

STEAM AND THE TEXTILE RECYCLING REVOLUTION; TOWARDS A SUSTAINABLE FUTURE

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Abstract— *Textile Recycling as a sustainable solution, together with the STEAM methodology, represents a response to reduce climate change by contributing a sustainable solution to the Sustainable Development Goals of the 2023 Agenda. Textile Recycling supports the reduction of climate change due to the decrease in CO₂ generation as it eliminates the need to cultivate new fibers, which consequently reduces CO₂ emissions into the atmosphere. It also prevents water pollution in textile processes, contributing to the solution of SDG 6 Clean Water and Sanitation. These actions together contribute to SDG 13 Climate Action, and furthermore, to SDG 12 Responsible Production and Consumption. There is a need to demonstrate efficient and successful models that can be replicated. Textile Recycling is an initiative carried out from an educational institution, which also contributes to SDG 4 Quality Education, due to the comprehensive training intended for students and the sharing of the successful case of creating new garments through the recycling of used clothes by the creative process of students in the Design Degree (UAM Azc.). The project uses the STEAM methodology, which facilitates the inclusion of different disciplines to achieve an innovative and sustainable solution. It is worth highlighting that the products created are an example of the application of Art in a product or innovation, aiming to promote this type of integrative and sustainable productions in order to reduce the main global problems by reusing materials and contributing to the SDGs.*

Index Terms— *Sustainable Development Goals, Sustainable solutions, STEAM, Textile Recycling*

INTRODUCTION

Climate change is today a problem created by the excessive use of resources to favor only economic interests. The development of humanity, leaving aside ethics, common sense, and sustainability, has led to the current state of agreement [1]. Climate change constitutes the most important challenge facing humanity in the present century. It is a complex phenomenon resulting from the current civilizing process that will further destabilize the natural and social cycles and dynamics of the entire globe.

In the midst of social, environmental, and economic crises, the best way is to combine knowledge to achieve a sustainable balance. Sustainability, according to [2], "is understood as the ability to maintain ecological, social, and economic balances over time, adapting to global changes and challenges." In this same sense, [3] mentions: "Sustainable development seeks to satisfy the needs of the present without compromising the ability of future generations to satisfy their own needs." During an era of technology and high consumption, it is difficult to maintain the balance between the three elements to achieve sustainability. According to [4] "Sustainability can be understood as the balance between the demands of modern society and the regenerative capacity of ecosystems." Achieving sustainability has become a challenge due to high consumption, as well as ecosystems and natural resources, which in many cases are threatened or compromised to obtain profit. These challenges must be addressed with the participation of all members of society so that with the sum of the participation a balance will be achieved for this world as mentioned [5] "Sustainability is not only an objective, but a dynamic process that involves the active participation of all sectors of society." In this same sense, society is required, including governments, international organizations, and preferably industrial and economic organizations to achieve results with true global impacts, as mentioned [6] "The concept of sustainability has expanded to include the importance of global governance and international cooperation." Sustainable challenges have diversified and contain countless elements, which complicate solutions as one of the responses to these complex situations and in search of sustainable solutions through the Synergy of Sciences, where knowledge from different disciplines is added to build a solution through the sciences of complexity. As mentioned [7], synergy is essential in research projects that combine multiple disciplines to address complex problems. Problems are becoming increasingly larger with more elements and multiple variables, which has led to the development of technology as well as computational systems that provide support to generate analysis and solutions. The union between society, science and technology is required to generate solutions [8]. The analysis of the synergy between different types of policies and tools is key to the effectiveness in the formulation of science and technology policies. In order to achieve beneficial results for all. The analysis of the synergy between different types of policies and tools is key to effective science and technology policymaking. To achieve win-win outcomes [9], collaboration between different scientific actors is crucial for progress and sustainability in various fields. In the same vein, [10], the interconnection between science, technology, and society is an area of study that highlights how these elements influence each other to drive progress or generate challenges. In order to respond to these major problems, the UN established the Sustainable Development Goals (SDGs) in the 2030 Agenda, which aims to globally combat the world's main problems that are expected to be resolved by society as a whole before 2030. Fig. 1 of the Sustainable Development Goals is shown below.



