTION

- Students will develop a deeper understanding of the importance of up-cycling and textile recycling in reducing environmental impact.
- Students will improve their creative writing skills and apply them to the development of a narrative around transformation.
- Students will gain practical skills in transforming old knitwear into new, functional pieces.
- Students will reflect on their own consumption habits and consider ways to reduce textile waste in their own lives.

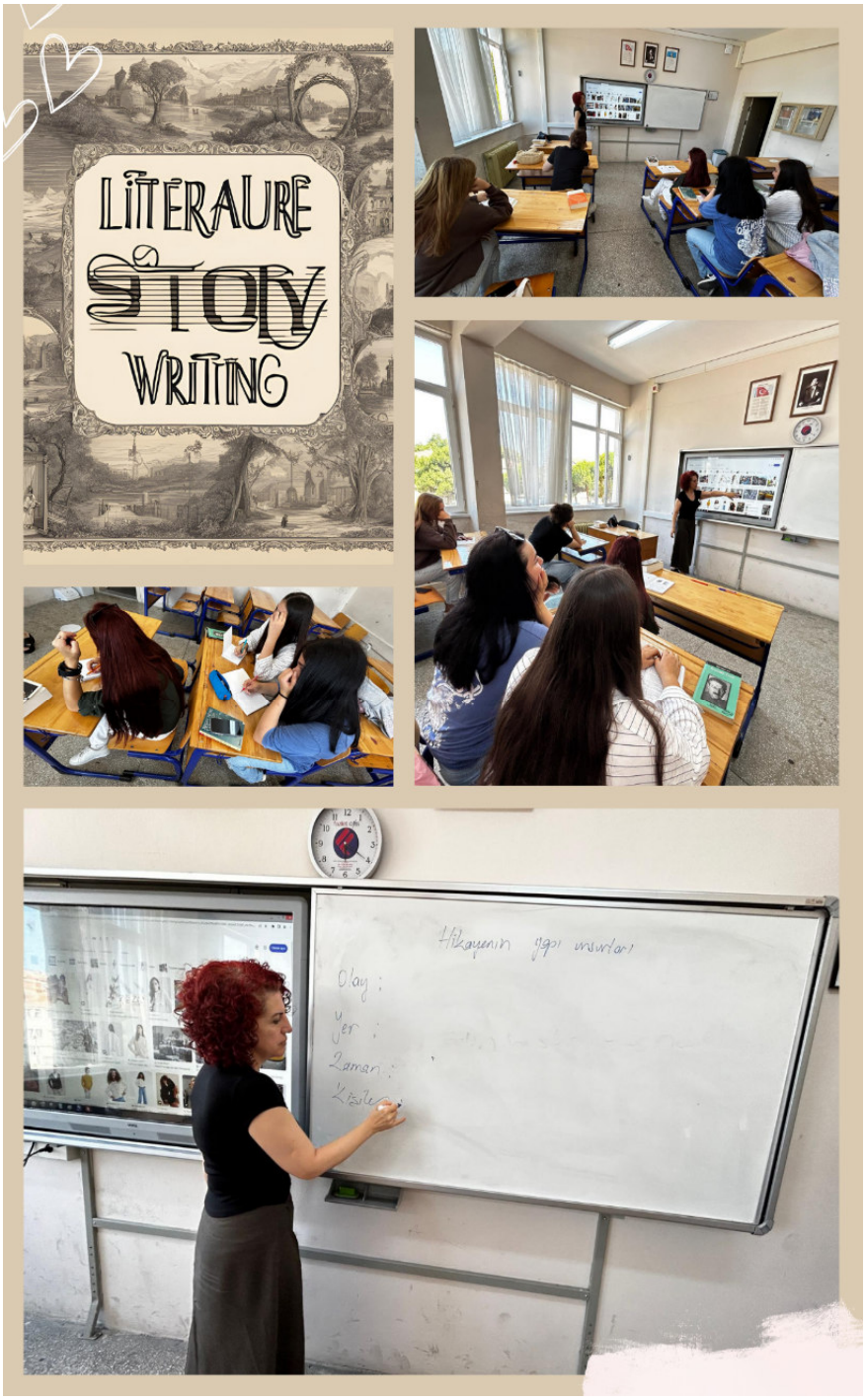
Students will have a deeper understanding of the concept of transformation in literature and textile art. They will have developed practical skills in up cycling and creative writing, as well as a greater appreciation for sustainable fashion practices.

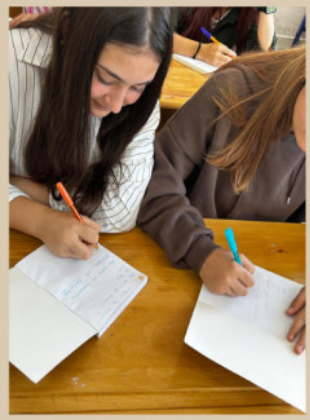
M. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
• Lack of student engagement	• Encourage active participation through interactive activities.
• Insufficient resources	• Plan ahead and ensure availability of necessary materials.
• Time constraints	• Manage time effectively during activities to cover all planned content.

N.BIBLIOGRAPHY

Internet sources





Lesson Plan no.8.

A. TITLE: *FAST FASHION: Being a conscious consumer and friendly to the environment.*

AUTHOR/AUTHORS: Textile, English teachers

AGE GROUP: 15-16 yrs.

GRADE: 10th -11th

DURATION OF THE ACTIVITY: A week's study is planned with 4 lessons .Each lesson is 40 minutes.

Total 160 minutes.

SUBJECTS: Fast fashion, being a conscious consumer, sustainability, textile recycling, up-cycling

LEARNING OBJECTIVES:

LO1: Students will be able to define fast fashion and explain its impact on the environment.
LO2: Students will understand the importance of being a conscious consumer and making sustainable fashion choices.
LO3: Students will be able to identify ways in which they can reduce their carbon footprint through their clothing choices.

B. NECESSARY RESOURCES

- PPT or a video fast fashion and sustainability.
- Reading text.
- Internet access for videos and online resources.

MATERIALS USED

- Projector or smart board.
- Presentation materials (slides on fast fashion, sustainability, and conscious consumerism, examples of sustainable fashion brands and practices)

  videos on textile recycling and up-cycling)
- Internet access for videos and online resources.
- Printed copies of the provided text on fast fashion and its environmental impact.

METHODS (teaching methods!)

- Narration
- Question and answer,

- Group work
- Practical work
- Brainstorming
- Principle of efficiency

FORMS OF ORGANIZATION: whole class.

C.DESCRIPTION OF THE ACTIVITY

No. students: 10

Time	Activity	Teacher role
1 week	**FAST FASHION: Being a conscious consumer and friendly to the environment.**	-providing guidance, support, and resources.
1st lesson (40 min)	***Lesson 1:*** **Introduction - (15 minutes)** ▪ Greet students and introduce the topic of fast fashion. ▪ Show a brief slideshow about fast fashion. ▪ Ask students what they know about fast fashion and its impact on the environment. ▪ Write their responses on the board. ▪ Introduce the concept of fast fashion and its negative impact on the environment, such as waste, pollution, and exploitation of garment workers. ▪ Explain that the goal of the lesson is to help students become more conscious consumers and make eco-friendly choices. **Vocabulary building (25 minutes)** ▪ Distribute the vocabulary list and review key terms: (Fast fashion, Landfill, Chemicals, Sustainable, Throwaway society) ▪ Use example sentences to illustrate each term. Provide visual aids or images to support understanding. ▪ Conduct a quick vocabulary matching activity: ▪ Students match words to their definitions on sticky notes or small cards. ▪ Discuss the matches as a class.	
2nd lesson	***Lesson 2:*** **Reading session (25 minutes)** ▪ Hand out the text about fast fashion to students . ▪ Students read the article silently. ▪ Encourage students for highlighting or underlining key points and unfamiliar words. Emphasize the key words and new vocabulary. ▪ Conduct a guided reading session. **Reading Comprehension Questions (15 minutes)** ▪ Ask them comprehension questions during or after the reading to ensure understanding.	

	▪ Discuss the answers as a class. ▪ Encourage students to provide evidence from the text to support their answers.	
3rd lesson	***Lesson 3:*** **Speaking Activity / Group Discussion** **Practical Steps to Reduce Carbon Footprint (40 minutes)** ▪ Divide students into small groups. ▪ Provide discussion questions: – What are some ways to reduce the environmental impact of fast fashion? – Do you think people should change their shopping habits? Why or why not? – Buying fewer clothes and shopping more mindfully – Choosing secondhand, vintage, or sustainable clothing options – Caring for and repairing clothes to extend their lifespan – Advocating for more sustainable practices in the fashion industry – How can companies promote sustainable fashion? ▪ Each group presents their ideas to the class. ▪ Discussion on the different ideas presented. ▪ Encourage students to ask questions and provide feedback.	-providing guidance, support, and resources.
4th lesson	***Lesson 4*****: Reflection and Conclusion (40 minutes)** ▪ Have the students watched the video about fast fashion environmental impact. Fast Fashion Environmental Impact | Fast Fashion Effects on Environment | The Planet Voice - YouTube ▪ Take a small quiz about the video (fast fashion destroying our planet) interactive or game mode. Fast Fashion - Definition - Causes &…: English ESL video lessons (islcollective.com) ▪ Discuss the various ways that students can make a difference in reducing the environmental impact of fast fashion. ▪ Writing slogans on the board. ▪ Close the lesson by having students reflect on what they learned and how they can apply it to their own clothing choices and behaviors.	-providing guidance, support, and resources.

D. Evaluation of student activity and results

- Students will be evaluated based on their participation in class discussions, group activities, and presentations.
- The evaluation will include understanding of key concepts, critical thinking skills, creativity in project work.
- Results will be assessed through quizzes, presentations, and reflection assignments to value students' comprehension and engagement with the topic.

This lesson plan aims to educate students about the importance of being conscious consumers in the fast fashion industry and empower them to make sustainable fashion choices to reduce their environmental impact.

E. RESULTS DESCRIPTION

- By the end of the week-long study, students will understand fast fashion, consumerism, sustainability, and textile recycling.
- They will also show critical thinking skills in analyzing the environmental impact of the fashion industry and present creative solutions in their projects.
- Through active participation, students will become more aware of their role as consumers and the importance of making sustainable choices in fashion

Lessons and activities can be adapted for use in other grade levels or subjects where sustainability education is relevant, fostering a broader culture of sustainability within schools.

F.ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
Lack of interest among students.	Use engaging multimedia and real-life examples to increase interest.
Difficulty in accessing on-line materials.	Provide alternative materials.
Time constraints for completing activities.	Manage time effectively by prioritizing essential activities and adjusting lesson plans if necessary.

G. BIBLIOGRAPHY

Reading text : 1 Fast fashion, Clothes, fashion, General reading comprehens… (islcollective.com)
Youtube video: Fast Fashion Environmental Impact | Fast Fashion Effects On Environment | The Planet Voice - YouTube
Quiz: Fast Fashion - Definition - Causes &…: English ESL video lessons (islcollective.com)

SOME PHOTOS


FAST
FASH
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WHAT CAN WE DO?
UNDERSTANDING FAST FASHION
HOW FAST FASHION WORKS

Lesson Plan no.9.

A. **TITLE:** Making jeans jacket for women

AUTHOR/AUTHORS: Jelena Krivčević, Olivera Anđelković, Haris Ademović

AGE GROUP: 17-19

GRADE: III and IV year of school for design of textile and leather

DURATION OF THE ACTIVITY: FEBRUAR – APRIL

SUBJECTS: Textile up-cycling, arts, history

LEARNING OBJECTIVES:

LO1: Familiarize students with the process of Up cycling,
LO2: Mood board
LO3: Create a sketch of clothing
LO4: Determine technological making process
LO5: Familiarize students with the negative effect of large amount of textile waste, possibilities of decreasing this effect
LO6: Develop awareness about need to protect human environment
LO7: Developing logical thinking and practical skills

B. NECESSARYRESOURCES

MATERIALS USED

-Old denim clothes

-Textile tapes for loops

-Scissors, sewing machine, overlock sewing machine

- string for sewing and embroidering

- wooden frame for embroidering

- computer

METHODS

-Lecture

-Demonstration

-Conversation

-Practical work

FORMS OF ORGANIZATION

Frontal, individual

C.DESCRIPTION OF THE ACTIVITY
No. students :5
Classroom mirror NOT THE CASE

Time	Activity	Teacher role
150 min	Research chosen historical period, style of clothing. Present a short essay about chosen historical period	The teacher presents the topic, points to sources, and needed literature. Distribute the tasks step by step. Give out deadlines and homework.
170 min	Presentation of finished homework on the topic of chosen historical period (end of 19th to beginning of 20th century) Conversation about the way of dressing and trends of chosen period and presentation of it.	Teachers answer and potential remarks and corrections.
180 min	Creation of 3 mood boards in IT classroom. Choosing one mood board.	Teacher leads the discussion, encourages students and helps with choosing.
180min	Creation of 10 sketches using different sketching techniques.	The teacher gives feedback and directs the work.
180min	Choosing 3 models that get realized, description of technological process of production for every model.	Teacher gives recommendations on criteria for choosing. Suggests through conversation how the process of production for every model is supposed to look.
180min	Choosing old clothes to be used, fashion appendix which match the chosen sketches. Choosing needed tools for work.	The teacher gives advice on which materials to use and which not to.

		
700min	Production of clothes, following the recommended technological process and rules for safety during work. - Making loops - Undoing seams on sleeves - Mark the place for attaching loops on sleeves - Stitching loops on marked place - Marking the places on front parts of jacket - Cutting of the marked parts - Making embroidered details by hand - Attaching the sleeves 	Teacher monitors the production process, gives advice and feedback about realization of model.
180min	Presentation of products and technological processes. Organization of small fashion show in school.	Teacher gives out responsibilities (who is going to wear the clothes and who is going to do a presentation of technological process).

		
180min	Making presentations (PowerPoint, Prezi, etc.)	The teacher helps in creating presentation and gives feedback.
180min	Evaluation of fashion show and technological process.	The teacher joins the discussion after finished work.

D. RESULTSDESCRIPTION

Through making these models we wanted to prolong the shelf life of certain products, to give them purpose, to send a message how massive production can harm the environment. The target group are young people from 15 to 19 years old. IT elements are used as innovation for creating mood boards and modern machines for embroidering. Project connects multiple different disciplines and subjects. Students understood the importance of a healthy environment and the need to preserve it. They understood there are different ways to transform textile products and use them again.

E.ANTICIPATINGRISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	**Measures/Solutions**
Not making the deadlines	Reorganization of activity in agreement with students.
Lacking resources	Finishing models in private companies.

F. BIBLIOGRAPHY

Photography's
internet,
city museum,
manual for history
fashion magazines

Lesson Plan no.10.

