“Zero waste” – current and essential concept in the fashion industry

DOI: 10.35530/IT.076.03.2024132

ELENA FLOREA-BURDUJA
LILIANA INDRIE
ALIONA RARU
MARCELA IROVAN
VALENTINA FRUNZE
AMALIA STURZA

ABSTRACT – REZUMAT

“Zero waste” – current and essential concept in the fashion industry

This article analyses the concept of “Zero Waste” in the fashion industry and highlights its current character and the need for its implementation. The aim of the paper is to examine the various strategies and benefits associated with adopting zero waste practices in the fashion sector in order to minimize the negative impact on the environment. The idea’s relevance is driven by growing global concerns about pollution and climate change, with the fashion industry considered one of the most polluting industries in the world. The main aim of the paper is to highlight the importance of adopting sustainable and innovative practices that will significantly reduce textile waste and promote a circular economy in this sector. The aim of the study process is to identify and analyse effective methods for implementing zero waste principles and to highlight the role of consumer education in maintaining these practices. As part of the research, concrete examples of designers and collections are presented that have successfully adopted these principles and demonstrate their feasibility as well as economic and ecological advantages. The information obtained as a result of the study process highlights the need for close collaboration between all stakeholders in the fashion industry to transform the way clothing is produced and consumed. The practical applications carried out by the authors demonstrate the possibility of obtaining models of current garments by applying modern design techniques using CLO 3D software. It highlights the fact that by applying innovative design and production practices, the fashion industry can become a model of sustainability, contributing to a more ecological and responsible future.

Keywords: *zero waste design, sustainability, sustainable processes in fashion, 3D prototyping, CLO 3D*

„Zero deșeuri” – concept actual și esențial în industria modei

Acest articol analizează conceptul de „zero deșeuri” în industria modei și evidențiază caracterul său actual, precum și necesitatea implementării acestuia. Scopul lucrării este de a examina diversele strategii și beneficiile asociate adoptării practicilor „zero deșeuri” în sectorul modei, în vederea minimizării impactului negativ asupra mediului. Relevanța acestei idei este determinată de îngrijorările globale tot mai accentuate cu privire la poluare și schimbările climatice, industria modei fiind considerată una dintre cele mai poluante industrii din lume.
Obiectivul principal al lucrării este de a evidenția importanța adoptării unor practici sustenabile și inovatoare care să reducă semnificativ deșeurile textile și să promoveze economia circulară în acest sector. Studiul urmărește identificarea și analiza unor metode eficiente de implementare a principiilor „zero deșeuri”, subliniind totodată rolul educației consumatorilor în implementarea acestor practici.
În cadrul cercetării sunt prezentate exemple concrete de designeri și colecții care au adoptat cu succes aceste principii, demonstrând fezabilitatea acestora, precum și avantajele economice și ecologice. Informațiile obținute în urma studiului evidențiază necesitatea unei colaborări strânse între toți actorii implicați în industria modei pentru a transforma modul în care sunt realizate producția și consumul de articolele vestimentare.
Aplicațiile practice realizate de autori demonstrează posibilitatea obținerii unor modele vestimentare actuale prin aplicarea tehnicilor moderne de design, utilizând CLO 3D. Se evidențiază faptul că, prin aplicarea unor practici inovatoare de proiectare și producție, industria modei poate deveni un model de sustenabilitate, contribuind la un viitor mai ecologic și responsabil.

Cuvinte-cheie: *industria modei, sustenabilitate, design „zero deșeuri, prototipare 3D, CLO 3D*

INTRODUCTION

The fashion industry, characterized by the rapid pace of change and excessive consumption, is recognized as one of the most polluting industries in the world. The large amount of toxic waste, including clothes that are not recycled or reused, ends up in landfills where they break down slowly, releasing microfibers and greenhouse gases. Fast fashion worsens this issue by driving rapid production and impulsive consumer behaviour, leading to more discarded items. In this context, the concept of sustainability in fashion refers to the adoption of practices that minimize this negative impact, encouraging responsible production, conscious consumption and efficient use of resources [1].

