INNOVATIVE TOOL FOR THE CIRCULAR DESIGN OF TECHNICAL TEXTILES

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Our planet is going through political, economic, social and ecological crisis, which are constantly feeding each other. Human activities driven by a rapidly growing global population, unsustainable economic growth, technological innovations, but also inappropriate production practices and consumption models- create increasing pressures on ecosystems and natural resources. Neither the social nor the ecological crisis can't be overpassed without changing the way of our economic system works and which involves the manner how innovative transformations take place. In this context, it is mandatory to use design as a strategy consist of people to understand the basic principles of design: user orientation, empathy, mental and physical process, future orientation, visual approach, co-creativity, interconnection of complex systems, continuous testing and iteration. The circular design is an innovative tool for implementing the circular economy whose main purpose is: "to connect all material flows, integrating them in a circular process, which ensures efficient consumption of resources and minimizes the amount of resulting waste". The paper presents a practical example of using an interactive map, owned by Delft University of Technology (Netherlands), applied as a technical analysis tool, in order to determine the reuse potential of a technical product components, specifically a laptop bag for transporting personal IT equipment.

Keywords: interactive map, circular design, technical textiles

INTRODUCTION

Europe must transform its economic model from a pattern of growth such as "obtaining, manufacturing, using, disposing" - a linear model that starts from the premise that resources are abundant, available and cheap to eliminate - to a pattern that favors the reuse, repair, reconditioning and recycling of existing materials and products.

Figure 1. Linear economy versus circular economy (Weetman, 2016)

The implementation of the concept of circular economy is essential for maintaining and increasing the competitiveness of the European Union (EC, 2015), requiring the promotion of political and legal measures to support the recycling and reuse of waste in productive processes (EC, 2010). The estimated impact of the implementation of the circular economy at European level will be manifested simultaneously on four levels (Rizos *et al.*, 2017; EEA, 2016):

- in economic terms, by increasing competitiveness, supporting innovative initiatives;
- social, through integration and social cohesion, increasing the quality of life, mutations of consumer behavior, creating new jobs;
- environment, by reducing the negative and irreversible effects on the climate and the environment;
- efficient use of resources, reducing the dependence of the European economy on imports of raw materials.

Increasing resource efficiency is based on six key concepts: circular economy, waste hierarchy, increasing responsibility in production, industrial symbiosis, new business models (Ecoprofit, 2014).

In the process of achieving a European circular economy, SMEs and social enterprises have been recognized as particularly important (EC, 2014). Among the barriers that can prevent the implementation of “circular” and “green” economy practices (Rizos *et al.*, 2015) can be mentioned distinct groups of barriers that refer to: organizational culture and management style, the need for financial investments for the implementation of sustainable solutions; Lack of adequate government support / legislation, lack of information, lack of internal technical skills, insufficient support from suppliers and consumers, high level of bureaucracy in monitoring and reporting data on the performance of SMEs in the field of circular economy.

Synthesizing the barriers encountered of companies in the implementation of the principles of the circular economy can be mentioned the following categories (Ritzén and Sandström, 2017): financial, structural, operational, attitudinal, technological.

The specialized literature indicates working tools that can be a support for the activity of specialists for the implementation of the concept of circular economy.

MATERIALS AND METHODS

The method used, “Hotspot Mapping” (Flipsen *et al.*, 2020), combines the disassembly of a product with the recording of all the steps necessary to reach the most critical parts of the product architecture. The method is unique in that it includes both economic and environmental value for each component. Critical parts are parts with a high failure rate or need for maintenance and / or with a high economic and environmental value, which should be easily accessible with little effort to enable efficient recovery processes. The ease of disassembly of a product is determined by factors that help or prevent the disconnection of critical parts from the rest of the product. A component part of a product with a high economic value or an impact on the built-in environment should be easily accessible for recycling loops. There are five indicators: the time required to disconnect the components, the difficulty of access, the priority elements, the impact on the environment and the economically valuable parts, which show the criticality of the part or activity involved.

The object of study was a product from the group of technical textiles, respectively a bag made mainly of textile elements, a product that may be a distinct element of a system of work equipment for various fields of use.

In order to detect the critical parts and the difficult activities involved, all the stages were recorded and aspects related to the functionality and wear rate of the components and the composition of the material were identified.

Steps:

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- Disassembly of the product without damaging the component parts;
- Completing the calculation sheet to identify the component parts after disassembly;
- Optionally, a product redesign can be made for greater disassembly ease.

RESULTS

The component parts and the activities undertaken for the disassembly of the product were identified respectively: the time to disassemble a component part, the difficulty of the activity in question, the priority of the part due to failure or replacement rate, environmental impact, built-in economic value.

Figure 2. Component parts of the bag – scheme

The interactive map (Table 1), highlights each step taken in the disassembly process of the product, in the centralization of its component parts, as well as in the characterization / hierarchy according to different parameters.

From the analysis of the included data, the following aspects can be mentioned:

- the disassembly operation, registered the greatest degree of difficulty, the time necessary to undo the seams of the textile elements being longer than in the case of the other operations specific to the analysis (normal aspect considering that the object of study is a technical product).
- the structure of the product is mostly made of textile elements, which can be reused through mechanical recycling or up-cycling operations.
- the number of component elements is in correlation with the product architecture determined by the functionality requirements, as well as by the creative capacity of the specialist.
- the symbolism of the characterization indicators from an economic point of view and of the protection of the environment allows the hierarchy of the component elements.

