

## Research for the conservation of cultural heritage in the context of the circular economy

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DORINA CAMELIA ILIEȘ  
MIHAELA CRISTINA LITE  
LILIANA INDRIE  
FLORIN MARCU  
CĂLIN MOȘ  
MĂDĂLINA ROPA  
BOGDAN STURZU

MONICA COSTEA  
ADINA VICTORIA ALBU  
PAUL SZABO-ALEXI  
ALPHONSE SAMBOU  
GRIGORE VASILE HERMAN  
TUDOR CACIORA  
NICOLAIE HODOR

### ABSTRACT – REZUMAT

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*The heritage woven objects could be analyzed for defects hidden to the naked eye using non-invasive and non-destructive ultrasonography techniques. Ultrasonography is able to offer information about altered areas, such as gasps, interruptions, discontinuances, narrowed areas, fiber breaks, different densities of the material, defects caused by natural or anthropic factors: improper storage and exposure conditions, the presence of microorganisms and traces of their activity, mechanical causes etc. By recycling of the cotton fibers from other decrepit materials, which are not directly usable, the recondition and rendition of the national and world cultural heritage of these refurbished objects would be accomplished. The impact on the environment is diminished compared to the case when new cotton fibers are created.*

**Keywords:** cultural heritage, ultrasonography, recycling, circular economy

#### Investigații privind conservarea patrimoniului cultural în contextul economiei circulare

*Textilele de patrimoniu ar putea fi analizate în ceea ce privește unele defecte care nu pot fi văzute cu ochiul liber, prin folosirea tehnicilor de ultrasonografie non-invazive și non-destructive. Ultrasonografia este capabilă să ofere informații despre zonele modificate, precum adâncituri, întreruperi, discontinuități, zone înguste, rupturi de fibre, diferite densități ale materialului, defecte cauzate de factori naturali sau antropici: condiții de depozitare și expunere necorespunzătoare, prezența microorganismelor și urme ale activității lor, cauze mecanice etc. Prin reciclarea fibrelor de bumbac din alte materiale uzate, care nu sunt direct utilizabile, s-ar putea realiza recondiționarea articolelor deteriorate, obiectele recondiționate putând fi redat patrimoniului cultural național și mondial. Impactul asupra mediului este diminuat în comparație cu cazul în care sunt create noi fibre de bumbac.*

**Cuvinte-cheie:** patrimoniu, ultrasonografie, reciclare, economie circulară

### INTRODUCTION

When thinking about the textile industry for the past century, it should be mentioned that most of the garments have been reused and recycled, as the technological process to obtain them was difficult and time consuming, but the materials were of natural provenance. In this manner, the impact over the environment was minimum, natural materials decomposed easily and there were no questions if the natural resources would be exhausted although the society was intensively using them. Amid the aggressive promotion of the consumer society, the world is currently witnessing, the increase of the moral perishability process of textile products, despite the fact that physically and functional they meet all the requirements. Scientists figured out that a linear economy is no longer sustainable for the society and the circular economy flourished, proving real benefits

both for now and for the future. Nevertheless, in the last few years, due to a growing awareness of the environmental issues, there has been a considerable interest in repair, maintenance, recycling and regeneration of the products. Some designers and producers have adopted techniques such as refurbishment, restyling and clothing redesigning, additional decorations and overlapping, patchworks, in order to restore used fabrics, increasing its value and delaying the removal from the landfill of waste. The study case is represented by an element of textile heritage, respectively an embroidered peasant blouse (“ie”) around 100 years old from Bihor County, Romania (figure 1). The embroidered peasant blouse (“IA”), part of the cultural heritage, represents an essential clothing component of the Romanian folk costume, incorporating a multitude of defying aspects for the specific identity of the local, especially rural, respectively of the geographical and historical space where it

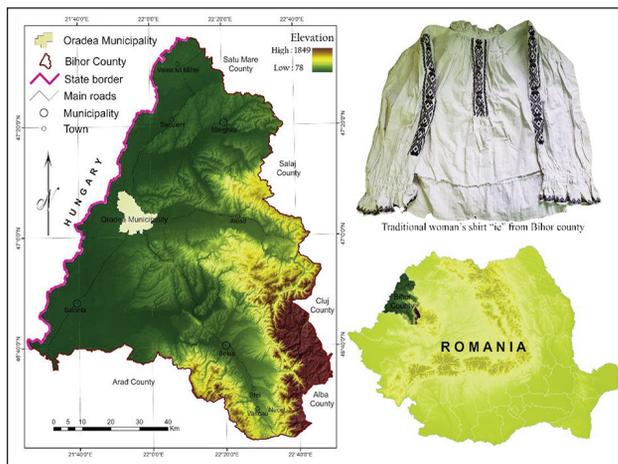


Fig. 1. The geographical location of the area of origin of the traditional women's shirt "ie"