The concept of “zero waste” comes as one of the solutions to reduce the negative impact of the fashion industry by minimizing waste and optimizing the use of resources [2]. According to a report by the Ellen

MacArthur Foundation, if fashion industry adopted the principles of a circular industry, including zero waste, greenhouse gas emissions would be reduced by up to 44% [3]. Optimising patterns so that there is no leftover, using recycled materials and extending the life cycle of products through repairs and reuse are some tangible solutions. These strategies not only protect the environment, but also reduce costs and educate both producers and consumers to adopt a more responsible and sustainable behaviour.

GENERAL ASPECTS REGARDING THE APPLICATION OF "ZERO WASTE" TECHNIQUES IN THE FASHION INDUSTRY

Today's waste problems in the fashion industry have highlighted its ecological responsibility. From a sustainable design perspective, material conservation can be achieved by employing zero waste design methods.

By adopting "zero waste" design principles, important steps will be taken in the development of a sustainable textile industry. The benefits of this concept will become obvious when this is applied by all actors involved in the fashion industry – producers and consumers. For this purpose, it is necessary to establish the application strategies and benefits of zero waste techniques in the fashion industry.

By adopting innovative design practices, using sustainable materials, optimizing production processes and educating consumers, the fashion industry can significantly reduce its negative impact on the environment and become a model for sustainability for other industries [4].

Achieving the goal of "zero waste" in the textile industry is not an easy task, but it is highly important for a sustainable future. By adopting innovative practices, working closely with industry players and educating consumers, the way we produce and consume textiles can be transformed. The textile industry has the potential to become a model of sustainability, a responsible and ecological approach is possible and beneficial in the long term for all.

In order to obtain sustainable models, it is necessary to take into account the listed strategies and to establish the main stages of creating "zero waste" clothing items (figure 1).

By following the steps shown in figure 1, designers and manufacturers can create "zero waste" clothing designs that will not only have a beneficial impact on the environment by reducing textile waste, but will also promote sustainability and innovation in the fashion industry.

"ZERO WASTE" DESIGNERS AND METHODS

The concept of cutting clothes without generating waste is not a new technique. It is known that since ancient times clothing was made from whole pieces of material, its role being exclusively utilitarian at the beginning. The technique of creating Greek chitons and traditional Indian sari, which involves using fabric without stitches to produce draped (fabric manipulation) garments, offers a way to make clothes without wasting any material [7, 8].

In contemporary society, clothing has not only a utilitarian role, but also an aesthetic one. Hence the need to create models of clothing products of complex shapes and cuts. Designers such as Holly McQuillan, Timo Rissanen, Stella McCartney, etc. are known for the sustainable techniques applied to the creation of clothing collections. They aim to minimize waste through design methods that effectively use every piece of material. Through precise cutting techniques and the design of ingenious patterns, "zero waste" designers considerably reduce the negative impact on the environment. Instead of being thrown away, leftover materials are integrated into new creations [9], turning waste into valuable resources.

Table 1 presents the names and strategies of designers who have implemented sustainable techniques in their collections.