Fig. 1. Sustainable Development Goals Source: [11]

Theoretical framework

Climate change is a consequence of the abuse in the use of natural resources, the consequences are serious and in different areas such as biodiversity as well as in activities of utmost importance such as agriculture that provides sustenance to the human species as mentioned [12] In recent years, agriculture has shown greater sensitivity to climate change, favoring processes of soil erosion, glacier retreat, loss of vegetation cover, increase in the intensity of rainfall and alteration in the dynamics of crops. This situation is an example, which is repeated around the world with the consequences in ecosystems according to [13] biodiversity is responsible for supporting essential functions and services for agriculture. So by affecting biodiversity consequently the impacts multiply as mentioned [14] Direct and indirect effects of elevation, temperature, precipitation, alteration of vegetation structure and climate change itself have been suffered. The water crisis is also a consequence as shown in the United Nations World Report on Water Development 2020 Water and Climate Change [15] It also mentions [16] Cryosphere alterations induced by climate change are also widespread and will cause a global reduction in snow and ice cover; Therefore, it is very likely that snow cover, glaciers and permafrost will continue to decrease in almost all regions throughout the 21st century.

Climate change is a consequence of industrialization. There are highly polluting sectors. In the case of the textile industry and its corporate sector, these are considered highly polluting sources due to the demand for water, oil, and CO₂ emissions, according to [17]. Recycling contributes to reducing climate change and promoting global well-being by supporting the circular economy model through the use and recovery of waste, as mentioned [18]. The Recycling Program foresees a successful model due to the existing projects being developed in Bogotá.

Circular Economy: Although the origins of the circular economy (CE) formally appear in various disciplines and schools of thought since the 1970s, the results show that environmental economics and industrial ecology were decisive in driving its development. [19] Industrial ecology (IE) in waste management, the value of materials, and pollution control were key elements in driving its development [20], [21], [22], [23] In the midst of a capitalist world, for years decisions are made according to economic interests causing an imbalance in terms of the environment and the human element, only favoring one element has the world in a truly serious crisis. The United Nations Environment Program severely questions the irrational use of natural resources, environmental pollution, adverse effects on

ecosystems and damage to human health [24] Unfortunately, a lifestyle based on permanent market growth continues to be promoted, which implies a systematic increase in the demand for products and services, as if natural and energy resources were infinite, thereby generating various environmental crises [25].

Upcycling: This term is used to recognize the creative process of creating a new product from an existing one. This creative process brings a new product to life without the environmental impact that a product would have from the extraction of materials and production to the final product.

The term "upcycling" is attributed to German engineer Reiner Pilz. In 1994, he defined upcycling as the transformation of a waste product or material into one of equal or greater value, rather than simply recycling it, which often involves the degradation of the material. Upcycling adds value to a material or improves it. Upcycling, also known as upcycling or creative reuse, is considered a more sustainable practice.

Upcycling offers the possibility of using a wide variety of materials, from textiles, paper, wood, and metals, and has become a common practice in fashion, design, and art. Another initiative is the book "Trash Doesn't Exist. Towards Upcycling and the Circular Economy" by Costa Rican expert Christopher Brosse, which proposes that eco-friendly products and lifestyles are multiplying, but without a comprehensive strategy or vision, efforts fall short. Upcycling is a hallmark, a technique, and a process within the Circular Economy. According to [26], considering upcycling as a design strategy can help solve environmental problems, specifically in waste management. Dr. Kyungeun [27] defines it as a process in which waste materials are converted into something of greater value and/or quality in their second life. Meanwhile, [28] points out that upcycling can encourage sensitivity to design ethics by bringing up the topic of waste, reuse, and reinvention of materials; and at the same time, raise awareness about the importance of recycling. [29] mentions that design is considered largely responsible for the environmental impact of existing goods, which points to opportunities for implementing significant changes.

Textile Recycling: Textile recycling is a very viable option for used, new, clearance, or out-of-season clothing, as well as textile waste. In each case, savings are achieved to a greater or lesser extent. The savings stem from not manufacturing or sowing the fiber. It also avoids the expenditure of resources, including water and energy, in the manufacturing of yarn, fabric, fabric finishing, manufacturing, and final processes. This reduces the water and carbon footprint per garment, taking into account the footprint left by the production process of each garment. This option is sometimes not possible due to the quality of the garment and fabric, which in recent years have been designed for use of about 12 washes or for a short period of time, which has been termed Fast Fashion. These types of products are designed to be discarded. For the system to work, consumer participation through the recovery, reuse, and recycling of waste is vital. Academic efforts to revolutionize textile recycling: Towards a Sustainable Future have been taking place from different perspectives, and for some years now, the Using Used Project from Colombia [30]

Textile recycling clothing project through upcycling [31]

Clothing recycling campaign on Instagram as a social responsibility program for a digital marketing agency from Peru in 2021 [32].