Table 1. Interactive map - summary table

Step number	1	2	3	4	5	6	7	8	9	10	11	
General properties	Bag	Handle bag	Seams	Tapes	Zippers	Elastic tape	Velcro	Main fabric	Polystyrene parts	Inner layer	Metallic pieces	Rubber part
	Subassembly	yes	no	yes	yes	yes	yes	no	yes	no	yes	yes
	Activity	Disconnect snapjoint	Cut	Remove	Remove	Remove	Remove	Remove	Remove	Cut	Disconnect snapjoint	Disconnect snapjoint
	Required tool	Hands	Wire cutter	Screwdriver	Screwdriver	Wire cutter	Wire cutter	Wire cutter	Hands	Hands	Wire cutter	Hands
Activity properties	Tool size	-	130 mm	180 mm	130 mm	130 mm	130 mm	-	130 mm	-	-	-
	Task frequency	1	5	2	4	1	1	2	2	2	1	1
Difficulty of access	Time to disconnect (sec)	5	300	180	120	30	30	60	10	10	20	5
	Force	level 0: Light resistance	level 2: Heavy resistance	level 1: Moderate resistance	level 2: Heavy resistance	level 1: Moderate resistance	level 1: Moderate resistance	level 1: Moderate resistance	level 0: Light resistance	level 1: Moderate resistance	level 0: Light resistance	level 0: Light resistance
	Accessibility	level 0: Clear	level 1: Recessed	level 1: Recessed	level 1: Recessed	level 0: Clear	level 0: Clear	level 1: Recessed	level 2: Obstructed	level 2: Obstructed	level 0: Clear	level 0: Clear
	Positioning	level 0: No to low precision	level 2: High precision	level 1: Moderate precision	level 1: Moderate precision	level 0 - No to low precision	level 0: No to low precision	level 1: Moderate precision	level 0: No to low precision	level 1: Moderate precision	level 0: No to low precision	level 0: No to low precision
Functional sensitivity	Maintenance	level 0: No to low maintenance part	level 0: No to low maintenance part	level 1: Part wears during use	level 0: No to low maintenance part	level 0: No to low maintenance part	level 1: Part wears during use	level 1: Part wears during use	level 2: High chance of breaking	level 0: No to low maintenance part	level 0: No to low maintenance part	level 2: High chance of breaking

Material properties	Functionality	level 1: Sub functionality	level 0: No to low functionality	level 2: Main functionality	level 2: Main functionality	level 0: No to low functionality	level 1: Sub functionality	level 0: No to low functionality	level 1: Sub functionality	level 1: Sub functionality
		Textile (synthetic)	Textile (synthetic)	Mixed materials mainly metals	Textile (synthetic)	Textile (synthetic)	Fibre Reinforced Plastic	Textile (synthetic)	Steel	Rubber
HotSpot indicators	Material group	05.mar	0.68	115.2	08.ian	03.ian	56.1	150	53.7	16.ian
	Weight (g)
	Time
	Activity
Results	Priority part									
	Environmental									
	Economic									
	Total:									
Results	Time to disassemble	770 sec	Average: force							
	Number of tasks	22	accessibility	4						
	Number of steps	11	positioning	3						
	Number of tools	6								

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CONCLUSIONS

- We are the generations that face most acutely the reduction of natural resources and the negative effects of the impact of human activities on the environment, and this fact forces us to change both our way of thinking and the way we relate to the environment and economic and social activities.
- The textile sector is one of the basic pillars of the sustainable development of the EU and at the same time the second largest polluter of the environment, with a fast pace of change which requires new ideas for future technologies, products and markets.
- A new economy of textile products is distributive by design which requires work tools specific to the application of the concept of circular economy both in the stage of professional training and in the production process.

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REFERENCES

- Ecoprofit (2014), Schimbarea societatii industriale; eficienta resurselor, <http://ecoprofit.ro/economia-circulara-schimbarea-societatii-industriale-eficienta-resurselor/>
- European Commission (2010), "Being wise with the waste. The EU's approach to waste management", Brussels: European Commission.
- European Commission (2014), "Green action plan for SMEs, Enabling SMEs to turn environmental challenges into business opportunities", Communication from the Commission to the European Parliament, the Council, the European economic and Social Committee and the Committee of the Regions, com (2014) 440 final.
- European Commission (2015), "Closing the loop: An EU action plan for the Circular Economy".
- European Environment Agency (2016), "Circular economy in Europe, Developing the knowledge base", Luxembourg: European Environment Agency, available at: <https://www.eea.europa.eu/publications/circular-economy-in-europe>.
- Flipsen, B., Bakker, C. and de Pauw, I. (2020), "Hotspot Mapping for product disassembly; a circular product assessment method", *Conference of Electronics Goes Green 2020+*, Berlin, September 1, 2020.
- Ritzén, S. and Sandström, G.O. (2017), "Barriers to the Circular Economy – integration of perspectives and domains", *Procedia CIRP*, 64, 7-12, <https://doi.org/10.1016/j.procir.2017.03.005>.
- Rizos, V., Behrens, A., Kafyeke, T., Hirschnitz-Garbers, M. and Ioannou, A. (2015), *The circular economy: barriers and opportunities for SMEs*, available at: <https://www.ceps.eu/publications/circular-economy-barriers-and-opportunities-smes>.
- Rizos, V., Tuokko, K. and Behrens, A. (2017), "The Circular Economy: A review of definitions, processes and impacts", CEPS Working Document, available at: <https://www.ceps.eu/publications/circular-economy-review-definitions-processes-and-impacts>.
- Weetman, C. (2016), "Linear versus circular; The circular economy as a new economic model", <https://c-voucher.com/circular-economy-vs-linear-economy/>