nº4

junio2024

proyecta 56

An industrial design journal

Proyecta56, an Industrial Design Journal | e-ISSN:2340-8391 | https://doi.org/10.24310/p56-idj12024

Proyecta56, an Industrial Design Journal

The Journal is released annually, has a scientific character, and specializes in Industrial Design. Its first issue was published in June 2021 by the University of Cádiz, and it moved to the University of Málaga's press for the 2023-2024 academic year, with its fourth issue published in June 2024. Proyecta56, an Industrial Design Journal, originated from a previous project: PROYECTA56. Between 2013 and 2015, the publication had a quarterly format and a popular science character. It was hosted by the cultural center La Térmica (Málaga), involving over 100 industrial design professionals from around the world and participating in national and international exhibitions. For this reason, the current scientific publication maintains a minimum percentage of popular science works, staying true to its origins.

The scientific content of this publication is reviewed by at least two external experts through a double-blind peer-review process, ensuring confidentiality and anonymity for both authors and reviewers.

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While we make every effort to ensure the accuracy of the information, we do not accept responsibility for any damage or prejudice that may be caused. The ideas and opinions expressed in this journal are those of the authors and do not necessarily reflect the views of the publishing entity, Editorial Board, or Scientific and Advisory Committee.

The publication maintains a policy of good practices in gender equality, reflected in the content of articles, the format of the publication, governing bodies, and reviewers.

Periodicity: anual (June 29th)
e-ISSN: 2340-8391 | ISSN: 2386-5414
Legal Deposit MA-1535-2014
https://doi.org/ 10.24310/p56-idj12024

Published by the University of Malaga - June 2024
https://revistas.uma.es/index.php/pro

Proyecta56, an Industrial Design Journal is indexed and deposited in

DOAJ Dialnet latindex DULCINEA

MIAR Matriz de Información para el Análisis de Revistas
ERIH PLUS EUROPEAN REFERENCE INDEX FOR THE HUMANITIES AND SOCIAL SCIENCES

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Welcome to the latest edition of Proyecta56: An Industrial Design Journal. This issue is dedicated to exploring the critical role of research in the field of industrial design. As we navigate through the complexities of the 21st century, rigorous research and evidence-based design practices have become essential for driving innovation, sustainability, and user-centered solutions.

One of the most pressing challenges facing industrial designers today is the urgent need for sustainability. In this issue, we spotlight groundbreaking research that addresses environmental concerns through innovative design. Barbara Pizzicato (from University of Campania, Italy) emphasizes the sustainable valorization of agro-industrial waste and by-products, transforming them into valuable resources for high-consumption sectors like textiles. By examining these research findings, we aim to inspire designers to integrate eco-friendly practices into their work and contribute to a more sustainable future.

Technological progress is rapidly transforming industrial design research. In this issue, Sara Lenzy introduces data sonification, a pioneering method to represent and communicate extensive datasets using sound, in her guest paper. This innovative approach fosters the creation of more efficient and groundbreaking products.

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At the heart of industrial design lies the principle of user-centered design. Understanding the needs, preferences, and behaviors of users is crucial for creating products that are functional, meaningful, and engaging. Our featured articles delve into the latest research methodologies used to empathize with users, such as participatory design emphasizing the importance of designing for diverse and global audiences. Ruiz Gutierrez, from University of Guadalajara (Mexico) highlight the importances of social innovation in an educational setting involving students in a meaningful learning process, and preparing them to face real-world challenges with creativity and social commitment.

On the other hand, in this isssue we reflect on the identity of Spanish industrial design. Martínez (University of A Coruña) and Fernández (University of Deusto) analyze the complexity of the development of industrial design in Spain and the difficulty in defining this identity.

As we embark on this journey through the pages of Proyecta56, we invite you to engage with the thought-provoking research and studies presented in this issue. Industrial design is a discipline that constantly challenges us to think differently, to innovate, and to create solutions that enhance the world around us. We hope that this edition not only informs but also inspires you to contribute to the ever-evolving narrative of industrial design through research.

Thank you for being a part of our community. Together, let us advance the field of industrial design through rigorous research and innovative thinking.

Sincerely,

María Alonso García

Editor of Proyecta56: An Industrial Design Journal

ISSN 2386-5414
e-ISSN: 2340-8391

Articulo de investigación | Research article

Innovación social desde el taller de diseño: implicaciones en la transformación urbana y social de comunidades vulnerables | Social innovation from the design workshop: implications in the urban and social transformation of vulnerable communities

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Recibido: 1 de marzo 2024 | Aceptado: 15 de mayo 2024 | Publicado: 29 de junio 2024
DOI:https://doi.org/10.24310/p56-idj1202419183

Resumen

El presente documento describe la experiencia de innovación social implementada en el taller de diseño del posgrado Maestría en Diseño e Innovación Industrial en el Centro Universitario de Arte, Arquitectura y Diseño de la Universidad de Guadalajara.

El enfoque multidisciplinario del taller, conformado por diferentes perfiles profesionales de estudiantes que participan en el calendario escolar 2023B y 2024A de la generación actual, implica la utilización de métodos de innovación social que forman parte esencial del plan de estudios del posgrado, los cuales facilitan el desempeño de las diferentes ac-ciones correspondientes con las diferentes herramientas que componen o estructuran el proceso de trabajo que los métodos de innovación requieren.

En su contenido, el documento describe dos casos de estudio puestos en marcha para atender cuestiones sociales identificadas al interior de un polígono urbano cercano al Cen-tro Universitario de Arte, Arquitectura y Diseño de la Universidad de Guadalajara y a tres colonias o subdistritos pertenecientes al municipio de Guadalajara, Jalisco.

En sus párrafos se reseña el avance del proceso de abordaje y de generación de propuestas de valor que desde la perspectiva de la innovación social han sido validadas, en primera instancia, por usuarios finales y autoridades del municipio de Guadalajara.

En la parte final se incluye una reflexión sobre la aportación que la innovación social tiene en la formación de estudiantes y en la comprensión de problemáticas sociales que repre-sentan un punto de partida para la transformación urbana y social de nuestro territorio.

Palabras clave: Diseño Industrial; Innovación social; taller de diseño; trabajo participativo; Educación en Diseño

Abstract

This document describes the experience of social innovation implemented in the design workshop of the postgraduate Master in Design and Industrial Innovation at the University Center of Art, Architecture and Design of the University of Guadalajara.

The multidisciplinary approach of the workshop, conformed by different professional profiles of the students participating in the school calendar 2023B and 2024A of the current generation, implies the use of social innovation methods that are an essential part of the postgraduate curriculum, which facilitate the performance of the different actions corresponding to the different tools that compose or structure the work process that innovation methods require.

The document describes two case studies implemented to address social issues identified within an urban polygon near the University Center of Art, Architecture and Design of the University of Guadalajara and three neighborhoods or sub-districts belonging to the municipality of Guadalajara, Jalisco.

In its paragraphs, the progress of the process of approaching and generating value proposals from the perspective of social innovation has been validated, in the first instance, by end users and authorities of the municipality of Guadalajara.

The final part includes a reflection on the contribution that social innovation has in the training of students and in the understanding of social problems that represent a starting point for the urban and social transformation of our territory.

Keywords: Industrial Design, social innovation, design workshop, participatory design, Design Education.

Introducción

La problemática social como punto de partida

La caracterización de la problemática social que prevalece en territorios urbanos vulnerables de nuestros días, demanda una necesaria clasificación de cosas que posibilitan su mejor comprensión y atención. A este respecto y de acuerdo con la Comisión Económica para América Latina y el Caribe (CEPAL, 1989), un problema social es "una condición que afecta a un número significativamente considerable de personas, de modo considerado inconveniente y que según se cree debe corregirse mediante la acción social colectiva". En esta definición subyace un conjunto de dimensiones que permiten visualizar una cantidad importante de variables que se involucran en su condición de problemática. En la primera de ellas, se establece de inicio el hecho de ser un grupo determinado de individuos los afectados "un número significativamente considerable de personas" (CEPAL, 1989, p. 2), y no alguien en particular. La segunda dimensión aborda aquella circunstancia que representa "una discrepancia entre un estado de deseabilidad" (CEPAL, 1989, p. 3) y lo que socialmente reconocemos como estandarizado. La tercera dimensión se enfoca en "la creencia en que es posible la solución mediante la acción colectiva" (CEPAL, 1989, p. 3), es decir, mediante la participación conjunta de varios de los elementos involucrados, directa e indirectamente en dicha condición.

Según el organismo internacional CEPAL (1989), los problemas sociales están determinados por las circunstancias espacio temporales en las cuales se manifiestan. De tal forma que lo estandarizado puede no ser necesariamente lo mejor. Aún así, el establecimiento de una problemática parece obedecer a un estado de discrepancia que por lo general se debe a la poca capacidad de operación de alguna de las variables con mayor peso en la toma de decisiones.

Al utilizar este precepto en el espacio urbano, abordado desde el taller de diseño, es necesario considerar la volatilidad que presentan las variables que lo componen. En una zona urbana con determinado nivel de crecimiento poblacional, el espacio correspondiente a un tiempo y lugar, difícilmente podrá satisfacer las necesidades y demandas de grupos sociales más grandes y diversos.

Como afirman Oszlak y O'Donnel, "ninguna sociedad posee ni la capacidad ni los recursos para atender omnímodamente todas las necesidades y demandas de sus integrantes... solo algunas son problematizadas, en el sentido que ciertas clases, fracciones de clase, organizaciones, grupos o incluso individuos estratégicamente situados creen que puede y debe hacerse" (CEPAL, 1989, p. 4).

Los problemas sociales son por lo tanto, circunstancias que pueden convertirse en cuestiones sociales cuando "ocurre una secuencia que se caracteriza por redefinir la situación, focalizar el descontento, capturar la atención pública y formar grupos de presión" (CEPAL, 1989, p. 4). Lo antes expuesto podría considerarse como una dimensión adicional, en la cual es posible colocar en el imaginario colectivo la necesidad de ser atendido y resuelto

El área de estudio y su problemática social

Para el desarrollo del presente proyecto de trabajo, el equipo de profesores y estudiantes involucrados tomaron la decisión de identificar una área geográfica en la ciudad a partir de tres aspectos relevantes: el primero refiere a la vulnerabilidad social que tiene su población, es decir, la susceptibilidad de sufrir algún tipo de daño tanto en la dimensión física como en la emocional por algún factor externo. El segundo a la cercanía necesaria al centro educativo sede del proyecto para facilitar el acceso de estudiantes involucrados al territorio. El tercer aspecto corresponde con las condiciones del entorno para generar oportunidades de desarrollo.

En consecuencia con lo ante señalado, se tomó la decisión de establecer un polígono de estudio integrado por tres subdistritos con antecedentes relacionados con vulnerabilidad social: Lomas del Paraíso, Zoológico y Huentitán El Bajo, todos pertenecientes a la Zona 03 Huentitán del Área Metropolitana de Guadalajara, Jalisco (In-Ciudades, 2020). Las tres colonias se ubican alrededor del Centro Universitario de Arte, Arquitectura y Diseño de la Universidad de Guadalajara, espacio sede del posgrado Maestría en Diseño e Innovación Industrial.

En la siguiente imágen (Figura 1) obtenida por el Instituto de Investigación y Estudios de las Ciudades (In-Ciudades) de la Universidad de Guadalajara (2020) mediante la plataforma INEGI (2020), el Plan parcial de desarrollo urbano de Jalisco (2020) y con datos de CONAPO (2020), se aprecia la dimensión territorial del área de estudio y las áreas geográficas o AGEBS que refieren niveles de marginación. Entendido esto último como "la carencia de oportunidades sociales y a la ausencia de capacidades para adquirirlas o generarlas pero también a privaciones e inaccesibilidad a bienes y servicios fundamentales para el bienestar" (IIEG, 2021). En la imagen destacan los 10 AGEBS con nivel medio de marginación identificados por el Censo de Población y Vivienda (2020) y publicados por el INEGI en 2020, quienes además le otorgan un nivel muy bajo de acuerdo con su metodología (IIEG, 2021), lo cual se interpreta para el presente documento como una área de oportunidad para el desarrollo de proyectos de innovación social al interior del taller de diseño.

En relación con las problemáticas o cuestiones sociales con mayor relevancia en el polígono que delimita el área de estudio, el equipo de trabajo elaboró una primera lista que destaca aquellas con mayor reconocimiento público por parte de medios de información, oficinas de gobierno y grupos de investigación de universidades locales: robo a vehículos particulares y violencia familiar (Transparencia Guadalajara, 2017), áreas de contaminación, hundimientos e inundaciones (In-Ciudades,

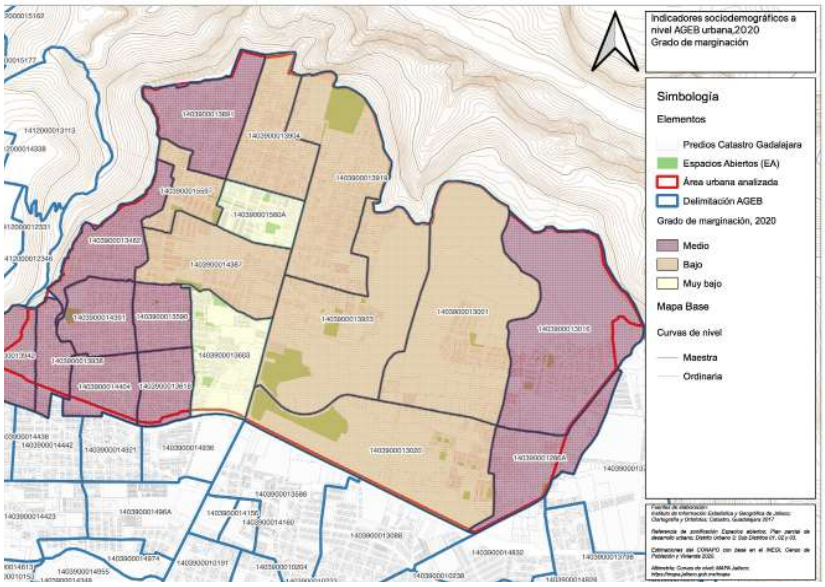

Figura 1. Indicadores sociodemográficos a nivel de AGEB urbana en 2020. Fuente: In-Ciudades, 2023.

2020), redensificación, rezago en materia de igualdad de género (INEGI, 2022), abandono escolar en nivel secundaria, espacios verdes vandalizados y subutilizados, así como inseguridad en general.

Metodología

El sustento teórico que soporta la inclusión de un método de pensamiento de diseño en el presente caso de estudio, radica en la necesidad de observar a detalle las necesidades del usuario y generar valor desde perspectivas diferentes a lo que usualmente ocurre en materia de proyectos sociales en los cuales se involucran de alguna manera organizaciones del orden público y civiles.

Con ello se busca no sólo manifestar evidencias que dejen al descubierto los atributos del método, sino también generar conocimientos en materia de desarrollo de proyectos orientados hacia la atención de necesidades tácitas o latentes de grupos sociales vulnerables (Micheli et al., 2019) desde la perspectiva de la innovación social.

Un aspecto complementario que argumenta el uso del método de pensamiento de diseño, refiere al proceso de trabajo colaborativo necesario para involucrar a estudiantes de diferentes perfiles profesionales en la creación de propuestas de valor que atienden problemáticas específicas. En este escenario de colaboración transversal, el método proporciona herramientas didácticas como el aprendizaje basado en proyectos o en problemas para impulsar la interacción necesaria entre los participantes, así como la iteración requerida de los procesos creativos resultantes de la validación sistemática por parte del usuario en las diferentes etapas del método.

Desde la visión de la docencia, el desarrollo del proyecto asume la discusión sobre el pensamiento de diseño; aquella que revisa las implicaciones sociales que el método tiene y el escenario de factibilidad que en términos de oportunidad de mercado proporciona el proyecto para los estudiantes involucrados, quienes mediante la experiencia de llevar a cabo su gestión e implementación, fortalecen el aprendizaje significativo en materia de diseño e innovación, aspectos de formación profesional fundamentales del posgrado que los convoca.

Se reconoce por lo tanto al pensamiento de diseño como “un enfoque alternativo a los enfoques estrictamente analíticos, que se consideran ineficaces en contextos caracterizados por la complejidad y el dinamismo” (Micheli et al., p. 22, 2019) para la resolución de problemas comunes que afectan a prácticamente cualquier escenario u organización del ámbito social.

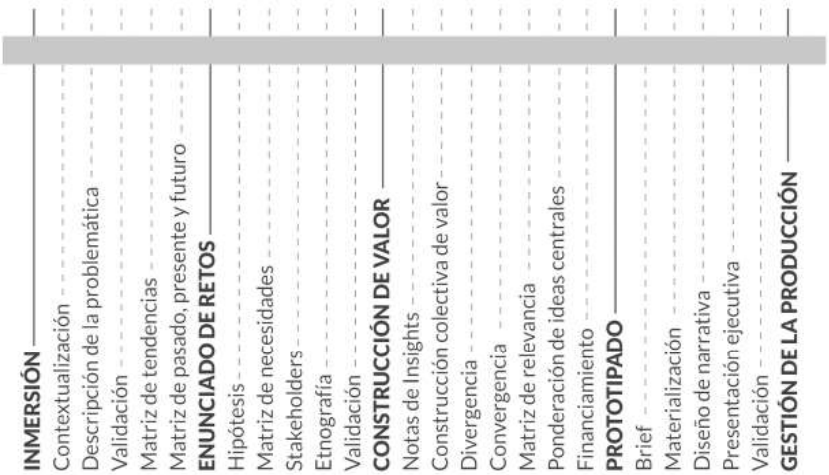

Figura 2. Desglose de herramientas utilidas en el método de innovación social. Fuente: IDEO, 2022

El uso del método de pensamiento de diseño en proyectos como el que refiere el presente artículo, fortalece el proceso teórico y práctico en periodos de tiempo relativamente cortos, lo cual permite a los participantes desarrollar habilidades de rápida resolución ante escenarios laborales futuros, caracterizados por el dinamismo. Vinculado con lo antes mencionado, el método posiciona la idea entre quienes se involucran en él, sobre la relevancia práctica que implica trabajar bajo procedimientos específicos que facilitan la comprensión de las variables que caracterizan los problemas comunes y la forma en que se traducen en oportunidades.

