

Circular Economy principles for developing New Food Products from fruit by-products

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**DESIGNA**2024  
INTERNATIONAL  
CONFERENCE  
ON DESIGN  
RESEARCH  
**CITIZENSHIP**  
OCT. 24—25<sup>th</sup>

BOOK OF ABSTRACTS  
DOCUMENTA

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DESIGNA 2024

CONFERÊNCIA  
INTERNACIONAL  
DE INVESTIGAÇÃO  
EM DESIGN

/

INTERNATIONAL  
CONFERENCE ON  
DESIGN RESEARCH

24-25 OCT 2024

UNIVERSIDADE DA  
BEIRA INTERIOR

COVILHÃ PT

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# IMPRENTA

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International Conference on Design Research

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Catarina Moura

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Joana Casteleiro (Multimedia and Interfaces)  
Júlio Londrim (Theory and Criticism)  
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Rita Salvado (Textiles and Community)  
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**Catarina Moura** . FAL Universidade da Beira Interior PT

# PRESENTATION

**In a time characterized by the ecological emergency, the effects of economic neoliberalism and the constant threat to fundamental human rights, Design has been embracing causes that, although departing from its project matrix, break with disciplinary circumscription and many academic and professional conventions that have characterized it. However, many areas of traditional Design activity persist and coexist with progressive procedural hybridization, opening themselves up to contamination, but also nurturing other areas of cultural and economic action that are fundamental to contemporary urban life.**

Design relates to multiple aspects of life in common, mediating relationships and projecting responses to pressing Citizenship issues, sometimes assuming a great ideological and political focus. Hence, the practice of Design in contemporary society demands a permanent and constant critical capacity in the face of the present, whether in professional responses or in its clear and recognized performance in formulating and articulating changes in social habits, imposed by the adoption of new values, motivated by the effects of austerity, climate change, pandemics or migration, among others.

This edition of DESIGNA aims to bring together, highlight, and discuss contributions of Design to Citizenship, both in the sphere of its relationship with citizens, individually considered, and in this declared and admittedly political perspective. On the other hand, in line with previous editions, the aim is to identify opportunities for new activities and design

practices, generating responses to complex emerging problems, both from an ecological and geo-strategic point of view, reconciling this scale with the public and private sphere of individual action. The natural constitution of Design as an academic and scientific field depends on the ability to interpret and react to these cultural changes, whose economic and technological implications alter the epistemological framework of Design, its teaching, and its practice.

DESIGNA 2024 is an in-person international conference which will take place on October 24th and 25th, 2024, at UBI, Covilhã, Portugal, aimed at the presentation and discussion of articles, research results, and projects, encompassing workshops, book launching, and the inauguration of exhibitions in the wide field of Design as well.

# PROGRAMA PROGRAM

DESIGNA 2024

International Conference on Design Research  
Universidade da Beira Interior, Covilhã, Portugal

## OCT 24 | THURSDAY

09h00 Reception and registration  
10h00 WELCOMING SESSION  
10h30 Plenary Session / 01  
12h00 Lunch  
14h30 Plenary Session / 02  
15h30 Coffee Break  
16h00 Parallel Thematic Sessions  
THEORY AND CRITICISM / 01  
HISTORY AND EDUCATION / 01  
DESIGN AND SUSTAINABILITY / 01  
VARIA / 01  
16h00 WORKSHOP  
17h30 BOOKS & JOURNALS  
19h30 Dinner / New Hand Lab  
[ registration required / additional fee ]

## OCT 25 | FRIDAY

09h00 Reception and registration  
09h30 Parallel Thematic Sessions  
THEORY AND CRITICISM / 02  
COMMUNICATION DESIGN  
PRODUCT DESIGN  
FASHION DESIGN  
11h00 Coffee Break  
11h30 Plenary Session / 03  
12h30 Lunch  
14h30 Plenary Session / 04  
16h00 Coffee Break  
16h30 Parallel Thematic Sessions  
HISTORY AND EDUCATION / 02  
MULTIMEDIA + INTERFACES  
DESIGN AND SUSTAINABILITY / 02  
TEXTILES AND COMMUNITY  
VARIA / 02  
18h00 Conference Closing



# OCT 24 THURSDAY

## 09h00 Registration

Anfiteatro da Parada  
*[open in permanence]*

## 10h00 Welcoming Session

Anfiteatro da Parada

Mário Raposo, Rector of UBI  
André Barata, President of the  
Faculty of Arts and Humanities  
Sara Velez, President of the Arts Department  
Francisco Paiva, Scientific Coordinator  
of Arts Research Unit  
Catarina Moura, DESIGNA's Scientific  
and Executive Committees