Fast Fashion: Fast fashion is a brand category that satisfies consumers with low prices, trends, and frequent merchandise turnover. At the same time, these brands face numerous problems in the manufacturing and distribution process, including human rights violations, low wages, and environmental pollution. [33] These types of products enjoy consumer preference due to their price and design. However, the consequences of this type of production are worrying, as they exacerbate environmental crises, cause social problems, and worsen the crisis in the textile sector in the region where they are established. For this reason, fast fashion brands are often considered the antithesis of sustainable fashion. [34] Consumers sometimes perceive the sustainable fashion of fast fashion brands as greenwashing. Greenwashing refers to the act of deceiving consumers about a company's environmental practices or the environmental benefits of its products or services. [35] Fast fashion and textile brands must commit to real sustainable actions, not all brands manage to demonstrate their actions, advertising campaigns and ecological labels are not enough, the real change is in the proper use of raw materials used, the management of resources such as energy and water, saving in production processes as well as the working conditions of their employees because the idea of little commitment still persists as mentioned in their study [36] Since fast fashion is often considered the opposite of sustainable fashion.

Sustainable Fashion and Functional Design: Sustainable fashion categories include fashion made with recycled materials, vintage fashion, fashion made with organic materials, animal-friendly fashion, artisanal fashion, tailored fashion, locally produced fashion, and fair trade fashion [37]. The commitment to sustainable production has reached every sector of the textile industry, which is why, as mentioned in the Fashion Industry Charter for Climate Action (FICCA), fashion industry stakeholders (companies and designers) established this new Charter. This new Charter includes the goal of achieving a carbon-neutral economy by 2050 and reducing emissions by 30% by 2030, thus promoting sustainable activities [38]. After recognizing the consequences of the textile industry in the world due to the lack of sustainability in its processes and decision making, there is an imminent need for new models where the use, functional and sustainable design are favored as mentioned [39] "It is knowing on the one hand what does not work, but also what has worked for them..."

methodology

The STEAM methodology fosters the development of projects in a different and innovative way to develop talent in its multiple aspects. It not only builds knowledge but also develops technological, scientific, and socio-emotional skills in students. The STEAM methodology promotes transdisciplinary creativity, achieved in collaborative work groups that create innovative solutions. Out of concern for increasing the number of students enrolled in science careers [40], the National Science Foundation created the STEAM program to promote the study of science and guarantee the development of new professionals who solve and create innovative solutions. This methodology develops STEM skills, which means having skills in science and technology, among other skills, as well as the knowledge of the different disciplines required to achieve new solutions. [41] STEAM fosters soft skills that will allow individuals to interact appropriately, form teams, self-direct, regulate, and manage their knowledge. [42] STEAM fosters the development of critical thinking and develops or strengthens the required job skills: the research process, diagnosis and proposal of solutions, work methodology, goal definition, prevention, conflict resolution, team management, and activity coordination.

STEAM is the acronym that corresponds to the acronyms S - Science - Technology, E - Engineering, A - Arts, and M - Mathematics. This methodology proposes, through established roles, the collaborative development of a project with scenarios similar to those experienced in the workplace.

Other disciplines have been present, such as [43] mentions the natural sciences, and technology has also been integrated into engineering, which is part of the technology dedicated to the production of artifacts. Thus, the integration of art gained importance to bring harmony to what is designed and foster creativity, making the incorporation of art essential. [44] This inclusion is a commitment to highlighting the importance of artistic training and developing creative skills, opening up innovation to the fourth industrial revolution by promoting an area that plays a fundamental role in the scientific field. [45] STEAM represents an opportunity to apply knowledge of advanced technologies and the ability to use the transversality of subjects. [46] STEAM as a methodology aims to develop sustainable innovative solutions, aiming to contribute to the UN's Sustainable Development Goals (SDGs). [11] STEAM is the methodology that favors sustainable innovative solutions through the construction of new knowledge, as well as for the development of multiple skills. STEAM incorporates PBL. Project-based learning are active strategies that seek the integration of the necessary knowledge to generate a solution from a project, as mentioned [47]. Project-based Methodology is a central strategy in STEAM education, since through it the key concepts of the associated disciplines are valued within the framework of a problematizing situation. PBL provides the ordered steps to follow within an investigation, which supports the endless knowledge that is gathered in the transdiscipline of STEAM. Fig. 2 is shown below. STEAM-PBL Methodology [48]