El método en acción

Para el desarrollo del proyecto de diseño e innovación social, se puso en marcha un método de pensamiento de diseño (Figura 2) que contiene 5 fases estratégicas: Inmersión, Enunciado de retos, Construcción de valor, Prototipado y Gestión de la producción. En cada una de las fases se incluye un conjunto de herramientas que permiten la comprensión del problema, sus variables, las implicaciones sociales resultantes, y por supuesto, las propuestas de valor materializadas en prototipos

En lo que respecta con el desglose del método, particularmente durante la primera fase estratégica (Inmersión) se inició un proceso de abordaje que requirió del análisis de la información documentada que al momento existía respecto a las problemáticas o cuestiones sociales de la población que vive actualmente en el polígono de estudio. Durante dicha actividad se dejó en claro la intención de analizar cada una de ellas y someterlas a criterios de viabilidad y factibilidad, previo a la selección de aquellas con mayor posibilidad de materialización. La captación, evaluación, selección y síntesis de las principales problemáticas identificadas (Peña, 2022, p.4) por parte de los grupos de trabajo, incluídos profesores de licenciatura y de posgrado, permitió establecer un proceso de evaluación, en el cual, la factibilidad resultó como el criterio con mayor relevancia para la selección de los casos de estudio en el taller de diseño.

Como resultado de lo anterior se identificaron 4 temáticas vinculadas a problemas específicos que propiciaron la integración de la misma cantidad de equipos de trabajo. Sin embargo para la realización de este artículo sólo se incluye información de 2 proyectos, los cuales presentaron un mejor escenario de factibilidad sustentado por la existencia de programas municipales y de Gobierno Federal (Pronaces, 2024) vinculados con las temáticas, lo cual se traduce como un escenario con mayor certidumbre.

En la tabla 1 se describen a detalle las problemáticas identificadas y la descripción del proyecto o reto de trabajo:

Una vez definido lo anterior, se procedió a implementar la segunda fase: Enunciado de retos. En esta etapa, cada equipo de trabajo

Tabla 1. Desglose de la problemática del centro barrial y del proyecto de trabajo.

PROBLEMATICA	Según INEGI (2022) el porcentaje de mujeres que habitan el polígono es el 51.24%, de las cuales, una parte importante padece un rezago en materia de igualdad de género y empoderamiento, particularmente las mujeres jefas de familia, es decir, el miembro de mayor jerarquía, ya sea por el sostén económico, por la edad o por ser quien toma las decisiones en la familia (INEGI, 2020).	De acuerdo con información de la Secretaría de Desarrollo e Integración Social del Estado de Jalisco (2018). Se estima que en Jalisco y su área metropolitana (AMG) existe un abandono de estudios de nivel secundaria correspondiente al 4.38% de la población estudiantil, lo cual se traduce en 19,091 estudiantes que se involucran por lo general a la informalidad.
PROYECTO	Rehabilitación del centro barrial Lomas del Paraíso para el fortalecimiento social de las mujeres jefas de familia que viven en la colonia.	Fortalecimiento de la infraestructura educativa y del entorno urbano inmediato de la Secundaria Técnica No. 78.

procedió al establecimiento de hipótesis, al análisis de las necesidades de los usuarios, a la identificación de los Stakeholders (partes interesadas), al diseño y análisis de entrevistas, así como la correspondiente validación de la información obtenida en este proceso de trabajo.

Resultados

A continuación se describen los resultados al cierre del mes de enero de 2024 de los proyectos en desarrollo al interior del posgrado Maestría en Diseño e Innovación Industrial (MDII) correspondientes con los calendarios escolares 2023B y 2024A (en curso) que manifiestan, desde la perspectiva de quien escribe el presente artículo, el aporte que la innovación social tiene en la formación profesional de los participantes y los beneficios que esto representa para la transformación urbana y social de comunidades vulnerables.

Proyecto 1: Rehabilitación del Centro Barrial Lomas del Paraíso II para el fortalecimiento social de las mujeres jefas de familia que viven en la colonia, cuyas principales problemáticas se relacionan con deserción escolar, bajos ingresos económicos, violencia y escasez de oportunidades para el desarrollo personal. Estudiantes participantes: Robles Vigil Cristina y Chávez López Eva Esperanza Margarita.

Este espacio comunitario dependiente del Desarrollo Integral de la Familia (DIF Jalisco), se encuentra sobre la calle Joaquín Mucel No. 664, en la demarcación Lomas de Paraíso II que se muestra en la siguiente imagen (Figura 3).

Este centro barrial se identifica como un punto de encuentro para la población que vive en sus alrededores. Junto a él colinda una iglesia, un centro de atención a la niñez y una estancia educativa de nivel preescolar, así como un conjunto de establecimientos comerciales establecidos e informales.

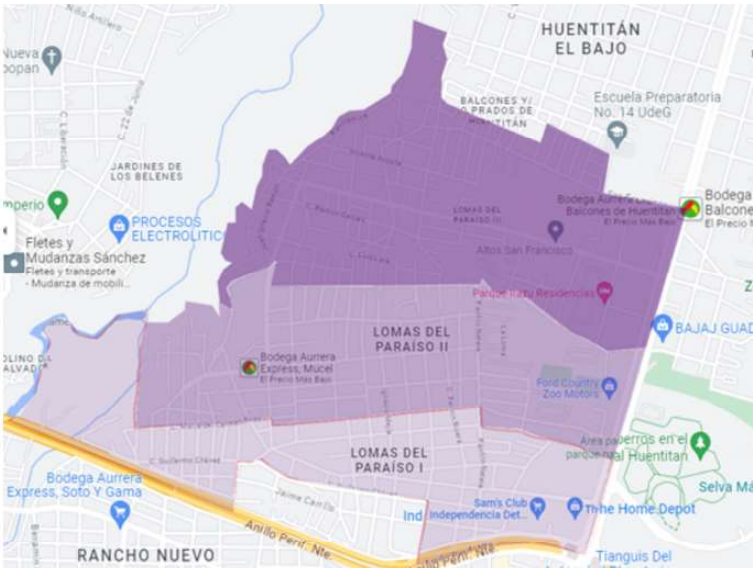

Figura 3. Demarcación de la colonia Lomas del Paraíso. Fuente: Google maps, 2023.

De acuerdo con la información obtenida en la etapa de Inmersión del método de innovación social, el centro barrial recientemente se reacondicionó físicamente por parte de autoridades municipales de la ciudad de Guadalajara, lo cual ha permitido la organización de actividades diversas, tanto en su exterior como en el interior, pero solo durante el horario matutino. Sin embargo, también se pudo evidenciar que carece de una oferta sistemática de actividades o programas sociales que impacten de manera significativa a la población vulnerable de la colonia.

El proyecto de innovación social resultante enfoca su propuesta de valor entre el sector de mujeres jefas de familia que habitan en la colonia, quienes de acuerdo con datos del Centro de Investigaciones y Estudios de Género (CIEG) a nivel de la ciudad de Guadalajara (2023), representan el 38.9% de los hogares censales que están a su cargo, quienes además, deben hacer frente a problemáticas vinculadas con algún tipo de violencia, así como a una desigualdad salarial relevante.

La propuesta de valor

El desglose de acciones encaminadas a consolidar la propuesta de valor para el centro barrial Lomas del Paraíso II agrupa 4 propuestas conceptuales, cuyo objetivo es contribuir significativamente en la transformación del entorno y del sector social objetivo mediante los siguientes proyectos:

Módulo informativo: Este espacio ubicado al interior del centro barrial permite a mujeres jefas de familia y población adulta en general, realizar trámites en línea para la gestión de apoyos y servicios de cualquier índole, impresión de documentos y su resguardo en dispositivos externos. Su horario de atención es flexible y se adapta a las necesidades del usuario principal. No tiene costo y solo se paga por las impresiones requeridas. Su financiamiento se obtiene con apoyos del gobierno municipal de Guadalajara y de terceros (empresas).

Laboratorio de cómputo: En este laboratorio se ofertan cursos de nivelación escolar para el sector social de madres jefas de familia de manera prioritaria. En él se ubican espacios complementarios que posibilitan el desarrollo de tareas o ejercicios que fortalezcan su formación. La propuesta incluye la disposición de equipos de cómputo y una agenda de talleres que buscan incrementar las habilidades y competencias del sector social objetivo, de manera prioritaria.

Ludoteca: Este espacio de servicio, diseñado para brindar atención a niños, niñas, jóvenes y adolescentes en áreas de formación complementaria, proporciona un valor de funcionalidad relevante para el sector social de mujeres jefas de familia, quienes por lo general asumen el reto de atenderlas en horarios laborales o de no tener apoyo alguno para ello.

La ludoteca se ubica en las mismas instalaciones del centro barrial y a la vista de las demás áreas que componen la propuesta de valor en general, lo cual posibilita la asistencia y participación de mujeres jefas de familia durante las actividades ofertadas para su desarrollo personal. Los horarios de atención y servicio abarcan turno matutino y vespertino y su operación involucra personal de servicio social y/o prácticas profesionales de escuelas y centros de educación ubicados en la cercanía (Preparatoria 14 y Centro Universitario de Arte, Arquitectura y Diseño).

Auditorio: Este espacio físico tiene por objetivo ser la sede de un conjunto de actividades que fomenten la cultura, el intercambio y el desarrollo de la comunidad. Opera mediante una agenda mensual que se publica en redes sociales y promocionales impresos, incluyendo además, actividades organizadas por otras instancias municipales y organizaciones civiles.

En la siguiente imagen (Figura 4) se muestra una comparativa entre el estado actual del centro barrial y algunas áreas que estructuran la propuesta de valor, particularmente la rehabilitación del

Figura 4. Imágenes actuales del centro barrial y prototipos de innovación social para sus espacios interiores. Fuente: MDII, 2023.

auditorio, de la ludoteca, el módulo informativo y el laboratorio de cómputo. El plano describe el área territorial (Figura 5) y permite ver la distribución de dichos elementos en relación con el resto que actualmente contiene.

El avance del proyecto mantiene en proceso la estrategia operativa del centro barrial y los apoyos de terceros. Sin embargo, los equipos responsables ya tienen acuerdos verbales con instancias universitarias del Centro Universitario de Arte, Arquitectura y

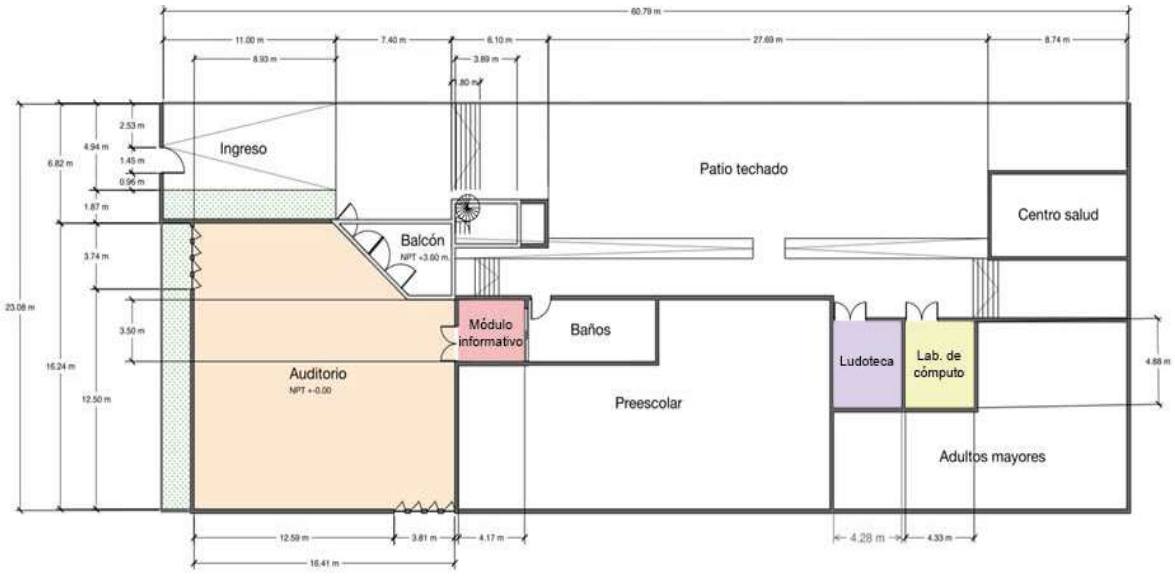

Figura 5. Plano del Centro Barrial Lomas del Paraíso II que destaca las 4 áreas que serán rehabilitadas como parte del proyecto de innovación social. Fuente: MDII, 2023.

Diseño de la Universidad de Guadalajara y con la Secretaría de Proyectos Especiales del H. Ayuntamiento de Guadalajara (2021-2024), quienes manifiestan interés por impulsar el proyecto, particularmente la oficina de gobierno municipal, toda vez que existen recursos económicos que pueden ser destinados a iniciativas del orden educativo y social.

A este respecto, durante la presentación de los proyectos en la sesión de Cabildo del día 22 de marzo de 2024 realizada en instalaciones del H. Ayuntamiento de Guadalajara, regidores y representantes de instancias educativas a nivel municipal y estatal manifestaron el interés de incorporar los proyectos en la agenda de seguimiento de la comisión de educación, situación que contribuye al seguimiento y materialización de los proyectos a mediano plazo.

Proyecto 2: Fortalecimiento de la infraestructura educativa y del entorno urbano inmediato de la Secundaria Técnica No. 78. Estudiantes: Gilberto Ortega Barbizani y Miguel Angel López Méndez

La imagen a continuación (Figura 6) muestra el territorio actual (4,484 mts2) de la Escuela Secundaria Técnica No. 78, la cual posee una infraestructura educativa para atender aproximadamente a 1,500 estudiantes que viven en sus alrededores. Se ubica en el subdistrito Huentitán El Alto de la ciudad de Guadalajara, Jalisco. El territorio urbano que la contiene se caracteriza por la vulnerabilidad social y urbana, la cual ha sido objeto en los últimos años de litigios derivados de conflictos con empresas constructoras que buscan edificar en la zona complejos habitacionales de lujo ante la oposición de sus habitantes.

Figura 6. Mapa del territorio que contiene a la Escuela Secundaria Técnica No. 78. Fuente: Google Earth, 2024.

Adicionalmente, la imagen da cuenta del recorrido que es necesario llevar a cabo por parte de estudiantes del plantel, que al vivir en el otro lado de la avenida Periférico, requieren de cruzar para acudir a sus hogares. Las características visibles de este espacio territorial posibilita imaginar los riesgos que esto puede generar (asaltos en vía pública, accidentes, violaciones) tanto para estudiantes como para profesores y padres de familia involucrados de alguna manera con la escuela secundaria.

En este orden de ideas, durante la etapa de entrevistas con directivos del plantel, se documentaron ilícitos reportados por las mismas autoridades, sobre todo en los horarios de salida de ambos turnos. Dicha situación derivó en la necesidad de solicitar apoyo de la policía municipal en los horarios de mayor riesgo.

De igual forma se mencionó que entre las principales problemáticas que acechan tanto el exterior de la escuela como el de las personas involucradas o familias, el narcotráfico y la presencia de familias disfuncionales son las principales cuestiones sociales que inciden en el rendimiento de los estudiantes. La evidencia de esta última afirmación compartida por las autoridades de la escuela es el incremento de la presencia de abuelos en las reuniones de padres de familia, quienes expresan de forma cotidiana su vulnerabilidad ante el hecho de tener que asumir la responsabilidad del cuidado y atención de jóvenes que son desatendidos por sus padres.

Un dato importante derivado de las entrevistas con estudiantes y personal del plantel educativo, es la opinión negativa respecto a la infraestructura interna y externa de la escuela (Figura 7), así como la plantilla de profesores del plantel; lo que trae como consecuencia que los padres o tutores procuren lugares más seguros y donde las clases sean regulares, es decir, sin

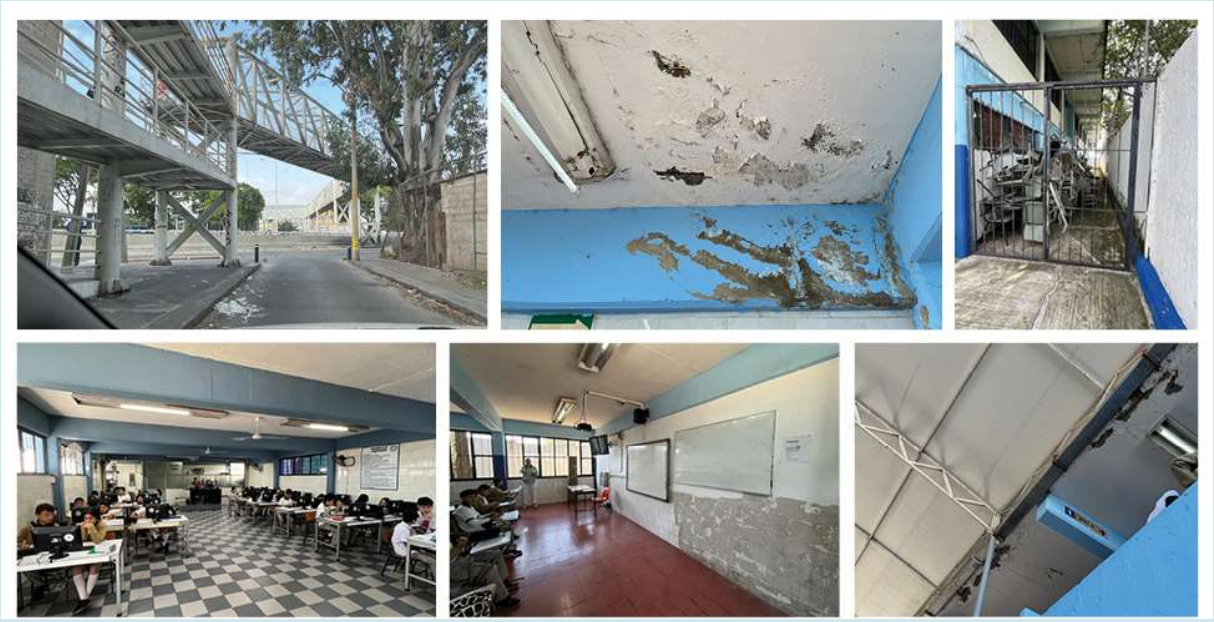

Figura 7. Imágenes de la infraestructura del plantel con detalles de aulas y espacios exteriores. Fuente: MDII, 2023.

deficiencias de planta docente para cubrir la totalidad de las materias que componen el plan de estudios de nivel secundaria y con espacios físicos adecuados para la formación de los estudiantes.

Es necesario aclarar que las condiciones del plantel no son caóticas, sin embargo, sí muestran importantes áreas de oportunidad que por lo general deben ser resueltas por los mismos directivos, pues a decir de los mismos, son ellos quienes deben implementar estrategias para conseguir apoyos y recursos que resuelvan las necesidades de la escuela y su operación.

En lo que respecta con la deserción escolar presente en la escuela secundaria, Directivos del plantel manifiestan que la situación económica, los divorcios y el entorno conflictivo son los principales factores que terminan por incidir en el abandono escolar.