## 10h30 PLENARY SESSION / 01

Anfiteatro da Parada  
Moderation: Rita Salvado

### **Multispecies citizens, clothing, design and nature**

Kate Fletcher  
Royal Danish Academy, Copenhagen, Denmark  
Oslo Metropolitan University, Oslo, Norway

### **Clothing consumers as citizens, and the role of design**

Ingun Grimstad Klepp  
Consumption Research Norway  
Oslo Metropolitan University, Norway

## 12h00 Lunch

## 14h30 PLENARY SESSION / 02

Anfiteatro da Parada  
Moderation: Mónica Romãozinho

### **Cold Sweat – A case study on how crucial art and design are in overcoming enormous difficulties**

Cristina Filipe  
CITAR, Catholic University of Porto, Portugal

## 15h30 Coffee break

Anfiteatro da Parada

## 16h00 PARALLEL THEMATIC SESSIONS

### 16h00 THEORY AND CRITICISM / 01

Room 2.12  
Moderation: Luís Miguel Ginja

### 16h00 ID18

#### **O que pensa, sente, diz, faz e escuta o cidadão: Um retrato das dinâmicas de participação cidadã no concelho do Seixal - Reflexões sobre o papel do Design na governança local**

Pedro Sancho  
REDES - Research & Education in Design,  
Desis Lab - Centro de Investigação em  
Arquitetura, Urbanismo e Design, Portugal

### 16h15 ID20

#### **Architectural Storywork: Storying Critical Perspectives of Identity, Autonomy, and Discourse through Cognitive Landscapes**

Alastair Brook  
Maynooth University, Ireland

### 16h30 ID73

#### **Design Total e Metadesign: Estudo Sobre uma Expansão Conceptual**

Daniel Baldaia  
Universidade da Beira Interior,  
LabCom / iArtes, Portugal  
Sara Velez  
Universidade da Beira Interior,  
LabCom / iArtes, Portugal

- 16h45 ID85  
**Sensory Nourishment: Unravelling and redressing neurodivergent sensory experiences with clothing**  
 Maureen Selina Laverty  
 Norwegian University of Science and Technology (NTNU), Norway
- 16h00 HISTORY AND EDUCATION / 01**  
 Sala dos Conselhos  
 Moderation: Catarina Moura
- 16h00 ID10  
**AURORA: Uma jornada de metodologia a meta-metodologia de Design para o Ensino Superior**  
 Tânia Saraiva de Melo Pinheiro  
 Universidade Federal do Ceará - UFC, Brazil  
 Rochelle Silveira Lima  
 Centro Universitário Católica de Quixadá - UNICATÓLICA, Brazil  
 Gabriela Machado Santos  
 Universidade Federal do Ceará - UFC, Brazil  
 Heron Veríssimo de Souza  
 Universidade Federal do Ceará - UFC, Brazil  
 Fellipe Mayan da Silva  
 Universidade Federal do Ceará - UFC, Brazil
- 16h15 ID35  
**Public communication of science and technology as a tool for enhancing bildbung for adults**  
 Guadalupe Téllez Amador  
 Escuela de Diseño del Instituto Nacional de Bellas Artes y Literatura (EDINBA), Mexico
- 16h30 ID43  
**Design as an enabler of education**  
 Sabine Bothner  
 University of Education Freiburg, Germany
- 16h45 ID68  
**The significance of structuralist and constructivist approaches in the pedagogy of design**  
 Yoad David Luxembourg  
 Universidade da Beira Interior, iArtes, Portugal
- 16h00 DESIGN AND SUSTAINABILITY / 01**  
 Anfiteatro da Parada  
 Moderation: Ana Margarida Ferreira
- 16h00 ID06  
**Participatory design research for sustainability: A design probe study from creative collaboration to the design inspiration**  
 Pelin Efiltili  
 Istanbul Technical University, Turkey  
 Koray Gelmez  
 Istanbul Technical University, Turkey  
 Ali Cankat Alan  
 Istanbul Technical University, Turkey  
 Onur Yılmaz  
 Istanbul Technical University, Turkey  
 Rengin Gürel  
 Istanbul Technical University, Turkey  
 Özge Çelikoğlu  
 Istanbul Technical University, Turkey  
 Özge Cordan  
 Istanbul Technical University, Turkey
- 16h15 ID15  
**Products for Sustainability Transitions: How product design within companies can contribute to system innovation**  
 Mattia Italia  
 Politecnico di Milano, Italy
- 16h30 ID29  
**MUB Collection: Entrepreneurial Action Research for Sustainability and Social Innovation**  
 Dalia Sendra Rodriguez  
 UNIDCOM/IADE, Portugal  
 Ana Margarida Gomes Ferreira  
 Universidade da Beira Interior, LabCom / iArtes, Portugal  
 Carlos A. M. Duarte  
 Universidade Europeia, UNIDCOM/IADE, Portugal
- 16h45 ID51  
**AYA Tecnologías de Duoc UC, proceso de investigación aplicada con enfoque social**  
 Pablo Melzer  
 Instituto Profesional Duoc UC, Chile