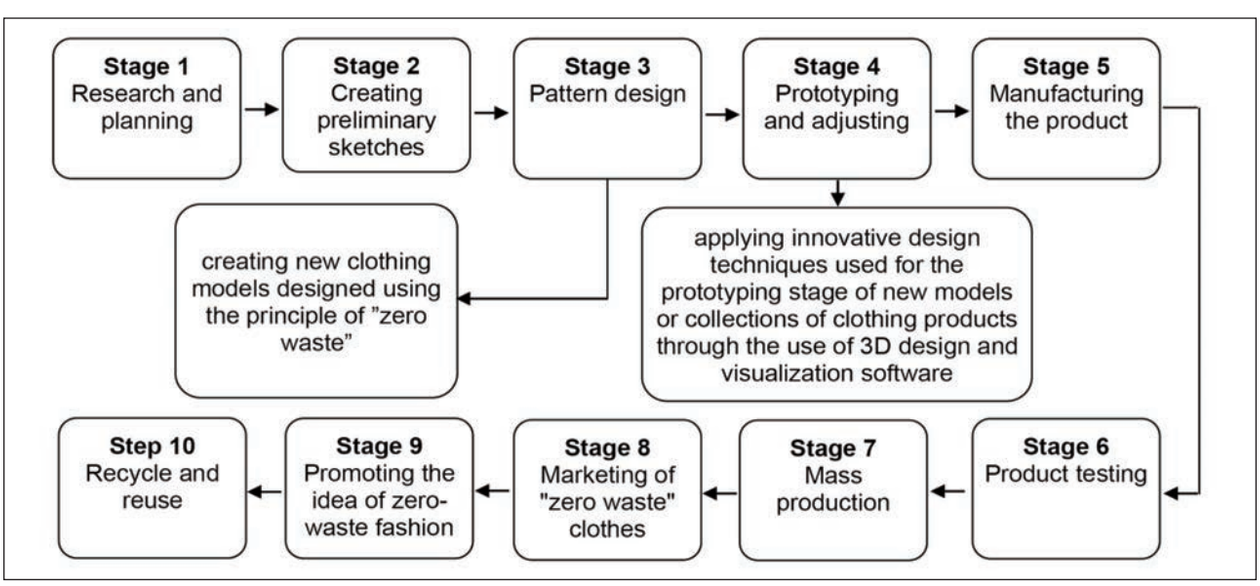


Fig. 1. The phases of the "Zero Waste" process [5, 6]

Table 1

EXAMPLES OF ZERO WASTE DESIGNERS	
Designers	**Techniques and strategies adopted**
Timo Rissanen [10]	He has dedicated his career to the research and development of design techniques that reduce material waste. His works include complex and elegant pieces created in the puzzle technique. Through methods such as cutting with efficient patterns and precise fitting of pieces, the designer proves that sustainable fashion can also be aesthetically pleasing.
Holly McQuillan [11]	It uses techniques such as cut-and-sew and digital design to create clothes that produce no material waste. It also explores the use of organic and biodegradable textiles, ensuring that each garment is sustainable throughout its life cycle.
Daniel Silverstein [12]	His brand "Zero Waste Daniel" creatively repurposes textile remnants and pre-consumer, post-production materials to craft unique garments. Amid rising worries about excessive waste and pollution in fashion, Daniel transforms textile scraps into unique and vibrant pieces of clothing. By using small pieces of fabric that would otherwise have been thrown away, they create patchwork designs that are not only sustainable, but also extremely attractive. It also promotes consumer awareness of the impact of textile waste and the importance of reusing materials.
Camilla Carrara [13]	She founded the Italian brand Zerobarracento, a brand dedicated to the production of clothing without waste. Each collection is created using zero-waste tailoring techniques and sustainable materials such as recycled wool and organic silk. Minimalist design focused on clean and timeless lines proves that sustainable fashion can be stylish and versatile.
Kit Willow [14]	She promotes ethical and sustainable fashion. She implements zero-waste techniques in its collections and uses eco-friendly materials such as organic cotton and regenerated silk. She also focuses on transparency and accountability in the supply chain, ensuring that every step of the production process is sustainable.
Charlotte Bialas [15]	Charlotte Bialas incorporates vintage textiles and utilizes zero-waste geometrical cutting techniques to significantly minimize fabric waste. Any leftover scraps are creatively repurposed into accessories like necklaces, bags, or sashes.
Bojana Draca [16]	Founder of the Farrah Floyd brand, she tackles the technique of cutting textiles into rectangles of different sizes and joining them according to the principle of a grid.