La propuesta de valor

El desarrollo de los instrumentos contenidos en las primeras etapas del método de innovación social generó un conjunto de Insights que dieron forma a una propuesta integral de valor estrechamente relacionada con los aprendizajes y oportunidades de la educación secundaria en México (CEPAL, 2021) que se traducen en los siguientes proyectos:

Diseño de identidad visual: Uno de las problemáticas percibidas por parte de la población estudiantil y docente, dejó en claro la necesidad de impulsar una estrategia que fortaleciera la identidad de los estudiantes con la institución y sus principales componentes o estructura operativa (profesores, instalaciones, personal administrativo). Lo antes señalado sirvió como argumento para el desarrollo de una identidad visual fundamentada en cuatro escenarios de acciones estratégicas (observa y explora, idea e imagina, crea comunidad, desarrolla) que se propone impacten no solo en la distribución de áreas del plantel y su correspondiente señalización, sino también en la operación de acciones que contribuyan a fomentar el aprendizaje significativo de una población estudiantil caracterizada por condiciones vulnerables.

Los elementos visuales que estructuran la propuesta de identidad para el plantel (Gráfica 8) y su organización operativa sugerida, consideran cuatro escenarios didácticos (observar y explorar, crear comunidad, idear e imaginar y desarrollar) que podrían impactar de manera relevante la condición actual de la secundaria.

El enfoque estratégico radica en implementar ajustes y acciones del orden didáctico en algunas de las materias del modelo educativo a partir de la interpretación semántica que sugiere cada

componente visual o escenario didáctico. Como ejemplo de lo antes mencionado podemos señalar el caso de las materias de cómputo, las cuales tendrían que ser rediseñadas en su planeación estratégica para incluir instrumentos didácticos como el aprendizaje basado en proyectos (ABP), lo cual no sólo tendría impacto en la formación de los estudiantes, sino en la creación de cultura al interior del plantel.

Aula modelo: Durante la etapa de identificación de Insights se evidenció la necesidad de crear prototipos de aulas que por su diseño y disposición de

Figura 8. Elementos de identidad visual para el plantel educativo, reconocidos como escenarios didácticos.

elementos internos (mobiliario) impulsan dinámicas colaborativas entre estudiantes y profesores, es decir, que rompan esquemas tradicionales y que se adapten más a la nueva realidad tecnológica de las generaciones de estudiantes.

La propuesta de innovación social permite a estudiantes de nivel de secundaria acceder a servicios tecnológicos para interactuar con los contenidos formativos de sus materias, a resguardar proyectos de trabajo, interactuar de forma colaborativa con otros compañeros y participar en sesiones en línea.

Aula de cómputo: En el mismo orden de ideas, el área de cómputo que actualmente se utiliza en la escuela muestra un conjunto de necesidades en aspectos como: equipo tecnológico, software, internet e instalaciones. El prototipo de aula de cómputo busca crear valor a partir de la disposición de un espacio físico diferente que contiene por lo menos 30 equipos de cómputo actualizados, cargados con software cuyo uso genera habilidades y competencias entre sus usuarios, así como equipos de proyección e internet de calidad que facilitan su uso para el desarrollo de proyectos y tareas de materias incluidas en el programa académico de la escuela. Incluso la propuesta considera el uso y disposición de equipos en horarios que no necesariamente correspondan con materias de cómputo, es decir, se busca la apropiación del lugar por parte de los estudiantes.

Biblioteca: El rediseño de este espacio físico al interior del plantel educativo pretende crear las condiciones necesarias para generar un ambiente de aprendizaje capaz de motivar a estudiantes para adquirir el hábito de la lectura, el intercambio de opiniones y el uso de tecnología para el desarrollo de tareas.

Instalaciones generales: El último componente de la propuesta de valor para la escuela secundaria, es la rehabilitación del área de canchas y de espacios verdes al interior del plantel. El enfoque integral de la rehabilitación de la escuela y de su entorno urbano inmediato se termina de configurar con este tipo de adecuaciones, lo cual constituye una mejora incremental desde la perspectiva de la innovación.

El conjunto de prototipos siguientes (Figura 9) destaca las principales áreas físicas ubicadas al interior del plantel que estructuran la propuesta de valor desglosada en párrafos anteriores. A este respecto, es importante señalar que tanto el proyecto de innovación social como el equipo de trabajo responsable del mismo, reconocen la relevancia que tiene el entorno urbano y la infraestructura educativa en la conducta y rendimiento (Injuve Barcelona, 2007) de los estudiantes del plantel educativo. Por consiguiente, las 5 propuestas buscan incidir en los espacios físicos y lugares externos que se

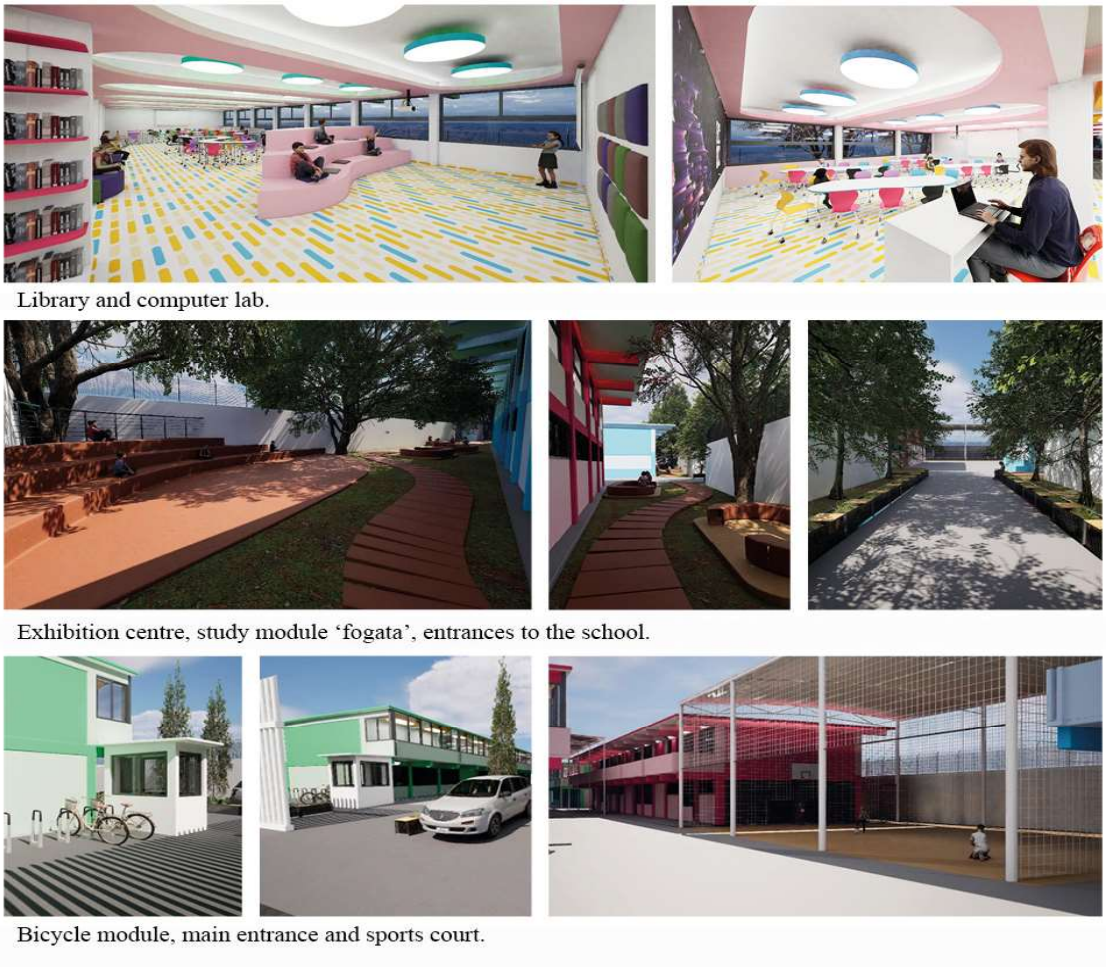

Figura 9. Renders de propuestas de valor desarrolladas para los diferentes espacios físicos del plantel que corresponden con la propuesta de valor incremental para la escuela secundaria. Fuente: MDII, 2023.escenarios didácticos. Fuente: MDII, 2023.

involucran directa e indirectamente en la formación educativa de los jóvenes que en la secundaria estudian.

Vinculado con lo anterior, durante el desarrollo de los prototipos se planteó ante autoridades de la escuela, la necesidad de establecer un programa de vinculación entre el plantel educativo de secundaria y actores relevantes u organizaciones presentes de su entorno urbano, con quienes se acuerde un conjunto de acciones que puedan representar valor para las partes interesadas.

La distribución de áreas en el territorio del plantel educativo incluidas en la propuesta de valor del proyecto de innovación social (Figura 10), guarda una relación estrecha con los enfoques de trabajo que la identidad visual establece (observar y explorar, crear comunidad, idear e imaginar, desarrollar) como mega estrategia didáctica, que en su conjunto, busca trascender de manera positiva en la formación de los estudiantes.

Un componente adicional de los prototipos previamente mostrados, corresponde con una serie de intervenciones del entorno urbano inmediato al plantel educativo en

Figura 10. Plano general de la Escuela Secundaria Técnica No. 78 que contiene la distribución de espacios físicos relacionados con las categorías de identidad visual. Fuente: MDII, 2023.

el que tanto estudiantes como padres de familia, profesores y administrativos, interactúan de manera cotidiana. Particularmente el proyecto considera como argumento para su desarrollo, necesidades latentes expresadas por los usuarios y validadas mediante revisión de documentos municipales que destacan lo siguiente: ausencia de parabuses y de una ruta peatonal segura, interrupción de ciclovía, falta de iluminación, existencia de punto ciego en la calle que conecta la vialidad de la escuela con la avenida Periférico (justo por debajo del puente peatonal), exposición a desarrollos industriales, predios abandonados e incluso animales libres que transitan por la zona.

En consecuencia con lo previamente señalado, la imagen siguiente (Figura 11) muestra el avance en cuanto a la transformación urbana del territorio inmediato al plantel educativo. El módulo 1 concentra su valor en la rehabilitación de calles secundarias que prácticamente rodean la escuela pero que respetan el sentido de las mismas. Su objetivo es contribuir con la seguridad de peatones y vehículos que transitan hacia la avenida Periférico a través de la calle que conecta con la secundaria. El módulo 2 propone generar una Zona 30 sobre la calle Sitio de Puebla para limitar la velocidad de vehículos y con ello, contribuir con la recuperación del valor social de las calles involucradas. Los módulos 3 y 4 se enfocan en la adecuación de un espacio externo para habilitarlo como estacionamiento para profesores y el correspondiente rediseño del ingreso del plantel desde una perspectiva inclusiva que asegura la atención de cualquier grupo social y mejora la habilidad, la oportunidad y dignidad de estudiantes con algún tipo de desventaja.

Figura 11. Avances de las propuestas de rehabilitación del entorno inmediato de la Escuela Secundaria Técnica No. 78. Fuente: MDII, 2023.

Conclusiones

Los talleres de diseño e innovación social son espacios de co-creación en los que ocurren un conjunto de actividades que permiten la entrega de valor a usuarios finales mediante el análisis de las variables que determinan el estado de las cosas; el intercambio de ideas; el trabajo colaborativo y transversal; el debate con terceros, y el desempeño transdisciplinar que posibilita el diseño y validación de prototipos destinados a satisfacer necesidades sociales.

Son instrumentos didácticos que manifiestan por lo general dos escenarios: el primero de ellos corresponde con la materialización de prototipos del orden social que demandan un análisis sistemático de la información obtenida en cada una de sus etapas o proceso de trabajo. El segundo escenario se caracteriza por poner en evidencia la dificultad para trabajar en equipo, para analizar las variables y describir de manera específica problemáticas sociales por parte de los estudiantes participantes, quienes por lo general, proceden de modelos educativos con importantes dificultades en cuanto al desarrollo de habilidades y conocimientos vinculados con una compleja realidad laboral situados por debajo del promedio establecido por la Organización para la Cooperación y el Desarrollo Económico (OCDE, 2017).

Bajo esta premisa, el taller se convierte en un instrumento didáctico con enorme potencial para generar aprendizaje significativo entre los estudiantes que en él participan. Lo es, porque además involucra equipos multidisciplinarios que colaboran sistemáticamente en el desarrollo de propuestas de valor que tienen como fundamento el análisis de la naturaleza de la problemática inicial, desde perspectivas profesionales diferentes.

La configuración del taller de diseño e innovación social del posgrado Maestría en Diseño e Innovación Industrial, de la Universidad de Guadalajara, pretende consolidar adicionalmente dos dimensiones generadoras de valor funcional: la primera de ellas refiere al beneficio que tiene establecer a la innovación social como hilo conductor de otros programas académicos que busquen desarrollar conocimientos y habilidades para generar valor al usuario final. La segunda corresponde con el hecho de incrementar el énfasis en la comprensión de la influencia que el entorno urbano tiene en el individuo que vive, crece y se desarrolla en una realidad (México) plagada de problemáticas que terminan por lapidar en gran medida su futuro. Como ejemplo de lo anterior, y de acuerdo con el Informe de Movilidad Social en México 2019 del Centro de Estudio Espinosa Yglesias (CEEY), el 49% de la población que nace en hogares de bajos recursos, nunca salen de esa realidad.

Para quien escribe el presente documento, un aspecto diferencial del taller de diseño e innovación social, refiere el impulso de nuevas formas de pensar y aprender, dos aspectos clave si consideramos la realidad laboral o de emprendimiento a la que los estudiantes tendrán que hacer frente al momento de egresar de su educación universitaria.

Si bien es cierto que los resultados hasta ahora obtenidos en materia de aprendizaje significativo de estudiantes involucrados en el desarrollo de proyectos sociales al interior del taller del posgrado (MDII) se han validado empíricamente mediante la revisión exhaustiva de sus procesos de trabajo y los resultados obtenidos, queda aún por resolver la forma en la que el programa académico de la maestría pueda extender y consolidar el valor del diseño y la innovación social entre organizaciones de gobierno y asociaciones civiles involucradas en la creación de soluciones ante problemáticas sociales que difícilmente visualizan proyectos más allá de sus periodos de tiempo administrativos.

A final de cuentas, el taller de diseño e innovación social, pretende ser un repositorio dinámico y flexible de herramientas e instrumentos cuyo uso y aplicación permita trascender más allá de la formación profesional del estudiante, más allá del aula universitaria y más allá del territorio urbano que nos contiene.

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Fuente de financiación

Este trabajo no ha recibido financiación alguna.

ISSN 2386-5414
e-ISSN: 2340-8391

Research article | Articulo de investigacón

Social innovation from the design workshop: implications in the urban and social transformation of vulnerable communities | Innovación social desde el taller de diseño: implicaciones en la transformación urbana y social de comunidades vulnerables

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Received: March 1, 2024 | Accepted: May 15, 2024 | Published: 29 de junio 2024
DOI:https://doi.org/10.24310/p56-idj1202419183

Abstract

This document describes the experience of social innovation implemented in the design workshop of the postgraduate Master in Design and Industrial Innovation at the University Center of Art, Architecture and Design of the University of Guadalajara.

The multidisciplinary approach of the workshop, conformed by different professional profiles of the students participating in the school calendar 2023B and 2024A of the current generation, implies the use of social innovation methods that are an essential part of the postgraduate curriculum, which facilitate the performance of the different actions corresponding to the different tools that compose or structure the work process that innovation methods require.

The document describes two case studies implemented to address social issues identified within an urban polygon near the University Center of Art, Architecture and Design of the University of Guadalajara and three neighborhoods or sub-districts belonging to the municipality of Guadalajara, Jalisco.

In its paragraphs, the progress of the process of approaching and generating value proposals from the perspective of social innovation has been validated, in the first instance, by end users and authorities of the municipality of Guadalajara.

The final part includes a reflection on the contribution that social innovation has in the training of students and in the understanding of social problems that represent a starting point for the urban and social transformation of our territory.

Keywords: Industrial design, social innovation, design workshop, darticipatory design, Design Education

Introduction:

Social problems as a starting point

The characterization of the social problems prevailing in today's vulnerable urban territories requires a necessary classification of things that make it possible to better understand and address them. In this regard and according to the Economic Commission for Latin America and the Caribbean (ECLAC, 1989), a social problem is "a condition that affects a significantly considerable number of people, in a manner considered inconvenient and which it is believed should be corrected through collective social action". Underlying this definition is a set of dimensions that make it possible to visualize an important number of variables involved in its problematic condition. In the first of these, it is established at the outset that a specific group of individuals is affected, "a significantly considerable number of people" (ECLAC, 1989, p. 2), and not someone in particular.

The second dimension addresses the circumstance that represents "a discrepancy between a state of desirability" (ECLAC, 1989, p. 3) and what we socially recognize as standardized. The third dimension focuses on "the belief that a solution is possible through collective action" (ECLAC, 1989, p. 3), that is, through the joint participation of several of the elements involved, directly and indirectly in that condition.

According to the international organization ECLAC (1989), social problems are determined by the spatio-temporal circumstances in which they manifest themselves. Thus, what is standardized may not necessarily be the best. Even so, the establishment of a problem seems to be due to a state of discrepancy that is generally due to the lack of operational capacity of some of the variables with the greatest weight in decision-making.

When using this precept in urban space, approached from the design workshop, it is necessary to consider the volatility of the variables that compose it. In an urban area with a certain level of population growth, the space corresponding to a given time and place will hardly be able to satisfy the needs and demands of larger and more diverse social groups.

ECLAC continues:

> As Oszlak and O'Donnel state, "no society possesses either the capacity or the resources to meet all the needs and demands of its members... only some are problematized, in the sense that certain classes, class fractions, organizations, groups or even strategically placed individuals believe that it can and should be done" (ECLAC, 1989, p. 4).

Social problems are therefore circumstances that can become social issues when "a sequence occurs that is characterized by redefining the situation, focusing discontent, capturing public attention and forming pressure groups" (ECLAC, 1989, p. 4). The above could be considered as an additional dimension, in which it is possible to place in the collective imaginary the need to be addressed and resolved.

The study area and its social problems

For the development of this work project, the team of teachers and students involved decided to identify a geographical area in the city based on three relevant aspects: the first refers to the social vulnerability of its population, that is, the susceptibility to suffer some kind of damage, both in the physical and emotional dimension, due to some external factor. The second refers to the necessary proximity to the educational center where the project is located to facilitate the access of the students involved to the territory. The third aspect corresponds to the conditions of the environment to generate development opportunities.