- 17h00 ID89  
**Projetos de Design Sustentável em Portugal: Pela inclusão e cidadania**  
 Cláudia Pedro Isidoro dos Santos  
 Universidade da Beira Interior, CIEBA, Portugal
- 16h00 VARIA / 01  
 Moderation: Flávio Almeida
- 16h00 ID05  
**Exploring Frugal Innovation for Enhancing Access to Assistive Technology for Locomotor Disabilities**  
 Yashika Kumar  
 Delhi Technological University, India  
 Ravindra Singh  
 Delhi Technological University, India  
 Chitra Kataria  
 ISIC - Institute of Rehabilitation Sciences, India
- 16h15 ID08  
**Uma experiência singular: O curso de design de portefólio artístico ou profissional no contexto da construção da imagem do "Eu"**  
 Mário Mesquita  
 Faculdade de Arquitectura da Universidade do Porto, Portugal  
 Antero Ferreira  
 Faculdade de Belas-Artes da Universidade do Porto, Portugal
- 16h30 ID11  
**Circular Economy principles for developing New Food Products from fruit by-products**  
 Raffaele Passaro  
 Politecnico di Torino, Italy  
 Cristian Campagnaro  
 Politecnico di Torino, Italy
- 16h45 ID14  
**An Application of Quality Function Deployment to Explore a Product Component Characterization – A Case Study of a Triple-Effect Green Energy Generator for the Taiwan Environment**  
 Shuo-Fang Liu  
 National Cheng Kung University, Taiwan  
 Yu-Shan Wei  
 National Cheng Kung University, Taiwan
- 17h00 ID28  
**Exploring Dynamic Morphologies: Aesthetic and Structural Transitions of Bamboo Weaving in Product Design**  
 Felnunmoi Gange  
 IDC School of Design, IIT Bombay, India  
 Avinash Shende  
 IDC School of Design, IIT Bombay, India
- 16h00 WORKSHOP  
 Design+Lab  
**Additive Manufacturing in Fashion: a new perspective**  
 João Victor Azevedo Correia de Melo  
 Pontifícia Universidade Católica do Rio de Janeiro - PUC-Rio,  
 Laboratory of Biodesign DASA/PUC-Rio
- 17h30 BOOKS & JOURNALS – Presentation  
 Anfiteatro da Parada  
 Moderation: Sara Velez / Thais Longaray
- 19h30 Dinner / New Hand Lab  
*[ registration required / additional fee ]*

# OCT 25 FRIDAY

## 09h00 Registration

Anfiteatro da Parada  
*[ open in permanence ]*

## 09h30 PARALLEL THEMATIC SESSIONS

### 09h30 THEORY AND CRITICISM / 02

Anfiteatro da Parada  
Moderation: Eduardo Gonçalves

09h30 ID12

**Disillusionment in Dark Times**  
Kylïèn Bergh  
Wim Crouwel Institute, Netherlands

09h45 ID21

**Right not to participate**  
Awoniyi Stephen  
Texas State University, USA

10h00 ID39

**Recentring Vulnerability in the Humanitarian  
Cyberspace: The Role of Designers**  
Ana Laura Santos  
Portugal  
Brita Fladvad Nielsen  
Norwegian University of Science and  
Technology (NTNU), Norway  
Kristin Bergtora Sandvik  
PRIO, Norway

10h15 ID65

**Design consciente: propostas para  
uma atuação responsável**  
Thais Longaray  
Universidade da Beira Interior,  
LabCom / iArtes, Portugal

## 09h30 COMMUNICATION DESIGN

Room 2.08  
Moderation: Sara Velez

09h30 ID09

**Interconnections between communication  
design, performing arts, and ecological  
thinking narratives: a possible  
meeting between communication,  
innovation, and hybrid languages**  
Daniela Dispoto  
Università La Sapienza, Italy

09h45 ID30

**Visible Food Systems: Hacking Labels as  
a Design Action for Food Citizenship**  
Saria Digregorio  
University of Nottingham, UK