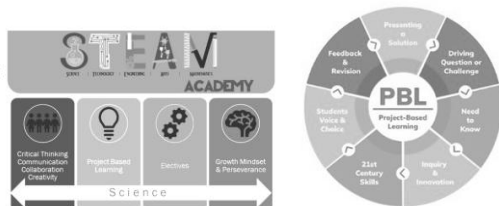


Fig. 2. Methodology STEAM + PBL

Source: own elaboration

STEAM+ H: In recent years, the need to include the social and human aspect in innovations has become very evident. Major innovations are developed without considering the social and historical context. This causes projects to fail when implemented or to face opposition and even create social problems that did not exist before. Therefore, the integration of the Humanities became imminent, giving space to the humanistic disciplines that enrich solutions. The need to return to the Human aspect is proposed. STEAM+H experiences.

STEAM+H is recognized as the integration of the Humanities to enrich projects and the development of innovations. The added H represents disciplines such as History, Sociology, Literature, Psychology, Communication, Anthropology, Economics, Philosophy, Music, Linguistics, etc., which were already present in most projects but were not named. This also promotes the integration of the Humanities, which contribute to the projects and can guarantee better results for sustainable innovative solutions by considering cultural and social aspects, as well as their impacts.

Humanity depends on human beings, their formation and the development of the dimensions that make up the degree of development of Humanity, the advancement of the human being must be evident in society. As Morin mentions [49] "all truly human development must include the joint development of individual autonomy, community participation and the awareness of belonging to the human species." STEAM + H offers the possibility of designing enriching experiences for students by having the possibility of integrating humanistic subjects as mentioned [50]

DEVELOPMENT

The General Model of the Design Process at Universidad Autónoma Metropolitana – Azcapotzalco

This research takes as reference the Model the General Model of the Design Process developed at the Universidad Autónoma Metropolitana, Unidad Azcapotzalco (UAM-A). Originally articulated in Against a Dependent Design, this model proposes a theoretical and methodological framework structured in five phases. [51] Its aim is twofold: to establish what is common across design as a discipline, while at the same time recognizing the specificity of its diverse fields. Through the interrelation of knowledge, analytical tools, and practical application, the model provides designers with a roadmap for interpreting reality, structuring problems, and generating responsive solutions.

1. Definition of the Model

A model, by its very nature, serves as a guide, a reference that can be imitated, adapted, or extended. The UAM General Model of the Design Process is not merely descriptive; it is prescriptive in the best sense of the word. It outlines essential parameters for engaging in design practice while opening space for critical interpretation.

The model is articulated in three constitutive parts:

1. Field of Study and Objectives: Focused on the dynamic interaction between human beings, their natural environment, and the resources available for use.
2. Analytical Instruments: The techniques, methods, and disciplinary interconnections that enable design to transcend the boundaries of a single field of knowledge.
3. Practical Application: The translation of theoretical reflection into productive techniques, where the very nature of the problem dictates the most appropriate tools and methods.

This tripartite structure is operationalized through five successive phases—Case, Problem, Hypothesis, Project, and Realization—each of which progressively refines the information available, hierarchizes systems and subsystems, and identifies both limitations and opportunities.

2. The Five Phases of the Model

2.1 Case: At this initial stage, the design situation is introduced and justified. Objectives and parameters are established within a theoretical framework that begins to chart the path for the design process.

2.2 Problem: Here, data from previous explorations are organized and interpreted. Systems and subsystems are structured, with emphasis placed on identifying relevant patterns. The outcome is a theoretically grounded, graphically supported formulation of the design problem.

2.3 Hypothesis: The designer formulates descriptive alternatives to the identified problem. Sketching and experimentation emerge as the first tangible steps toward a solution. Modifications are expected, as this stage constitutes the preliminary blueprint for the final design.

2.4 Project: In this phase, the designer engages in direct interaction with the materialization of the idea. A full-scale prototype (1:1) is produced, grounded in professional expertise and established design methodologies. This confrontation between concept and reality often reveals adjustments—minor or significant—that refine the proposal.

2.5 Realization: The final phase marks the transition from prototype to production. Material selection, labor, manufacturing processes, and distribution channels are considered. Importantly, user validation becomes a critical feedback mechanism, ensuring that the design fulfills its intended function and resonates with its target audience.