Consequently, the decision was made to establish a study polygon composed of three sub-districts with backgrounds related to social vulnerability: Lomas del Paraíso, Zoológico and Huentitán El Bajo, all belonging to Zone 03 Huentitán of the

Metropolitan Area of Guadalajara, Jalisco (In-Ciudades, 2020). The three neighborhoods are located around the University Center of Art, Architecture and Design of the University of Guadalajara, headquarters of the Master's Degree in Industrial Design and Innovation.

In the following image (Figure 1) obtained by the Institute for Research and Studies on Cities (In-Ciudades) of the University of Guadalajara (2020) through the INEGI platform (2020), the Partial Urban Development Plan of Jalisco (2020) and with data from CONAPO (2020), the territorial dimension of the study area and the geographic areas or AGEBS (Basic Urban Geostatistical Area of Mexico) that refer to levels of marginalization can be seen. The latter is understood as "the lack of social opportunities and the absence of capacities to acquire or generate them, as well as deprivation and inaccessibility to goods and services that are fundamental for well-being" (IIEG, 2021). The image highlights the 10 AGEBS with medium level of marginalization identified by the Population and Housing Census (2020) and published by INEGI in 2020, who also give it a very low level according to its methodology (IIEG, 2021), which is interpreted for this document as an area of opportunity for the development of social innovation projects within the design workshop.

In relation to the social problems or issues with greater relevance in the polygon that delimits the study area, the work team prepared a first list that highlights those with greater public recognition by the media, government offices and research groups of local universities: theft from private vehicles and family violence (Transparencia Guadalajara, 2017), areas of pollution, subsidence and flooding (In-Ciudades, 2020), redensification, gender equality lag (INEGI, 2022), school dropouts at secondary level, vandalized and underutilized green spaces, as well as insecurity in general.

Methodology

The theoretical basis that supports the inclusion of a design thinking method in this case study, lies in the need to observe in detail the user's needs and generate value from different perspectives than what usually occurs in social projects in which public and civil organizations are involved in some way.

The aim is not only to show evidence that reveals the attributes of the method, but also to generate knowledge on the development of projects aimed at meeting the tacit or latent needs of vulnerable social groups (Micheli et al., 2019) from the perspective of social innovation.

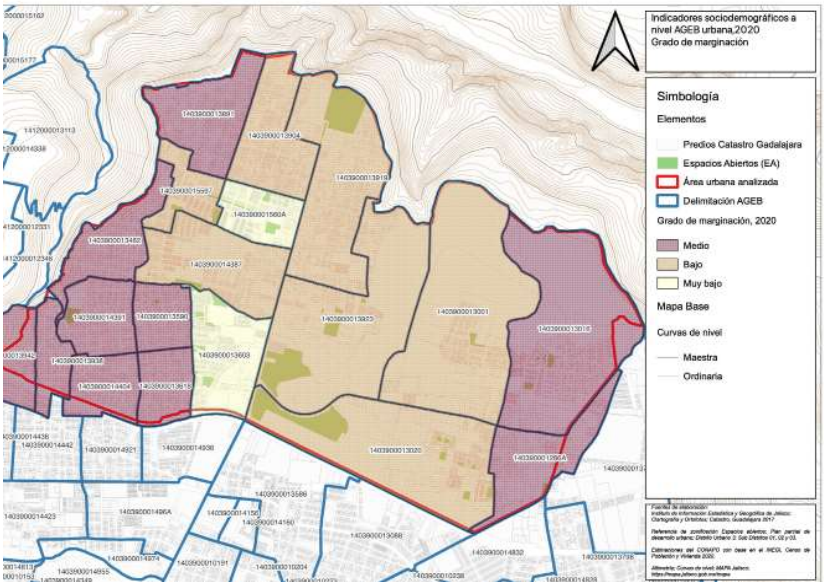

Figure 1. Socio-demographic indicators at the urban AGEB level in 2020. Source: In-Cities, 2023.

A complementary aspect that argues for the use of the design thinking method refers to the collaborative work process necessary to involve students from different professional profiles in the creation of value propositions that address specific problems. In this scenario of transversal collaboration, the method provides didactic tools such as project-based or problem-based learning to drive the necessary interaction among participants, as well as the required iteration of the creative processes resulting from the systematic validation by the user in the different stages of the method.

From the teaching point of view, the development of the project assumes the discussion on design thinking; that which reviews the social implications that the method has and the feasibility scenario that in terms of market opportunity the project provides for the students involved, who through the experience of carrying out its management and implementation, strengthen the significant learning in design and innovation, fundamental aspects of professional training of the postgraduate program that summons them.

Design thinking is therefore recognized as "an alternative approach to strictly analytical approaches, which are considered ineffective in contexts characterized by complexity and dynamism" (Micheli et al., p. 22, 2019) for the resolution of common problems that affect virtually any scenario or organization in the social realm.

The use of the design thinking method in projects such as the one referred to in this article, strengthens the theoretical and practical process in relatively short periods of time, which allows participants to develop rapid resolution skills for future work scenarios, characterized by dynamism. Linked to the above, the method positions the idea among those involved in it, about the practical relevance of working under specific procedures that facilitate the understanding of the variables that characterize common problems and the way in which they are translated into opportunities.

The methodology applied in action

For the development of the design and social innovation project, a design thinking method was implemented (Figure 2) containing 5 strategic phases: Immersion, Challenge Statement, Value Construction, Prototyping and Production Management. Each of the phases includes a set of tools that allow the understanding of the problem, its variables, the resulting social implications, and of course, the value propositions materialized in prototypes.

With regard to the breakdown of the method, particularly during the first strategic phase (Immersion), an approach process was initiated that required the analysis of the documented information that currently existed regarding the problems or social issues of the population currently living in the study area. During this activity, it was made clear the intention of analyzing each of them and submitting them to viability and feasibility criteria, prior to the selection of those with the greatest possibility of materialization. The collection, evaluation, selection and synthesis of the main problems identified (Peña, 2022, p.4) by the working groups, including undergraduate and graduate professors, made it possible to establish an evaluation process in which feasibility was the most relevant criterion for the selection of the case studies in the design workshop.

As a result of the above, 4 themes linked to specific problems were identified, which led to the integration of the same number of work teams. However, for this article we only include information on 2 projects, which presented a better feasibility scenario supported by the existence of municipal and federal government programs (Pronaces, 2024) linked to the themes, which translates into a scenario with greater certainty.

The table 1 describes in detail the problems identified and the description of the project or work challenge:

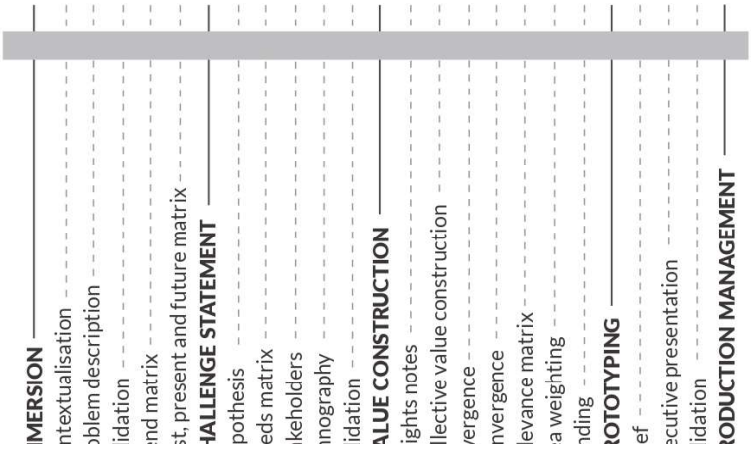

Figure 2. Breakdown of tools used in the social innovation method. Source: IDEO, 2022.

Once the above was defined, the second phase was implemented: Challenges statement. In this stage, each work team proceeded to establish hypotheses, analyze user needs, identify stakeholders, design and analyze interviews, as well as the corresponding validation of the information obtained in this work process.

Results

Below is a description of the results at the end of January 2024 of the projects under development within the Master's Degree in Industrial Design and Innovation (MDII) corresponding to the school calendars 2023B and 2024A (in progress) that show, from the perspective of the writer of this article, the contribution that social innovation has in the professional training of the participants and the benefits that this represents for the urban and social transformation of vulnerable communities.

Project 1: Rehabilitation of the Lomas del Paraíso II Neighborhood Center for the social strengthening of women heads of household living in the neighborhood, whose main problems are related to school dropout, low income, violence and lack of opportunities for personal development. Participating students: Robles Vigil Cristina and Chávez López Eva Esperanza Margarita.

This community space, which depends on the Integral Family Development (DIF Jalisco), is located on Joaquín Mucel Street No. 664, in the Lomas de Paraíso II district, as shown in the following image (Figure 3).

This neighborhood center is identified as a meeting point for the population living in the surrounding area. It is adjacent to a church, a childcare center and a preschool, as well as a number of established and informal commercial establishments.

Table 1. Issues at the center and work project

PROBLEM	According to INEGI (2022), the percentage of women living in the area is 51.24%, of which, a significant portion is lagging behind in terms of gender equality and empowerment, particularly women heads of household, i.e., the most senior member, either because of their economic support, age or because they are the decision-makers in the family (INEGI, 2020).	According to information from the Ministry of Development and Social Integration of the State of Jalisco (2018). t is estimated that in Jalisco and its metropolitan area (AMG) there is a high school dropout rate corresponding to 4.38% of the student population, which results in 19,091 students who are generally involved in informality.
PROJECT	Rehabilitation of the Lomas del Paraíso neighborhood center for the social strengthening of women heads of household living in the neighborhood.	Strengthening of the educational infrastructure and the immediate urban environment of Technical High School No. 78.

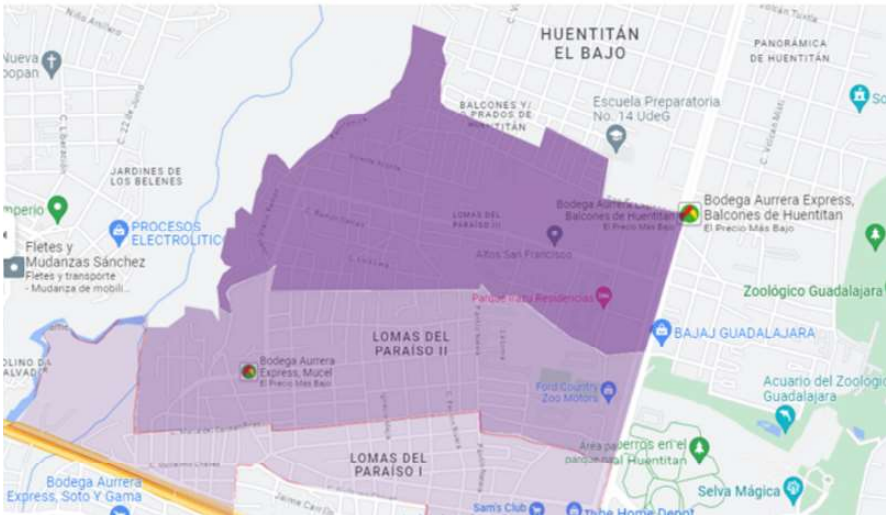

Figure 3. Demarcation of the Lomas del Paraíso neighborhood. Source: Google maps, 2023.

According to the information obtained in the Immersion stage of the social innovation method, the neighborhood center was recently physically reconditioned by municipal authorities of the city of Guadalajara, which has allowed the organization of various activities, both outside and inside, but only during the morning hours. However, it was also evident that it lacks a systematic offer of activities or social programs that have a significant impact on the vulnerable population of the neighborhood.

The resulting social innovation project focuses its value proposition on the sector of women heads of household living in the neighborhood, who according to data from the Center for Research and Gender Studies (CIEG) at the city of Guadalajara (2023), represent 38.9% of the census households under their care, who also face problems related to some type of violence, as well as significant wage inequality.

The value proposal

The breakdown of actions aimed at consolidating the value proposal for the Lomas del Paraíso II neighborhood center groups 4 conceptual proposals, whose objective is to contribute significantly to the transformation of the environment and the target social sector through the following projects:

Information Module: This space located inside the neighborhood center allows women heads of household and the adult population in general, to carry out online procedures for the management of support and services of any kind, printing of documents and their safekeeping in external devices. Its hours of operation are flexible and can be adapted to the needs of the main user. It is free of charge and you only pay for the required printouts. Its financing is obtained with support from the municipal government of Guadalajara and third parties (companies).

Computer lab: In this laboratory we offer school leveling courses for the social sector of mothers who are heads of household as a priority. It includes complementary spaces that enable the development of tasks or exercises to strengthen their education. The proposal includes the provision of computer equipment and an agenda of workshops that seek to increase the skills and competencies of the target social sector, as a priority.

Playroom: This service space, designed to provide care for children, youth and adolescents in areas of complementary education, provides a value of functionality relevant to the social sector of women heads of household, who usually assume the challenge of attending to them during working hours or without any support for it.

The playroom is located in the same facilities of the neighborhood center and within sight of the other areas that make up the overall value proposition, which

enables the attendance and participation of women heads of household during the activities offered for their personal development. The hours of attention and service cover morning and afternoon shifts and its operation involves social service personnel and/or professional internships from nearby schools and education centers (High School 14 and Centro Universitario de Arte, Arquitectura y Diseño).

Auditorium: The purpose of this physical space is to host a series of activities that promote culture, exchange and community development. It operates through a monthly agenda that is published in social networks and printed promotional materials, including activities organized by other municipal agencies and civil organizations.

The following picture (Figure 4) shows a comparison between the current state of the neighborhood center and some of the areas that make up the value proposition, particularly the rehabilitation of the auditorium, the playroom, the information module and the computer lab.

The plan describes the territorial area (Figure 5) and shows the distribution of these elements in relation to the rest that it currently contains.

Figure 4. Current images of the neighborhood center and social innovation prototypes for its interior spaces. Source: MDII, 2023.

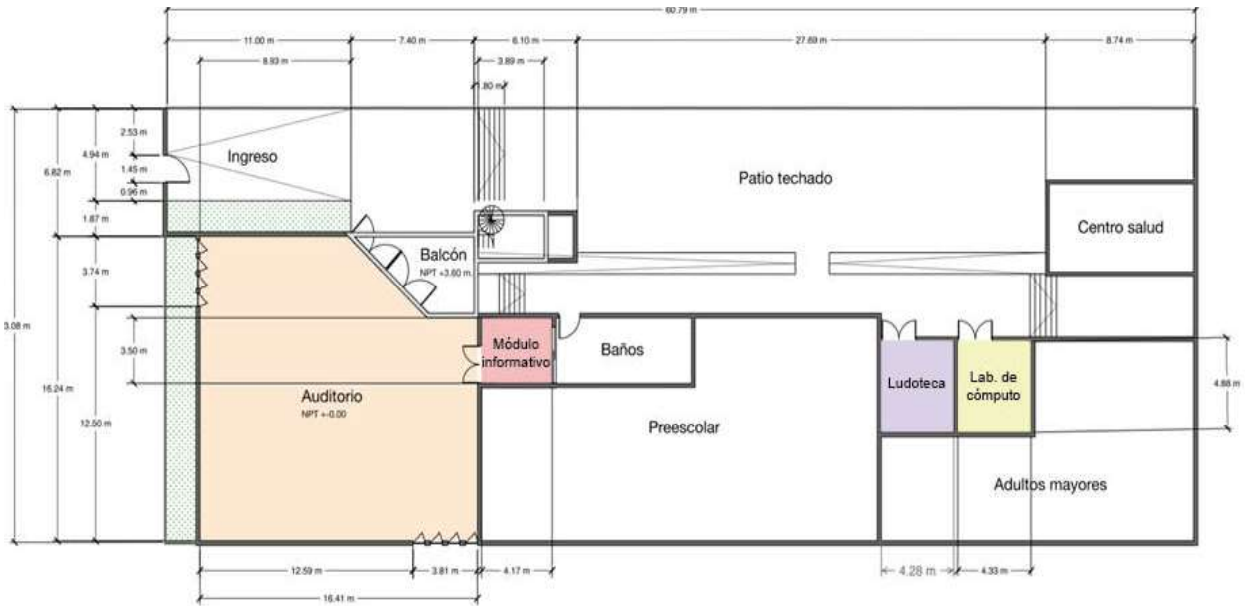

Figure 5. Plan of the Lomas del Paraíso II Neighborhood Center highlighting the 4 areas that will be rehabilitated as part of the social innovation project. Source: MDII, 2023.

The progress of the project keeps the operational strategy of the neighborhood center and the support of third parties in process. However, the responsible teams already have verbal agreements with the University Center of Art, Architecture and Design of the University of Guadalajara and with the Special Projects Secretariat of the Guadalajara City Council (2021-2024), who are interested in promoting the project, particularly the municipal government office, since there are economic resources that can be used for educational and social initiatives.

In this regard, during the presentation of the projects at the City Council meeting held on March 22, 2024 at the Guadalajara City Hall, aldermen and representatives of municipal and state educational agencies expressed their interest in incorporating the projects in the follow-up agenda of the education commission, a situation that contributes to the follow-up and materialization of the projects in the medium term.

Project 2: Strengthening of the educational infrastructure and the immediate urban environment of Junior High School No. 78: Gilberto Ortega Barbizani and Miguel Angel López Méndez.

The following picture (Figure 6) shows the current territory (4,484 mts2) of Junior High School No. 78, which has an educational infrastructure to serve approximately 1,500 students living in the surrounding area. It is located in the Huentitán El Alto subdistrict of the city of Guadalajara, Jalisco. The urban territory that contains it is characterized by social and urban vulnerability, which in recent years has been the subject of litigation arising from conflicts with construction companies seeking to build luxury housing complexes in the area in the face of opposition from its inhabitants.

In addition, the picture shows the route that must be taken by the students of the school, who need to cross to go home, since they live on the other side of Periferico Avenue. The visible characteristics of this territorial space make it possible to imagine the risks

Figure 6. Map of the territory containing Junior High School No. 78. Source: Google Earth, 2024.