10h00 ID36

**Películas, historietas y guerrilla gráfica: El  
uso del diseño de comunicación, afectivo y  
activista en entornos universitarios frente a la  
normalización de la violencia psicoemocional  
contra mujeres en relaciones de pareja**  
Frida García Rodríguez  
Escuela de Diseño del Instituto Nacional de  
Bellas Artes y Literatura (EDINBA), Mexico  
Liliana Del Villar Arias  
Escuela de Diseño del Instituto Nacional de  
Bellas Artes y Literatura (EDINBA), Mexico

10h15 ID78

**Taller relacional para la planificación  
urbana: materializando intangibles**  
Milagros Hurtig  
Norwegian University of Science and  
Technology (NTNU), Norway  
Brita Fladvad Nielsen  
Norwegian University of Science and  
Technology (NTNU), Norway

10h30 ID81

**Visual metaphors' embodiment of  
ineffability for mental health design**  
Katie Aurora Lineer  
Norwegian University of Science and  
Technology (NTNU), Norway

**09h30 PRODUCT DESIGN**

Sala dos Conselhos

Moderation: Mónica Romãozinho

09h30 ID44

**Do Tradicional ao Contemporâneo, Inovação no Design de Mobiliário com Materiais Naturais**

Rui Tomás

Faculdade de Arquitetura, Universidade de Lisboa, Portugal

CIAUD, Centro de Investigação em Arquitetura, Urbanismo e Design

09h45 ID59

**Product Design Curriculum in an Evolving Landscape**

Clara Watkins

Cardiff Metropolitan University, UK

Joseph Venables

Cardiff Metropolitan University, UK

David-John Jarvis

Cardiff Metropolitan University, UK

10h00 ID69

**Mobility, Citizenship and Energy Transition – Challenges and Opportunities in the Electric Automotive Design Process**

António Calhamar

Universidade da Beira Interior, Portugal

João Monteiro

Universidade da Beira Interior, Portugal

Júlio Londrím

Universidade da Beira Interior, Portugal

10h15 ID82

**Análise de elementos finitos e análise do ciclo de vida de um polímero advindo de resíduos sólidos urbanos para a confecção de composteiras domésticas**

Bruna Ribeiro Frogel

Universidade do Estado de Santa

Catarina (UDESC), Brazil

Guilherme Bertoli Telma

Universidade do Estado de Santa

Catarina (UDESC), Brazil

Fernanda Hänsch Beuren

Universidade do Estado de Santa

Catarina (UDESC), Brazil

**09h30 FASHION DESIGN**

Room 2.12

Moderation: Rafaela Norogrande

09h30 ID41

**Promoção da cultura imaterial. Estudo de caso da marca Behén**

Madalena Barata

Universidade da Beira Interior, iArtes, Portugal

Catarina Moura

Universidade da Beira Interior,

LabCom / iArtes, Portugal

Fernando Oliveira

Universidade Europeia, IADE, Portugal

09h45 ID74

**Guiomar Torrezão, uma mulher à frente do seu tempo**

Cristina L. Duarte

Universidade da Beira Interior, Portugal

Ilda Soares de Abreu

Portugal

10h00 ID76

**Adaptability of small fashion brands in the face of the shift from physical to digital shopping behavior with the advance of the Covid-19 pandemic**

Gisele Nepomuceno

Universidade da Beira Interior, iArtes, Portugal

Catarina Moura

Universidade da Beira Interior,

LabCom / iArtes, Portugal

Fernando Oliveira

Universidade Europeia, IADE, Portugal

10h15 ID84

**The Portrait(s) of the Invisible: History and Meanings of a Dress**

Ana Luisa Vidal

Universidade da Beira Interior, Portugal

Cristina L. Duarte

Universidade da Beira Interior, Portugal

10h30 ID88

**Bringing Atlantic Crafts Traditions in Dialogue Through Fashion and Innovation**

Dalia Sendra Rodriguez  
UNIDCOM/IADE, Portugal  
Ana Margarida Gomes Ferreira  
Universidade da Beira Interior,  
LabCom / iArtes, Portugal  
Carlos A. M. Duarte  
Universidade Europeia, UNIDCOM/IADE, Portugal

**11h00 Coffee break**

Anfiteatro da Parada

**11h30 PLENARY SESSION / 03**

Anfiteatro da Parada  
Moderation: Ana Margarida Ferreira

**Navigating the personal and the political – Understanding Female-Centered NGOs through social design research**

Janka Csernák  
Moholy-Nagy University of Art and Design Budapest, Hungary

**12h30 Lunch**

**14h30 PLENARY SESSION / 04**

Anfiteatro da Parada  
Moderation: Sara Velez

**Did you mean bare life? The Design and Technology of Fortress Europe**

Ruben Pater  
Designer / Researcher, Netherlands

**Bauhaus of the Seas - a Portuguese Vision for the New European Bauhaus**

Nuno Jardim Nunes  
Técnico, University of Lisbon, Portugal

**16h00 Coffee break**

**16h30 PARALLEL THEMATIC SESSIONS**

**16h30 HISTORY AND EDUCATION / 02**

Sala dos Conselhos  
Moderation: Catarina Moura

16h30 ID34

**Fostering Civic Engagement through Healthy Educational Environments: Optimizing Light to Address Sick School Syndrome**