A. TITLE: Making skirt for women

AUTHOR/AUTHORS: Jelena Krivčević, Olivera Anđelković, Haris Ademović

AGE GROUP: 17-19

GRADE: III and IV of school for design of textile and leather

DURATION OF THE ACTIVITY: JANUAR - FEBRUAR

SUBJECTS: Textile up-cycling, arts, history

LEARNING OBJECTIVES:

LO1: Familiarize students with process of Up cycling,
LO2: Mood board
LO3: Create a sketch of clothing
LO4: Determine technological making process
LO5: Familiarize students with the negative effect of large amount of textile waste, possibilities of decreasing this effect
LO6: Develop awareness about need to protect human environment
LO7: Developing logical thinking and practical skills

B. NECESSARYRESOURCES

MATERIALS USED

- Old denim clothes (pants)
- white cotton material
- lace details
- Scissors, sewing machine, overlock sewing machine
- string for sewing
- computer

METHODS

-Lecture

-Demonstration

-Conversation

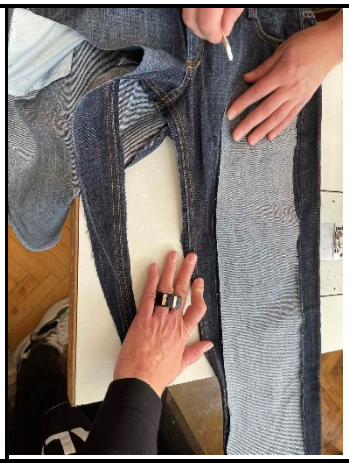
-Practical work

FORMS OF ORGANIZATION

Frontal, individual

C.DESCRIPTION OF THE ACTIVITY
No. students :5

Time	Activity	Teacherrole
150 min	Research chosen historical period, style of clothing. Present a short essay about chosen historical period	The teacher presents the topic, points to sources, and needed literature. Distribute the tasks step by step. Give out deadlines and homework.
170 min	Presentation of finished homework on the topic of chosen historical period (end of 19th to beginning of 20th century) Conversation about the way of dressing and trends of chosen period and presentation of it.	Teachers answer and potential remarks and corrections.
180 min	Creation of 3 mood boards in IT classroom. Choosing one mood board.	Teacher leads the discussion, encourages students and helps with choosing.
180min	Creation of 10 sketches using different sketching techniques.	The teacher gives feedback and directs the work.
180min	Choosing 3 models that get realized, description of technological process of production for every model. 	Teacher gives recommendation on criteria for choosing. Suggests through conversation how the process of production for every model is supposed to look.

		
180min	Choosing old clothes to be used, fashion appendix which matches the chosen sketches. Choosing needed tools for work.  	The teacher gives advice on which materials to use and which not to.
700min	Production of clothes, following the recommended technological process and rules for safety during work. - Mark the lines for cutting trouser legs - Cut out 2 trims from white cotton material - Attach trims on overlock machine - Mark the place on pants for stitching trims - Stitch the trims	Teacher monitors the production process, gives advice and feedback about realization of model.

	- Fold the skirt - Stitch the lace details 	
180min	Presentation of products and technological process. Organization of small fashion show in school.	Teacher gives out responsibilities (who is going to wear the clothes and who is going to do a presentation of technological process).
180min	Making presentations (PowerPoint, Prezi, etc.)	The teacher helps with creating presentation and gives feedback.
180min	Evaluation of fashion show and technological process.	The teacher joins the discussion after finishing work.

Evaluation of student activity and results

H. RESULTSDESCRIPTION

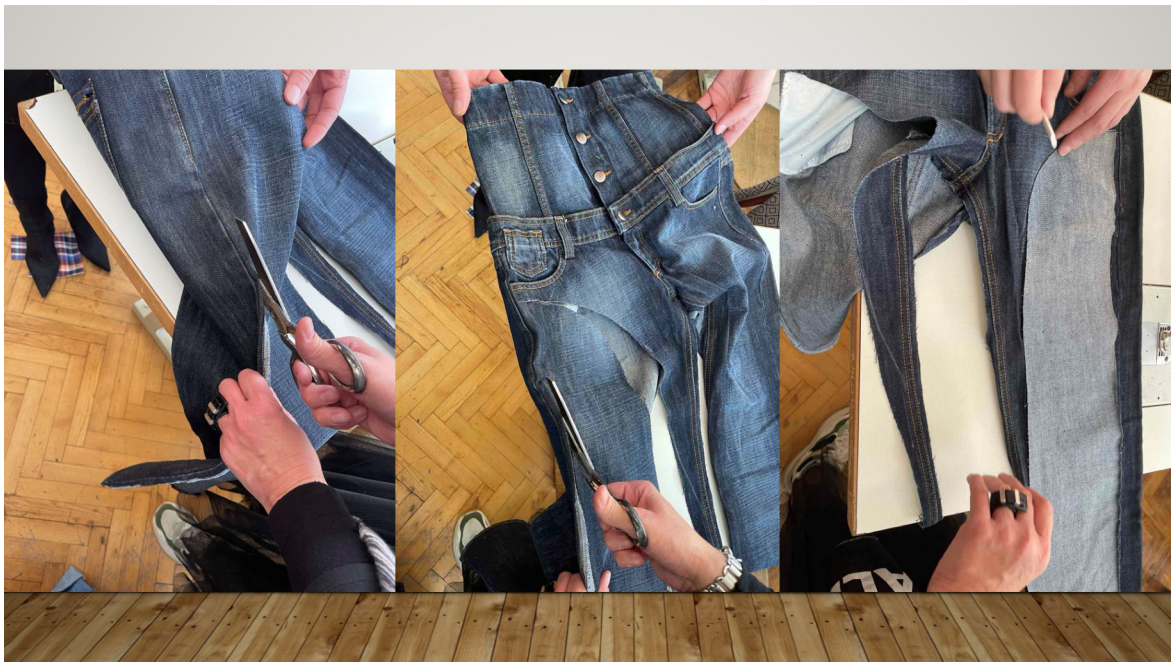
Through making these models we wanted to prolong the shelf life of certain products, to give them purpose, to send a message how massive production can harm the environment. The target group are young people from 15 to 19 years old. IT elements are used as innovation for creating mood boards and modern machines for embroidering. Project connects multiple different disciplines and subjects. Students understood the importance of healthy environment and the need to preserve it. They understood there are different ways to transform textile products and use them again.

I. ANTICIPATINGRISKS;POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
Not making the deadlines	Reorganization of activity in agreement with students.
Lacking resources	Finishing models in private companies.

J. BIBLIOGRAPHY

Photography's
internet,
city museum,
manual for history
fashion magazines



Lesson Plan no.11.

A. TITLE: Making pants for women

AUTHOR/AUTHORS: Jelena Krivčević, Olivera Anđelković, Haris Ademović

AGE GROUP: 17-19

GRADE: III and IV of school for design of textile and leather

DURATION OF THE ACTIVITY: JANUAR – FEBRUAR

SUBJECTS Textile up-cycling, arts, history

LEARNING OBJECTIVES:

LO1: Familiarize students with the process of Up cycling,
LO2: Mood board
LO3: Create a sketch of clothing
LO4: Determine technological making process
LO5: Familiarize students with the negative effect of large amount of textile waste, possibilities of decreasing this effect
LO6: Develop awareness about need to protect human environment
LO7: Developing logical thinking and practical skills

B. NECESSARYRESOURCES

MATERIALS USED

-Old denim clothes

-Cotton pattern material

-Scissors, sewing machine, overlock sewing machine

- string for sewing

- computer

METHODS (teaching methods!)

-Lecture

-Demonstration

-Conversation

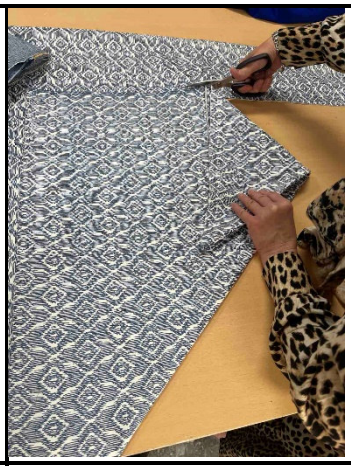
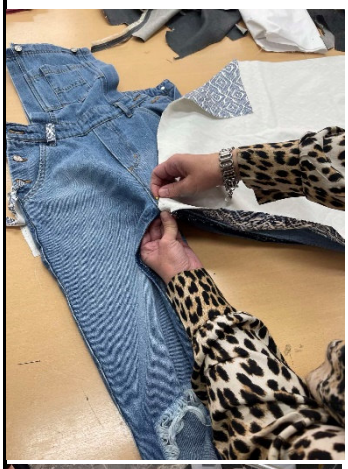
-Practical work

FORMS OF ORGANIZATION

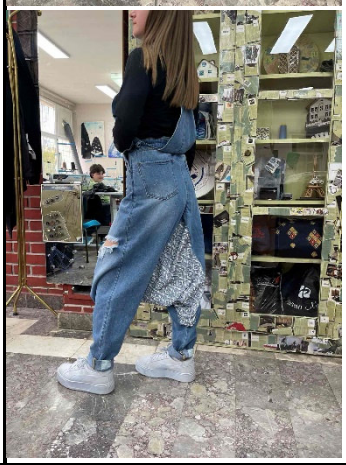
Frontal, individual

C.DESCRIPTION OF THE ACTIVITY
No. students :5

Time	Activity	Teacherrole
150 min	Research chosen historical period, style of clothing. Present a short esey about chosen historical period	Teacher presents the topic, points to sources, needed literature. Distributes the tasks, step by step. Gives out deadlines and homework.
170 min	Presentation of finished homework on the topic of chosen historical period (end of 19th to beginning of 20th century) Conversation about the way of dressing and trends of chosen period and presentation of it.	Teachers answer and potential remarks and corrections.
180 min	Creation of 3 mood boards in IT classroom. Choosing one mood board.	Teacher leads the discussion, encourages students and helps with choosing.
180min	Creation of 10 sketches using different sketching techniques.	The teacher gives feedback and directs the work.
180min	Choosing 3 models that get realized, description of technological process of production for every model. 	Teacher gives recommendation on criteria for choosing. Suggests through conversation how the process of production for every model is supposed to look.

		
180min	Choosing old clothes to be used, the fashion appendix which matches the chosen sketches. Choosing needed tools for work.  	The teacher gives advice on which materials to use and which not to.

700min	Production of clothes, following the recommended technological process and rules for safety during work. - Undo seams on pants - Make inserts out of patterned material - Mark the place for attaching inserts - Stitching inserts on marked place - Processing seams on trouser legs - Inserting details out of patterned material  	Teacher monitors the production process, gives advice and feedback about realization of model.
180min	Presentation of products and technological processes. Organization of small fashion show in school.	Teacher gives out responsibilities (who is going to wear the clothes and who is going to do a presentation of technological process).

	 	
180min	Making presentations (PowerPoint, Prezi, etc.)	The teacher helps in creating presentation and gives feedback.
180min	Evaluation of fashion show and technological process.	The teacher joins the discussion after finished work.

B. RESULTS DESCRIPTION

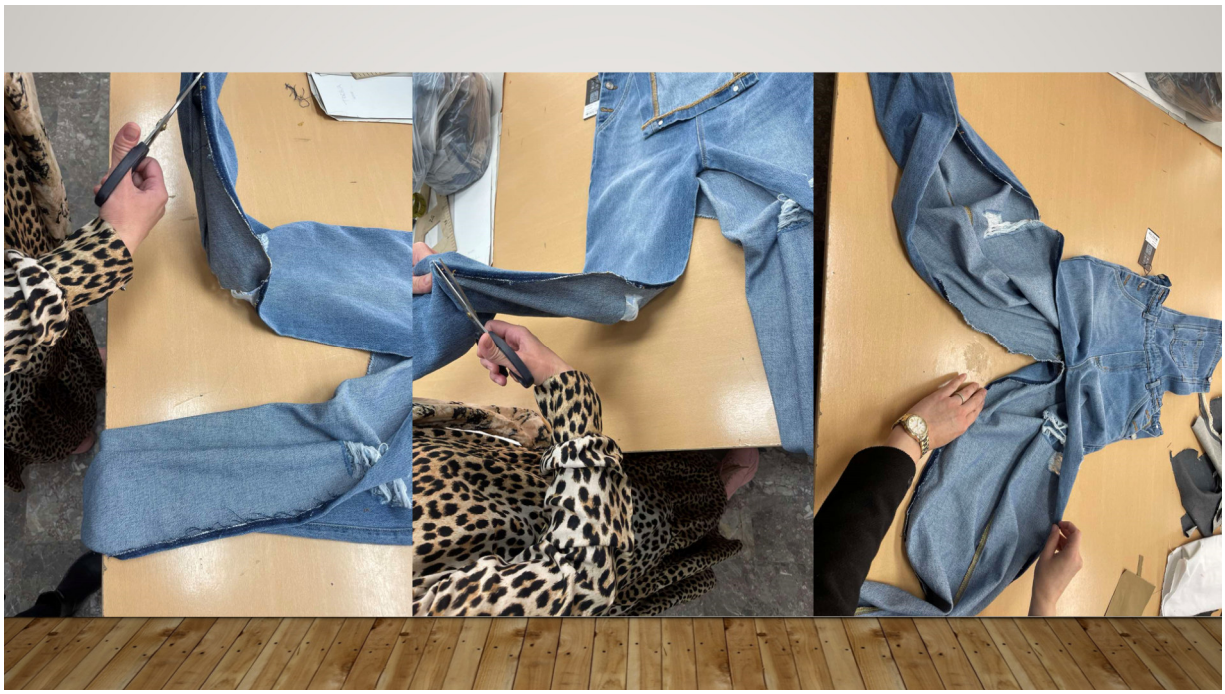
Through making these models we wanted to prolong shelf life of certain products, to give them purpose, to send a message how massive production can harm the envirioment. Targeted group are young people from 15 to 19 years old. IT elements are used as innovation for creating moodboards and modern machines for embroidering. Project connects multiple different disciplines and subjects. Students understood the importance of healthy envirioment and the need to preserve it. They understood there are different ways to transform textile products and use them again.

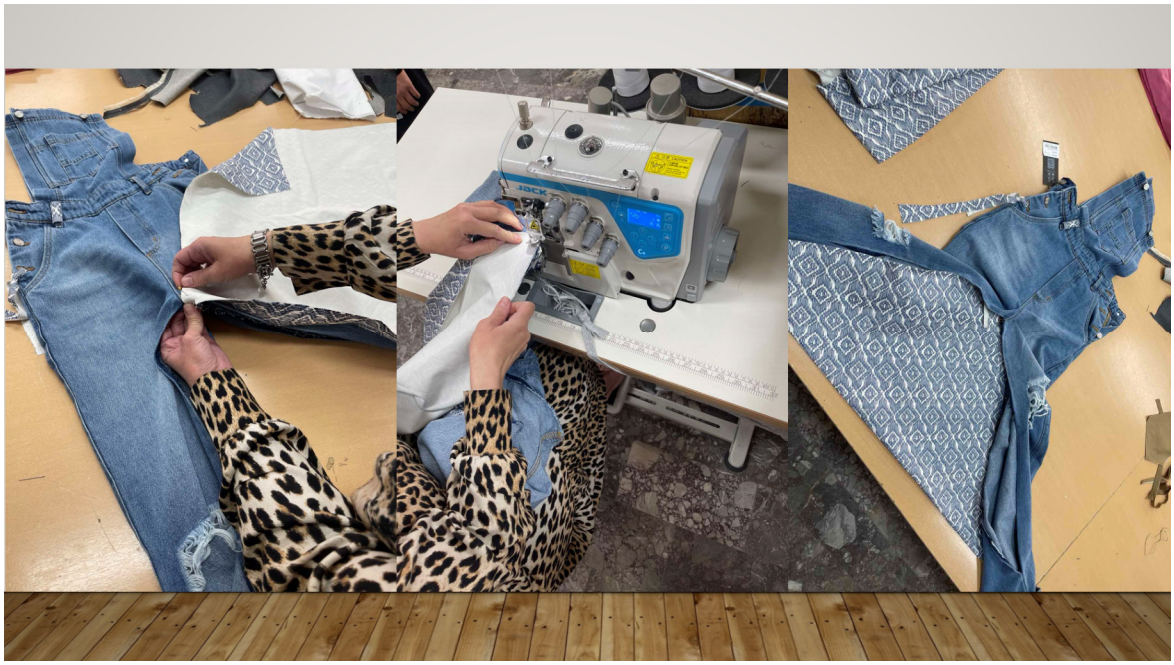
C. ANTICIPATINGRISKS;POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
Not making the deadlines	Reorganization of activity in agreement with students.
Lacking resources	Finishing models in private companies.