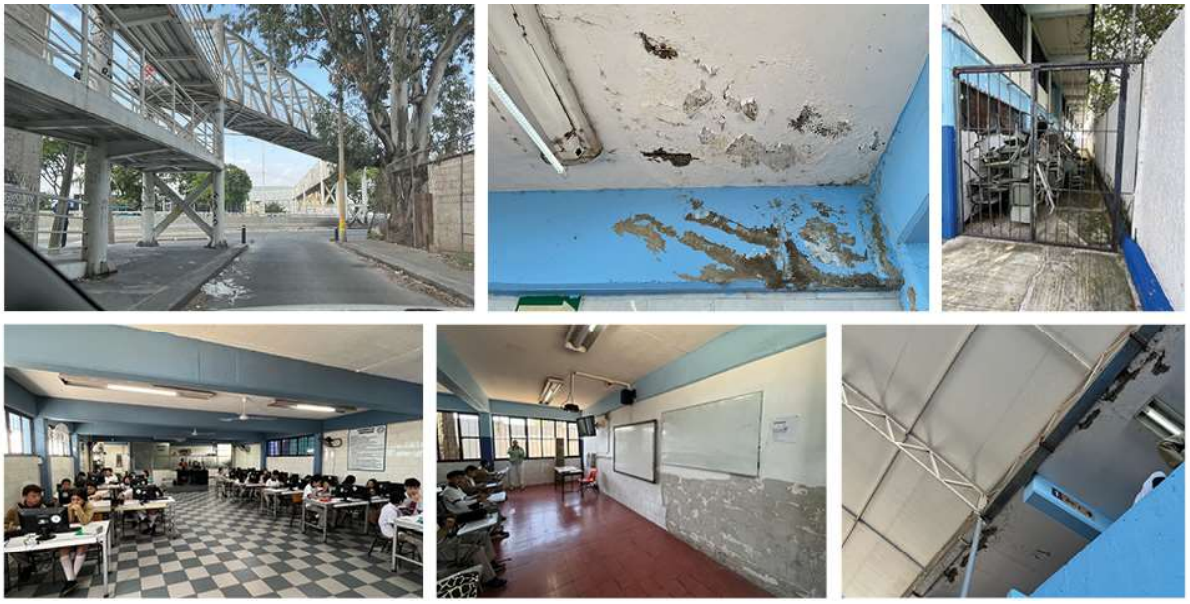

Figure 7. Pictures of the campus infrastructure with details of classrooms and outdoor spaces.

that this can generate (assaults on public roads, accidents, rapes) both for students and for teachers and parents involved in some way with the secondary school.

In this order of ideas, during the interviews with the school's directors, illegal acts reported by the authorities themselves were documented, especially during the departure times of both shifts. This situation led to the need to request support from the municipal police during the hours of greatest risk.

It was also mentioned that among the main problems that beset both the outside of the school and the people involved or families, drug trafficking and the presence of dysfunctional families are the main social issues that affect the performance of students. Evidence of this last statement shared by school authorities is the increased presence of grandparents at parents' meetings, who express on a daily basis their vulnerability in the face of having to assume responsibility for the care and attention of young people who are neglected by their parents.

An important fact derived from the interviews with students and school staff is the negative opinion regarding the internal and external infrastructure of the school (Figure 7), as well as the school's teaching staff, which results in parents or guardians seeking safer places where classes are regular, that is, without deficiencies in the teaching staff to cover all the subjects that make up the secondary level curriculum and with adequate physical spaces for the education of students.

It is necessary to clarify that the conditions of the school are not chaotic, however, they do show important areas of opportunity that generally must be solved by the directors themselves, since, according to them, they are the ones who must implement strategies to obtain support and resources to solve the needs of the school and its operation.

Regarding high school dropouts, school administrators state that the economic situation, divorces and the conflictive environment are the main factors that end up having an impact on school dropouts.

The value proposal

The development of the instruments contained in the first stages of the social innovation method generated a set of Insights that gave shape to a comprehensive value proposition closely related to the learning and opportunities of secondary education in Mexico (ECLAC, 2021) that translate into the following projects:

Visual identity design: One of the problems perceived by the student and faculty population made clear the need to promote a strategy to strengthen the identity of students with the institution

and its main components or operational structure (teachers, facilities, administrative staff). The aforementioned points were the basis for the development of a visual identity based on four scenarios of strategic actions (observe and explore, idea and imagine, create community, develop) that are proposed to impact not only on the distribution of areas of the campus and its corresponding signage, but also on the operation of actions that contribute to promote meaningful learning of a student population characterized by vulnerable conditions.

The visual elements that structure the identity proposal for the campus (Figure 8) and its suggested operational organization consider four didactic scenarios (observe and explore, create community, devise and imagine, and develop) that could have a relevant impact on the current condition of the secondary school.

The strategic approach lies in implementing adjustments and actions of the didactic order in some of the subjects of the educational model based on the semantic interpretation suggested by each visual component or didactic scenario. As an example of the aforementioned, we can point out the case of computer subjects, which would have to be redesigned in their strategic planning to include didactic instruments such as project-based learning (PBL), which would not only have an impact on students' education, but also on the creation of culture within the school.

Model classroom: During the Insights identification stage, the need to create prototypes of classrooms that, due to their design and arrangement of internal elements (furniture), promote collaborative dynamics between students and teachers, i.e., that break with traditional schemes and adapt to the new technological reality of the new generation of students, became evident.

The social innovation proposal allows high school students to access technological services to interact with the formative contents of their subjects, to save work projects, to interact collaboratively with other classmates and to participate in online sessions.

Computer classroom: In the same vein, the computer area currently used in the school shows a set of needs in aspects such as: technological equipment, software, internet and facilities. The computer classroom prototype seeks to create value from the provision of a different physical space that contains at least 30 updated computer equipment, loaded with software whose use generates skills and competencies among its users, as well as projection equipment and quality internet that facilitate their use for the development of projects and tasks of subjects included in the academic program of the school. The proposal even considers the use and availability of equipment in schedules that do not necessarily correspond to computer subjects, that is, it seeks the appropriation of the place by the students.

Figure 8. Elements of visual identity for the educational campus, recognized as didactic scenarios. Source: MDII, 2023.

Library: The redesign of this physical space within the school aims to create the necessary conditions to generate a learning environment capable of motivating students to acquire the habit of reading, exchanging opinions and the use of technology for the development of tasks.

General facilities: The last component of the value proposition for the high school

is the rehabilitation of the playground and green spaces inside the school. The integral approach to the rehabilitation of the school and its immediate urban environment is completed with this type of adaptation, which constitutes an incremental improvement from the perspective of innovation.

The following set of prototypes (Figure 9) highlights the main physical areas located inside the campus that structure the value proposition described in previous paragraphs. In this regard, it is important to note that both the social innovation project and the work team responsible for it recognize the relevance of the urban environment and educational infrastructure in the behavior and performance (Injuve Barcelona, 2007) of the students at the school. Therefore, the 5 proposals seek to influence the physical spaces and external places that are directly and indirectly involved in the educational formation of the young people who study at the high school.

In connection with the above, during the development of the prototypes, the need to establish a linkage program between the secondary school and relevant actors or organizations present in the urban environment was raised with school authorities, with whom a set of actions that could represent value for the interested parties could be agreed upon.

The distribution of areas in the territory of the school included in the value proposition of the social innovation project (Figure 10), is closely related to the work approaches that the visual identity establishes (observe and explore, create community, devise and imagine, develop) as a mega didactic strategy, which as a whole, seeks to transcend in a positive way in the education of students.

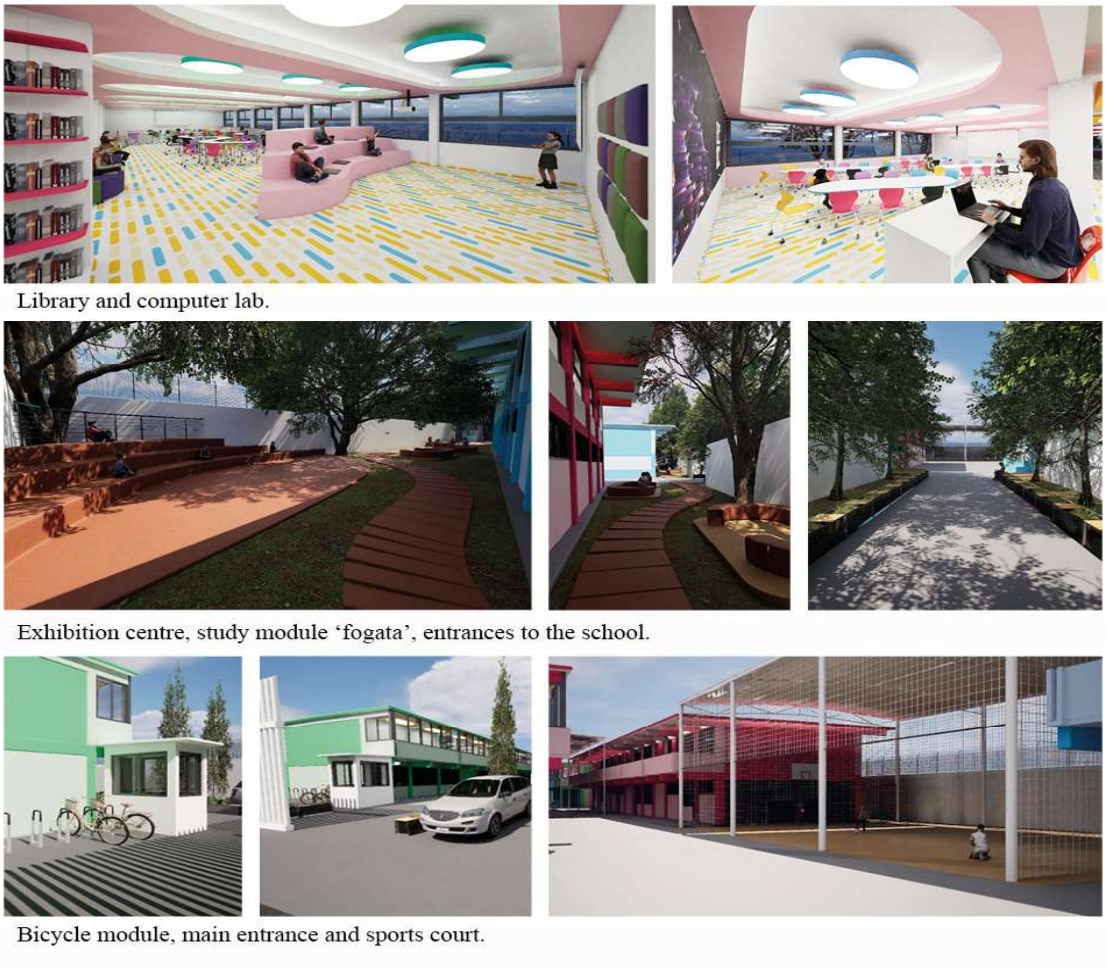

Figure 9. Renderings of value propositions developed for the different physical spaces of the campus that correspond to the incremental value proposition for the high school. Source: MDII, 2023.

Figure 10. General plan of Junior High School No. 78 containing the distribution of physical spaces related to the categories of visual identity. Source: MDII, 2023.

An additional component of the prototypes previously shown corresponds to a series of interventions in the urban environment immediately surrounding the school where students, parents, teachers and administrators interact on a daily basis. Particularly, the project considers as an argument for its development, latent needs expressed by users and validated through the review of municipal documents that highlight the following: absence of bus stops and a safe pedestrian route, interruption of bicycle lanes, lack of lighting, existence of a blind spot on the street that connects the school road with Periferico Avenue (just below the pedestrian bridge), exposure to industrial developments, abandoned properties and even free animals that pass through the area.

Consequently, the following picture (Figure 11) shows the progress in terms of urban transformation of the territory immediately surrounding the school. Module 1 concentrates its value on the rehabilitation of secondary streets that practically surround the school but respect the direction of the same. Its objective is to contribute to the safety of pedestrians and vehicles that travel towards Periferico Avenue through the street that connects with the high school. Module 2 proposes to generate a Zone 30 on Sitio de Puebla Street to limit the speed of vehicles and thus contribute to the recovery of the social value of the streets involved. Modules 3 and 4 focus on the adaptation of an external space to be used as a parking lot for teachers and the corresponding redesign of the entrance of

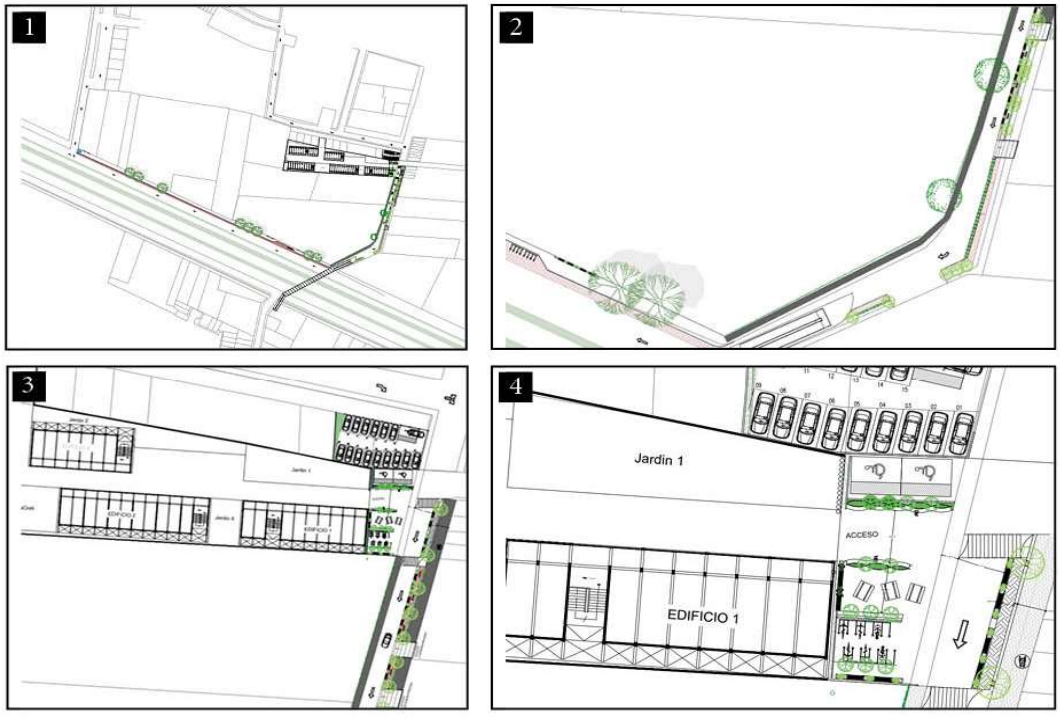

Figure 11. Progress of the proposals for the rehabilitation of the immediate surroundings of Junior High School No. 78: MDII, 2023.

the campus from an inclusive perspective that ensures the attention of any social group and improves the ability, opportunity and dignity of students with some type of disadvantage.

Conclusions

The design and social innovation workshops are spaces for co-creation in which a set of collaborative activities take place that allow the delivery of value to end users through the analysis of the variables that determine the state of things; the exchange of ideas; the collaborative and transversal work; the debate with third parties, and the transdisciplinary performance that makes possible the design and validation of prototypes aimed at satisfying social needs.

They are didactic instruments that generally show two scenarios: the first one corresponds to the materialization of prototypes of the social order that demand a systematic analysis of the information obtained in each of their stages or work process. The second scenario is characterized by highlighting the difficulty to work in teams, to analyze variables and to specifically describe social problems on the part of the participating students, who generally come from educational models with significant difficulties in terms of the development of skills and knowledge linked to a complex labor reality located below the average established by the Organization for Economic Cooperation and Development (OECD, 2017).

Based on this assumption, the workshop becomes a didactic instrument with enormous potential to generate significant learning among the students who participate in it. It is so because it also involves multidisciplinary teams that systematically collaborate in the development of value proposals based on the analysis of the nature of the initial problem, from different professional perspectives.

The configuration of the design and social innovation workshop of the Master's Degree in Design and Industrial Innovation of the University of Guadalajara, aims to additionally consolidate two dimensions that generate functional value: the first one refers to the benefit of establishing social innovation as a guiding thread of other academic programs that seek to develop knowledge and skills to generate value for the end user. The second corresponds to the fact of increasing the emphasis on understanding the influence that the urban environment has on the individual who lives, grows and develops in a reality (Mexico) plagued by problems that end up stoning his future to a great extent. As an example of the above, and according to the Report on Social Mobility in Mexico 2019 of the Centro de Estudio Espinosa Yglesias (CEEY), 49% of the population born in low-income households, never leave that reality.

For the author of this paper, a differential aspect of the design and social innovation workshop refers to the promotion of new ways of thinking and learning, two key aspects if we consider the labor or entrepreneurial reality that students will have to face when they graduate from their university education.

While it is true that the results obtained so far in terms of significant learning of students involved in the development of social projects within the postgraduate workshop (MDII) have been empirically validated through a thorough review of their work processes and the results obtained, it still requires to be solved the way in which the academic program of the master's degree can extend and consolidate the value of design and social innovation among government organizations and civil associations involved in creating solutions to social problems that hardly visualize projects beyond their administrative periods of time.

At the end of the day, the design and social innovation workshop aims to be a dynamic and flexible repository of tools and instruments whose use and application will transcend beyond the student's professional training, beyond the university classroom and beyond the urban territory that contains us.

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Source of funding

This work has not received any funding.

ISSN 2386-5414
e-ISSN: 2340-8391

Revisión | Review

Las claves de la ausencia de identidad del diseño industrial español | The keys to the lack of identity in Spanish industrial design

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Recibido: 15 de enero 2024 | Aceptado: 2 de mayo 2024 | Publicado: 29 de junio 2024

DOI:https://doi.org/10.24310/p56-idj1202418553

Resumen

A lo largo de la historia, el desarrollo del diseño industrial en España ha sido un proceso complejo que ha dificultado la definición de una identidad distintiva. En otras palabras, el diseño industrial español ha carecido de una identidad clara y ha enfrentado desafíos para establecer una estrategia de éxito coherente, similar a lo que ha ocurrido en otros países.

Este estudio destaca la importancia de la identidad nacional a lo largo de la historia, centrándose especialmente en el s. XX. Se examina el desarrollo del diseño en España y se compara con las estrategias exitosas adoptadas en otros lugares para comprender por qué resulta difícil definir una identidad en el ámbito del diseño industrial español. Por último, el trabajo presenta una serie de reflexiones que invitan a discutir sobre la identidad del diseño español, su evolución y su aprovechamiento potencial, incidiendo en la necesidad de forjar una cultura de diseño propia y aprovechando la diversidad y su eclecticismo.

Palabras clave: diseño industrial, caso de estudio, diseño español, identidad, identidades de diseño, teoría del diseño.

Abstract

Throughout history, the development of industrial design in Spain has been a complex process that has made it difficult to define a distinctive identity. In other words, Spanish industrial design has lacked a clear identity and has faced challenges in establishing a coherent success strategy, similar to what has happened in other countries.

This study highlights the importance of national identity throughout history, focusing particularly on the 20th century. It examines the development of design in Spain and compares it to successful strategies adopted elsewhere to understand why it is challenging to define an identity in the field of Spanish industrial design. Finally, the work presents a series of reflections that invite discussion about the identity of Spanish design, its evolution and its potential use, emphasizing the need to forge its own design culture and taking advantage of diversity and its eclecticism.

Keywords: IIndustrial design, case study, Spanish design, identity, design identities, design theory.