Daniela Alvarez Miranda  
Escuela de Diseño del Instituto Nacional de Bellas Artes y Literatura (EDINBA), Mexico  
Liliana Del Villar Arias  
Escuela de Diseño del Instituto Nacional de Bellas Artes y Literatura (EDINBA), Mexico

16h45 ID61

**Pedagogias Feministas e Práticas de Ensino no Design: Uma Abordagem Interseccional**

Joana Lai  
CIEBA - Centro de Investigação e de Estudos em Belas-Artes, Portugal  
Renata Bruni  
CIEBA - Centro de Investigação e de Estudos em Belas-Artes, Portugal  
Sofia Alexandre  
CIEBA - Centro de Investigação e de Estudos em Belas-Artes, Portugal  
Victor Almeida  
CIEBA - Centro de Investigação e de Estudos em Belas-Artes, Portugal

17h00 ID90

**Entre expectativas e realidades - um ensaio sobre o papel da formação em Design de Moda na região da Beira Interior**

Aline Moreira Monçores  
Universidade da Beira Interior, iArtes, Portugal

**16h30 MULTIMEDIA + INTERFACES**

Room 2.08

Moderation: Joana Casteleiro

16h30 ID23

**Impacto da Profundidade do Baixo-relevo na Perceção de Elementos Espaciais por Pessoas com Deficiência Visual**

Maria João Ramos

Universidade do Minho, Portugal

Óscar Carvalho

Universidade do Minho, Portugal

Miguel Bandeira Duarte

Universidade do Minho, Portugal

16h45 ID47

**Os desafios da participação e da experiência digital numa plataforma de partilha e cocriação de memórias coletivas de património e eventos culturais**

Ana Velhinho

Universidade de Aveiro, Portugal

17h00 ID64

**The creation of future generation graduates through the integration of Generative Artificial Intelligence alongside traditional skills within Product Design**