3. Conclusion

Design is neither static nor definitive; it is a continuous process of inquiry, adaptation, and renewal. The UAM General Model of the Design Process affirms the responsibility of designers to innovate while maintaining openness to new perspectives and interdisciplinary collaboration. The ultimate aim is to ensure that design outcomes not only achieve initial objectives but also engage meaningfully with society and its users.

Below is the diagram that represents the General Design Model of the UAM-A see the Fig. 3

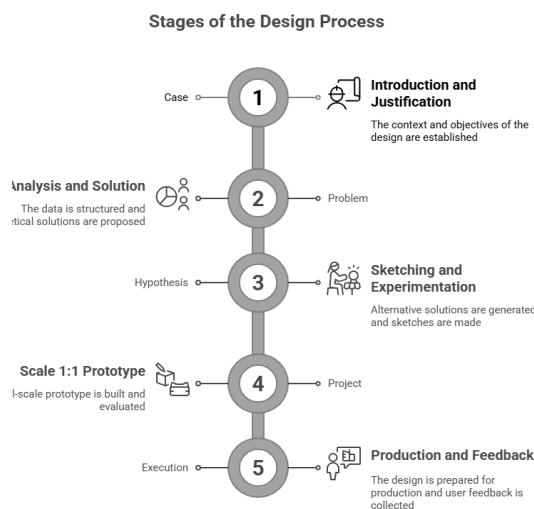


Fig. 3. Model of the Design Process at Universidad Autónoma Metropolitana – Azcapotzalco

Source: own elaboration

The General Model of the Design Process Applied to the Upcycling Project at UAM-A

Description

The Upcycling project is described below: development of the, carried out within the Bachelor’s Degree in Industrial Design at Universidad Autónoma Metropolitana, Azcapotzalco (UAM-A). Over the course of two academic periods —organized by quarters and involving two Learning Units (UEA): Structuring III and Product Development III— the General Model of the Design Process (UAM) was applied to investigate, define, and materialize a design hypothesis related to textile surplus. The central hypothesis proposed the reuse of discarded textiles, transforming them into new garments without chemical processes, directly through design, cutting, and sewing, thereby eliminating the need for new raw materials. The result was translated into innovative, sustainable, and socially relevant proposals, presented in an academic fashion show as the culmination of the project.

Keywords: industrial design, upcycling, UAM model, sustainability, social innovation.

1. Introduction

Contemporary design faces global challenges such as climate change, industrial overproduction, and labor exploitation within mass-consumption chains. In this context, methodologies that link design practice with sustainable, socially impactful solutions become indispensable.

The General Model of the Design Process at UAM-A, developed through the work Against a Dependent Design, constitutes a methodological framework structured into five phases (Case, Problem, Hypothesis, Project, and Realization), enabling the integration of research, creativity, and practical application.

The Upcycling project was conceived as an academic exercise within the Learning Units Structuring III and Product Development III, where students were engaged in identifying global issues and generating feasible, real-world solutions.

2. Theoretical Framework

The UAM model is articulated through three core dimensions:

Field of Study and Objectives – examining the relationship between human beings, their environment, and the resources at their disposal.

Analytical Instruments – techniques and methodologies that enable interdisciplinary integration.

Practical Application – the transformation of a detected problem into a tangible, applicable solution.

These dimensions are deployed through five methodological phases, each of which allows information to be structured, hypotheses to be formulated, prototypes to be developed, and results to be validated.

3. Methodology

3.1 Academic Planning

Duration: two academic quarters.

Learning Units involved:

Structuring III: identification, analysis, and resolution of global challenges.

Product Development III: idea generation, sketching, and prototyping.

3.2 Application of the Model’s Phases

Case: investigation into the problem of textile overproduction and its environmental impact.

Problem: analysis of the clothing production and consumption cycle, identifying disadvantages at each stage.

Hypothesis: reuse of textile surplus without chemical processes, transforming it into sustainable new garments.

Project: creative dynamics (brainstorming, mental agility exercises) and the production of 50 sketches per student, filtering the most viable ideas.

Realization: fabrication of final prototypes, presented in an academic fashion show.

4. Project Development

The project focused on the collection, cleaning, decomposition, and reuse of garments.

Operational functions: creation of functional products without increasing costs.

Expressive functions: highlighting the potential of discarded materials, protesting against fast fashion, and promoting individual identity.

Practical functions: ensuring comfort and protection while preserving useful non-textile elements (zippers, buttons).

Productive functions: avoiding the use of fast-fashion materials and optimizing processes.