D.BIBLIOGRAPHY

Photography's
internet,
city museum,
manual for history
fashion magazines





Lesson Plan no.12.

TITLE: Use and RE-use

AUTHOR/AUTHORS Teachers: Jorge Jesus and Mariana Rêgo

AGE GROUP: 16 years old

GRADE: 2nd year (secondary level)

DURATION OF THE ACTIVITY: 12 weeks

SUBJECTS (textile recycling, up-cycling)
"USA e ReUSA" → "Use and Reuse" (Recycling)

LEARNING OBJECTIVES:
LO1: Acquire awareness that natural resources are finite.
LO2: : Familiarize yourself with the notion of environmental impact and its implications.
LO3: Awakening to the social awareness of design.
LO4: Understand the problem of sustainability in urban space and everyday artifacts; understand the importance of new paths for human development and settlement (in terms of waste and reuse).

B. NECESSARY RESOURCES

MATERIALS USED

- End-of-life utility objects
- Sewing kit / Sewing machines
- Drawing material (sheets, pencil/pen, etc.)
- Computers
- Other materials to finish objects

METHODS (teaching methods!)

- Each student must collect end-of-life utility objects according to the examples presented (images).
- These will be analyzed and studied in order to allow the possible production of new objects to serve new uses (fashion accessories).
- The methodology should be applied in a process that combines graphic exploration at the level of sketch and the realization of mockups.

FORMS OF ORGANIZATION (individual, in groups/pairs and frontal)

C. DESCRIPTION OF THE ACTIVITY

No. students: 25 students

Time	Activity	Teacher role
45 min	Collected objects and photograph them	Mediator Knowledge mediator Accompany and guides students in the learning process Self-regulation facilitator
90 min	Mood board	
360 min	Initial sketches/quoted sketches	
180 min	Research on related objects	
180 min	Digital exercises	
130min	Brief technical drawings subject shape/function	
90 min	Descriptive memory and justification	
120 min	Introductory exercises (experiments)	
180 min	Execution of the objects	
360 min	Reports with photographs, materials, instruments and techniques used	
180 min	Presentation of the work	

D. Evaluation of student activity and results

E. RESULTS DESCRIPTION
What are expected:

- **Appropriation and reflection:**
  - ✓ Different cultural and artistic manifestations
  - ✓ Environmental sustainability
  - ✓ Terminologies specific to each area
- **Experimental work:**
  - ✓ Use creative thinking tools
  - ✓ Explore materials, techniques and technologies
  - ✓ Critical thinking
- **Interpretation and communication:**
  - ✓ Use audio/digital drawings
  - ✓ Produce dossiers, reports, and portfolios
  - ✓ Present and defend the work developed
- **Relational and organizational:**
  - ✓ Autonomy
  - ✓ Respect
  - ✓ Sense of inclusion
  - ✓ Collaborative work
  - ✓ Dedication
  - ✓ Respect

F. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
Low involvement	Finding references in the student's family and cultural contexts
Difficulty dissociating objects from the original function	Show examples and references
Time management	Make the student responsible for creating their time table as a self-regulation

G. BIBLIOGRAPHY

Attached to the lesson plan are the following documents:

1. Work proposal “EN_U3_23_24”
2. Rotation of the work groups “EN_rotacao-U3”
3. Assessment/Feedback grid “EN_Grelha de Avaliacao 11C2 2023-24”

Work proposal "EN_U3_23_24"

Course **Product Design**	**PROBLEMATIC** The finite nature of natural resources and the limited capacity of the world to resolve transformations imposed by man.
Discipline **Project and Technologies**	**THEME** Use and Reuse. Objects or materials without commercial value in our society. The limits of its functionality and its reuse.
School Year **2023.24** Class **11º C2** Período **2º Período** Start / End **Jan 03 to Mar 16**	**TEXT 1** "Twenty-five percent of the world's population, estimated at six trillion people, is responsible for eighty percent of the use of chemical products. By 2050, twenty billion people should live on the planet, which represents ten times more than the population at the beginning of the 20th century. Scientists estimate that, to this date, human activities are responsible for increasing atmospheric temperatures by between 1.5 and 6 degrees. Global warming on a scale never seen before has melted ice caps, with the consequent rise in sea levels by up to 60 centimeters. The world is not equitable. A typical consumer in the rich regions of the developed "north" consumes between ten and twenty times more resources than a typical consumer in the developing regions of the "south.
Teachers **Adelino Pereira** **Jorge Jesus** **Mariana Rego** **Marta Cruz** **Mécia Soares** Emails **adelinopereira@easr.pt** **jorgejesus@easr.pt** **marianarego@easr.pt** **mcruz@easr.pt** **meciasoares@easr.pt**	**TEXT 2** "The recent awareness of the magnitude of the impacts of human activities on ecosystems leads consumers to begin looking for and demanding more environmentally beneficial products. Progressive social and governmental pressures have induced companies to rethink their industrial processes and their design and production methodologies for new products. Sustainable solutions require an integration of various types of knowledge, and to this extent, design can play a facilitating and integrating role. (Wahl, 2006) As the project is an initial phase of a product's life cycle, it is extremely important to act at this critical stage, in order to minimize environmental impacts and costs that affect subsequent phases. We must invest in prevention, to the detriment of the use of end-of-line technologies. The search for sustainable solutions requires the incorporation of the environmental variable from conception to the end of the product's life cycle, which is understood as ecological product design, ecodesign or Design for Environment (DfE). Integrating ecodesign into product design is an emerging trend, essential for companies that wish to distinguish themselves through the quality of their products, and assume a competitive position in the market.

	As an incentive for innovation, the use of ecodesign encourages the optimization of product design, in order to improve their environmental performance. However, for designers environmental considerations represent a new challenge. Traditionally, these confined their work to specific considerations at one stage of the product life cycle, linking consumer needs to the performance required by products. But for a successful application of ecodesign, designers' considerations must extend to all stages of the products' life cycle. (Burall, 1996; Lewis et al., 2001)
OBJECTIVES	Acquire awareness that natural resources are finite; Familiarize yourself with the notion of environmental impact and its implications; Awakening to social awareness of design; Understand the issue of sustainability in urban space and everyday artifacts; Understand the importance of new paths for development and human settlement. Each student must collect end-of-life utility objects according to the examples presented (DP U3 cloud). These will be analyzed and studied in order to allow the possible production of new artifacts to meet new uses. The highlight will be "fashion accessories". The design methodology must be applied, in a process that combines graphic exploration at the sketch level and technical drawing, with the creation of study models.
EXERCISES January 3rd January 10th and 12th January 17th February 10th March 2nd March 7th March 9th to be included in the dossier	Photograph the objects you collected and represent them through sketches; Creation of Moodboard and initial suggestions for creating new objects with new functionality "Fashion accessories collection" (design one object that covers all technological areas or two that together cover the three technologies); Carry out an investigation into objects similar to the one you intend to create (photographic records, formal and functional characteristics, constituent materials); Start the object in the workshops of the respective technological areas; Prepare scaled sketches of the final object(s); Create digital technical drawings of the final object(s); Write a description and justification of the solution or solutions. It must contain elements relating to the conception, development and realization of the object in the workshop areas;

	Prepare a summary sheet, A4 format, for each of the objects. Each sheet must contain: the name of the object, the technical drawing, a sketch and a photograph of the original objects; Carry out technical reports with photographs of the materials and techniques used in all stages of the work.
DOSSIER	"Analog" and "digital" A4 format You must compile all information relating to the three areas of the discipline (Project, Representation and Technologies). Bibliographic reference is mandatory.
PRESENTATION March 14th and 16th	This oral/digital presentation must summarize all the work carried out and must last a maximum of 10 minutes.
EXTRA	Duration of work: 21 classes (the last 2 are intended for the presentation and evaluation of U3).
EVALUATION	Diagnostic (beginning of the unit), Formative (continuous) and Summative. It will be carried out in accordance with the Assessment Criteria approved for the current academic year and the following considerations.
PROJECT AREA AND DIGITAL REPRESENTATION Analysis and Records (Appropriation and Reflection + Experimentation and Creation)	• Photographic survey and collected objects (0.5 value) • Moodboard (0.5 value) • Initial sketches and quoted sketches (1 value) • Research on related objects (0.5 value) • Digital exercises (1 value) • Digital technical drawings (1.5 value) • Object - form/function relationship (0.5 value) • Summary sheet (0.5 value) • Descriptive memory and justification (1 value)
TECHNOLOGICAL AREA (Appropriation and Reflection + Experimentation and Creation)	• Introductory approaches/exercises (2 values) • Execution of the object(s) (3 values) • Technology reports with photographs of the materials, instruments and techniques used (2 values)
ORAL/DIGITAL PRESENTATION	Clarity and correction (1 value)
DOSSIER	• Presentation, layout and organization (analog and digital) (1 + 1 value)
ORGANIZATIONAL AND RELATIONAL (Behaviors/attitudes)	• Initiative and autonomy, respect, punctuality, responsibility and attitude in the classroom, meeting deadlines, ... (3 values)

Rotation of the work groups “EN_rotacao-U3”

GROUP	Nº	STUDENT
A	1	Ana Ferreira
	2	Ana Pereira
	3	Ana Moreira
	4	Beatriz Ribeiro
	5	Carolina Guimarães
	6	Daniela Ribeiro
	7	Dinis Luças
B	8	Duarte Ferreira
	9	Fabiano Ferreira
	10	Iara Ferreira
	11	Inês Pinto
	12	Inês Nunes
	13	Inês Baptista
	14	Júlia Souza
C	15	Lara Costa
	17	Margarida Magalhães
	18	Maria Costa
	19	Maria Barbosa
	20	Maria Pacheco
	21	Maria Cardoso
D	22	Mariangel Sanchez
	23	Maria Cardoso
	24	Reina Kleipool
	25	Rostyslava Hutsul
	26	Rute Pinheiro
	27	Sofia Costa

Assessment/Feedback grid “EN_Grelha de Avaliacao 11C2 2023-24”

		2nd PERIOD								
		AREAS - PT DISCIPLINE					CLASSIFICATION		SELF-EVALUATION	
Nº	STUDENT	PROJECT	DIG. REP.	WOODS	METALS	TEXTILE	AVARAGE	FINAL WEIGTHING	U3	2nd P
1	Ana Filipa Gomes Ferreira	18,0	16,8	16,7	17,9	16,4	17,1	17	17	18
2	Ana Fulé Lopes da Silva Pereira	19,0	18,6	19,3	20,0	18,2	19,0	20	20	20
3	Ana Pinto Moreira	18,9	19,7	18,6	20,0	18,5	19,1	20	20	20
4	Beatriz Amorim Ribeiro	17,5	16,0	15,9	16,9	17,1	16,7	17	18	17
5	Carolina Liberal Afonso Borges Guimarães	17,7	16,9	17,6	18,5	15,9	17,3	17	17	17
6	Daniela Filipa Barbosa Ribeiro	13,3	11,2	10,8	12,6	14,0	12,4	12	13	13
7	Dinis Botelho Borges de Andrade Luças	12,6	15,4	14,0	14,0	11,3	13,5	13	missed	missed
8	Duarte da Silva Ferreira	17,4	14,3	12,9	16,5	15,5	15,3	16	17	17
9	Fabiano Gabriel Teixeira Ferreira	16,2	17,0	16,0	17,2	15,4	16,4	16	17	17
10	Iara Beatriz Ribeiro Ferreira	15,4	17,0	12,4	14,9	15,3	15	15	16	15
11	Inês Duarte Pinto	14,1	15,8	14,2	15,4	15,8	15,1	15,0	13	14

12	Inês Ferreira Nunes	17,4	17,5	16,5	17,4	16,7	17,1	17	17	17
13	Inês Pinto Bompastor Baptista	16,7	16,9	16,7	17,1	16,0	16,7	17	18	18
14	Júlia Ferreira de Souza	12,0	13,7	12,9	17,2	12,5	13,7	15	missed	missed
15	Lara Rita Santos Costa	18,1	15,8	17,1	17,4	17,2	17,1	17	17	17
16	Margarida Paulo de Magalhães	16,9	15,9	16,4	16,1	16,5	16,4	16	missed	missed
17	Maria Beatriz da Rocha Costa	15,9	15,3	16,5	16,0	15,9	15,9	16	15	15
18	Maria Costa Azevedo Valente Barbosa	15,3	13,2	15,9	14,4	16,0	15,0	16	missed	missed
19	Maria Francisca Bodas Iria Miranda Pacheco	11,8	13,6	16,2	15,3	12,6	13,9	15	missed	missed
20	Maria Luis Portal e Silva Cardoso	17,2	15,6	15,2	15,3	156,9	15,8	16	16	16
2	Mariangel Valentina Morales Sanchez	18,2	19,1	18,6	19,3	16,9	18,4	19	19	19
12	Maria Vitória Campos Cardoso	14,3	12,2	15,0	16,6	16,2	14,8	15	15	15
22	Reina Gabrielle Sophie Kleipool	17,2	16,5	17,6	19,0	15,6	17,2	18	18	17
23	Rostyslava Hutsul	15,9	16,7	17,1	17,8	15,7	16,7	17	missed	missed
24	Rute Isabel Oliveira Pinheiro	17,1	14,8	16,5	15,8	16,5	16,1	16	17	17
25	Sofia Cristina Alves da Costa	13,9	12,4	14,9	15,7	14,8	14,3	14	15	14

Lesson Plan no.13.

TITLE: Sustainable Design

AUTHOR/AUTHORS Teachers: Jorge Jesus and Mariana Rêgo

AGE GROUP: between 16 and 18 years old

GRADE: 2nd/3rd year (secondary level)

DURATION OF THE ACTIVITY: 1 weeks

SUBJECTS
„Sustainable Design " → "sustainable and biodegradable textile materials

LEARNING OBJECTIVES:
LO1: Visualize and Communicate Key Concepts of Sustainable and Biodegradable Textiles Through a Mood board.
LO2: Explore Sustainable and Biodegradable Alternatives in the Textile Industry
LO3: Apply Principles of Sustainable Design in the Development of Eco-friendly Textiles
LO4: Understand the Environmental Impact of Conventional Textile Materials.

B. NECESSARY RESOURCES
MATERIALS USED

- Straw
- Cork
- Printing eco-friendly products
- Sewing kit / Sewing machines
- Drawing material (sheets, pencil/pen, etc.)
- Computers
- Other materials to finish objects

METHODS

- Each student, based on the text, will create a moldboard (a kind of mural that can be composed of images and visual elements that represent the essence of a project) and choose a theme/concept for their work.
- Based on the mood boards the students will develop two fashion accessories, using Biodegradable materials (cork/straw), In each item, eco-friendly printing techniques must be used.
- The methodology should be applied in a process that combines graphic exploration at the level of sketch and the realization of mockups.