Introducción

El desarrollo del diseño industrial ha estado ligado a etapas y periodos históricos de los que han ido surgiendo movimientos o corrientes de diseño, como por ejemplo el Modernismo o el Diseño Pop. Este desarrollo también se ha visto afectado por las necesidades de unas localizaciones concretas como reflejan el Styling americano o el Constructivismo ruso (Dormer, 1993). Esta asociación histórica y geográfica genera unas características en el diseño, marcando un estilo, una identidad. De hecho, como sostiene Guy Julier (2010a), una identidad está marcada por todas las circunstancias que influyen en esa materia, en este caso, el diseño se ve directamente influenciado por la geografía, la cultura, la política o la economía. Este mismo autor propone hablar de culturas de diseño más allá de una simple cultura visual, afirmando que el diseño necesita una cultura propia. Julier (2006) se refiere a este concepto en los siguientes términos:

"Es un término que para mí define como piensan y trabajan los diseñadores a través de diferentes medios. Diferentes enfoques y procesos de pensamiento, pero con un objetivo común: comunicar. El diseño es una forma de vida; está en todo lo que nos rodea. Todos deberíamos hacer las cosas mejor".

A través de este término el autor remarca la importancia del papel del diseño en la creación de identidades, hábitos de consumo y estilos de vida, concibiéndolo como una práctica cultural que tiene un valor económico. Así, el diseño no puede ser entendido desde un punto de vista individualista o aislado, sino como el resultado de movimientos nacionales e internacionales, con sus flujos e identidades. Además, distingue tres momentos históricos en la creación de identidades nacionales en el diseño (Julier, 2010b): (1) 1890-1910: Asumido el papel de la revolución industrial en la industria manufacturera, se produce una búsqueda de características nacionales del diseño dentro del marco internacional del Art Nouveau y sus variantes nacionales; (2) 1945-1980: Tras la segunda guerra mundial se produce una reconstrucción de las naciones después de seis años de conflicto; potenciando la necesidad de volver a lo cotidiano de la estética y las prácticas localizadas; y (3) 1980-1990: La modernidad llega en un contexto de reivindicación se puede localizar la intención de buscar a través del diseño la expresión de la pureza y naturalidad de lo local, a través de la transmisión de tradiciones, herencias y costumbres.

En este mismo texto, Julier realiza la siguiente reflexión sobre la importancia del surgimiento de culturas del diseño:

"Hay que observar el diseño más allá de las fronteras y al mismo tiempo prestar atención a las condiciones locales de las culturas visuales, ya que se trata de una práctica ideológicamente construida que incluye la observación de la vida cotidiana".

Por otro lado, el término cultura del diseño sugiere una doble interpretación. En primer lugar, se le atribuye a este término la interpretación de múltiples contextos que estructuran la forma y la expresión del diseño. En segundo lugar, refleja una nueva sensibilidad y una nueva posición para la práctica del diseño. Guy Julier (2010b) sugiere un modelo para la cultura del diseño en el que intervienen los siguientes factores:

- 1. El valor. El rol del diseñador en la creación de valor.
- 2. La circulación. El diseño se mueve teniendo en cuenta una serie de elementos que influyen a los procesos productivos; desde las tecnologías disponibles hasta la política y la fluctuación económica.
- 3. La práctica. Los individuos como portadores de prácticas realizadas colectivamente.

Dejando de lado el término de cultura del diseño, el concepto estilo, entre sus diferentes acepciones, supone la significación de un conjunto de características que individualizan la tendencia artística de una época. Usualmente, un estilo puede tener un origen geográfico y temporal, por lo que está inherentemente influenciado por una cultura y unas circunstancias determinadas. En otras ocasiones, un estilo puede asociarse directamente al trabajo de uno o varios autores. Es así como, por ejemplo, el diseño británico, concretamente en los años 40 y 50, persigue conseguir la apreciación del buen diseño y el buen gusto por parte del público (Dormer, 1993).

Una vez que se ha instaurado un estilo y que este es asumido socialmente, se produce el fenómeno del reconocimiento estilístico, a través del cual las personas son capaces de extraer las características propias del mismo, e incluso llegar a obtener una imagen visual de obras que pertenezcan a esa categorización. Del mismo modo, surge así la capacidad de categorizar una obra y afirmar que pertenece a un determinado estilo. Cuando esto sucede, se puede afirmar que una obra o creación responde a una identidad, es decir, que tiene una serie de rasgos propios que la caracterizan frente a otras obras, definiendo y promoviendo diferentes identidades. Esta categorización sucede en un gran número de ámbitos que rodean la vida humana y así se han definido a lo largo de la historia estilos artísticos, literarios o arquitectónicos. De forma similar, en la reciente historia del diseño industrial han surgido también multitud de estilos y, por lo tanto, se ha categorizado el diseño (Bürdek, 2002).

Análisis

El uso de la identidad nacional como elemento de competitividad

Con la mención del constructo diseño escandinavo una persona con nociones mínimas de diseño industrial puede enumerar algunas de sus características y su ámbito de actuación (en este caso, geográficamente ligado al propio nombre). De acuerdo con la literatura, se puede afirmar que sus señas de identidad son las formas puras, el uso de la madera laminada, la experimentación con la flexibilidad de este material o la búsqueda de líneas elegantes (Fiell and Fiell, 2003). Además, su aparición remarcaba la modernidad de la sociedad escandinava a comienzos del s. XX.

Es necesario valorar la importancia de que un producto responda a una determinada identidad, como agente o motivo de consumo en la industria del diseño. Un claro ejemplo es precisamente el denominado diseño escandinavo, por la explotación cultural y económica de su identidad (Saarela, 2000).

Uno de los factores clave en la germinación y floración de un estilo es la influencia geográfica y cultural, y por ello la tradición, el clima, el paisaje, el folklore sueco, danés, noruego y finlandés son motivos determinantes en la definición del diseño escandinavo. En palabras de Ettore Sottsass (1998) "(...) el diseño se conduce por un camino que comprende cosas arcaicas y cargas tradicionales., porque somos tradición, antigüedad, ... y las emociones más extrañas".

Del mismo modo, en la Alemania de la primera mitad del s. XX se buscaban soluciones universales en el mundo del diseño, combinando dos estilos conocidos como el funcionalismo y el racionalismo. La Bauhaus, siguiendo la frase "La forma sigue a la función" propuesta por el arquitecto Louis Sullivan trabaja con el acero, el cristal y las estructuras tubulares para crear muebles y edificios funcionales (Fiell and Fiell, 2011). De este modo, con el funcionalismo se puede identificar a Alemania como una de las regiones más representativas, del mismo modo que hablar de diseño radical, de Arts & Crafts o constructivismo, se vincula con países como Italia, Inglaterra y Rusia, respectivamente.

Esta asociación o reconocimiento estilístico remarca la existencia de una componente originaria en la aparición de un estilo. Es decir, un vínculo o nexo entre las características que configuran dicho estilo y su ámbito geográfico de actuación (Pasini, 2005).

Un análisis en profundidad de cada uno de los anteriores estilos mencionados revelaría que la cultura, el momento social, los recursos, la ideología y la tradición de un territorio son los factores que han modulado dichos estilos, y que estas identidades están marcadas también por los valores y los sentimientos de la sociedad. Precisamente este vínculo es el que propone el concepto de cultura del diseño propuesto por Julier.

Por lo tanto, el diseño es un agente importante en la creación de una identidad, en los hábitos de consumo y en el estilo de vida de una sociedad, pero por otro lado no puede ser entendido de forma individual, como elemento aislado. La forma en la que el diseño es llevado a cabo, atendiendo a las circunstancias que lo rodean, genera la creación de una cultura de diseño transmisora de una determinada narrativa local.

Cabe destacar la reflexión llevada a cabo por Gil (2002) acerca de la evolución deshumanizadora de los productos de consumo. Desde el estallido de la revolución industrial y por lo tanto de la revolución del consumo, poco a poco los productos fueron adaptando sus características para lograr una fabricación cada vez más industrializada y de este modo se perdía la estética artesanal, desapareciendo el componente personalizador en la concepción y fabricación de objetos. Esta premisa llegó a ser una de las máximas de la Bauhaus, generando objetos que expresaban una estética cercana a la máquina, dejando de lado la componente estética. Sin embargo, esta premisa también generó debates y puntos de vista enfrentados. De acuerdo con el arquitecto Frank Lloyd Wright: "Form follows function - that has been misunderstood. Form and function should be one." Es decir, función y forma deberían ir de la mano, ya que no se puede considerar una función sin que la estética la sugiera, y viceversa. Este aspecto remarca la necesidad de dotar a un producto de cierta identidad.

En medio de la disyuntiva forma-función, la industrialización ha llevado al olvido ciertos aspectos relacionados con el ser humano. Pese a la producción industrial, un producto debe cubrir las necesidades humanas, relacionándose con el usuario. Además, el término cultura del diseño propuesto por Julier remarca la importancia de que los productos se comuniquen con los usuarios, transmitiendo una identidad. Por lo tanto, no solo es necesario que existan una serie de valores en la concepción de un producto, sino que es vital que estos sean detectados por los receptores, los usuarios (Chaves, 2006).

Desde el Arts & Crafts británico hasta el fenómeno del design italiano

Hoy en día resulta relativamente sencillo identificar el diseño llevado a cabo en países como Italia o Estados Unidos a lo largo del s. XX. Diferentes culturas han predominado sobre el resto, es decir, se han promovido unas identidades sobre otras. Podemos afirmar que a lo largo del s. XX en el ámbito del diseño se han ido consumiendo una serie de identidades nacionales, ligadas directamente con el ámbito geográfico, pero que más allá de un determinado estilo respondían a unas características propias de mayor alcance: a una sociedad y a una cultura (Sparke, 2010).

El éxito de las identidades nacionales a lo largo del s. XX no reside en una única estrategia, sino que precisamente estas identidades se han visto influenciadas por el propio entorno del diseño, diferente en cada caso. Como sostiene Guy Julier (2010a), el éxito en la promoción de identidades –individual, empresarial o nacional- guarda relación con la existencia de una cultura del

diseño en cada caso. Por lo tanto, conocer las diferentes estrategias y las bases en cada caso particular servirá como reflexión en torno a la creación de una identidad y su promoción.

Así, las naciones del Reino Unido, en especial Inglaterra con sus grandes urbes, fueron pioneras en mostrar su identidad material, gracias a la inminente industrialización. La forma de mostrar los avances de su identidad fue a través de las exposiciones universales, fraguando una identidad en torno al movimiento que se denominaría Arts&Crafts. La asociación era sencilla, Arts&Crafts significaba lo británico. Con William Morris como abanderado del movimiento, se pretende poner en valor la funcionalidad de los objetos, pero sin descartar la ornamentación y decoración final de los mismos, ya que no se podía renunciar a la búsqueda de la belleza (Parry, 1996).

Pese al eclecticismo de las poblaciones británicas, hoy en día sigue existiendo una asociación directa entre Arts&Crafts y Reino Unido. A la hora de definir de manera amplia la identidad del diseño británico sigue predominando la asociación con la artesanía, la delicadeza y la dedicación de los creadores –makers– en piezas únicas, aportando un gran valor añadido, respetando la funcionalidad, pero sin la renuncia a la ornamentación y la decoración con sentido.

Por otro lado, en el caso de Francia, esta nación prefiere avanzar creando una identidad sin descartar ni rechazar su propia tradición autóctona, siendo un país, durante los primeros compases del s. XX con una fuerte actividad mercantil y una fuerte cultura del consumo (Frauly, 2002). El diseño francés sigue apostando por la industria del lujo, con trabajos de joyería y mobiliario refinado, que se convertirán en la cultura material del momento. Por este hecho, Penny Sparke sostiene que Francia es uno de los primeros ejemplos de comprensión de cultura material girando entonces en torno a la opulencia y el lujo.

No se puede obviar que desde tempranas etapas el diseño francés estaba dirigido a clases sociales adineradas y a las altas esferas. Incluso después de los periodos de guerra las creaciones seguían dirigiéndose a una élite cada vez más reducida y estéticamente conservadora (Torrent and Marín, 2005). Tal fue el arraigo del diseño francés a sus orígenes que las variaciones de su estilo fueron mínimas pasada la primera mitad del s. XX, donde el diseño francés se situaba entre el glamour y el kitsch.

Alemania busca a principios del s. XX una identidad nacional y una ideología de diseño a través de la que expresarse (Heskett, 1986). Observando el movimiento Arts & Crafts, pronto asume este modelo y se convierte en uno de los mejores ejemplos de unión de arte e industria, aprovechando el impulso de las políticas de formación llevadas a cabo por escuelas como la Deutscher Werkbund (Federación Alemana de Trabajo), fundada en 1907 con el objetivo de aplicar el arte a la industria. A diferencia de lo ocurrido con el movimiento Arts & Crafts, esta organización se centra en dar apoyo a la industria en lugar de mantener su mirada en el ámbito del arte, persiguiendo el objetivo de mejorar el diseño y la calidad de los productos alemanes. Bajo este discurso, Alemania consigue ser el punto de referencia en el ámbito del diseño durante las primeras décadas del s. XX.

Otro de los aspectos básicos en la formación de la identidad del diseño alemán es la apuesta por la aplicación del racionalismo de la producción en serie, procurando una actuación libre sin presiones del mercado, algo que hoy ya no es posible. Pese al paso del tiempo, el diseño alemán actual sigue respondiendo a la identidad propuesta en sus primeras etapas de industrialización, por lo que es remarcable la importancia de los orígenes y la respuesta de la sociedad ante una identidad. Así, hoy en día compañías como Bosch u Opel siguen refiriéndose a la fiabilidad alemana, a su tradición tecnológica o a su coherencia a lo largo del tiempo, en esencia, siguen haciendo uso de su marca país.

A diferencia de los casos anteriores, en Estados Unidos resulta complejo encontrar una cultura material reciente o propia a comienzos del s.XX, y mucho menos indagar acerca de sus raíces en relación con el artesanado. En sus inicios, el diseño americano oscila entre populismo, elitismo, belleza, avances tecnológicos y exclusividad (Antonelli, 2008).

La identidad material norteamericana se basa en una vida facilitada por la tecnología, alejada de las tradiciones. De este modo, la propuesta estadounidense era totalmente moderna, convirtiéndose quizás en el primer ejemplo de sociedad de consumo, ya que su cultura material se irá formando en función de las necesidades y demandas del mercado. Como sostiene Penny Sparke en su libro Diseño y cultura, "los consumidores son los verdaderos norteamericanos", dando así lugar al nacimiento del American Way (antecesor de lo que hoy en día entendemos como sociedad de consumo).

Además de la industria del automóvil (uno de los primeros ejemplos de puesta en marcha de la producción en serie), es importante mencionar la importancia de los avances aeroespaciales, así como el aprovechamiento y conversión de la industria de guerra en una industria destinada a la fabricación de productos de consumo. Este aspecto destaca la importancia de la visión industrial del diseño en EE.UU., así como la importancia de su evolución ligada al desarrollo tecnológico.

Por otro lado, el diseño escandinavo ha sido uno de los referentes en el transcurso de la historia del diseño, alcanzando su máximo auge a mediados del s. XX. Todavía hoy en día resulta sencillo imaginar los rasgos que lo caracterizan. Noruega, Suecia, Finlandia, Dinamarca e Islandia son un núcleo de países que pese a sus diferencias encuentran una identidad común en torno al diseño industrial como elemento promotor de una cultura. La base del diseño escandinavo se basa en un enfoque democrático, en continua búsqueda de una sociedad ideal, con una mejor calidad de vida a través de la tecnología y de productos funcionales asequibles (Fiell and Fiell, 2003).

Existe en el caso del diseño escandinavo una clara influencia de la Deustche Werkbund, persiguiendo valores como la democracia social y el paso de la artesanía a la producción industrial. Sin embargo, el modelo escandinavo prefiere dejar en un segundo plano el racionalismo alemán en pos de un estilo decorativo más suave, humanista y doméstico (Demargne and Hervy, 2003). En su éxito hay que destacar además que a partir de la década de 1950 se establece el uso del distintivo Diseño Escandinavo, y se fomenta a través de exposiciones itinerantes bajo el nombre de Design in Scandinavia.

En el caso de Italia, la identidad del diseño se forja a raíz del boom económico que vive el país durante la década de los 50. Aprovechando este periodo, arquitectos y diseñadores orientan sus esfuerzos en tratar de entender y explotar los avances tecnológicos de la época. Si algo distingue el diseño italiano de este periodo -y quizás hoy en día también- es su carácter investigador e innovador, siempre en búsqueda de nuevas posibilidades (Bosoni, 2008). Empresas como Kartell, fundada en 1949, apuestan desde sus inicios por la exploración, y en este caso concreto, por la obtención de productos realizados en polipropileno, material desconocido o poco empleado hasta la época. Diseñadores y arquitectos, por aquel entonces menos conocidos (nombres como Ettore Sottsass, Pier Giacomo Castiglioni, Vico Magistretti o Marco Zanuso) aprovechan la oportunidad brindada por los avances tecnológicos lanzando al mercado productos totalmente innovadores.

Además, el diseño italiano se vio apoyado por la creación de revistas como Domus, Abitare o Casabella, que proporcionaban un constante diálogo sobre el diseño (Sparke, 1988). Alrededor del design comenzaron a surgir eventos como el Salón del Mueble o la celebración de las Triennales de Milán, encargadas de polinizar a la sociedad

explicando las bondades del diseño italiano. De esta forma, Italia se convierte en el epicentro mundial del diseño, alcanzando su máximo esplendor en el año 1972, con la exposición "Italia, el nuevo paisaje doméstico" celebrada en el MoMA de Nueva York.

Algunos pilares de las identidades nacionales

Tras el repaso de las identidades nacionales en diseño surgidas a lo largo del s. XX, se puede observar cómo su formación puede alcanzarse a través de diferentes estrategias. A modo de resumen, se pueden identificar los siguientes parámetros como susceptibles en la consecución de identidad:

- - Importancia de la industrialización y aparición de nuevas industrias.
- - Pujanza económica de empresas y consumidores.
- - Promoción y apoyo sostenido en el tiempo de los valores de calidad, innovación y valor añadido empresarial y económico que aporta el diseño.
- - Comunicación sostenida de esos valores sólidos del diseño tanto internamente a la sociedad como externamente en la imagen del país, sus empresas, productos y diseñadores.
- - Utilización de los grandes eventos como las Exposiciones Universales.
- - Aparición de diseñadores o empresas de primer nivel mundial, que ejercen un liderazgo en diseño y creación de identidad.
- - Fomento de las escuelas de diseño y de sus modelos formativos.
- - Apoyo y fomento de la cultura de la innovación.

En conjunto, se pueden resumir estos parámetros como los pilares de la construcción y apoyo sostenido en el tiempo de la cultura de diseño propia en cada país.