Ecological functions: reducing textile waste, extending the life cycle of materials, and preventing unnecessary extraction of new raw resources.

5. Results: The results materialized in collections of garments that were innovative, sustainable, and aesthetically and symbolically valuable, presented in an academic fashion show (documented on video). Each prototype demonstrated the convergence of creativity, methodological rigor, and sustainability into socially impactful solutions.

6. Project Conclusions : The Upcycling project confirms that the UAM-A methodology fosters not only critical learning but also the generation of proposals with ethical and productive viability. Looking ahead, this academic exercise opens the possibility of developing a business model based on the reuse of textile surplus, with potential for collaboration between designers, local brands, and manufacturers. In this way, design is reaffirmed as a field of permanent dialogue between innovation, sustainability, and social responsibility.

The Project: Upcycling — Requirements and Scope

The Upcycling project is based on the collection, purification, decomposition, and reuse of garments to create new products. This approach seeks to transform previously discarded textile elements into functional, aesthetically appealing items with a strong social and environmental message. Operational Functions: The core of the project lies in the creation of products by reconfiguring original garment elements. These new items must meet personal needs without hindering the user’s experience due to their shape or composition. Furthermore, their production must not entail a higher cost than manufacturing a new garment, thus ensuring economic viability. On an expressive level, the project aims to raise awareness about responsible consumption by highlighting the value and potential of garments previously considered unusable. This translates into a reduction in the purchase of clothing designed under planned obsolescence criteria, fostering a culture of reuse. The differentiating factor will be that the products generated from this process will offer a diversification of styles, contributing to the sense of identity of those who wear them. Likewise, a component of symbolic protest against the consumerist-capitalist model will be integrated, rejecting interventions on garments from brands that lack social responsibility and prioritizing affordability without sacrificing visual appeal.

Below is the diagram of the project’s Requirements Matrix (see Fig. 4).

Requirements Matrix
Project: Upcycling Textiles — Reuse of Surplus Materials for New Garments
 The project seeks to reduce the environmental impact of the textile industry by directly transforming surplus textiles into new garments, without relying on chemical processes or additional raw materials. The initiative emphasizes collaboration with local brands and large-scale manufacturers that currently lack surplus management agreements, thereby promoting a circular economy model and sustainable production practices.

User Requirements	Functional Requirements	Non-Functional Requirements	Validation
<ul style="list-style-type: none"> Needs Access to low-cost garments with aesthetic value. Personal identity expressed through unique styles. Expectation of comfortable, functional, and upcycled products. Desire for visual and symbolic appeal, including a form of protest against fast fashion. 	<p>Operational Functions</p> <ul style="list-style-type: none"> Reconfiguration of textiles without chemical processes. Development of products that meet personal use and functional needs. <p>Expressive Functions</p> <ul style="list-style-type: none"> Emphasizing the value of material reuse as a central design principle. Reducing consumer dependence on purchases driven by programmed obsolescence. 	<p>Aesthetic</p> <ul style="list-style-type: none"> Diversification of styles, integrating ornamental value and strong visual appeal. <p>Ergonomic</p> <ul style="list-style-type: none"> Comfortable design that provides protection and enhances the user’s overall experience. <p>Sustainability</p> <ul style="list-style-type: none"> Exclusion of fast fashion materials to ensure ethical coherence. Energy savings through efficient processes of separation and production. 	<p>User Testing</p> <ul style="list-style-type: none"> Systematic evaluation of comfort, aesthetics, and usability through direct interaction with end-users, ensuring alignment between design intentions and user expectations. <p>Technical Reviews</p> <ul style="list-style-type: none"> Analysis of production costs and material durability, assessing the economic feasibility and long-term resistance of the proposed products. <p>Prototypes</p> <ul style="list-style-type: none"> Development of pilot pieces created from surplus textiles, serving as experimental artifacts to validate design hypotheses before large-scale implementation.

Fig. 4 Requirements Matrix. Source: own elaboration

This project has practical functions. In other words, in addition to their aesthetic value, the resulting items must fulfill practical functions such as protecting and providing comfort to the wearer. In the case of garments or objects with non-textile elements—such as buttons, zippers, or decorative accessories—these will not be removed if they provide ornamental value, thus allowing savings in the component separation process and maintaining the essence of the original object. Economic and productive functions. From a productive perspective, the use of materials from brands associated with fast fashion will be avoided, ensuring that the value chain is free of practices that encourage excessive consumption and labor exploitation. This not only strengthens the project's ethical coherence but also contributes to optimizing resources during manufacturing. The ecological functions of the project reduce the generation of textile waste and utilize existing resources, thus reducing the environmental footprint. The reuse of components and materials becomes a fundamental axis for extending the useful life of products and avoiding the unnecessary exploitation of new raw materials. The Project Functions diagram is shown below (see Fig. 5).