FORMS OF ORGANIZATION
Groups

C.DESCRIPTION OF THE ACTIVITY
No. students : 45 students

Time	Activity	Teacher role
180 min	Create a mood board	Mediator Knowledge mediator Accompany and guides students in the learning process Self-regulation facilitator
180 min	Develop a theme/concept	
240 min	Analyze biodegradable textile materials	
480min	Develop the printing process	
240 min	Apply printing to the material/support	
300 min	Develop fashion accessories	
120 min	Finishing touches	
180 min	Presentation of the work	

E. Evaluation of student activity and results

F. RESULTS DESCRIPTION

- Experimental Work
  - ✓ Development and testing of biodegradable and eco-friendly textile materials, including assessing their physical properties, durability, and environmental impact.
  - ✓ Experimentation with eco-friendly printing techniques on sustainable fabrics, evaluating the quality, adherence, and degradation of prints over time.
- Interpretation and Communication
  - ✓ Clear presentation of research findings, including the performance of biodegradable textiles and eco-friendly printing methods, through written reports, visuals, and presentations.
  - ✓ Effective communication of the environmental benefits and challenges associated with the use of sustainable materials, ensuring key stakeholders understand the significance of the results.
- Relational and Organizational

✓ Collaboration with interdisciplinary teams, including designers, material scientists, and sustainability experts, to ensure the project meets both technical and environmental objectives.

✓ Coordination of resources and timelines to ensure that experimental processes, such as material testing and eco-friendly printing, align with the project's goals.

- Innovative Development
  - ✓ Creation of new sustainable fashion accessories and prototypes using biodegradable textiles, incorporating eco-friendly design principles and techniques.

- ✓ Implementation of finishing techniques that maintain the biodegradability of the textiles while ensuring aesthetic and functional quality.

F. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
Management and Coordination Among	Implement a clear project timeline with milestones and deadlines to keep students on track. Encourage teamwork and assign roles to ensure smooth
Students	coordination, distributing workload evenly among team members
Difficulty in Communicating Sustainability Concepts	Provide examples of effective communication strategies, offering feedback on draft presentations and reports. Incorporating peer reviews can also help students refine their ability to convey complex ideas more clearly

G. BIBLIOGRAPHY

Attached to the lesson plan are the following documents:

1. Work proposal "**erasmus+_22_23_swot_opo**"

Work proposal "**erasmus+_22_23_swot_opo**"

Work Proposal **Sustainable Design** Date **6 jun a 9 jun 2023** Teachers **Cláudia Ribeiro** **Jorge Jesus** **Mariana Rego** Email's **claudiaribeiro@easr.pt** **jorgejesus@easr.pt** **marianarego@easr.pt**	"Sustainability is the ability of our human society to perpetuate itself within the cycles of nature", The Natural Step. And if we can say that sustainability is a trendy, it is propitious to ask if the Fashion Industry can be Sustainable… The concept of sustainability echoes around the world… The current fashion system is linear, that is, raw material extraction, production, use and disposal. In the whole chain there is an enormous load on resources, pollution, degradation of the ecosystem, in addition to a great social impact. As more companies look for ways to reduce their environmental impact, biodegradable to creating new job opportunities. It's clear that these materials are becoming more and more popular as companies strive to become more environmentally friendly [1]. Biodegradable textiles are typically made from plant-based materials such as bamboo, hemp or corn. These materials are not only renewable and relatively inexpensive, but also decompose without releasing toxic chemicals or other pollutants into the soil. Recycling, reuse, biological and second-hand are always options, as long as an informed and conscious decision is always on the table [2]. The path towards more conscious fashion is possible, but it is a slow and long process that requires a major change in the way clothing is seen, produced, consumed and discarded [1]. [1] https://ts2.space/pt/as-vantagens-dos-materiais-biodegradaveis-e-ecologicos-para-a-producao-textil/ [2] https://comunidadeculturaearte.com/quao-sustentavel-e-a-moda-sustentavel/
Project Exercise **Moodboard**	Based on the text, create a moodboard (a kind of mural that can be composed of images and visual elements that represent the essence of a project). 1. Choose your theme/concept; 2. Use Canva (http://canva.com or other similar software that you feel comfortable); 3. A3 format (portrait or landscape); 4. Convert to PDF to print.
Textile Exercise **Biodegradable Materials**	Starting from the moodboards, develop two fashion accessories according to: 1. Biodegradable materials (cork/straw); 2. Stamping techniques; 3. Develop: 1 clutch + 1 textile accessories; 4. Use the available models; 5. Adapting the colors and the edges.

Lesson Plan no.14.

A. TITLE: Eco print

AUTHOR Teacher:Cristina Manhente

AGE GROUP: 17/18 years old

GRADE: 3rd year (Third level)

DURATION OF THE ACTIVITY: 8 weeks

SUBJECTS (textile plants)
Ecological art

LEARNING OBJECTIVES:
LO1: Acquire awareness that natural resources are finite.
LO2: Familiarize yourself with the notion of environmental impact and its implications.
LO3: Raise awareness of the dangers that lurk on the planet and promote its conservation.
LO4: Strengthen communication and citizen participation in the defense of nature.

B. NECESSARY RESOURCES
MATERIALS USED
- Plants
- Flowers
- Natural fabrics
- Salt
- Vinegar
- Other materials to finish objects

METHODS:
- Perform a pre-mordant on the selected natural fabric
- Perform various exercises with the natural elements using natural mordants (salt/vinegar)

FORMS OF ORGANIZATION (individual)

C.DESCRIPTION OF THE ACTIVITY
No. students : 23 students

Time	Activity	Teacher role
all time	Collected objects and photograph them	Mediator
90 min	Mood board	Knowledge mediator

360 min	Initial sketches/quoted sketches	Accompanies and guides students in the learning process Self-regulation facilitator
180 min	Research on related objects	
90 min	Descriptive memory and justification	
120 min	Introductory exercises (experiments)	
180 min	Execution of the objects	
360 min	Reports with photographs, materials, instruments and techniques used	
180 min	Presentation of the work	

D. Evaluation of student activity and results

E. RESULTS DESCRIPTION

What are expected:

- Search organic dyeing
- Collect information on dyeing plants
- Collect recipes on each plant (what color it gets, location, growing season)
- Environmental sustainability
- Terminologies specific to each area

Experimental work:

- Use creative thinking tools
- Explore materials, techniques and technologies
- Critical thinking

Interpretation and communication:

- Produce dossiers, reports, and portfolios
- Present and defend the work developed

Relational and organizational:

- Autonomy
- Respect
- Dedication
- Respect

F. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk Measures/Solutions

Low involvement

Finding references in the student's family and cultural contexts

Lesson Plan no.15.

A. TITLE: Improving sustainability through textile product design

AUTHORS:
Rita CARVALHAS
Graça GUEDES
Jorge JESUS
Marta CRUZ

AGE GROUP:
16 – 18 years old.

GRADE:

High School – 12th grade

DURATION OF THE ACTIVITY:
120 hours

SUBJECTS:
Training in Work Context (TWC), Sustainability Textile Product Design, and Sustainability Textile Technologies

LEARNING OBJECTIVES:
LO1: Make students aware of the European Community goals for society´s sustainable development.
LO2: Make students understand textile sustainability as a global problem, and create solutions that can be applied in
students' personal life context.
LO3: Understand the importance of printing in defining the different uses of textiles and their appropriation by users.
LO4: Understand the implications of the concepts of luxury, brand, and fashion in the different markets (national and
international). Know the luxury printing textile market produced by the sector in which the partner company operates.
LO5: Understand the concept of collection in Textile Design.
LO6: Understand the importance of the choices to be made in terms of materials and technologies in the context of
sustainable industrial production.
LO7: Master the techniques of development, representation and communication of ideas combining analogue and digital
media. Know how to communicate, in a concise and effective way, the concepts and

implications of the project.

B. NECESSARY RESOURCES
MATERIALS USED
- Printing frames.
- Printing inks and other specific chemical products.
- Printing table, and carousel.
- Fabrics of different materials, and hemp fabrics offered by various companies contacted for this purpose.

METHODS (teaching methods!)
- Active Teaching Method.
- Internship at Adalberto Stamp Company

FORMS OF ORGANIZATION
The Adalberto Stamp Company challenged each student to create a textile Design Collection of printed fabrics from Designs based on processes of creativity and innovation of textile packaging in food products' transport and storage.
The textile industry should be seen in the context of the circular economy. The prints must arouse the consumer's interest in large surfaces – bulk stores – and small markets or fairs. The call for reuse and the search for new uses, for upcycling and, as a last resort, for recycling, must be clear.

C.DESCRIPTION OF THE ACTIVITY
No. students: 8 (eight) students
The aim is to develop printed fabrics to embody luxury textile eco-packaging for 3 different food products: rice, dried pasta, and pulses, which can be used by packaging and wrapping companies, bulk stores, other retailers, and the end consumer.
The collection must come from Design based on processes of creativity and innovation of textile industry products in the context of the circular economy and eco-design. The prints must be able to arouse interest in the consumer, in large supermarkets, bulk stores and small markets/fairs. The appeal to reuse (same use and/or new uses), upcycling and ultimately recycling, must be evident, without neglecting the product inside (rice, extruded dried pasta and pulses). It is essential that all production is focused on reducing the environmental footprint, taking sustainability issues into account, such as: reducing water use, avoiding the use of chemicals that are harmful to the environment, and reducing the use of non-renewable energy sources.
Theme: Printing Applied to Eco-Packaging for Dry Foods (Rice, Extruded Pasta, and Legumes).
The use of textile packaging in the transport and storage of food products is important in order to eliminate plastics in the food industry. Textile materials facilitate the reuse of packaging, as well as its recycling, when they are made material: fabrics/knits preferably

when used alone (100% hemp), in solutions suited to their function and manufacture, recommended for use in sustainable societies. Based on a comprehensive artistic and technological research project, the student/trainee will create a collection of prints consisting of (at least) 12 original rapport patterns. These will meet the objectives of reducing the environmental footprint in all phases of the Eco-design methodology: conception, design, production, transport, storage, trade, use and disposal (end of life). Particular attention will be paid to the end of life, where the prints created are intended to open space for new uses. The development process should consider technical issues of proportion, elements, motifs and scales, issues related to the production techniques of three-dimensional objects and the importance of the technologies involved in production, visual and functional characteristics and those linked to ecological concerns and environmental sustainability. The eco-packaging will pack 500 g, 1 kg, 3 kg and 5 kg of rice, extruded pasta, and legumes.

The students had instructions to apply the basic Design Methodology. They received instructions during the class, to research and present the results in a survey. For example, at the end of Wednesday, January 25th, 2023, they had in the Google Classroom of the class/discipline to upload the work done. Research survey report, and Mood Board for Textile Technology - Printing with the following items:

1) What do you understand by circular economy from a textile print perspective?
2) Develop the concept of sustainable printing.
3) Show your knowledge in the various printing techniques and processes, and
4) TWC mood board.

In the table 1. Is possible to find out how each student responded to the request.

	Student A	Student B	Student C	Student D	Student E	Student F	Student G	Student H
What do you understand by circular economy (CE) from a textile print perspective?	The concept of circular economy in the context of textile printing focuses on creating a sustainable system where resources are reused, recycled, and regenerated, minimizing waste and environmental impact.	One of the key principles of the circular economy in textile print design is the focus on longevity. Durable materials, such as high quality, long-lasting fabrics that can withstand multiple uses and washes, avoid the frenzy of fast fashion. Ensuring that these materials are reused, or recycled, closes the loop.	The best way to ensure that the economy does not destroy natural resources are by using materials from recycling and upcycling processes. This involves using fabrics made from recycled materials, such as PET bottles, excess production, or old clothes. Upcycling transforms	In the same way that strategies have been created to deliver products to the end customer quickly and efficiently, like Amazon from A to Z, today it is essential to create the opposite path in order to create the loop. Return programs that encourage	Design plays a very important role in the success of sustainability and the circular economy, through the creation of Timeless Designs: Creating prints that remain elegant over time, reducing the need for frequent replacements. This is possible with a more moderate use of color, hence the		It is not enough to teach students about the concepts of the circular economy; it is necessary to educate parents and elders (all consumers). Raise awareness about the importance of sustainable practices and how consumers can contribute, with	

			waste materials or old fabrics into new, high-quality products with added value.	consumers to return old fabrics or clothing items that they no longer use for recycling or reuse	trend towards nude, neutral tones.		easy actions, to a common good: a healthier planet.	
Develop the concept of sustainable printing. The concept of sustainable printing was broken own the in a way that's easy to understand. Each student worked in a specific question.	Eco-friendly materials - fabrics: One of the topics of sustainable printing is the right selection of supports to be printed. Alternative fibers, or "organic" versions of the fibers most used in textiles, are key choices for reducing the environmental footprint. Materials such as bamboo or hemp can be used instead of cotton. Bamboo, for example, grows much faster and requires less land, which can free up space for food production or forestry (without food and air there is no life on earth).	Eco-friendly materials - inks: Looking for sustainable printing inks is like getting into biotechnology. Any material is less harmful to the environment than traditional petroleum-based inks. Algae, fungi and soy are already the basis of many inks, and they are now being tested and improved, which makes me believe in a more sustainable future, that is, one that is even more environmentally friendly. It should be mandatory the use of inks free from harmful chemicals.	Energy conservation: Digital printing can be the most energy-efficient printing equipment in use. In addition to saving many pounds of ink for different colors, they are designed to use less energy. Choosing energy efficient models can significantly reduce energy consumption.		In order to ensure that sustainable printing practices are having an effect, companies need to measure and reduce carbon emissions whenever possible.		Sustainable Printing: Techniques and Processes, Stamping Evolution, Emergence of the Print, and The Print in the Present Days.	Sustainability also involves relationships between people, respect, and the right to receive the economic return for their work. It is essential to contribute to social and governance criteria to encourage sustainable actions among citizens.
Show your knowledge identify by naming the various printing techniques and processes	Textile Printing Transfer, Stamp, Stencil, Continuous roll, Silkscreen – Lionesa, and Digital.	Textile Printing: Transfer, Stamp, Stencil, Continuous roll, Silkscrean – Lionesa, and Digital.	Textile Stamping: Stamp, Digital, Continuous roller; Transfer. and Silkcrean.	Stencil, Stamp, Digital, Continuous roller; and Silkscreen.	Textile printing - What is it? Digital textile printing- What is it?	Textile printing techniques: Stamp printing, stencil printing, and Transfer	What are the printing techniques? Hand painting on fabrics, Stencil,	

							Stamps, Silkscreen, and Transfer.	
TWC mood board	Attachment 1	Attachment 2	Attachment 3	Attachment 4	Attachment 5	Attachment 6	Attachment 7	Attachment 8

Table 1. - Topics requested in the class assignment, versus topics presented and answered by students.

Source: Own elaboration.

Table 1. makes clear the skills that the students acquired. During the TWC, the students revealed that they became more aware of their actions concerning the planet necessities.