appeared and evolved [1, 2]. There has been a while when, either from ignorance or carelessness, the embroidered peasant blouses were thrown away to the garbage can, as they were not "fashionable anymore". The disappearance of the custom of wearing embroidered peasant blouses represents a dramatic period for the Romanian traditional art. The major fashion houses started to be inspired by the patterns and motifs sewn once on the traditional costumes, including the Romanian ones. In the last few years, the embroidered peasant blouses have experienced a delightful come back. Famous designers have brought on the fashion catwalk the Romanian embroidered peasant blouse. Once returned in trends, the famous blouse of the traditional folk costume gained the attention of the Romanian women as well. The embroidered peasant blouses started to be reused, to be reconditioned, even workshops were created where women are learning how to create an embroidered peasant blouse. The old embroidered peasant blouses are different from the ones that are now being worked in series to be marketed, because they are made of cotton cloth different in texture from the present ones. For the assessment of the fibrillary structure of the fabric's identification of visible and less visible defects on naked eye of the textile materials, the use of high ultrasonography has been tried. Common in medicine, it can also contribute to the analysis of other structures that can be penetrated by ultrasounds. Modern ultrasounds are equipped with high resolution (high frequency) suitable to qualitative analysis of superficial structures, such as fabrics. The extremely high resolution of the obtained images gives the possibility of a fine analysis of the structure of the yarns of a woven material.

## CASE STUDY

### Literature review

The circular economy proposes a different approach based on the reuse and recycling of the goods instead of disposing them as soon as there are no longer useful [3, 4]. There is a major link between circular economy and sustainable development as

circular economy embraces the principles of sustainable development, having its starting point in the Agenda [4, 5]. Mostly CE it is referred as cyclical closed – loop system which could solve the linear economy environmental issues [6, 7]. The interest for the circular economy is high among scholars from different domains due to the benefits it brings to the modern society and the perspective for the future [8]. Large sports equipment companies have started using recycling since 2010 to create highly performing sports equipment with the least impact on the environment [9, 10].

The purpose of the present study is to highlight new methods and techniques for investigating some elements of textile heritage for the assessments of their condition, conservation and reconditioning, in the context of imposing a new conceptual approach to the circular economy, focused on volume reduction of waste, recycling and reuse [11–21]. The present study is a continuation of others scientific approaches that had as subject different elements of textile heritage [22–29].

### Method

X-radiography tools used for textile contributes to a good documentation for a better condition assessment and for the preserving of the objects, being a non-invasive and non-destructive technique; the analysis and interpretation of the obtained images highlight certain details and the hidden characters of the textile material, the techniques of sewing and weaving, repair, use, patterns of decay and dating, through digital image manipulation and interpretation [30]. Such techniques have been successfully used in the analysis of textile on the mummies in Peru, within the Peruvian Institute of Bioanthropology [31], Utrecht Museum being a pioneer in introducing the public in the use of X-rays in research [31]. As an objective method of analyzing the integrity of the fabric we used ultrasonography, a Samsung RS 80 (Samsung Healthcare Ultrasound) device, equipped with high resolution linear probes: L3-12A probe, with variable frequency up to 12MHz, respectively LA4-18B probe, with variable frequency up to 18MHz.

### Results and discussions

At a frequency of 15–18 MHz, high-frequency ultrasonography achieves an axial resolution (the possibility to distinguish two points perpendicular to the plane of the ultrasound waves) of 100  $\mu\text{m}/\text{pixel}$  and a lateral resolution (the possibility to distinguish two points in the plane parallel to the ultrasound waves) of 90  $\mu\text{m}/\text{pixel}$ , which can be used to differentiate certain lesions and interruptions in mass of material larger than 0.1 mm [32].

The study object is an embroidered peasant blouse around 100 years old from Bihor County, Romania (figure 1). The aim was to identify on the ultrasound images the interrupted, thin threads or the presence of larger defects inside the fabric, the lack of homogeneity of the material and respectively the presence



Fig. 2. Clinical echography images of the fabric of the traditional shirt ("ie")



Fig. 3. Photo of deteriorated fabric of traditional shirt ("ie")

of several gaps in its mass (figures 2 and 3). It is possible to identify and interpret, monitor and map the degraded and vulnerable areas, where the density of the material is different from the average, where there are gaps in the mass of the material, broken, broken or thinned fibers, etc. In the future, an objective method of analysis will be refined regarding the examination protocol: choosing the place where the examination will be carried out; the surface of the fabric examined; meticulous identification and quantification of defects identified in the field and use of statistical methods.