En la actualidad, aunque es más sencillo hablar de diseño italiano o de diseño francés, en otros países se plantea el ejercicio de creación de identidad. Así lo demuestran trabajos como el de Özcan (2009) o Chung (1998), que plantean el diseño de determinados territorios como una estrategia para la consecución de modernidad y desarrollo. Sirve como ejemplo la apuesta del diseño holandés por el concepto open design, en referencia a la apertura de su sociedad; imagen potenciada por el gobierno y diferentes organizaciones culturales (Calvera, 1998). Con este contexto, conviene cuestionar el desarrollo de esta materia en el caso español, y analizar la posible consecución de una identidad, así como de los factores condicionantes del desarrollo de una cultura de diseño propia durante el s. XX.

La no identidad del diseño español. Convulsión y eclecticismo

El diseño industrial en España ha sufrido históricamente un desfase con respecto a los principales países europeos y Norteamérica. Este desfase se ha visto reflejado a lo largo del transcurso de la historia, motivado por la tardía industrialización y por un convulso desarrollo histórico.

Desde las guerras sufridas, pasando por el periodo de dictadura instaurado entre los años 1939 y 1975, hasta el auge económico y la explosión cultural vivida a finales de los 70 y en la década de 1980. Como consecuencia, el diseño industrial nace y crece como una disciplina que carece de un discurso propio y que ve frenada su expansión por los mencionados acontecimientos.

Históricamente, a España llegan los estilos, los movimientos y también las tendencias con retraso. Además, gran parte del sector (diseñadores y empresas productoras) introducen las novedades llegadas de

otros países sin cuestionar su origen, sus motivaciones, y sin analizar el discurso que implica su aceptación (Martínez, López y Cataño, 2015).

Tras la caída de la dictadura a finales de los años 70, y a pesar de la profunda crisis económica a nivel mundial, España vive una impresionante eclosión cultural, llamada a revertir de manera positiva en el desarrollo del diseño industrial en el país. Sin embargo, en lugar de continuar con las bases propuestas en los años 60, en los que el diseño industrial español encontraba en el valor cultural su principal atributo (Galán et. al., 2010), el grueso de los diseñadores y diseñadoras españoles se suma al movimiento radical surgido en Italia como respuesta al Bel design de los años 60 en este país. España simplemente se limita a adoptar su código estético, sin comulgar con sus ideales. Según Capella (1998), el término diseño se devalúa rápidamente y se empieza a identificar esta disciplina con el capricho estético, la falta de funcionalidad o la incomodidad en algunos casos.

Este carácter contestatario desde el punto de vista político se torna en un boom en los años 80 (Torrent and Marín, 2005). Durante esta década se suceden acontecimientos que cambiarán el devenir de esta disciplina de consumo, como la entrada de España en la Comunidad Europea o la implantación del mercado único europeo. En este momento se genera un desajuste, buscando una mayor visibilidad en lugar de seguir apostando por ser un capital cultural (Narotzky, 2000).

En la década de los 80 y principio de los 90, con los Juegos Olímpicos de Barcelona y la Exposición Universal de Sevilla, además de los acontecimientos ya mencionados, en España comienza a hablarse de diseño, hasta el punto de acuñar expresiones como ¿Diseñas o trabajas? (Zabalbeascoa, 2011). Sin embargo, a día de hoy en el mismo territorio, es complejo entender el diseño industrial y los agentes promotores todavía hacen hincapié en explicar de qué hablamos cuando al referirnos al diseño y tratan de trasladar a empresas y fabricantes lo beneficioso que resultaría sumar el componente diseño a sus compañías.

A modo de resumen, se aprecian dos puntos de partida que han caracterizado el modo de entender el diseño en España:

- 1. En primer lugar, el entendimiento del diseño industrial y su nacimiento desde el mundo de las artes decorativas, siendo esta disciplina desarrollada de la mano del campo de las bellas artes en sus primeras etapas, y posteriormente de la mano de la arquitectura. Por esto, el entendimiento de una disciplina autónoma fue lento y pausado.
- 2. Por otro lado, es importante destacar el fuerte arraigo de la artesanía, debido a una industrialización lenta y casi inexistente en las primeras etapas de la revolución industrial, estableciéndose grandes diferencias con el resto del continente europeo. Además, dentro del propio territorio español esta industrialización gozó de más éxito en determinadas zonas del territorio, como Cataluña, País Vasco o Valencia.

Como destaca Anna Calvera (1998) en su escrito "Antecedentes" sobre el diseño español del s. XX, desde las primeras etapas del diseño fue un reto el cambio de paradigma y el paso de artes decorativas y artesanía a diseño industrial e industria respectivamente. Pese a la distancia, hoy en día España sigue comprobando estas diferencias de industrialización en su geografía, siendo un país de regiones muy diferenciadas. Por este motivo, no hay que buscar un estilo de diseño español definitivo (Julier, 1991), sino que predomina un diseño ecléctico, compuesto por diversos estilos y opiniones.

El hecho de que el territorio español sea muy diverso desde el punto de vista cultural, complica la extracción de unos rasgos fundamentales que caractericen el diseño español, esto es, la obtención de una identidad fundamentada. Sin embargo, existen ciertos patrones que, a través del análisis de los principales referentes

bibliográficos, inciden en diversos aspectos nucleares del diseño español. Juli Capella (2005) lo caracteriza como un diseño imaginativo, atrevido, que juega con la ironía y el humor, y siempre pendiente de la versatilidad de su uso, incidiendo en que los productos concentran todo su potencial en una forma única. Al igual que Quim Larrea (2002), coincide en afirmar la existencia de un fuerte componente emocional, nostálgico y de arraigo a nuestras memorias, resultando diseños que quieren comunicarse con su receptor. Estos dos autores remarcan que el diseño español intenta modernizar algunos elementos populares jugando con ellos para ponerlos al día, emergiendo así un sustrato regional importante. Siguiendo este hilo argumental, Enric Satué, premio nacional de diseño en 1998, destaca la influencia subconsciente de la cultura, funcionando el diseño como un agente transmisor (Arias, 1996).

Sin embargo, otros autores afirman que estas características no son extrapolables a la totalidad del diseño español. Emili Farré Escofet afirma la no existencia de una identidad española y sí de un diseño con un marcado carácter mediterráneo (Arias, 1996). Otro argumento contrario a la definición identitaria es la implacable globalización, que obliga a renunciar a una identidad geográfica. Coincidiendo con Guy Julier (1991) el diseño español está caracterizado entonces por un marcado eclecticismo, ya que esta actividad es individual y no se identifica con determinados estilos.

Por otro lado, estudios profesionales o diseñadoras como Emiliana Design o Jaime Hayón, destacan la importancia del carácter español en los planteamientos del diseño, hablando de frescura, vitalidad, atrevimiento o riesgo (Sánchez, 2012).

Es importante destacar que, como mencionan varios autores, el diseño español está fuertemente ligado al mundo de la artesanía y al producto hecho a mano. Las empresas son pequeñas, tecnológicamente limitadas, pero saben suplir esas carencias con creatividad, innovación y aportación de valor añadido (Burkhadt, 2005). Como afirma Santiago Miranda en la obra de Arias (1996): "La tecnología pueden aportarla otros ya que el diseño español destaca en el campo de las ideas y de la cultura para diseñar".

Así, Bravo (2005) considera España como un país dotado especialmente para la creación. Del mismo modo, Alberto Corazón, añade que España posee técnicas de transformación y materias primas que son particularmente propias y que, mediante el diseño, el producto español es capaz de destacar y competir a nivel mundial (Arias, 1996).

El dinamismo en la producción, la utilización de técnicas innovadoras, así como la utilización de materias primas propias es otra de las características que hacen que el diseño español sea, a pesar de las limitaciones, ágil y competitivo en el trabajo a pequeña escala (Sánchez, 2012). Además, precisamente basándose en estas características productivas, el hábitat emerge como el sector en el que el diseño industrial ha dejado un mayor número de creaciones (Zabalbeascoa, 2010).

Por último, la globalización también ha mellado en la internacionalización del diseño español, siendo cada vez más los estudios y diseñadores que orientan sus creaciones hacia nuevos mercados (Galán et. al., 2010). Este hecho obliga al conocimiento de la filosofía de las empresas productoras de estos países, lo que puede causar cierta desconexión o desarraigo con la identidad nacional.

A pesar de las opiniones recogidas, resulta complejo caracterizar la identidad del diseño español. En ocasiones las visiones de los principales autores son refutadas por miembros del sector, siendo quizás el eclecticismo el atributo en el que todos coinciden, o que al menos no es rechazado. Tachy Mora (2010) explica este eclecticismo como la esencia del diseño español, debido a que los principios y las características son muy diferentes y variadas entre sí.

Por otro lado, los documentos consultados se centran en análisis particulares y en explicar las bondades del diseño español como actividad creativa, siendo prácticamente inexistentes los que tratan este asunto de forma más amplia que permitan descifrar su identidad. Esta complejidad es mencionada por Juli Capella en su libro, "Los objetos esenciales del diseño español", en el que indica que debido a la variedad de estilos y a que los diseñadores y diseñadoras intentan distinguirse cada vez más del resto, no se puede definir con precisión un diseño español concreto. Precisamente en esta de búsqueda de atributos comunes, propios de las raíces y orígenes, incide la exposición "From Spain with Design: Identidad y territorio", que itinera desde el año 2022 reivindicando la creación desde los distintos puntos de la geografía española.

En resumen, se observa que son muchos y muy variados los rasgos empleados por los principales autores para referirse al diseño español, lo que denota el eclecticismo mencionado. Sin embargo, a pesar de que el eclecticismo puede ser bueno desde el punto de vista de la diversidad o la globalización, diluye el reconocimiento estilístico y por lo tanto el valor racional de la identidad, dificultando su proceso de aparición, explicando así la posible ausencia de identidad en el caso del diseño español.
Conclusiones

El uso de la identidad en diseño industrial ha sido importante en el desarrollo social y económico de diferentes regiones. Además, la consecución de esta identidad está inherentemente relacionada con la obtención y comprensión de una cultura del diseño de diferentes agentes –diseñadores, empresas y países-. Desde el punto de vista histórico, más allá de no alcanzar una identidad para el diseño industrial español, el desarrollo de esta disciplina no ha logrado calar en la cultura empresarial. En otras palabras, no se ha conseguido una cultura en diseño sólida, todavía en fase de consolidación en la actualidad.

Por otro lado, a la hora de caracterizar el diseño realizado en España, no se observa un patrón común. A pesar de la existencia de buenos ejemplos referentes a nivel internacional, no es posible listar unos rasgos con la facilidad con la que ocurre, por ejemplo, en el caso escandinavo.

Se puede concluir que esto sucede porque el diseño español no comparte aquellas premisas que han permitido a otros países gozar de identidad. Así, se proponen los siguientes motivos que remarcan la ausencia de identidad del diseño español:

- - El desarrollo histórico del país ha impuesto un pensamiento que frenaba la cultura de la innovación y el diseño en particular. Como consecuencia, tradicionalmente ha existido un bajo nivel de concienciación en las empresas respecto al valor de la innovación en general; en productos, procesos y servicios. La creación de identidad y valor empresarial mediante la innovación y consecuente aportación de valores racionales, culturales y también experienciales al producto (valores intangibles en gran medida) no ha estado suficientemente presentes en la mente de las empresas. Por lo tanto, a lo largo del s. XX no ha habido una cultura de innovación en general ni de diseño en particular.
- - Ha existido una comunicación inadecuada de los valores del diseño. En ocasiones el mensaje que ha llegado a la sociedad ha sido incluso negativo, dando una imagen superficial en lugar de poner de relieve la aportación del diseño a la competitividad de las empresas; así como su valor económico y los valores de calidad, funcionalidad y confort transmitidos al usuario. El mensaje no ha sido correcto ni sostenido tanto internamente como de cara al exterior.
- - El desarrollo industrial mucho más tardío y débil, con excepción de algunas regiones como Cataluña. No ha habido, en general, una burguesía

industrial fuerte con empresas propias que impulsara la innovación y el diseño. La industrialización de la segunda mitad del s. XX se debía en general a la implantación de empresas extranjeras, que diseñaban desde el exterior. Así, no se ha producido un fuerte efecto locomotora generado por empresas propias.

- - No ha habido épocas de bonanza económica sostenida durante el s. XX. La situación ha revertido en la última década y en los primeros años del s. XXI, sin embargo, estos brotes han visto truncados por una crisis muy profunda. Esto no ha propiciado ni el desarrollo industrial, ni el consumo interno de diseño.

- - La aportación a la identidad de valores racionales (tangibles) ha sido dispersa y salvo excepciones no ha habido una valoración suficiente de estos. Así, el eclecticismo resulta ser el denominador común que viene a ser lo contrario de la identidad estilística; sin embargo, bien podría considerarse un estilo en si mismo propio del diseño español.

- - No se ha aprovechado el enorme caudal de múltiples identidades culturales disponibles en España (Desde las artes, las letras, la historia, la gastronomía, el deporte, las tradiciones, la variedad de culturas y pueblos, o el legado de una de las lenguas más habladas del mundo). Estos componentes han sido desaprovechados por las empresas a la hora de aportar múltiples valores positivos, claramente identificables, a sus productos y a su identidad como marcas. Además, en ningún momento se ha ligado el diseño español a la identidad del país (no se ha hecho uso de la marca país).

- - Hasta hace pocos años no ha habido una tradición de escuelas de diseño. La propia incorporación de esta disciplina a la Universidad ha sido muy reciente, por lo que su función creadora y transmisora de innovación apenas está empezando. Por el mismo motivo, la visión de gestor integral del producto, las habilidades de comunicación y estrategia que el diseñador debe tener, estaban limitadas simplemente por su formación. Como añadido, el empresario no tenía la suficiente formación y mentalización –cultura- sobre el uso e importancia del diseño.

- - A pesar de la importante labor de los denominados pioneros del diseño español en el desarrollo interno de la disciplina, no ha habido figuras de primer nivel mundial en el campo del diseño y la vanguardia artística que abanderasen con su propio éxito y el de sus productos la imagen exterior de España como país de diseño.

- - El impulso del diseño desde las instituciones a lo largo del s. XX ha sido errático e inconstante. Los esfuerzos de promoción del diseño se han realizado desde el colectivo profesional o desde determinados sectores productivos. Esta ausencia de impulso todavía es notable en la actualidad, con la ausencia de organismos públicos estatales que velen por los intereses del diseño, tras la desaparición de la DDI (Sociedad Estatal para el Desarrollo del Diseño y la Innovación).

Estos aspectos han dificultado la creación y difusión de una cultura de diseño en España y por tanto de una identidad propia en el campo del diseño. Más allá de pequeñas similitudes y aspectos comunes (formales o temporales), el diseño español evidencia una ausencia de identidad y por lo tanto no goza de sus beneficios.

En el contexto actual de una sociedad global, no se pueden obviar los beneficios que ha supuesto la utilización de la identidad como estrategia competitiva. Queda por delante la tarea de plantear la estrategia más exitosa en el caso del diseño español, entendiendo lo positivo que puede resultar su eclecticismo y diversidad.

En resumen, la mejor forma de plantear una identidad será comenzar por el fomento del diseño y por la apuesta de esta disciplina en las empresas españolas tomando como referencia el desarrollo de la disciplina durante el s. XX. La identidad debe ir más allá del reconocimiento estilístico, y por ello su consecución está asociada al logro de una cultura de diseño propia.

Fuente de financiación

Este trabajo no ha recibido financiación alguna.

Contribución de autores:
R. M.-Ro: Conceptualización, metodología, investigación y escritura del artículo.
P.F.-G.: Conceptualización, escritura del artículo y elaboración de materiales.

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proyecta 56

An industrial design journal

ISSN 2386-5414
e-ISSN: 2340-8391

Review | Revisión

The keys to the lack of identity in Spanish industrial design | Las claves de la ausencia de identidad del diseño industrial español

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Received: January 15, 2024 | Accepted: May 2, 2024 | Published: June 29, 2024

DOI:https://doi.org/10.24310/p56-idj1202418553

Abstract

Throughout history, the development of industrial design in Spain has been a complex process that has made it difficult to define a distinctive identity. In other words, Spanish industrial design has lacked a clear identity and has faced challenges in establishing a coherent success strategy, similar to what has happened in other countries.

This study highlights the importance of national identity throughout history, focusing particularly on the 20th century. It examines the development of design in Spain and compares it to successful strategies adopted elsewhere to understand why it is challenging to define an identity in the field of Spanish industrial design. Finally, the work presents a series of reflections that invite discussion about the identity of Spanish design, its evolution and its potential use, emphasizing the need to forge its own design culture and taking advantage of diversity and its eclecticism.

Keywords: IIndustrial design, case study, Spanish design, identity, design identities, design theory.

Introduction

The development of industrial design has been linked to historical stages and periods from which design movements or trends have emerged, such as Modernism or Pop Design. This development has also been influenced by the needs of specific locations, as reflected in American Styling or Russian Constructivism (Dormer, 1993). This historical and geographical association generates characteristics in design, marking a style, an identity. In fact, as Guy Julier (2010a) asserts, an identity is shaped by all the circumstances that influence that matter; in this case, design is directly influenced by geography, culture, politics, or the economy. This same author proposes discussing design cultures beyond a simple visual culture, asserting that design needs its own culture. Julier (2006) refers to this concept in the following terms:

"It is a term that, for me, defines how designers think and work through different media. Different approaches and thought processes, but with a common goal: to communicate. Design is a way of life; it is in everything around us. We should all strive to do things better."

Through this term, the author emphasizes the importance of the role of design in the creation of identities, consumption habits, and lifestyles, conceiving it as a cultural practice that has economic value. Thus, design cannot be understood from an individualistic or isolated point of view, but as the result of national and international movements, with their flows and identities. Furthermore, he distinguishes three historical moments in the creation of national identities in design (Julier, 2010b): (1) 1890-1910: Assuming the role of the industrial revolution in the manufacturing industry, there is a search for national characteristics of design within the international framework of Art Nouveau and its national variants; (2) 1945-1980: After World War II, nations undergo reconstruction after six years of conflict, enhancing the need to return to the everyday aesthetics and localized practices; (3) 1980-1990: Modernity arrives in a context of reclamation where the intention to express the purity and naturalness of the local through design can be identified, through the transmission of traditions, heritage, and customs.