Table 2. Planning

Time	Activity	Teacher role
1st Phase:	● Definition of the problem. ● Study of the company and its market. ● Formal, technological, and ideological and artistic research/references.	In addition to the initial instructions found in the Workplace Training Plan provided to students, the teachers provided a range of information to help students further their research. They provided names of new fibers, possibilities for new dyes and innovative textile recycling processes.
2nd Phase:	● Exploration of ideas. ● Graphic development and formalization. ● Study models.	Teachers will analyze the ideas and ask technical questions about production and functionality. These questions, asked individually and directly to students, aim to clarify the ideas presented.
3rd Phase:	● Development of the project. ● 2D and 3D analog/digital technical representation. ● Tests of materials, technologies, and finishes.	The Digital Representation teacher teaches students how to use 2D and 3D digital technical representation programs. Textile teachers lead workshops where students learn how to test materials, technologies and finishes.
4th Phase	● Creation of a presentation model in the offices. ● Expressive analog/digital drawing. ● Descriptive and explanatory report.	Teachers guide the creation of a presentation model in the workshops: printing samples. Teachers review the texts that students produce

		throughout the Training in a Work Context.
5th Phase:	● Systematization of research and report. ● Presentation to the company and class.	

Table 2. – Five phases planning.

Source: SWOT elaboration, and own information filling.

This plan is given to students at the beginning of the Work in Training Place. The division into parts favors the orientation and focus of the students, thus avoiding dispersion or even the possibility of blockage.

D. Evaluation of student activity and results

There will be two assessment moments: one halfway through the process and another at the end of the project. The first moment will consist of a reflection on the work developed and any design and/or technological adjustments will be made. The second moment will be the summative assessment, which will lead to a final FCT grade. In both moments, the student will make his/her self-assessment. The monitors representing the company will monitor the process and participate with a qualitative assessment, based on technical, production and market acceptance issues. The final FCT assessment is based on the respective report, which is prepared by the student/trainee, which must describe the activities developed during the FCT period, as well as his/her assessment of them. This report is assessed and discussed by all participants. Assessment elements and criteria:

● Acquisition of concepts and skills – acquisition of a basic design culture; social and environmental awareness; design capacity (regarding the search for alternative solutions) – 35%

● Carrying out the proposed work – capacity for synthesis and communication through representation means; articulation of knowledge; capacity for problem-solving; mastery of materials and technologies (traditional) and IT; preparation of the final report – 40%

● Attitudes, and behaviors – initiative and autonomy; motivation and participation; integration in teamwork; attendance and punctuality - 25%

Table 3. Evaluation results

First Assessment of the Traditional School Curriculum				Assessment of Training in the Work Context				Ratings Variation
STUDENTS	TEXTILE EVALUATION	AVERAGE OF THE THREE ASPECTS OF THE SUBJECT - DESIGN, TEXTILES, AND DIGITAL MEDIA	FINAL CLASSIFICATION	ADALBERTO TEXTILE SOLUTIONS EVALUATION	TEXTILE EVALUATION	AVERAGE OF THE THREE ASPECTS OF THE SUBJECT - DESIGN, TEXTILES, DIGITAL MEDIA, AND COMPANY ADALBERTO	FINAL CLASSIFICATION	
Student H	13	13	13	17,6	13	12,2	12	-1
Student B	14	12,4	13	16,8	16	15,3	15	2
Student E	19	19	19	20	20	20	20	1
Student D	18	14,2	14	15,2	17	16,3	16	2
Student A	15	15,2	15	16,8	15	15	15	0
Student F	18	16,3	16	13,6	17	17	17	1
Student C	15	13	13	16	16	15	13	0

Table 3. – Analysis of the evaluation results.

Source: Own elaboration.

When analyzing Table 3., is possible to see, that the rankings went up. Of eight students, five increased their classification by one or two values, and two maintained it. While on one side of the evaluation scale, a student reached the maximum classification, out of twenty values, on the other side, Student H had a decrease in the evaluation, ending up with twelve values, out of twenty. It should be noted that this Student H was ill and absent a considerable part of the WTC.

E. RESULTS DESCRIPTION

This form of learning has been found to be very beneficial for students, as it shows them what it is like to work in their area of interest, in this case Textile Product Design.

F. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
Risk of students not knowing how to organize their work.	5th phases planning.

G. BIBLIOGRAPHY/REFERENCES

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Attachment 1

E A
S R escola artística de soares dos reis
design de produto

Coleção nAtExplore

Autor: Maria Coutinho, n.13, 12c2

Coleção realizada para a criação de embalagens têxteis para leguminosas, especificamente ervilhas.

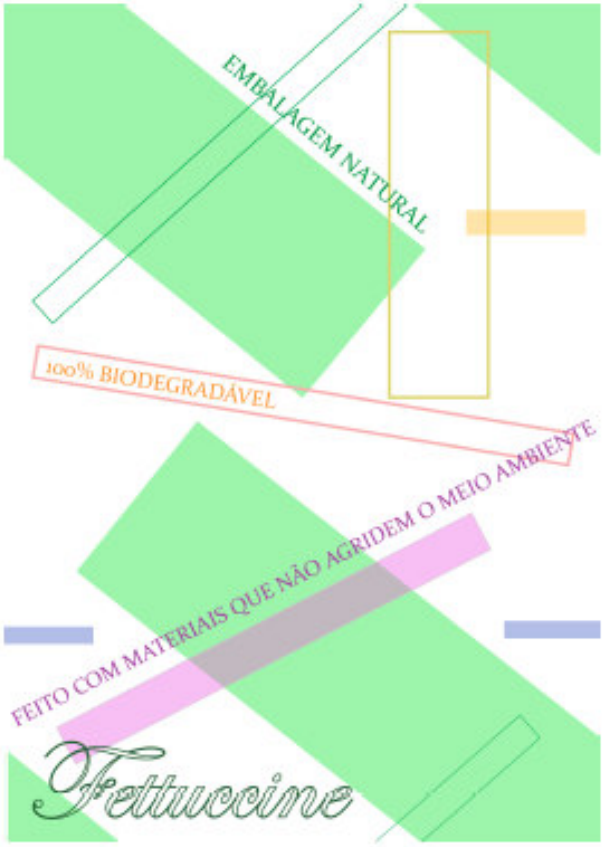
Coleção focada em explorar as origens da ervilha em diversas fases, bem como a geometria possível de encontrar nesta.

E A
S R escola artística de soares dos reis
design de produto

Coleção nAtExplore

Autor: Maria Coutinho, n.13, 12c2

Coleção realizada para a criação de embalagens têxteis para massas secas, especificamente o Fettuccine.
Coleção focada em explorar a geometria encontrada no fettuccine.



Attachment 2

Envolvimento

Envolver a sustentabilidade no nosso dia a dia!

Padrão para embalagens alimentares referentes a massa

Medidas em mm:

Embalagem 1: 100 x 150
Embalagem 2: 150 x 150
Embalagem 3: 150 x 200

Materiais:

Cânhamo

Autor: Diana Sarmento / nº06 /12ºC2

Empresa: Adalberto

Envolvimento

Envolver a sustentabilidade no nosso dia a dia!

Padrão para embalagens alimentares referentes a arroz

Medidas em mm:

Embalagem 1: 100 x 150
Embalagem 2: 150 x 150
Embalagem 3: 150 x 200

Materiais:

Cânhamo

Autor: Diana Sarmento / nº06 /12ºC2

Empresa: Adalberto

Envolvimento

Envolver a sustentabilidade no nosso dia a dia!

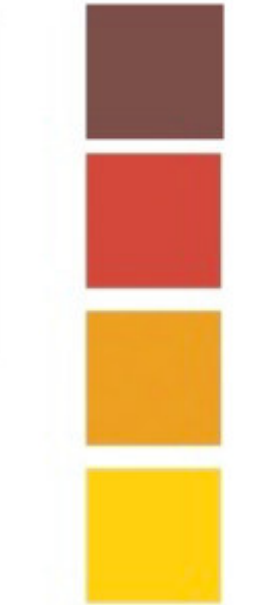
Padrão para embalagens alimentares referentes a leguminosas

Medidas em mm:

Embalagem 1: 100 x 150
Embalagem 2: 150 x 150
Embalagem 3: 150 x 200

Materiais:

Cânhamo



Autor: Diana Sarmento / nº06 /12ºC2

Empresa: Adalberto

Attachment 3

PP

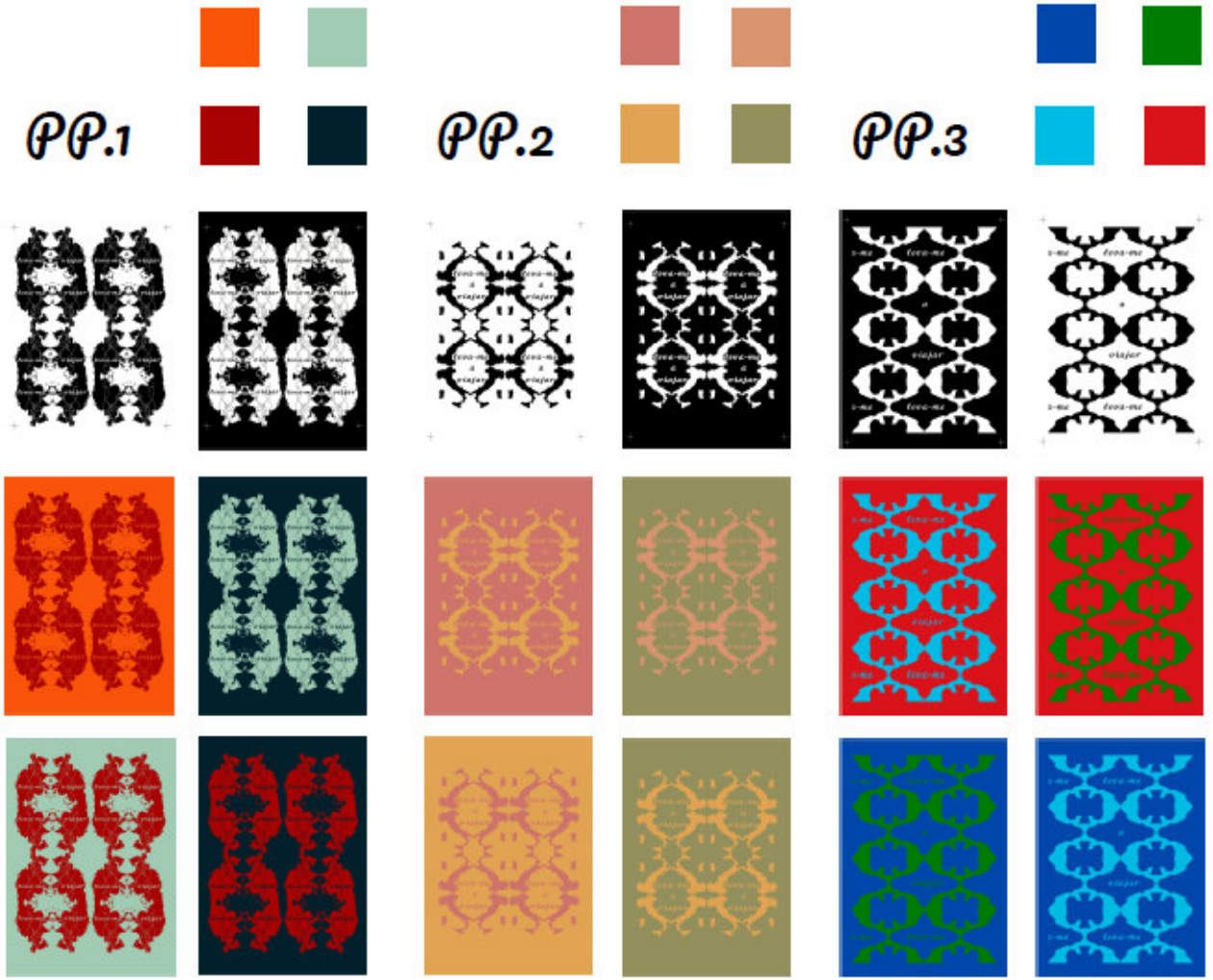
Coleção de Design Têxtil

Inicialmente pensada para embalagens de alimentos secos, com o incentivo a reutilização posterior com novas funções combatendo o uso de embalagens descartáveis.

Dimensões : 21 x 29.7cm / 29.7 x 42cm

Materiais: 100% Cânhamo com processo de estampagem digital.

Parceria: Adalberto **Autor:** Paulo Pires



Attachment 4

Restampa

Coleção de estampados em cânhamo
com uma mensagem de sustembabilidade

Autor:Manuel Cruz

Cliente:Adalberto Soluções Texteis

E A S R escola artística de soares dos reis design de produto

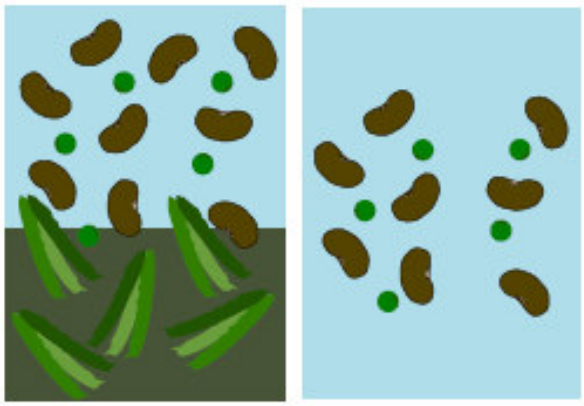
Funded by
the European Union

Restampa

Coleção de estampados em cânhamo
com uma mensagem de sustembabilidade

Autor:Manuel Cruz

Cliente:Adalberto Soluções Texteis



E A
S R
escola artística de soares dos reis
design de produto

Funded by
the European Union

Restampa

Coleção de estampados em cânhamo
com uma mensagem de sustembabilidade

Autor:Manuel Cruz

Cliente:Adalberto Soluções Texteis

E A S R escola artística de soares dos reis
design de produto

Attachment 5

E A
S R escola artística de soares dos reis design de produto

Natureza e Sustentabilidade

Estampado individual para Eco Embalagens de tecido de cânhamo para arroz, massa e feijão.