Spectrum of functions of recycled products, from the basic to the symbolic



Fig. 5 Project's functions. Source: own elaboration

RESULT

The Upcycling project, developed within the Bachelor's Degree in Industrial Design at the Autonomous Metropolitan University, Azcapotzalco Unit (UAM-A), demonstrates the relevance and validity of the General Model of the Design Process (UAM) as a methodological tool, in conjunction with the STEAM-PBL Methodology, that allows for the articulation of design thinking with contemporary social and environmental demands. The proposed hypothesis—reusing surplus textiles and transforming them into new garments without resorting to chemical processes or new raw materials—was not only an academic exercise, but also an essay in ethical responsibility regarding consumption and production. The methodology applied in the Teaching-Learning Units Structuring III and Product Development III resulted in an orderly process that ranged from research to the materialization of prototypes. This process, using STEAM-PBL, allowed students to understand design not only as a discipline for generating objects, but also as a field of critical reflection capable of addressing real-world problems. Specifically, in the Design Area, the sequential logic of the General Model of the Design Process, applied in this context, demonstrated its ability to unleash creativity without neglecting rigor in the formulation and validation of solutions. The results, presented in the academic fashion show documented in the video, showcase not only the students' creativity but also the viability of an alternative textile production model based on reuse. Each garment constitutes a manifesto in favor of sustainability and social innovation: these proposals maintain a balance between the aesthetic, the functional, and the symbolic, demonstrating that design can simultaneously be a poetic exercise and a pragmatic response. From a teaching perspective, this project makes it clear that the classroom is a privileged space to test possible transformations in reality, achieving the Textile Recycling Revolution: Towards a Sustainable Future. Below are the results of the Design Interrelationship. (see Fig. 6).

Development of the UAM Design Model

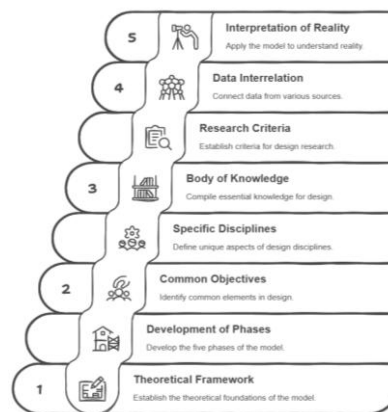


Fig. 6 Interrelationship of Design. Source: own elaboration

In order to understand the Upcycling process in a general way, the diagram is presented, see figure 7 below.

Garment Upcycling Cycle

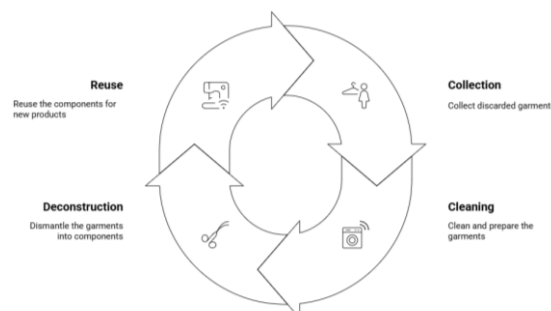


Fig. 7 Garment Upcycling Cycle . Source: own elaboration

As part of the development of the STEAM and Textile Recycling project, some stages of the process are presented, such as the sketches where the products made from the collected used garments are captured, see figure 8 below.