David-John Jarvis

Cardiff Metropolitan University, UK

Joseph Venables

Cardiff Metropolitan University, UK

Clara Watkins

Cardiff Metropolitan University, UK

17h15 ID87

**A familiaridade no design de interfaces contemporâneos**

Guilherme Mendes

Universidade da Beira Interior, Portugal

Sara Velez

Universidade da Beira Interior,

LabCom / iArtes, Portugal

**16h30 DESIGN AND SUSTAINABILITY / 02**

Anfiteatro da Parada

Moderation: Ana Margarida Ferreira

16h30 ID38

**Participatory Design for Sustainable Rural Housing: Insight from the 'Building with/for Bridport' Project**

Alexandra Carr

University of Plymouth, UK

Duhan Olmez

University of Plymouth, UK

Alejandro Veliz Reyes

University of Plymouth, UK

16h45 ID62

**Sustentabilidade no Design: A relação entre o material e o digital, o humano e o artefacto**

Gabriela Santos

CIEBA - Centro de Investigação e de

Estudos em Belas-Artes, Portugal

Joana Costa

CIEBA - Centro de Investigação e de

Estudos em Belas-Artes, Portugal

Victor Almeida

CIEBA - Centro de Investigação e de

Estudos em Belas-Artes, Portugal

17h00 ID71

**Product Design and Sustainability in the Archipelago of São Tomé and Príncipe**

Aílton Penhor

Universidade da Beira Interior, Portugal

Júlio Londrim

Universidade da Beira Interior, Portugal

João Monteiro

Universidade da Beira Interior, Portugal

- 17h15 ID75  
**Empreendedorismo feminino e inovação social: Caminhos para a Igualdade de Gênero**  
 Juliana Santos  
 Universidade do Estado de Santa Catarina (UDESC), Brazil  
 Fernanda Hänsch Beuren  
 Universidade do Estado de Santa Catarina (UDESC), Brazil  
 Icléia Silveira  
 Universidade do Estado de Santa Catarina (UDESC), Brazil
- 16h30 TEXTILES AND COMMUNITY**  
 Room 2.12  
 Moderation: Rita Salvado
- 16h30 ID17  
**Ervas Daninhas - Pintando à Margem**  
 Marta Leite  
 Universidade da Beira Interior, iArtes, Portugal
- 16h45 ID60  
**A joia contemporânea: legado de lugar e herança cultural**  
 Soraia Maduro  
 Universidade da Beira Interior, iArtes, Portugal  
 Mónica Romãozinho  
 Universidade da Beira Interior, iArtes, Portugal
- 17h00 ID72  
**Melhores práticas de Economia Circular no setor têxtil: Revisão sistemática da literatura**  
 Fernanda Hänsch Beuren  
 Universidade do Estado de Santa Catarina (UDESC), Brazil  
 Sandra Sofia Ferreira da Silva Caeiro  
 Universidade Aberta, Portugal
- 17h15 ID80  
**Museu Sentimental da Moda, Moda e memória: Uma história de vida contada através de uma peça de roupa**  
 Andreia Santos  
 Universidade da Beira Interior, Portugal  
 Cristina L. Duarte  
 Universidade da Beira Interior, Portugal
- 16h30 VARIA / 02**  
 Moderation: João Bravo
- 16h30 ID07  
**Creating a Library Environment for Teenagers in Denmark: Exploration in Inclusive and Participatory Design Methods**  
 Asa Jackson  
 Design School Kolding, Denmark
- 16h45 ID24  
**For "La Gente del Río": Weaving home away from home**  
 Antonia Reina Salas  
 Universidad de los Andes, Colombia  
 Ritalina Arce  
 Embera Katio Indigenous Community, Colombia  
 Tintiliano Queracama  
 Embera Katio Indigenous Community, Colombia  
 Celia Arce  
 Embera Katio Indigenous Community, Colombia  
 Eloisa Manugama  
 Embera Katio Indigenous Community, Colombia  
 Fernando Manugama  
 Embera Katio Indigenous Community, Colombia
- 17h00 ID37  
**An Innovative and Design-Oriented Solution Proposal Against the Climate Crisis on a Local Scale: Climate School**  
 Huseyin Elia Aydin  
 Eskisehir Technical University, Turkey  
 Fusun Curaoglu  
 Eskisehir Technical University, Turkey
- 17h15 ID45  
**À procura do tempo perdido: O têxtil como ferramenta de reconexão no Craft Design**  
 Luísa Silva  
 Universidade da Beira Interior, iArtes, Portugal  
 Virgínia Garbin  
 Universidade da Beira Interior, Portugal
- 18h00 Conference Closing**  
 Anfiteatro da Parada



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ID11

### **Circular Economy principles for developing New Food Products from fruit by-products**

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#### **Keywords**

Food Design, Transdisciplinary Approach, Apple Pomace, Fruit By-products, Circular Economy.

#### **Introduction**

This research deals with the challenges related to the sustainable management of food resources aimed at increasing the competitiveness of the agro-industrial sector in the Piedmont region (Italy). Focusing on a specific action-research project aimed at identifying new uses for food by-products from the Piedmont fruit-growing chain, with a particular focus on apple pomace.

Through desk and field research, the first part of the work focuses on understanding the current and potential uses of fruit processing by-products for human consumption. The focus is on apple pomace, a by-product of fruit processing into juice, which is now present in the region but has traditionally been spread on fields or destined for composting.

The second phase of the research focuses on making new food products by designing their aesthetic and organoleptic characteristics by applying a transdisciplinary approach, involving farmers, juice producers and professional bakers. It allows the experimentation of new concepts of edible processed foods by advancing progressively through the Technology Readiness Levels (TRL).

Preliminary results confirm the possibility of valorising food by-products and transforming them into new edible products, thus contributing to the systemic

and complex challenge of responsible use of food resources, following the broad debate on this issue.

#### **1. *Make the most of food*” an urgent issue**

The current global context calls for a reflection on the management of food resources, a key sector for sustainability and food security. The growing awareness of the negative environmental impacts associated with the linear use of resources - based on the “extract-produce-consume-disposal” approach - has led the European Union to define new sustainable strategies in the coming years.

In this context, the circular economy applied to food plays a strategic role, as highlighted by the Circular Economy Action Plan (European Commission, 2021), which calls on governments, institutions and research to reduce the environmental impact of products by adopting a systemic approach to design, applying the principles of the circular economy to turn waste and by-products into resources.

In a Circular Economy, food waste is designed out to maximise material value. Preventing and managing food waste has become an key item on the UN's global agenda, formalised by SDG 12.3, which aims to reduce global food waste and loss by 2030.

In this sense, this work is part of the broader reflection proposed by authors and foundations such as Ellen MacArthur Foundation, which highlight the need to rethink food systems and identify new system, service and product solutions to reuse waste from production processes. In particular, the “making the most of food” principle (Ellen MacArthur Foundation, 2018, p. 38) highlights the need to intervene at different stages of the food supply chain with actions and projects oriented to: preventing food waste, redistributing food surpluses, using by-products to create new processed foods .