Dimensão

Embalagem de 1kg - 12x16 cm

(medida ajustável ao tamanho da embalagem)

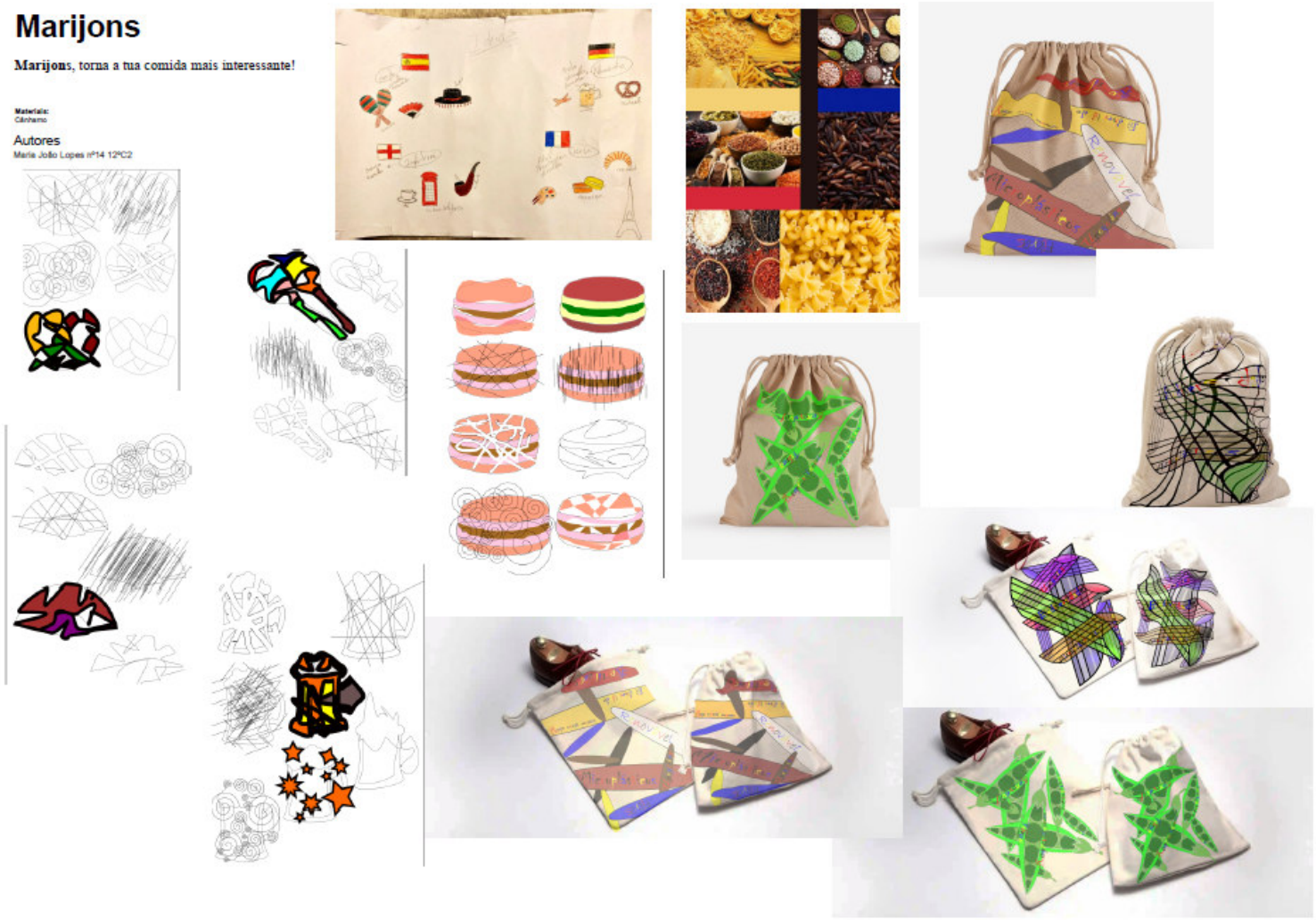
Autor

Daniela Barros

Material

Tecido 100% cânhamo

Attachment 6



Marijons

Marijons, torna a tua comida mais interessante!

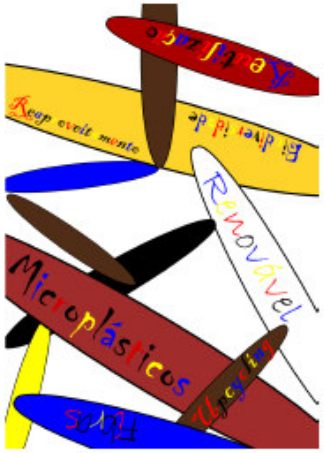
Coleção de estampados em cânhamo para transmitir a mensagem de sustentabilidade.

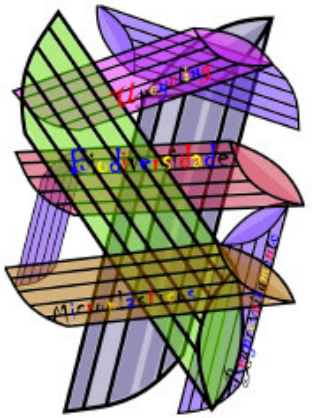
Materiais:
Cânhamo

Autor:
Maria João Lopes nº14 12ºC2

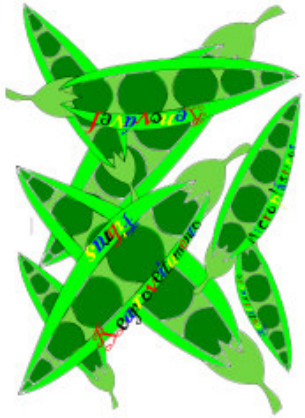
Empresa parceira:

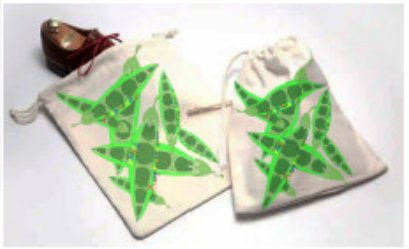
adalberto





E A
S R
escola artística de soares dos reis
design de produto





Attachment 7

Composição U

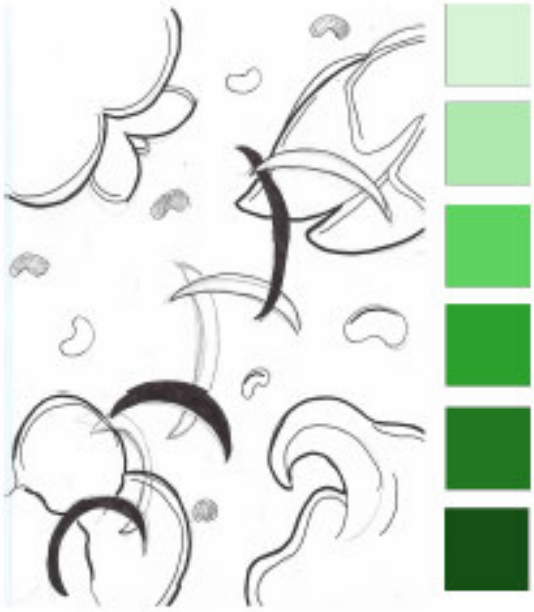
Ecoembalagem
2022/2023

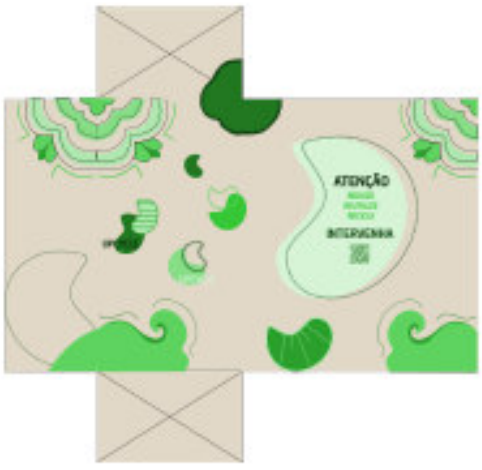
Embalagem ecológica para produtos alimentares.
(leguminosas)
Inspirada na fase 6 do crescimento do feijoeiro, consoante a escala fenológica, a floração.

Apela à preservação do planeta e a sustentabilidade, por isso o uso de tons verdes, inspirados na natureza.

Técnica
Estamparia

Materiais
Cânhamo





Parceria:
Ana Maia adalberto

Composição S

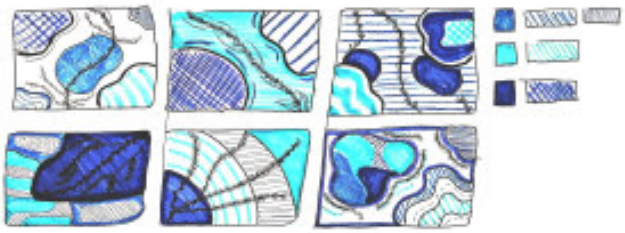
Ecoembalagem
2022/2023

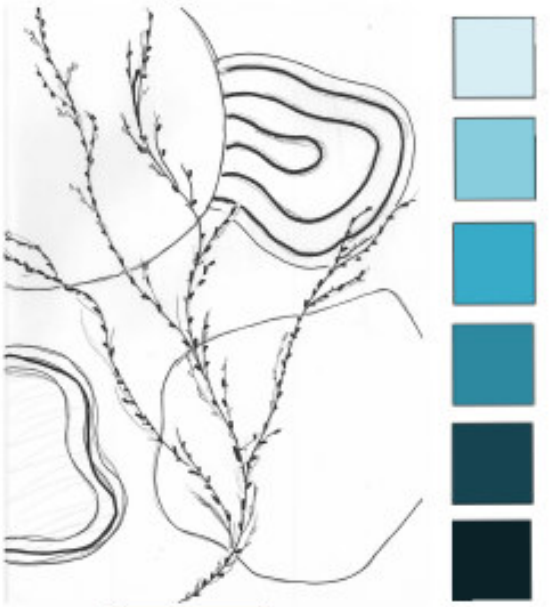
Embalagem ecológica para produtos alimentares. (arroz)
Inspirado nos arrozais orientais, as suas formas orgânicas e inerentes na natureza, jogando com a forma da planta do arroz.

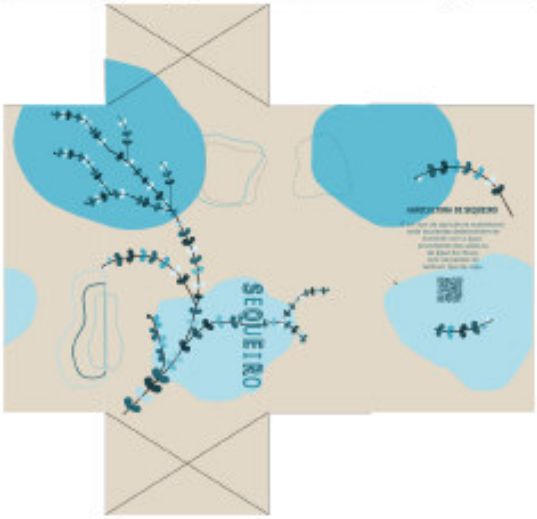
Tem como crítica o excesso de água nos arrozais, por isso o uso de tons azuis. Apela à agricultura de sequeiro.

Técnica
Estamparia

Materiais
Cânhamo







Parceria:
Ana Maia
adalberto
E A S R

Composição G

Ecoembalagem
2022/2023

Embalagem ecológica para produtos alimentares.(massa seca) Inspirada na cidade de Gragnamo, a sudoeste de Nápoles na Itália. Cidade conhecida por marcar a história da massa seca em todo o mundo.

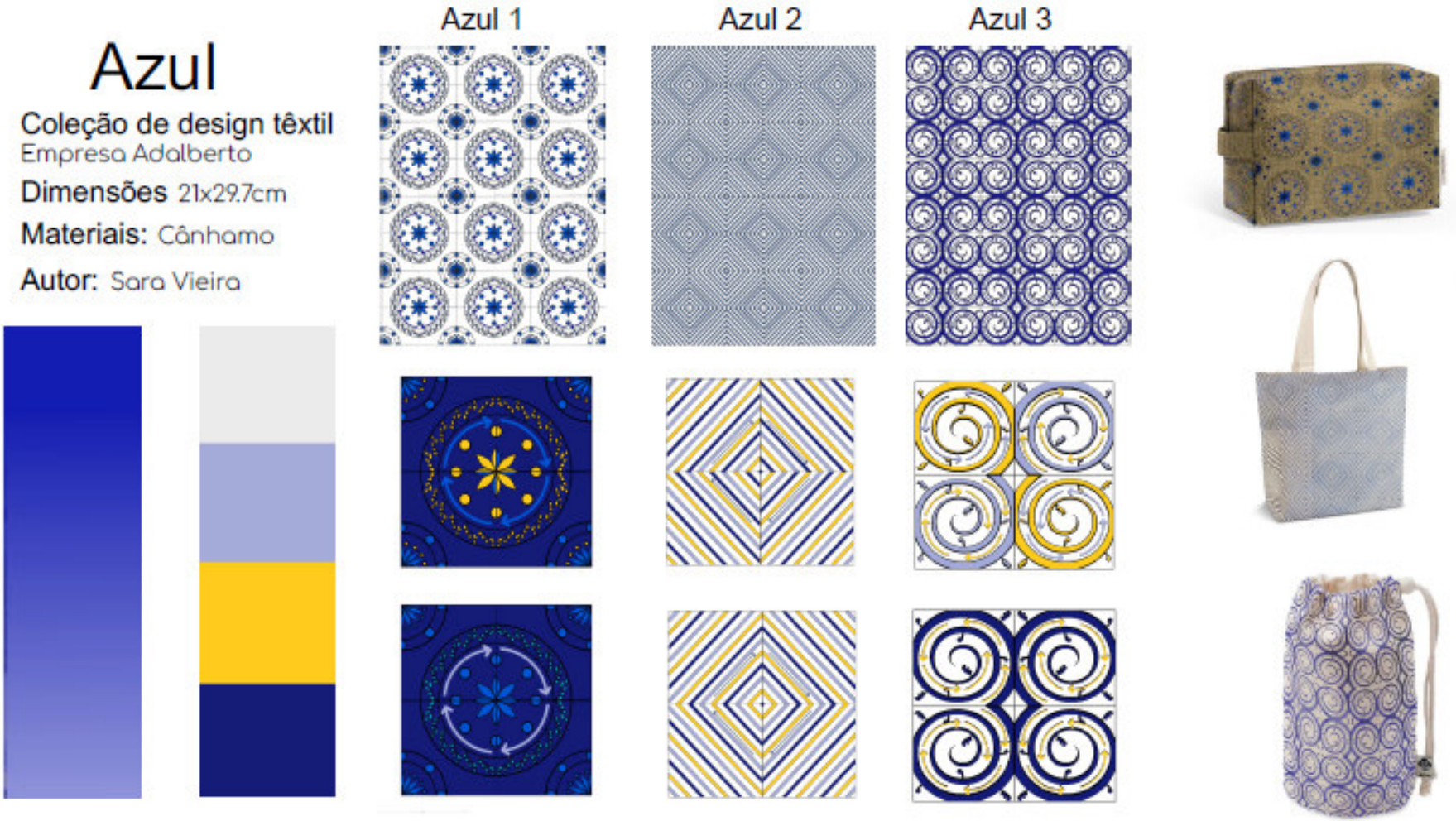
Apela à riqueza desta cidade e a toda a sua história, uma pequena viagem através dos tons terrosos utilizados.

Técnica
Estamparia

Materiais
Cânhamo

Parceria:
Ana Maia
adalberto

Attachment 8



Lesson Plan no.16.