The cotton material of the embroidered peasant blouse could be reconditioned on the areas thus identified and which requires it, with the use of a similar or even identical raw material by recycling/regenerating the cotton yarns from other materials, not recoverable for direct use [33, 34].

## CONCLUSIONS

The circular economy proposes a different approach based on the reuse and recycling of the goods instead of disposing them as soon as there are no longer useful so that the impact on the environment is greatly diminished. This is successfully implemented by the major fashion houses in the world, but also in the field of high-performance sports. The non-invasive and non-destructive technique of monitoring and interpreting the images obtained by ultrasonography (including textile materials) has proved very useful in evaluating the state of the objects, identifying, quantifying, interpreting material defects (gaps, broken fibers, thinned etc.) for good preservation by recycling/regenerating textile fibers from other end-of-life materials, but which can be used successfully for reconditioning and reinvents the materials for future generations.

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**Authors:**

DORINA CAMELIA ILIEŞ<sup>1</sup>, MIHAELA-CRISTINA LITE<sup>2,3</sup>, LILIANA INDRIE<sup>4</sup>, FLORIN MARCU<sup>5</sup>,  
CĂLIN MOŞ<sup>5</sup>, MĂDĂLINA ROPA<sup>6</sup>, BOGDAN STURZU<sup>1</sup>, MONICA COSTEA<sup>7</sup>, ADINA VICTORIA ALBU<sup>4</sup>,  
PAUL SZABO-ALEXI<sup>1</sup>, ALPHONSE SAMBOU<sup>8</sup>, GRIGORE VASILE HERMAN<sup>1</sup>, TUDOR CACIORA<sup>1</sup>,  
NICOLAIE HODOR<sup>9</sup>

<sup>1</sup>University of Oradea, Faculty of Geography, Tourism and Sport, 1<sup>st</sup> University Street, Oradea, 410087, Romania  
e-mail: [iliesdorina@yahoo.com](mailto:iliesdorina@yahoo.com), [bogdan\\_sturzu\\_laurentiu@yahoo.com](mailto:bogdan_sturzu_laurentiu@yahoo.com), [anamaria\\_lazuran@yahoo.com](mailto:anamaria_lazuran@yahoo.com),  
[pszabo@uoradea.ro](mailto:pszabo@uoradea.ro), [grigoreherman@yahoo.com](mailto:grigoreherman@yahoo.com)

<sup>2</sup>National Research and Development Institute for Textiles and Leather,  
16 Lucretiu Patrascanu street, 030508, Bucharest, Romania  
e-mail: [cristina.lite@incdtp.ro](mailto:cristina.lite@incdtp.ro)

<sup>3</sup>Politehnica University of Bucharest, 1-7 Gheorghe Polizu street, 011061, Bucharest, Romania

<sup>4</sup>University of Oradea, Faculty of Energy Engineering and Industrial Management, Department of Textile,  
Leather and Industrial Management, 4 B.St. Delavrancea street, 410058, Oradea, Romania  
e-mail: [liliindri@yahoo.com](mailto:liliindri@yahoo.com), [adina\\_victoria@yahoo.com](mailto:adina_victoria@yahoo.com)

<sup>5</sup>University of Oradea, Faculty of Medicine and Pharmacy, Oradea, Romania  
e-mail: [mfmihai27@yahoo.com](mailto:mfmihai27@yahoo.com), [drmoscalin@yahoo.com](mailto:drmoscalin@yahoo.com)

<sup>6</sup>National College „Avram Iancu” Ştei, Bihor, Romania  
e-mail: [madalinaropa@yahoo.com](mailto:madalinaropa@yahoo.com)

<sup>7</sup>Faculty of Environmental Protection, University of Oradea, 26 Gen. Magheru street, 410048, Oradea, Romania  
e-mail: [costea.monica@yahoo.it](mailto:costea.monica@yahoo.it)

<sup>8</sup>University of Ziguinchor, Training and Research Unit of Economic and Social Sciences,  
Department of Tourism, Senegal  
e-mail: [asambou@univ-zig.sn](mailto:asambou@univ-zig.sn)

<sup>9</sup>Babes-Bolyai University, Faculty of Geography, 5-6 Clinicilor Street, Cluj Napoca, Romania  
e-mail: [nicolaiehodor@ubbcluj.ro](mailto:nicolaiehodor@ubbcluj.ro)

**Corresponding author:**

TUDOR CACIORA  
e-mail: [tudor.caciora@yahoo.com](mailto:tudor.caciora@yahoo.com)