What emerges is the crucial role of design activities in defining new “wasting away” strategies able to create new cycles of food waste utilisation in the creation of new food products, objects and services which are able to exploit the unexpressed potential of waste. In this sense, the central role of designers - practitioners and researchers - in developing new healthy and

sustainable processed foods emerges, and how Design has the power to influence what we eat (Ibid, p. 39).

Based on these assumptions, the Polito Food Design Lab adopted the principle of "make the most of food" by exploring the possibility of creating new food products from apple pomace: a by-product of apple processing, rich in fibre and nutrients, which is nowadays mainly discarded, although existing studies have shown that it is a useful product for human nutrition. The action-research starts in March 2023 as part of the NODES project, whose overall objective is to identify new strategies, based on the principles of the circular economy, aimed at increasing the competitiveness of the agro-industrial sector in the Piedmont region.

## **2. A By-product to be valorized: Apple Pomace**

The focus of the research group was on the apple, the first cultivar grown in Piedmont with more than 1,500,000 quintals per year, and in particular on the juice production process. Apple pomace is the by-product of the juice production process, which represents around 30% of the fresh weight of the apple, which remains after the apple has been pressed, and is mainly composed of peel and pulp, seeds and stems.

To date, the traditional use of apple pomace is for the production of raw pectin, while the most common method of disposal is to dump it directly into the soil, which causes serious environmental problems due to its fermentation capacity and high oxygen demand to activate the degradation process (Shalini & Gupta, 2010).

Given the large volume of this by-product, the identification of new commercial applications can have a great economic impact (ibid, p. 366), especially for small producers who are diversifying their agricultural activities (e.g. agritourism, food processing) as a means of protecting their income in the light of the increasing instability of the fruit market. In this sense, recent studies show the research interest in identifying new experimental uses of apple pomace aimed at animal nutrition, fertiliser production, bioethanol production and human nutrition.

The chemical composition of apple pomace makes it a good source of dietary fibre, which has been attributed to beneficial effects such as the reduc-

tion of cardiovascular disease due to its antioxidant and anti-inflammatory properties. These properties have encouraged experimentation in formulating new processed foods, such as functional foods and alcoholic beverages. However, to date, research into the use of apple pomace - and fruit pomace in general - has focused mainly on the nutritional properties of the by-product, demonstrating how it can be used to produce new products for human consumption. The working group opted to explore this dimension, which belongs to the field of Food Design.

## **3. Methodology**

According to the classification of Design Domains proposed by Jones (2014), the research is developed within Design 2.0, where the tools and knowledge of Design underpin the development of new products and services to address complex problems such as the valorisation of food waste. The activities are related to Design-With-Food here, food becomes design material, to experiment, through its transformation, the realisation of new edible products that can be produced and marketed in an artisanal production context.

The transdisciplinary approach lies in the skills - external to Design - integrated in the research process, belonging to the world of agriculture and bakery. The active involvement of the farmers made it possible to identify the best apple varieties to use, as they were local and organic, and the knowledge of the bakers helped to find recipes that could improve the organoleptic characteristics of the apple pomace to obtain products with a pleasant taste. Through co-design activities, the research group fostered the partners in the creation of prototypes of new bakery products using apple pomace. The actors' background was crucial in obtaining new food products, represented by the formulation of recipes that enhance the organoleptic and nutritional components of the apple.

The design process is divided into two phases: a meta-design phase and a design phase. The meta-design activities include desk research of the literature on pomace, its current and experimental uses, and field visits to trade fairs and apple production sites to analyse the state of the art in the regional fruit supply chain. This phase also includes concept generation tasks to define new food concepts.

The second phase of the project is focused on laboratory experimentation in order to formulate new edible products, design the aesthetic and organoleptic characteristics of the processed foods.

### **3.1 Desk & Field Activities**

The desk research is focused on a literature review by reading documents, publications and articles on fruit pomace and its potential. At the same time, two national apple fairs were visited to meet local producers. Through the field research it was possible to interact with apple producers, mainly represented by small family farms of 3 hectares, who sell their product individually or through the 11 producer organisations in the area. Of the 51 producers interviewed, 45 process apples into other food products such as juice, cider, jams and bakery products. 37 of them produce apple juice and cider. In dialogue with 12 producers, the question “Why do you produce other products in addition to apples?” was asked, and the answers always emphasised the need to increase income, to differentiate the offer and to cope with the ever-increasing costs of fruit production.