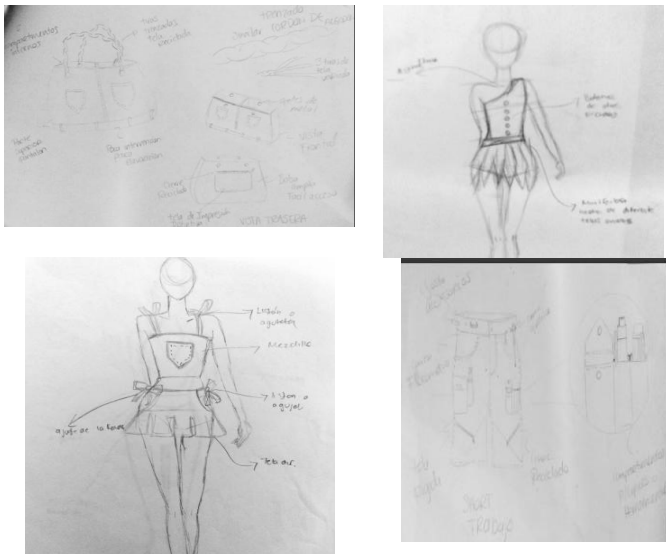


Fig. 8 Sketches of designed products Upcycling Cycle. Source: own elaboration

Below are the garments obtained from the Upcycling project, which are evidence of the achievement of the STEAM+ ABP application, creating sustainable products, see figure 9 below

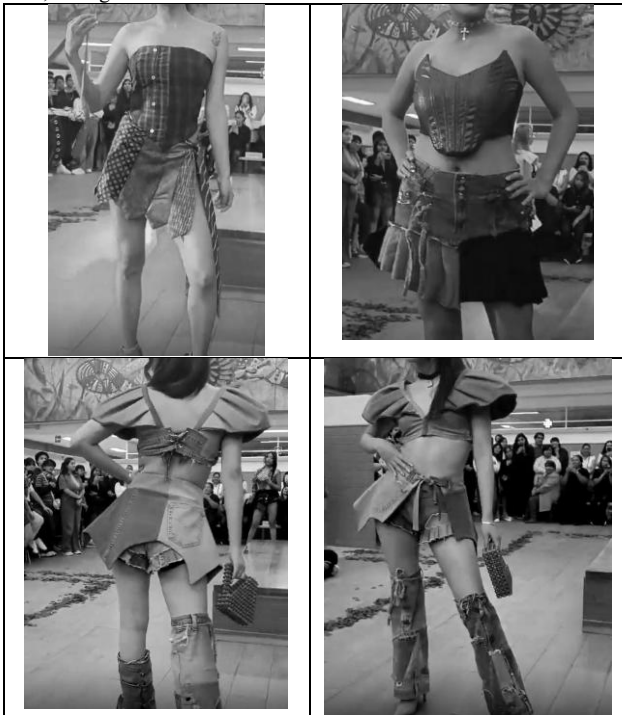


Fig. 9 The garments obtained from the Upcycling project

Conclusion

Textile recycling through the STEAM methodology, with the implementation of upcycling, was not merely a tailoring exercise or a creative display, but a test of the future: a practice that invites us to consider how the discipline of industrial design can reconfigure production chains, promote circular models, and establish links between academia, industry, and society. Looking to the future, the experience opens up the possibility of articulating a business model based on the reuse of surplus textiles, bringing together designers, local brands, and manufacturers committed to reducing environmental impact. The project thus confirms that design education at UAM-A is not limited to the transmission of technical knowledge, but rather promotes critical and situated learning, in which ethics, innovation, and sustainability are not incidental dimensions but constitutive of the design process. In short, Upcycling reaffirms that industrial design, under the umbrella of the UAM General Model of the Design Process, is configured as a field in constant dialogue between the human and the technical, between creativity and responsibility, between necessity and utopia. It is in this intermediate space that design finds its true meaning: as a driver of change and reflection in a world urgently seeking new ways of creating, producing, and inhabiting.

The results of this project are valuable. They show how educational centers are able to incentivize and influence lifestyles, as well as train students as sustainably conscious citizens and professionals. It also confirms that collaborative work is an option for successfully influencing sustainable actions, as mentioned [1] by collective efficacy, with the aim of strengthening the capacity and willingness of individuals and communities to achieve significant and urgent changes that contribute to avoiding the worst possible scenarios of the climate crisis.

Textile recycling through the STEAM methodology fulfilled the purpose of designing innovative and sustainable proposals to contribute to reducing climate change, as well as Sustainable Development Goal 6 (SDG 6) for Clean Water and Sanitation, in addition to contributing to SDG 13 Climate Actions, and contributing to SDG 12. Responsible for Production and Consumption. It is shown that STEAM+ H through the transdisciplinarity of science contributes to the creation of sustainable solutions as well as developing cognitive, digital, socio-emotional skills. It also develops the much-requested Critical Thinking as well as for the generation of awareness to improve in the field of Sustainability and in this case especially to improve SDG 4 of Quality Education also in Education for Sustainable Development EDS. This is how I pay for the creation of the educational campaign that complies with the generation of awareness.

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