The creations of pioneering designers in the world of sustainable fashion not only reduce the impact on the environment, but also inspire other fashion designers to adopt environmentally friendly techniques.

Through their commitment to green practices, they inspire positive change in the fashion industry and encourage consumers to make more responsible choices. The contribution of both the fashion designer and the consumer serves to achieve the common global goal of having a cleaner planet where nothing goes to waste.

By creating zero-waste models, designers express their desire to minimize the negative impact of fashion on the environment. Zero-waste techniques (cutting, draping, folding) or using scrap materials focus on optimizing materials, reducing material losses in the production process, and recycling or reusing materials creatively.

"Zero waste" methods in fashion represent an innovative and sustainable approach aimed at minimizing the waste generated during the entire production cycle of a textile product [17].

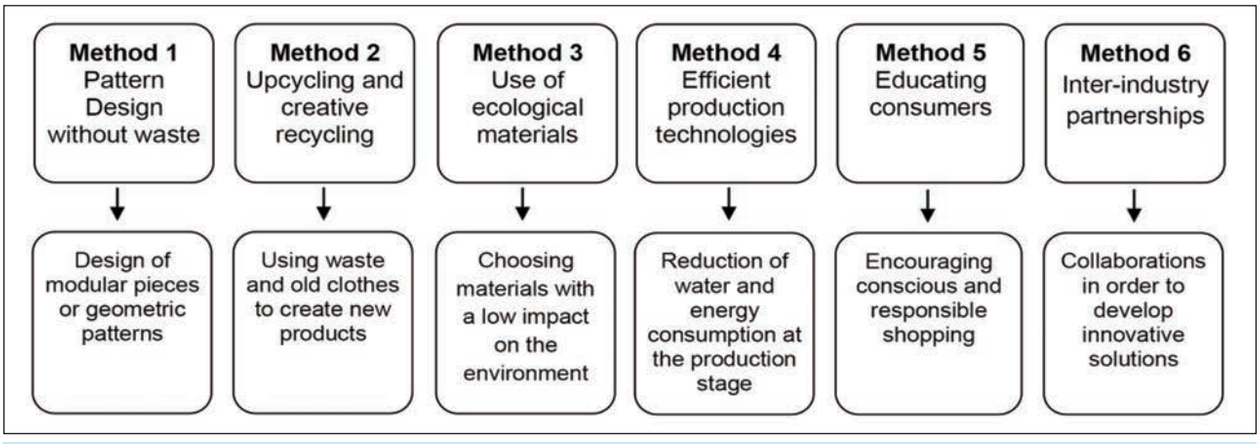


Fig. 2. "Zero waste" methods

In order to exclude some waste-generating technologies, it is necessary to adopt methods of making sustainable clothing models (figure 2).
By individually or collectively applying the methods presented in figure 2 these will contribute to the development of a durable and sustainable fashion industry.