Although the survey is not exhaustive and refers to a small sample of local producers, it shows that small producers need to find new strategies to increase their activities’ added value to improve their competitiveness. At this stage, it has been possible to establish contact with one producer in adding value to apple pomace. The Cascina Danesa farm in Cavour (Turin) offered to the research group the by-product from the pressing of five local organic varieties. The pomace collected on the farm was subsequently dried (35°C for 48 hours) and ground in a stone mill to obtain 12 kg of apple pomace flour, which was used as a raw material for subsequent research activities.

### **3.2 Concept Generation**

Through the participatory workshop, around 60 people - design students, citizens, researchers - were involved in 6 practical design sprint activities, generating 27 new concepts. The workshops last between 5 and 8 hours, during which the participants, divided into heterogeneous working groups of 4 people, use their practical and theoretical skills in creative co-design processes, animated and guided by the research team.

### **3.3 New Processed Food Development**

The project phase starts with prototype development activities to increase the TRL from 3 to 4. In detail, this means pursuing the increase in the technological maturity of the products by finalising the formulation, taste and aesthetics to obtain procedures that allow the replication of the processed foods and guarantee small batch production. From September 2023, a collaboration with the Panacea Social Farm team began to experiment with the most interesting new concepts and started a co-design process to create new bakery products at the artisanal level. During this phase, 12 experiments - each lasting 8 hours - were carried out at the Panacea’s laboratory, involving the research group and the cooperative’s employees in the creation of the new products.

At the end of the sessions 7 new processed foods were obtained, which include in their formulations a percentage between 10 and 20% of apple dried pomace. The new processed foods made can be traced to the mereological category of bakery products, specifically: biscuits, breadsticks, crackers, muffins, snacks, bread, focaccia.

### **3.4 Strategies for future analysis**

To date, the research has reached the evaluation stage. Given the technological maturity of the developed processed foods, contacts have been made with chemical laboratories and research groups from other departments to carry out the new products’ sensory (June 2024), nutraceutical (June 2024) and economic evaluations (July 2024).

## **4. Preliminary Outputs and Outcomes**

The research has made it possible to identify a set of preliminary outcomes and outputs. The first outcome is the recognition of pomace as a valuable product, both for those who produce it and those who have the skills to process and use it. The stakeholders recognise the new process as an opportunity to valorise a wasted by-product, underlining the importance of the transdisciplinary approach adopted, which has contributed significantly to the preliminary results.

The second outcome lies in the relationships created between producers and bakers, which show how the

involvement of local actors in the experiments can catalyse the interactions between different sectors of the food chain. These relationships are meant to be preliminary to the construction of a local supply chain - which does not exist today - linking the production of pomace to bread-making. A short supply chain, at local level, which could remunerate farmers for the sale of a product.

The first output is represented by the collection of the 27 new co-designed concepts, which are intermediate outputs that guide the decision-making process towards the selection of the final products.

The 7 prototypes at TRL 4 are the second output of the experiment. Although still imperfect and subject to further improvements, they represent the formal characteristics of the products (shape, size, texture, colour, mode of use and consumption). Their recipes and the information obtained from the production processes provide helpful material for replicating the process and experimenting with new ones, perhaps using pomace from other fruits.

Preliminary feedback from tasting the new foods represents another output. The information obtained is strategic to support future changes and improvements until the definition of sensory evaluation and acceptance by potential consumers.

### 5. Conclusions and future developments

This work intends to contribute to the debate on creating new sustainable and innovative strategies in the Piedmont fruit supply chain. In this sense, the evidence discussed here represents the first step for a series of future developments that aim to consolidate and expand research, intending to contribute in a tangible way to changing the perception of by-products from process waste to valuable and sustainable resources.

Preliminary results confirm the possibility of valorising apple by-products and transforming them into new food products using appropriate low-energy technology approaches, contributing to the systemic and complex challenge of responsible use of food resources.

The research shows that the use of apple pomace in the design of new bakery products is a viable strategy

that can be further explored, confirming the possibility of turning a wasted by-product into a new resource that will benefit and reward both producers and transformers in the area involved in applying circular economy principles to the fruit supply chain. If the current research shows how apple pomace "can be considered as a safe product that can be successfully used in the food chain as part of the circular economy framework" (Sionek, 2022), the research conducted by the Polito Food Design Lab focuses on the practical possibility of realising processed foods that are pleasing to the senses and aesthetically appropriate to the local artisanal dimension.

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ID14

### An Application of Quality Function Deployment to Explore a Product Component Characterization – A Case Study of a Triple-Effect Green Energy Generator for the Taiwan Environment

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### Keywords

Auxiliary energy; industrial design; quality function deployment; renewable energy hybrid system.

Reducing primary energy use and increasing the amount of renewable energy generated is a common