A. **TITLE:** "Old Denim Up-cycling"

AUTHORS: prof. Carolina Muni – Valentina Santagati – Rosaria Puglisi

AGE GROUP: 16-18

GRADE: secondary school – second level

DURATION OF THE ACTIVITY: 8 hours

SUBJECTS:

- practical training in textile industry domain
- jeans recycling
- jeans up-cycling

LEARNING OBJECTIVES:
LO1: Production of handbags and shopping bags from recycled jeans materials
LO2: Identification and selection of recycled /reused jeans
LO3: Correct use of tools and sewing machines
LO4: Choose of sewing machines according to the type of stich
LO5: Cut of the materials according to patterns and models
LO6: Learning how to work respecting health and safety rules
LO7: Learning the importance of recycling second hand materials following the rules of circular economy

B. NECESSARY RESOURCES

MATERIALS USED

- used jeans fabrics, old clothes
- sewing thread, buttons/zipper
-textile industry domain tools and equipment

Teaching methods

-Learning through discovering
-Conversation
-Practical activities
- Individual work
- Exercise
-Exposure

FORMS OF ORGANIZATION

- individual
- in pairs
- frontal

C.DESCRIPTION OF THE ACTIVITY

No. students: 15

Time	Activity	Teacher role
2 hours	- Invite students to wear suitable working clothes or provide for them suitable clothes - Present the subject and the purpose of the lesson - Provide the necessary materials and distribute to the students	- Ensure a pleasant atmosphere in the workshop - Present the types of mechanical stitches. - Compare different types of stitches. - Present different models of patchworks - Show how to cut the materials according to the pattern - Show how to make simple stitching using the sewing machine - Show the right use of the sewing machine - Demonstrate in slow motion, step by step, the execution of stitches.
4 hours	The students work in groups of 2/3; they discuss about what they want to make from the old materials provided The students design the patchwork and create the pattern for their creations They choose materials to use for the "new" clothes They cut materials, pin the pieces and sew pieces according to the garment they want to create.	- Guide the students during activity - Give positive or negative feedback to help the students to be successful
2 hours	Present and evaluate of the work done by students	- Evaluate the work done by students - Give feedback - Appreciate the successful works - Explain possible mistakes

H. Evaluation of student activity and results

Continuous evaluation is carried out throughout the activity through systematic direct observation

The final evaluation is carried out at the end of the activity according to the evaluation sheet

Evaluation and marking grid

Evaluation criteria	Maximum score per criteria	Evaluation indicators	Score on indicator.	
			Maximum	Granted
1. Receiving and planning the workload	**30 points**	1.6.Selection and preparation of sewing patterns and materials.	**4 points**	
		1.7.Preparing the machines for processing operations (checking the technical condition of the sewing machine, adjusting the stitch pitch, sewing test, thread tension adjustment).	**10 points**	
		1.8.Interpretation of the technical documentation in order to execute the technological operation (seam technical sheet). 1.9.Identification of the type of seam to be executed - from the technical sheet of the seam and the standard sample.	**10 points**	
		1.10. Ensuring the conditions for the application of specific rules regarding health and safety at work and the environment.	**6 points**	
2. Accomplishing the work load	**40 points**	2.1. Serving the machines and changing the color of the threads as required by the work load (threading the needle, winding the	**20 points**	

		bobbins, introducing the bobbins into the shuttle).		
		2.2.Execution of seams in accordance with the technical sheet, sample time norms.	**10 points**	
		2.3.Execution of thermal processing operations	**4 points**	
		2.4. Compliance with occupational health and safety rules when processing items (sewing, ironing).	**6 points**	
3. Presentation of the work load	**30 points**	3.1. Self-evaluation of technological operations performed.	**10 points**	
		3.2. Correct use of the specific terminology for reporting task performance.	**20 points**	
4. Total score	**100 points**		**100 points**	

I. RESULTS DESCRIPTION

Needs analysis

The lesson plan has been carried out in accordance with the school curriculum for students in technological education, specializing in Fashion Designer Technician for the development of specific professional skills but also to develop their interest about health and environment.

Target groups

- students in technological secondary schools (last two years)
- Educators looking for an innovative and multidisciplinary approach to didactic methods.

Elements of innovation

By making new items from recyclable textile materials (mostly Denim), we develop in students, in addition to the professional skills provided in the professional training standards, also skills to protect the environment by making them aware of the importance of reusing end-of-use textile materials and develop a circular economy.

Expected impact

- Enhanced Professional Skills: The lesson plan is expected to improve students' professional skills by engaging them in practical and creative activities.
- Increased Environmental Awareness: Through the creation of decorative items using secondhand clothing or used/old jeans, students are encouraged to think about the importance of nature and sustainable living, fostering a sense of environmental

responsibility.
- Improved Collaboration and Communication: Group activities promote teamwork and communication skills among students and with the teachers.

Transferability potential

The project can be taken over bringing our students in contact with younger students of the elementary level (6-10 years old) and of the first level of secondary schools (11-13 years old) – visiting schools of the territory and organizing events in our school inviting schoolchildren, their teachers and their families. Our students, now educated about recycling, up-cycling and slow fashion can explain to younger students the importance of all these aspects.

J. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
- Non-involvement of all students in the proposed activities	- Adaptation of the proposed tasks according to the abilities of each student - Encourage to work using various materials and methods
- Conflicts in groups	- Assign roles in groups and emphasize the importance of each student
- Students can misunderstand or oversimplify the environmental message in their work	- Encourage discussions and critical thinking about the environmental message - Provide examples to illustrate the importance of sustainability
- Students can have distress or anxiety when you are discussing about environmental issues.	- Approach environmental topics with sensitivity, emphasizing positive solutions. - Create an open environment where students can express their thoughts and feelings about environmental concerns

Lesson Plan no.17.

A. TITLE: "Recycling and upcycling scarps of curtains"

AUTHORS: prof. Carolina Muni – Rosaria Maccarrone – Rosaria Puglisi

AGE GROUP: 15-16

GRADE: secondary school – second level

DURATION OF THE ACTIVITY: 8 hours

SUBJECTS:

- practical training in textile industry domain
- use and recycling scarps of curtains
- up-cycling curtains and scarps of curtains

LEARNING OBJECTIVES:

LO1: Production of elegant handbags, belts, wallets and clothing accessories from scarp of curtains
LO2: Identification and selection of scarps of curtains
LO3: Correct use of tools and sewing machines
LO4: Choose sewing machines according to the type of stich
LO5: Cut of the materials according to patterns and models
LO6: Learning how to work respecting health and safety rules
LO7: Learning the importance of using and up-cycling little and big pieces of materials (for example pieces of curtains) following the rules of "no waste".

B. NECESSARY RESOURCES

MATERIALS USED

- scraps of curtains, old curtains
- sewing thread, buttons/zipper
-textile industry domain tools and equipment

Teaching methods

-Learning through discovering
-Conversation
-Practical activities
- Individual work
- Exercise
-Exposure

FORMS OF ORGANIZATION

- individual
- in pairs
- frontal

C.DESCRIPTION OF THE ACTIVITY No. students: 15

Time	Activity	Teacher role
2 hours	- Invite students to wear suitable working clothes or provide them suitable clothes - Present the subject and the purpose of the lesson - Provide the necessary materials and distribute to the students	- Ensure a pleasant atmosphere in the workshop - Present the types of mechanical stitches. - Compare different types of stitches. - Present different models of patchworks - Show how to cut the materials according to the pattern - Show how to make simple stitching using the sewing machine - Show the right use of the sewing machine - Demonstrate in slow motion, step by step, the execution of stitches.
4 hours	The students work in groups of 3; they discuss about what they want to make from the materials provided The students design the patchwork and the pattern for their creations They choose materials to use for the "new" bags and accessories They cut materials, pin the pieces and sew pieces according to the garment they want to create.	- Guide the students during activity - Give positive or negative feedback to help the students to be successful
2 hours	Present and evaluate of the work done by students	- Evaluate the work done by students - Give feedback - Appreciate the successful works - Explain possible mistakes

D. Evaluation of student activity and results

Continuous evaluation is carried out throughout the activity through systematic direct observation The final evaluation is carried out at the end of the activity according to the evaluation sheet

Evaluation and marking grid

Evaluation criteria	Maximum score per criteria	Evaluation indicators	Score on indicator.	
			Maximum	Granted
1. Receiving and planning the workload	**30 points**	1.1.Selection and preparation of sewing patterns and materials.	**4 points**	
		1.2.Preparing the machines for processing operations (checking the technical condition of the sewing machine, adjusting the stitch pitch, sewing test, thread tension adjustment).	**10 points**	
		1.3. Interpretation of the technical documentation in order to execute the technological operation (seam technical sheet). 1.4. Identification of the type of seam to be executed - from the technical sheet of the seam and the standard sample.	**10 points**	
		1.5. Ensuring the conditions for the application of specific rules regarding health and safety at work and the environment.	**6 points**	
2. Accomplishing the work load	**40 points**	2.1. Serving the machines and changing the color of the threads as required by the work load (threading the needle, winding the bobbins, introducing the bobbins into the shuttle).	**20 points**	
		2.2. Execution of seams in accordance with the technical sheet, sample time norms.	**10 points**	
		2.3. Execution of thermal processing operations	**4 points**	

		2.4. Compliance with occupational health and safety rules when processing items (sewing, ironing).	**6 points**	
3. Presentation of the work load	**30 points**	3.1. Self-evaluation of technological operations performed.	**10 points**	
		3.2. Correct use of the specific terminology for reporting task performance.	**20 points**	
4. Total score	**100 points**		**100 points**	

E. RESULTS DESCRIPTION

Needs analysis

The lesson plan has been carried out in accordance with the school curriculum for students in technological education, specializing in Fashion Designer Technician for the development of specific professional skills but also to develop their interest about health and environment.

Target groups

- students in technological secondary schools (second and third year)
- Educators looking for an innovative and multidisciplinary approach to didactic methods.

Elements of innovation

By making new items from recyclable textile materials (mostly pieces and samples of curtains), we develop in students, in addition to the professional skills provided in the professional training standards, also skills to protect the environment by making them aware of the importance of using all the materials, even little scraps and samples, and develop a "no waste" economy.

Expected impact

- Enhanced Professional Skills: The lesson plan is expected to improve students' professional skills by engaging them in practical and creative activities.
- Increased Environmental Awareness: Through the creation of decorative items using samples and scraps, students are encouraged to think about the importance of nature and sustainable living, fostering a sense of environmental and economical responsibility.
- Improved Collaboration and Communication: Group activities promote teamwork and communication skills among students and with the teachers.

Transferability potential

The project can be taken over bringing our students in contact with groups of young girls and boys of the elementary level (6-10 years old) and of the first level of secondary schools (11-13 years old) – visiting schools of the territory and organizing

events in our school inviting schoolchildren, their teachers and their families. Our students, now educated about "no-waste" of materials can explain to younger people the importance of this aspect in the economy and its low impact on the environment.

F. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
- Non-involvement of all students in the proposed activities	- Adaptation of the proposed tasks according to the abilities of each student - Encourage to work using various materials and methods
- Conflicts in groups	- Assign roles in groups and emphasize the importance of each student
- Students can misunderstand or oversimplify the environmental message in their work	- Encourage discussions and critical thinking about the environmental message - Provide examples to illustrate the importance of sustainability
- Students can have distress or anxiety when you are discussing about environmental issues.	- Approach environmental topics with sensitivity, emphasizing positive solutions. - Create an open environment where students can express their thoughts and feelings about environmental concerns

Lesson Plan no.18.

A. TITLE: "Use and upcycling of plastic shopping bags"

AUTHORS: prof. Carolina Muni – Valentina Santagati – Donatella La Maestra

AGE GROUP: 16-17

GRADE: secondary school – second level

DURATION OF THE ACTIVITY: 8 hours

SUBJECTS:

- practical training in textile industry domain
- plastic recycling
- plastic up-cycling

LEARNING OBJECTIVES:

LO1: Production of handbags, shopping bags and shoes from recycled plastic materials
LO2: Identification and selection of recycled /reused plastic
LO3: Correct use of tools and sewing machines
LO4: Choose of sewing machines according to the type of stich
LO5: Cut of the materials according to patterns and models
LO6: Learning how to work respecting health and safety rules
LO7: Learning the importance of recycling second hand materials following the rules of circular economy

B. NECESSARY RESOURCES

MATERIALS USED

- used plastic bags
- sewing thread, buttons, glue materials

-textile industry domain tools and equipment

Teaching methods

-Learning through discovering
-Conversation
-Practical activities
- Individual work
- Exercise

-Exposure

FORMS OF ORGANIZATION

- individual

- in pairs
- frontal

C.DESCRIPTION OF THE ACTIVITY No. students: 15

Time	Activity	Teacher role
2 hours	- Invite students to wear suitable working clothes or provide for them suitable clothes - Present the subject and the purpose of the lesson - Provide the necessary materials and distribute to the students	- Ensure a pleasant atmosphere in the workshop - Present the types of mechanical stitches. - Compare different types of stitches. - Present different models of patchworks - Show how to cut the materials according to the pattern - Show how to make simple stitching using the sewing machine - Show the right use of the sewing machine - Demonstrate in slow motion, step by step, the execution of stitches and how to stick plastic.
4 hours	The students work in groups of 2/3; they discuss about what they want to make from the old materials provided The students design the patchwork and create the pattern for their creations They choose materials to use for the "new" clothes They cut materials, pin the pieces and sew pieces according to the garment they want to create.	- Guide the students during activity - Give positive or negative feedback to help the students to be successful
2 hours	Present and evaluate of the work done by students	- Evaluate the work done by students - Give feedback - Appreciate the successful works - Explain possible mistakes

D. Evaluation of student activity and results

Continuous evaluation is carried out throughout the activity through systematic direct observation. The final evaluation is carried out at the end of the activity according to the evaluation sheet

Evaluation and marking grid

Evaluation criteria	Maximum score per criteria	Evaluation indicators	Score on indicator.	
			Maximum	Granted
1. Receiving and planning the workload	**30 points**	1.3.Selection and preparation of sewing patterns and materials.	**4 points**	
		1.4.Preparing the machines for processing operations (checking the technical condition of the sewing machine, adjusting the stitch pitch, sewing test, thread tension adjustment).	**10 points**	
		1.3. Interpretation of the technical documentation in order to execute the technological operation (seam technical sheet). 1.4. Identification of the type of seam to be executed - from the technical sheet of the seam and the standard sample.	**10 points**	
		1.5. Ensuring the conditions for the application of specific rules regarding health and safety at work and the environment.	**6 points**	
2. Accomplishing the work load	**40 points**	2.1. Serving the machines and changing the color of the threads as required by the work load (threading the needle, winding the bobbins, introducing the bobbins into the shuttle).	**20 points**	
		2.2. Execution of seams in accordance with the technical sheet, sample time norms.	**10 points**	
		2.3. Execution of thermal processing operations	**4 points**	

		2.4. Compliance with occupational health and safety rules when processing items (sewing, ironing).	**6 points**	
3. Presentation of the work load	**30 points**	3.1. Self-evaluation of technological operations performed.	**10 points**	
		3.2. Correct use of the specific terminology for reporting task performance.	**20 points**	
4. Total score	**100 points**		**100 points**	

E. RESULTS DESCRIPTION

Needs analysis

The lesson plan has been carried out in accordance with the school curriculum for students in technological education, specializing in Fashion Designer Technician for the development of specific professional skills but also to develop their interest about health and environment.

Target groups

- students in technological secondary schools (third and fourth year)
- Educators looking for an innovative and multidisciplinary approach to didactic methods.

Elements of innovation

By making new items from recyclable textile materials (mostly plastic), we develop in students, in addition to the professional skills provided in the professional training standards, also skills to protect the environment by making them aware of the importance of reusing end-of-use textile materials and develop a circular economy.

Expected impact

- Enhanced Professional Skills: The lesson plan is expected to improve students' professional skills by engaging them in practical and creative activities.
- Increased Environmental Awareness: Through the creation of decorative items using secondhand clothing or used/old plastic, students are encouraged to think about the importance of nature and sustainable living, fostering a sense of environmental responsibility.
- Improved Collaboration and Communication: Group activities promote teamwork and communication skills among students and with the teachers.