PRACTICAL APPLICATIONS REGARDING THE CREATION OF CLOTHING USING THE "ZERO WASTE" PRINCIPLE

Zero waste fashion design advocates for the simultaneous improvement of fashion design and pattern making processes. The goal of zero waste pattern pieces is to use every inch of fabric, thus eliminating cut-and-sew waste by the end of the fashion production process.
As per [18–19], the difficulty of transforming 2D designs into 3D forms, which frequently leads to uneven results, is an obstacle to the industrial adoption of zero-waste fashion. This issue gives rise to potential application for 3D modelling software such as 'CLO', which is capable of accurately simulate the behaviour of materials in a realistic 3D garment [20]. According to McQuillan [21], implementing 3D software systems will facilitate the industry's transition to zero-waste practices. The author proposed modifying the zero-waste design process by eliminating the requirement for multiple design and pattern revisions between the initial concept and the sample through the use of 3D software.
In this part, digital resources have been used to test the pattern drafting method and simulating the end result within the 3D space. We aimed to investigate methods for eliminating textile waste in clothing production by designing three distinct zero waste fashion garments. By using the CLO 3D virtual fashion software, patterns have been both digitally and manually drafted and nested in order to minimize the waste and the garments were simulated.
It is well known that during the cutting process, a significant amount of fabric waste, ranging from 10 to 15 percent, is generated due to various factors, including marker efficiency, marker planning, and the garment's style. Garment patterns are composed of different shapes, such as curved corners and straight lines. When these patterns are laid out on a marker plan, gaps may appear, resulting in cut-and-sew waste [22].
The development of the zero waste patterns drafting technique involves creating an initial set of classic patterns that serve as the base in terms of shape and dimensions. This classic pattern set facilitates a final comparison of fabric usage and marker efficiency among the types of patterns.
In this study, the "zero waste" concept is a process that can be divided into several main stages. Figure 3 shows the component steps used by the authors to create models using this concept.
In the first stage of the process, the initial data needed to design the product collection were established. The initial data used are user and product data. There were included the values of the anthropometric dimensions of the wearer's body, body shape, product type, material type, etc. In the case of designing clothing products using the "zero waste" principle, an important aspect is the correct selection of textile materials. It is necessary that they present the same visual appearance on both the warp and the weft, so as to allow the placement of markers without taking into account certain framing standards.
The second stage included the creative process that aimed to create the models of the collection. Models can be developed by hand drawing or using various specialized software, such as Adobe Photoshop, Corel Draw, etc. In this work, the details of each model differ in both length and configuration. It was taken into account that the patterns must be designed so that the pieces of clothing fit together like a puzzle without leaving any unused spaces. Also, some markers on the front and back are identical because they can help reduce material waste through proper positioning.
In the third stage, the material was selected virtually from the software library, material similar to the real one. When choosing the virtual material, its visual and physical characteristics must be taken into account, so that they are as close as possible to those of the real material.
The fourth stage was carried out using the prototyping tools of the CLO 3D software. Designing the markers in 2D windows allows for the necessary details to be obtained that can be arranged in a manual frame. Simultaneously with this process, the model on the avatar's body can be viewed in the 3D window (figure 4).
Each model represents a different number of details. The number of details must be optimized in such a way as to allow obtaining an effective framing from the point of view of the use of materials, without negatively influencing the duration of the technological

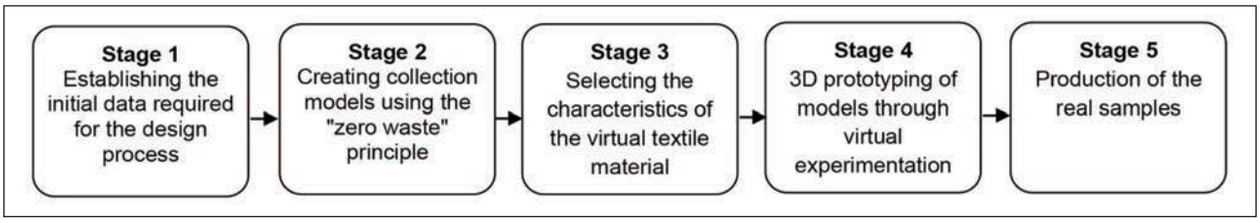


Fig. 3. The stages of the collection development process using the "zero waste" principle

Fig. 4. The models in the collection

process. Table 2 shows the components of the structure of the collection models in which their markers can be identified.

The fifth stage is the stage of actually making the collection models. The markers will be cut taking into account the manual framing, on the material selected in stage 1.

Next, it is presented the comparative analysis of the framing done manually and automatically of the collection models (table 3).

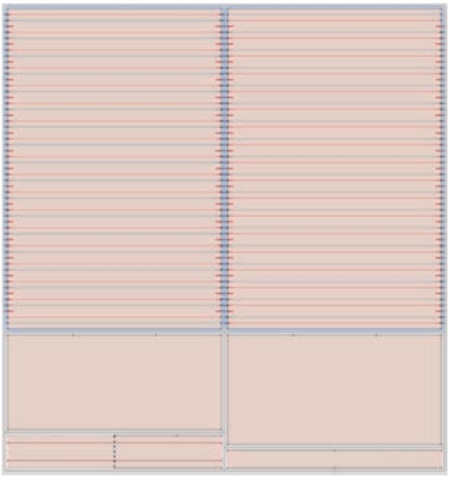
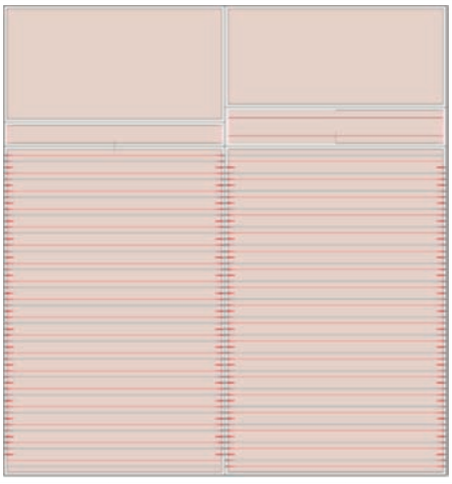
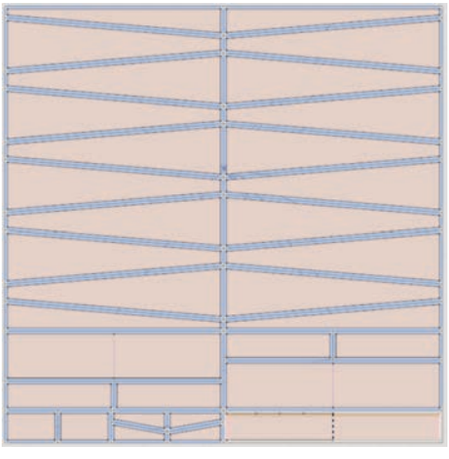
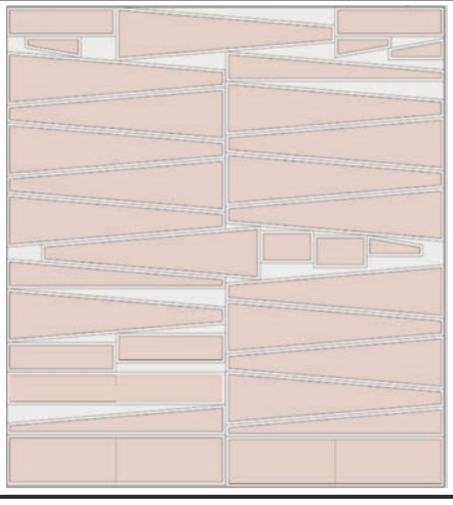
Considering the analysis of the models made in the practical part of this paper, it can be noticed:

1. 100% efficiency in the case of manual framing according to the puzzle principle. This aspect helps us save textile materials and respectively reduce the negative impact on the environment, but it will lead to increasing the time needed for creating the models and making the frames.
2. Automatic framing shows very good results in the case of rectangular markers (efficiency 100% – model 1), but in the case of markers of complex

Table 2

THE COMPONENTS OF THE COLLECTION MODEL STRUCTURE			
No./ The analysed criterion	**Model 1**	**Model 2**	**Model 3**
Representation of front elements			
Representation of back elements			
The number of elements	6	7	33

Table 3

FRAMING THE MODEL PARTS						
No./ The analysed criterion	**Manual framing**			**Automated framing**		
	Framing area, m²	**Maximum efficiency of the framing, %**	**Framing wastes, %**	**Framing area, m²**	**Maximum efficiency of the framing, %**	**Framing wastes, %**
1	**2**	**3**	**4**	**5**	**6**	**7**
Model 1	2.3236	100	0	2.3236	100	0
						
Model 2	1.6280	100	0	1.7212	86.18	13.82
						
Model 3	2.1909	100	0	2.4006	72.48	27.52
						

shape, the waste surface increases (efficiency 86.18% – model 2, efficiency 72.48% – model 3).