Transferability potential

The project can be taken over bringing our students in contact with younger students of the elementary level (6-10 years old) and of the first level of secondary schools (11-13 years old) – visiting schools of the territory and organizing events in our school inviting schoolchildren, their teachers and their families. Our students, now educated about recycling, up-cycling and the bad impact of plastic materials on the

environment can explain to younger students the importance of all these aspects. The project can also involve elder people asking them to collect plastic bags and other plastic items that can be recycled by our students.

F. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
- Non-involvement of all students in the proposed activities	- Adaptation of the proposed tasks according to the abilities of each student - Encourage to work using various materials and methods
- Conflicts in groups	- Assign roles in groups and emphasize the importance of each student
- Students can misunderstand or oversimplify the environmental message in their work	- Encourage discussions and critical thinking about the environmental message - Provide examples to illustrate the importance of sustainability
- Students can have distress or anxiety when you are discussing about environmental issues.	- Approach environmental topics with sensitivity, emphasizing positive solutions. - Create an open environment where students can express their thoughts and feelings about environmental concerns

Lesson Plan no.19.

A. **TITLE:** "Old Denim Up-cycling"

AUTHORS: prof. Carolina Muni – Valentina Santagati – Rosaria Puglisi – Donatella La Maestra – Angela Inferrera

AGE GROUP:18-19

GRADE: secondary school – second level

DURATION OF THE ACTIVITY: 10 hours

SUBJECTS:
- practical training in textile industry domain
- transformation of old clothes
- old clothes up-cycling

LEARNING OBJECTIVES:
LO1: Production of skirts, pullovers and shirts from old dresses
LO2: Identification and selection of old dresses and clothes
LO3: Correct use of tools and sewing machines
LO4: Choose of sewing machines according to the type of stich
LO5: Cut of the materials according to patterns and models
LO6: Learning how to work respecting health and safety rules
LO7: Learning the importance of recycling second hand materials following the rules of circular economy

B. NECESSARY RESOURCES

MATERIALS USED
- used dresses, old clothes
- sewing thread, buttons/zipper
-textile industry domain tools and equipment

Teaching methods
-Learning through discovering
-Conversation
-Practical activities
- Individual work
- Exercise
-Exposure

FORMS OF ORGANIZATION

- individual
- in pairs
- frontal

C.DESCRIPTION OF THE ACTIVITY

No. students: 15

Time	Activity	Teacher role
2 hours	- Invite students to wear suitable working clothes or provide suitable clothes for them - Present the subject and the purpose of the lesson - Provide the necessary materials and distribute to the students	- Ensure a pleasant atmosphere in the workshop - Present the types of mechanical stitches. - Compare different types of stitches. - Present different models of patchworks - Show how to cut the materials according to the pattern - Show how to make simple stitching using the sewing machine - Show the right use of the sewing machine - Demonstrate in slow motion, step by step, the execution of stitches.
6 hours	The students work in groups of 2/3 (3h) and later individual (3h); they discuss about what they want to make from the old and used materials provided The students design the patchwork and create the pattern for their creations They choose materials to use for the "new" clothes and dresses They cut materials, pin the pieces and sew pieces according to the garment they want to create.	- Guide the students during activity - Give positive or negative feedback to help the students to be successful
2 hours	Present and evaluate of the work done by students	- Evaluate the work done by students - Give feedback - Appreciate the successful works - Explain possible mistakes

D. Evaluation of student activity and results

Continuous evaluation is carried out throughout the activity through systematic direct observation

The final evaluation is carried out at the end of the activity according to the evaluation sheet

Evaluation and marking grid

Evaluation criteria	Maximum score per criteria	Evaluation indicators	Score on indicator.	
			Maximum	Granted
1. Receiving and planning the workload	**30 points**	1.1. Selection and preparation of sewing patterns and materials.	**4 points**	
		1.2. Preparing the machines for processing operations (checking the technical condition of the sewing machine, adjusting the stitch pitch, sewing test, thread tension adjustment).	**10 points**	
		1.3. Interpretation of the technical documentation in order to execute the technological operation (seam technical sheet). 1.4. Identification of the type of seam to be executed - from the technical sheet of the seam and the standard sample.	**10 points**	
		1.5. Ensuring the conditions for the application of specific rules regarding health and safety at work and the environment.	**6 points**	
2. Accomplishing the workload	**40 points**	2.1. Serving the machines and changing the colour of the threads as required by the workload (threading the needle, winding the bobbins, introducing the bobbins into the shuttle).	**20 points**	
		2.2.Execution of seams in accordance with the technical sheet, sample time norms.	**10 points**	
		2.3. Execution of thermal processing operations	**4 points**	
		2.4. Compliance with occupational health and	**6 points**	

		safety rules when processing items (sewing, ironing).		
3. Presentation of the work load	**30 points**	3.1. Self-evaluation of technological operations performed.	**10 points**	
		3.2. Correct use of the specific terminology for reporting task performance.	**20 points**	
4. Total score	**100 points**		**100 points**	

E. RESULTS DESCRIPTION

Needs analysis

The lesson plan has been carried out in accordance with the school curriculum for students in technological education, specializing in Fashion Designer Technician for the development of specific professional skills but also to develop their interest about health and environment and circular economy.

Target groups

- students in technological secondary schools (last year)
- Educators are looking for an innovative and multidisciplinary approach to didactic methods.

Elements of innovation

By making new items from recyclable textile materials (mostly old/used dresses), we develop in students, in addition to the professional skills provided in the professional training standards, also skills to protect the environment by making them aware of the importance of reusing end-of-use textile materials and developing a circular economy.

Expected impact

- Enhanced Professional Skills: The lesson plan is expected to improve students' professional skills by engaging them in practical and creative activities.
- Increased Environmental Awareness: Through the creation of decorative items using secondhand clothing or used/old dresses, students are encouraged to think about the importance of nature and sustainable living, fostering a sense of environmental responsibility.
- Improved Collaboration and Communication: Group activities promote teamwork and communication skills among students and with the teachers.

Transferability potential

The project can be taken over bringing our students in contact with coetaneous students (same age) – visiting schools of the territory and organizing events in our school inviting students, their teachers and their families. Our students, now educated about recycling, up-cycling and slow fashion, can explain to other students the importance of all these aspects.

F. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	Measures/Solutions
- Non-involvement of all students in the proposed activities	- Adaptation of the proposed tasks according to the abilities of each student - Encourage to work using various materials and methods

- Conflicts in groups	- Assign roles in groups and emphasize the importance of each student
- Students can misunderstand or oversimplify the environmental message in their work	- Encourage discussions and critical thinking about the environmental message - Provide examples to illustrate the importance of sustainability
- Students can have distress or anxiety when you are discussing about environmental issues.	- Approach environmental topics with sensitivity, emphasizing positive solutions. - Create an open environment where students can express their thoughts and feelings about environmental concerns

Lesson Plan no.19.

B. TITLE: "Old Denim Up-cycling"

AUTHORS: prof. Carolina Muni – Valentina Santagati – Rosaria Puglisi – Donatella La Maestra – Angela Inferrera

AGE GROUP:18-19

GRADE: secondary school – second level

DURATION OF THE ACTIVITY: 10 hours

SUBJECTS:
- practical training in textile industry domain
- transformation of old clothes
- old clothes up-cycling

LEARNING OBJECTIVES:
LO1: Production of skirts, pullovers and shirts from old dresses
LO2: Identification and selection of old dresses and clothes
LO3: Correct use of tools and sewing machines
LO4: Choose of sewing machines according to the type of stich
LO5: Cut of the materials according to patterns and models
LO6: Learning how to work respecting health and safety rules
LO7: Learning the importance of recycling second hand materials following the rules of circular economy

B. NECESSARY RESOURCES

MATERIALS USED
- used dresses, old clothes
- sewing thread, buttons/zipper
-textile industry domain tools and equipment

Teaching methods
-Learning through discovering
-Conversation
-Practical activities
- Individual work
- Exercise
-Exposure

FORMS OF ORGANIZATION

- individual
- in pairs
- frontal

C.DESCRIPTION OF THE ACTIVITY

No. students: 15

Time	Activity	Teacher role
2 hours	- Invite students to wear suitable working clothes or provide suitable clothes for them - Present the subject and the purpose of the lesson - Provide the necessary materials and distribute to the students	- Ensure a pleasant atmosphere in the workshop - Present the types of mechanical stitches. - Compare different types of stitches. - Present different models of patchworks - Show how to cut the materials according to the pattern - Show how to make simple stitching using the sewing machine - Show the right use of the sewing machine - Demonstrate in slow motion, step by step, the execution of stitches.
6 hours	The students work in groups of 2/3 (3h) and later individual (3h); they discuss about what they want to make from the old and used materials provided The students design the patchwork and create the pattern for their creations They choose materials to use for the "new" clothes and dresses They cut materials, pin the pieces and sew pieces according to the garment they want to create.	- Guide the students during activity - Give positive or negative feedback to help the students to be successful
2 hours	Present and evaluate of the work done by students	- Evaluate the work done by students - Give feedback - Appreciate the successful works - Explain possible mistakes

G. Evaluation of student activity and results

Continuous evaluation is carried out throughout the activity through systematic direct observation

The final evaluation is carried out at the end of the activity according to the evaluation sheet

Evaluation and marking grid

Evaluation criteria	Maximum score per criteria	Evaluation indicators	Score on indicator.	
			Maximum	Granted
1. Receiving and planning the workload	**30 points**	1.6. Selection and preparation of sewing patterns and materials.	**4 points**	
		1.7. Preparing the machines for processing operations (checking the technical condition of the sewing machine, adjusting the stitch pitch, sewing test, thread tension adjustment).	**10 points**	
		1.8. Interpretation of the technical documentation in order to execute the technological operation (seam technical sheet). 1.9. Identification of the type of seam to be executed - from the technical sheet of the seam and the standard sample.	**10 points**	
		1.10. Ensuring the conditions for the application of specific rules regarding health and safety at work and the environment.	**6 points**	
2. Accomplishing the workload	**40 points**	2.1. Serving the machines and changing the colour of the threads as required by the workload (threading the needle, winding the bobbins, introducing the bobbins into the shuttle).	**20 points**	
		2.2.Execution of seams in accordance with the technical sheet, sample time norms.	**10 points**	
		2.3. Execution of thermal processing operations	**4 points**	

		2.4. Compliance with occupational health and safety rules when processing items (sewing, ironing).	**6 points**	
3. Presentation of the work load	**30 points**	3.1. Self-evaluation of technological operations performed.	**10 points**	
		3.2. Correct use of the specific terminology for reporting task performance.	**20 points**	
4. Total score	**100 points**		**100 points**	

H. RESULTS DESCRIPTION

Needs analysis

The lesson plan has been carried out in accordance with the school curriculum for students in technological education, specializing in Fashion Designer Technician for the development of specific professional skills but also to develop their interest about health and environment and circular economy.

Target groups

-students in technological secondary schools (last year)

- Educators are looking for an innovative and multidisciplinary approach to didactic methods.

Elements of innovation

By making new items from recyclable textile materials (mostly old/used dresses), we develop in students, in addition to the professional skills provided in the professional training standards, also skills to protect the environment by making them aware of the importance of reusing end-of-use textile materials and developing a circular economy.

Expected impact

- Enhanced Professional Skills: The lesson plan is expected to improve students' professional skills by engaging them in practical and creative activities.
- Increased Environmental Awareness: Through the creation of decorative items using secondhand clothing or used/old dresses, students are encouraged to think about the importance of nature and sustainable living, fostering a sense of environmental responsibility.
- Improved Collaboration and Communication: Group activities promote teamwork and communication skills among students and with the teachers.

Transferability potential

The project can be taken over bringing our students in contact with coetaneous students (same age) – visiting schools of the territory and organizing events in our school inviting students, their teachers and their families. Our students, now educated about recycling, up-cycling and slow fashion, can explain to other students the importance of all these aspects.

I. ANTICIPATING RISKS; POSSIBLE MEASURES/SOLUTIONS

Risk	**Measures/Solutions**
- Non-involvement of all students in the proposed activities	- Adaptation of the proposed tasks according to the abilities of each student - Encourage to work using various materials and

	methods
- Conflicts in groups	- Assign roles in groups and emphasize the importance of each student
- Students can misunderstand or oversimplify the environmental message in their work	- Encourage discussions and critical thinking about the environmental message - Provide examples to illustrate the importance of sustainability
- Students can have distress or anxiety when you are discussing about environmental issues.	- Approach environmental topics with sensitivity, emphasizing positive solutions. - Create an open environment where students can express their thoughts and feelings about environmental concerns

4. CONCLUSIONS

All the partners involved have identified the need that students and teachers act towards reducing the consumption of textile products and reducing the amount of textile waste, to reduce the amount, to ensure re-use and recycling, to protect natural resources, protect the environment, energy recovery and prevent climate change, teaching students be aware of not only recycling textile waste but also recycling in all areas.

Our students belong to socio-economic poor areas and deprived social groups. This project responds to their need of training for the future society, and to empower them with green skills and pro-environment attitude. Our multidisciplinary approach combines technology, arts, ICT and foreign languages. They need to get in real touch with other educational, social and economic realities in order to motivate their wish to confront themselves, reinforcing also their natural curiosity and creativity, especially related to their professional competences enhancing their sense of initiative and entrepreneurship
necessary for our future tailors and model makers.

Educational Impact and Exchange of Best Practices

- **International collaboration**
- Each teacher developed a unique lesson plan tailored to their cultural and educational context, bringing diverse perspectives on textile recycling and sustainability to the classroom.
- Classroom activities demonstrated that interactive methods and practical applications encourage students to engage actively in the learning process and deepen their understanding of sustainability's importance.

Raising Awareness and Developing Ecological Competencies

- Through these activities, students became more aware of the environmental impact of textiles and their role in reducing textile waste. This project contributed to shaping an ecological mindset among students.
- Practical skills related to recycling and reuse were developed, and students learned to appreciate the value of recycled materials, which may influence their future consumer choices and ecological behaviors.

Challenges Faced and Lessons Learned

- Differences in curriculum and infrastructure among participating countries posed a challenge, but also offered an opportunity to adapt materials and activities to each school's specific needs.
- Implementing recycling activities required material resources and logistical support, which varied according to each teacher's local context. This highlighted the need for additional support in developing recycling infrastructure in schools.

Sustainability and Future Development Possibilities

- The project demonstrated that integrating sustainability into the educational curriculum through practical, collaborative activities is feasible. This initiative can serve as a model for other disciplines and educational projects.

- It is recommended that the project be expanded in the future to include more participants or to develop ongoing professional development for teachers, focusing on new technologies and innovations in sustainable textiles.

Overall Conclusion

- The project was a success, showing that through international collaboration and practical education, teachers and students can become ambassadors of sustainability. The initiative helped build a community of teachers promoting sustainable textiles and left a positive impact on students, shaping their perception of environmental responsibility and natural resource stewardship.

5. OUR PROJECT IN IMAGES:

The first learning activity for students- 06-10.02.2023, Arad, Romania

The second learning activity for students- 05.06.2023-09.06.2023, Porto, Portugal

Ther third learning activity for students- 04.12.2023-08.11.2023, Sinop, Turkey

The fourth learning activity for students- 04.03.2024-08.03.2024, San Giovani de la Punta, Italy

The fifth learning activity for students- 15.04.2024-19.04.2024, Novi Pazar, Serbia

The sixth learning activity for teachers- 06-10.02.2023, Arad, Romania

The seventh learning activity for teachers- 04.03.2024-08.03.2024, San Giovani de la Punta, Italy