3. In the case of markers of more complex shapes, it is recommended to make additional divisions, but not to complicate the technological process extensively.
4. When making models by applying pattern design principles so that all textile surfaces are used, it is recommended to keep into account the specific attributes of the chosen fabric, including its usability and printed designs.

5. The examples of the models created in this work prove that it is possible to create modern clothing without waste, in addition, the use of CLO 3D design software excludes the consumption of textile materials during the prototyping stages.

CONCLUSIONS

The application of the "zero waste" concept in the fashion industry is not just a transitory trend, but a necessity in the context of the current ecological challenges. By reducing waste and using resources responsibly, the fashion industry will contribute significantly to reducing the negative impact on the environment. This approach meets the demands of consumers aware of the importance of sustainability and offers economic opportunities by optimizing resources and reducing production costs.

The studies and examples presented in this paper demonstrate that the application of the "zero waste" concept can significantly reduce textile waste. Through the collaboration between designers, producers and consumers, and by the use of advanced technologies, the fashion industry can achieve the goal of "zero waste", becoming a model of sustainability for other sectors.

Further research directions will be considered:

- the development of the model collection according to the established principles and its actual production;
- the development of new projection methods based on the "Zero Waste" principle;
- the development of collections using the modular method.

ACKNOLEDGEMENTS

This research was funded by the University of Oradea within the framework of the grant's competition "Scientific Research of Excellence Related to Priority Areas with Capitalization through Technology Transfer: INO-TRANSFER-UO-2nd Edition" projects no. 232/2022.

REFERENCES

[1] MClennan, J.F., The Philosophy of the Sustainable Design, Ecotone Design Publishing Company, Canada, 2004

[2] Gupta, L., Saini, H.K., *Achieving Sustainability through Zero Waste Fashion-A Review*, In: Curr World Environ, 2020, 15, 2, http://dx.doi.org/10.12944/CWE.15.2.02

[3] Ellen MacArthur Foundation, *Fashion and the circular economy – deep dive*, Available at: https://www.ellen macarthurfoundation.org/fashion-and-the-circular-economy-deep-dive [Accessed on June 1, 2024]

[4] Zlatev, Z., Ilieva, J., *Automated recognition and sorting of recycled textiles for sustainable fashion,* In: Communications in Development and Assembling of Textile Products, 2021, 2, 2, ISSN 2701-939X, 151–161

[5] Olaru, S., Popescu, G., Anastasiu, A., Mihăilă, G., Sălișteanu, A., *Innovative concept for personalized pattern design of safety equipment*, In: Industria Textila, 2020, 71, 1, 50–54, http://doi.org/10.35530/IT.071.01.1620

[6] Avadanei, M., Curteza, A., Dulgheriu, I., Dorin, S.-I., Viziteu, D., Loghin, E.-C., *A digital-integrated solution for a customised 3D design process of garments*, In: Industria Textila, 2022, 73, 3, 333–338, http://doi.org/10.35530/IT.073.03.202171

[7] Enes, E., Saygili, B.B., *Zero waste and modular fashion design: a suggested collection*, In: Tekstil ve Mühendis, 2023, 30, 131, 180–191

[8] Harjani, C., *Fashion Creativity in Zero-Waste Pattern Making*, In: Advances in 2nd International Media Conference 2019 (IMC 2019), Social Science, Education and Humanities Research, 2019, 423, 60–70

[9] Indrie, L., Ilieva, J., Zlatev, Z., Tripa, S., Sturza, A., *Development of an Algorithm for Textile Waste Arrangement,* In: Sustainability, 2023, 15*,* 11399, https://doi.org/10.3390/su151411399

[10] Rissanen, T., + *textile toolbox*, Available at: https://alabamachanin.com/journal/2016/04/timo-rissanen-textile-toolbox [Accessed on July 3, 2024]

[11] McQuillan, H., *Projects*, Available at: https://hollymcquillan.com/ [Accessed on July 3, 2024]

[12] Zero waste Daniel, Available at: https://zerowastedaniel.com/pages/about [Accessed on July 3, 2024]

[13] Carrara, C., *Redress Design Award 2015/16*, Available at: https://www.redressdesignaward.com/alumni/2015-16/camilla-carrara [Accessed on July 3, 2024]

[14] Witchery-KTX, Available online: https://www.witchery.com.au/style-collective/kit-willow/ [Accessed on July 3, 2024]

[15] Bialas, C., *Sustainability*, https://www.charlottebialas.com/sustainability/ [Accessed on July 3, 2024]

[16] Gabardi, S., *Zero Waste Designers Who Are Just Killing It*, Eluxe Magazin, Available at: https://eluxemagazine.com/fashion/zero-waste-designers/ [Accessed on July 3, 2024]

[17] Marin, I.-E., Bocancea, V., Loghin, M.C., *Developing a zero-waste pattern drafting method suitable for mass production*, In: Industria Textila, 2024, 75, 2, 171–176, http://doi.org/10.35530/IT.075.02.202344

[18] McQuillan, H., *Hybrid zero waste design practices. Zero waste pattern cutting for composite garment weaving and its implications*, In: Design Journal, 2019, 22, 803–819, http://doi.org/10.1080/14606925.2019.161309

[19] Saeidi, E., Wimberley, V.S., *Precious cut: Exploring creative pattern cutting and draping for zero-waste design,* In: International Journal of Fashion Design, Technology and Education, 2018, 11, 2, 243–253, https://doi.org/10.1080/17543266.2017.1389997

[20] Irovan, M., Indrie, L., Frunze, V., Florea-Burduja, E., Raru, A., *Digital methods in the development of adaptive clothing for people with disabilities*, In: Industria Textila, 2023, 74, 1, 28–34, http://doi.org/10.35530/IT.074.01.202295

[21] McQuillan, H., *Digital 3D design as a tool for augmenting zero-waste fashion design practice*, In: International Journal of Fashion Design, Technology and Education, 2020, 13, 1, 89–100, https://doi.org/10.1080/17543266.2020.1737248

[22] Aus, R., Moora, H., Vihma, M., Unt, R., Kiisa, M., Kapur, S., *Designing for Circular Fashion: Integrating Upcycling into Conventional Garment Manufacturing Processes*, In: Fash. Text., 2021, 8, 34

Authors:

ELENA FLOREA-BURDUJA[1], LILIANA INDRIE[2], ALIONA RARU[1], MARCELA IROVAN[1], VALENTINA FRUNZE[1], AMALIA STURZA[3]

[1]Technical University of Moldova, Faculty of Design, Department of Design and Technology in Textiles, Sergiu Radautan Str., no. 4, Chisinau MD-2019, Republic of Moldova
e-mail: elena.florea@dtt.utm.md, aliona.raru@dtt.utm.md, marcela.irovan@dtt.utm.md, valentina.frunze@mtctp.utm.md

[2]University of Oradea, Faculty of Energy Engineering and Industrial Management, Department of Textiles, Leather and Industrial Management, Universității Str., no. 1, 410087, Oradea, Romania

[3]University of Oradea, Faculty of Construction, Cadastre and Architecture, B. Șt. Delavrancea str. No. 4, 410058 Oradea, Romania
e-mail: asturza@uoradea.ro

Corresponding author:

LILIANA INDRIE
e-mail: lindrie@uoradea.ro