In this same text, Julier reflects on the importance of the emergence of design cultures:

"We must look at design beyond borders and at the same time pay attention to the local conditions of visual cultures, as it is an ideologically constructed practice that includes the observation of everyday life."
On the other hand, the term design culture suggests a double interpretation. Firstly, this term is attributed the interpretation of multiple contexts that structure the form and expression of design. Secondly, it reflects a new sensitivity and a new position for the practice of design. Guy Julier (2010b) suggests a model for design culture in which the following factors are involved:

- 1. Value. The designer's role in creating value.
- 2. Circulation. Design moves considering a series of elements that influence productive processes; from available technologies to politics and economic fluctuations.
- 3. Practice. Individuals as bearers of collectively performed practices

Leaving aside the term design culture, the concept of style, among its different meanings, implies the signification of a set of characteristics that individualize the artistic trend of an era. Usually, a style can have a geographical and temporal origin, and thus is inherently influenced by a particular culture and circumstances. On other occasions, a style can be directly associated with the work of one or several authors. For instance, British design, specifically in the 1940s and 1950s, aims to achieve public appreciation of good design and good taste (Dormer, 1993).

Once a style has been established and socially accepted, the phenomenon of stylistic recognition occurs, through which people can identify its distinctive characteristics and even form a visual image of works that belong to that categorization. Similarly, the ability to categorize a work and assert that it belongs to a particular style emerges. When this happens, it can be said that a work or creation corresponds to an identity, meaning it has a set of unique features that distinguish it from other works, defining and promoting different identities. This categorization occurs in many areas surrounding human life, and throughout history, artistic, literary, and architectural styles have been defined in this way. Similarly, in the recent history of industrial design, many styles have also emerged, leading to the categorization of design (Bürdek, 2002).

Analysis

The use of national identity as a competitive element

With the mention of the construct "Scandinavian design," a person with minimal knowledge of industrial design can enumerate some of its characteristics and its scope (in this case, geographically linked to the name itself). According to the literature, it can be said that its hallmarks are pure forms, the use of laminated wood, experimentation with the flexibility of this material, and the search for elegant lines (Fiell and Fiell, 2003). Additionally, its emergence highlighted the modernity of Scandinavian society at the beginning of the 20th century.

It is necessary to assess the importance of a product responding to a specific identity, as an agent or reason for consumption in the design industry. A clear example is precisely the so-called Scandinavian design, for the cultural and economic exploitation of its identity (Saarela, 2000).

One of the key factors in the germination and flourishing of a style is geographical and cultural influence. Therefore, tradition, climate, landscape, and Swedish, Danish, Norwegian, and Finnish folklore are determining factors in defining Scandinavian design. In the words of Ettore Sottsass (1998), "(...) design follows a path that encompasses archaic things and traditional burdens, because we are tradition, antiquity, ... and the strangest emotions."

Similarly, in Germany in the first half of the 20th century, universal solutions in the world of design were sought, combining two styles known as functionalism and rationalism. The Bauhaus, following the phrase "Form follows function" proposed by architect Louis Sullivan, worked with steel, glass, and tubular structures to create functional furniture and buildings (Fiell and Fiell, 2011). Thus, with functionalism, Germany can be identified as one of the most representative regions. Likewise, speaking of radical design, Arts & Crafts, or constructivism, one associates these with countries like Italy, England, and Russia, respectively.

This association or stylistic recognition highlights the existence of an originating component in the emergence of a style. That is, a link or nexus between the characteristics that configure said style and its geographical area of activity (Pasini, 2005).

An in-depth analysis of each of the aforementioned styles would reveal that culture, social moment, resources, ideology, and tradition of a territory are the factors that have shaped these styles, and that these identities are also marked by the values and feelings of society. This link is precisely what the concept of design culture proposed by Julier suggests.

Therefore, design is an important agent in the creation of identity, consumption habits, and the lifestyle of a society, but on the other hand, it cannot be understood individually, as an isolated element. The way in which design is carried out, considering the surrounding circumstances, generates the creation of a design culture that transmits a specific local narrative.

It's worth noting the reflection carried out by Gil (2002) regarding the dehumanizing evolution of consumer products. Since the onset of the industrial revolution and thus the consumption revolution, products gradually adapted their characteristics to achieve increasingly industrialized manufacturing, thereby losing the artisanal aesthetic and disappearing the personalized component in the conception and manufacture of objects. This premise became one of the maxims of the Bauhaus, generating objects that expressed an aesthetic close to the machine, setting aside the aesthetic component. However, this premise also sparked debates and opposing views. According to architect Frank Lloyd Wright: "Form follows function - that has been misunderstood. Form and function should be one." In other words,

function and form should go hand in hand since one cannot consider a function without the aesthetics suggesting it, and vice versa. This aspect emphasizes the need to imbue a product with a certain identity.

In the middle of the form-function dilemma, industrialization has led to the neglect of certain aspects related to the human being. Despite industrial production, a product must meet human needs and relate to the user. Furthermore, the term design culture proposed by Julier emphasizes the importance of products communicating with users, conveying an identity. Therefore, it's not only necessary for a series of values to exist in the conception of a product, but it is vital for these to be detected by recipients, the users (Chaves, 2006).

From the British Arts & Crafts movement to the phenomenon of Italian design.

Today, it is relatively easy to identify the design carried out in countries like Italy or the United States throughout the 20th century. Different cultures have prevailed over others, meaning that certain identities have been promoted over others. We can affirm that throughout the 20th century, in the field of design, a series of national identities have been consumed, directly linked to geographical areas, but beyond a specific style, they responded to broader characteristics: to a society and a culture (Sparke, 2010).

The success of national identities throughout the 20th century does not rely on a single strategy, but precisely these identities have been influenced by the design environment itself, which varies in each case. As Guy Julier (2010a) argues, the success in promoting identities - individual, corporate, or national - is related to the existence of a design culture in each case. Therefore, understanding the different strategies and foundations in each particular case will serve as a reflection on the creation of an identity and its promotion.

Thus, the nations of the United Kingdom, especially England with its large cities, were pioneers in showcasing their material identity, thanks to imminent industrialization. The way to showcase the advances of their identity was through universal exhibitions, forging an identity around the movement that would be called Arts & Crafts. The association was simple, Arts & Crafts meant British. With William Morris as the standard-bearer of the movement, the aim was to value the functionality of objects, but without disregarding their ornamentation and final decoration, as the pursuit of beauty could not be abandoned (Parry, 1996).

Despite the eclecticism of British populations, there is still a direct association between Arts & Crafts and the United Kingdom today. When broadly defining the identity of British design, the association with craftsmanship, the delicacy, and dedication of creators - makers - in unique pieces still predominates, adding great added value, respecting functionality, but without renouncing ornamentation and decoration with meaning.

On the other hand, in the case of France, this nation prefers to advance by creating an identity without discarding or rejecting its own native tradition, being a country, during the early stages of the 20th century, with strong mercantile activity and a strong culture of consumption (Frauly, 2002). French design continues to focus on the luxury industry, with refined jewelry and furniture works that will become the material culture of the moment. For this reason, Penny Sparke argues that France is one of the first examples of understanding material culture revolving around opulence and luxury.

It cannot be overlooked that from early stages, French design was aimed at wealthy social classes and the upper echelons. Even after periods of war, creations continued

to target an increasingly reduced and aesthetically conservative elite (Torrent and Marín, 2005). Such was the rootedness of French design in its origins that variations in its style were minimal past the first half of the 20th century, where French design oscillated between glamour and kitsch.

At the beginning of the 20th century, Germany sought a national identity and a design ideology through which to express itself (Heskett, 1986). Observing the Arts & Crafts movement, it quickly adopted this model and became one of the best examples of the union of art and industry, harnessing the momentum of training policies carried out by schools such as the Deutscher Werkbund (German Association of Work), founded in 1907 with the aim of applying art to industry. Unlike what happened with the Arts & Crafts movement, this organization focuses on supporting industry rather than keeping its focus on the realm of art, pursuing the goal of improving the design and quality of German products. Under this discourse, Germany managed to be the reference point in the field of design during the first decades of the 20th century.

Another basic aspect in the formation of German design identity is the commitment to the application of rationalism in mass production, seeking free action without market pressures, something that is no longer possible today. Despite the passage of time, contemporary German design still responds to the identity proposed in its early stages of industrialization, highlighting the importance of origins and society's response to an identity. Thus, today companies like Bosch and Opel still refer to German reliability, their technological tradition, or their consistency over time; essentially, they continue to use their country brand.

Unlike the previous cases, in the United States, it is complex to find a recent or proprietary material culture at the beginning of the 20th century, let alone to inquire about its roots in relation to craftsmanship. In its early days, American design oscillated between populism, elitism, beauty, technological advancements, and exclusivity (Antonelli, 2008).

The American material identity is based on a life facilitated by technology, distant from traditions. Thus, the American proposal was entirely modern, perhaps becoming the first example of a consumer society, as its material culture would be shaped according to the needs and demands of the market. As Penny Sparke argues in her book "Design and Culture," "consumers are the true Americans," thus giving rise to the birth of the American Way (predecessor of what we now understand as a consumer society).

In addition to the automotive industry (one of the earliest examples of implementing mass production), it is important to mention the significance of aerospace advancements, as well as the utilization and conversion of the war industry into an industry dedicated to manufacturing consumer products. This aspect highlights the importance of the industrial vision of design in the United States, as well as the importance of its evolution linked to technological development.

On the other hand, Scandinavian design has been one of the benchmarks in the history of design, reaching its peak in the mid-20th century. Even today, it is easy to imagine the characteristics that define it. Norway, Sweden, Finland, Denmark, and Iceland are a core group of countries that, despite their differences, find a common identity around industrial design as a promoter of culture. The foundation of Scandinavian design is based on a democratic approach, continuously seeking an ideal society with a better quality of life through technology and affordable functional products (Fiell and Fiell, 2003).

In the case of Scandinavian design, there is a clear influence from the Deutscher Werkbund, pursuing values such as social democracy and the transition from craftsmanship to industrial production.

However, the Scandinavian model prefers to prioritize a softer, more humanistic, and domestic decorative style over German rationalism (Demargne and Hervy, 2003). In its success, it is also worth noting that from the 1950s onwards, the distinctive label "Scandinavian Design" is established, and it is promoted through traveling exhibitions under the name "Design in Scandinavia."

In the case of Italy, the identity of design is forged in the wake of the economic boom experienced by the country during the 1950s. Taking advantage of this period, architects and designers focus their efforts on trying to understand and exploit the technological advances of the time. If anything distinguishes Italian design from this period - and perhaps today as well - it is its investigative and innovative character, always in search of new possibilities (Bosoni, 2008). Companies like Kartell, founded in 1949, have been betting on exploration from the outset, and in this particular case, on obtaining products made of polypropylene, a material unknown or little used up to that time. Designers and architects, who were less known at that time (names like Ettore Sottsass, Pier Giacomo Castiglioni, Vico Magistretti, or Marco Zanuso) seize the opportunity offered by technological advances by launching completely innovative products onto the market.

Furthermore, Italian design was supported by the creation of magazines such as Domus, Abitare, or Casabella, which provided a constant dialogue about design (Sparke, 1988). Around design, events began to emerge such as the Salone del Mobile or the celebration of the Milan Triennials, which served to spread the benefits of Italian design to society. In this way, Italy became the world's epicenter of design, reaching its peak in 1972 with the exhibition "Italy: The New Domestic Landscape" held at the MoMA in New York.

Some pillars of national identities

After reviewing the national identities in design that emerged throughout the 20th century, it can be observed how their formation can be achieved through different strategies. As a summary, the following parameters can be identified as susceptible in achieving identity:

- - Importance of industrialization and the emergence of new industries.
- - Economic strength of companies and consumers.
- - Promotion and sustained support over time for values of quality, innovation, and added value that design brings to business and the economy.
- - Sustained communication of these solid design values both internally to society and externally in the image of the country, its companies, products, and designers.
- - Utilization of major events such as World's Fairs.
- - Emergence of world-class designers or companies that exert leadership in design and identity creation.
- - Promotion of design schools and their educational models.
- - Support and promotion of a culture of innovation.

Taken together, these parameters can be summarized as the pillars for the construction and sustained support over time of the unique design culture in each country.

In the present day, while it is easier to talk about Italian or French design, in other countries, the exercise of creating identity is being considered. This is demonstrated by works such as Özcan (2009) or Chung (1998), which propose the design of specific

territories as a strategy for achieving modernity and development. An example is the Dutch design's commitment to the concept of open design, referring to the openness of its society; an image promoted by the government and various cultural organizations (Calvera, 1998). In this context, it is worth questioning the development of this field in the case of Spain and analyzing the possible achievement of an identity, as well as the factors conditioning the development of a unique design culture during the 20th century.

The lack of identity in Spanish design. Turmoil and eclecticism

Industrial design in Spain has historically lagged behind the leading European countries and North America. This lag has been reflected throughout history, driven by delayed industrialization and a tumultuous historical development.

From the wars endured, through the period of dictatorship established between 1939 and 1975, to the economic boom and cultural explosion experienced in the late 1970s and the 1980s. As a result, industrial design is born and grows as a discipline lacking its own discourse and hindered in its expansion by the mentioned events.

Historically, Spain receives styles, movements, and trends with delay. Moreover, a large part of the sector (designers and producing companies) introduces novelties from other countries without questioning their origin, motivations, and without analyzing the discourse implied by their acceptance (Martínez, López, and Cataño, 2015).

After the fall of the dictatorship in the late 1970s, and despite the profound economic crisis worldwide, Spain experiences an impressive cultural flourishing, expected to have a positive impact on the development of industrial design in the country. However, instead of continuing with the foundations proposed in the 1960s, when Spanish industrial design found its main attribute in cultural value (Galán et al., 2010), the majority of Spanish designers align with the radical movement that emerged in Italy in response to the Bel design of the 1960s in that country. Spain simply adopts its aesthetic code without embracing its ideals. According to Capella (1998), the term "design" quickly depreciates, and this discipline begins to be associated with aesthetic whim, lack of functionality, or discomfort in some cases.

This political rebellious character turns into a boom in the 1980s (Torrent and Marín, 2005). During this decade, events unfold that will change the course of this consumer discipline, such as Spain's entry into the European Community or the implementation of the European single market. At this moment, a mismatch is generated, seeking greater visibility instead of continuing to bet on being a cultural capital (Narotzky, 2000).

In the 1980s and early 1990s, with the Barcelona Olympic Games and the Universal Exposition of Seville, in addition to the aforementioned events, design begins to be talked about in Spain, to the point of coining expressions like "Do you design or work?" (Zabalbeascoa, 2011). However, today in the same territory, it is complex to understand industrial design, and promoters still emphasize explaining what we mean when referring to design and try to convey to companies and manufacturers how beneficial it would be to add the design component to their companies.

In summary, two starting points can be appreciated that have characterized the way design is understood in Spain:

- 1. First, the understanding of industrial design and its origins from the world of decorative arts, with this discipline being developed hand in hand with the field of fine arts in its early stages, and later with architecture. Therefore,

the understanding of an autonomous discipline was slow and gradual.

- 2. On the other hand, it is important to highlight the strong roots of craftsmanship, due to slow and almost non-existent industrialization in the early stages of the industrial revolution, establishing significant differences with the rest of the European continent. Additionally, within the Spanish territory itself, this industrialization was more successful in certain areas such as Catalonia, the Basque Country, or Valencia.

As emphasized by Anna Calvera (1998) in her essay "Antecedents" on Spanish design of the 20th century, from the early stages of design, the shift from decorative arts and craftsmanship to industrial design and industry respectively was a challenge. Despite the distance, Spain still experiences these differences in industrialization in its geography today, being a country with highly differentiated regions. For this reason, it is not necessary to seek a definitive Spanish design style (Julier, 1991), but rather an eclectic design prevails, composed of diverse styles and opinions.

The fact that the Spanish territory is very diverse from a cultural standpoint complicates the extraction of fundamental traits that characterize Spanish design, that is, the establishment of a grounded identity. However, there are certain patterns that, through analysis of the main bibliographic references, emphasize various core aspects of Spanish design. Juli Capella (2005) characterizes it as imaginative, daring design that plays with irony and humor, always mindful of the versatility of its use, emphasizing that products concentrate all their potential in a unique form. Similarly, Quim Larrea (2002) agrees in affirming the strong emotional, nostalgic component and the attachment to our memories, resulting in designs that seek to communicate with their recipient. These two authors emphasize that Spanish design seeks to modernize some popular elements by playing with them to bring them up to date, thus emerging as an important regional substrate. Following this line of argument, Enric Satué, national design award winner in 1998, highlights the subconscious influence of culture, with design functioning as a transmitting agent (Arias, 1996).

However, other authors affirm that these characteristics are not extrapolable to the totality of Spanish design. Emili Farré Escofet affirms the nonexistence of a Spanish identity and the presence of a design with a marked Mediterranean character (Arias, 1996). Another argument against identity definition is the relentless globalization, which forces us to renounce a geographic identity. Coinciding with Guy Julier (1991), Spanish design is then characterized by a marked eclecticism, as this activity is individual and not identified with certain styles.

On the other hand, professional studies or designers such as Emiliana Design or Jaime Hayón, highlight the importance of the Spanish character in design approaches, speaking of freshness, vitality, audacity, or risk (Sánchez, 2012).

It is important to highlight that, as several authors mention, Spanish design is strongly linked to the world of craftsmanship and handmade products. Companies are small, technologically limited, but they know how to overcome these limitations with creativity, innovation, and the contribution of added value (Burkhadt, 2005). As Santiago Miranda states in Arias' work (1996): "Others can provide technology since Spanish design stands out in the field of ideas and culture for design".

So, Bravo (2005) considers Spain as a country especially endowed for creation. Similarly, Alberto Corazón adds that Spain possesses transformation techniques and raw materials that are particularly unique, and through design, the Spanish product is capable of standing out and competing globally (Arias, 1996).

The dynamism in production, the use of innovative techniques, as well as the utilization of native raw materials are other characteristics that make Spanish design, despite limitations, agile and competitive in small-scale work (Sánchez, 2012). Furthermore, precisely based on these productive characteristics, the habitat emerges as the sector in which industrial design has left a greater number of creations (Zabalbeascoa, 2010).

Lastly, globalization has also affected the internationalization of Spanish design, with an increasing number of studios and designers orienting their creations towards new markets (Galán et. al., 2010). This fact necessitates understanding the philosophy of the producing companies in these countries, which can cause some disconnection or detachment from national identity.

Despite the gathered opinions, it is complex to characterize the identity of Spanish design. Sometimes the views of the main authors are refuted by members of the sector, with perhaps eclecticism being the attribute on which all agree, or at least not rejected. Tachy Mora (2010) explains this eclecticism as the essence of Spanish design, because the principles and characteristics are very different and varied among themselves.

On the other hand, the consulted documents focus on particular analyses and explaining the virtues of Spanish design as a creative activity, with virtually no comprehensive treatments of the subject that would allow deciphering its identity. This complexity is mentioned by Juli Capella in his book, "Los objetos esenciales del diseño español" ("The Essential Objects of Spanish Design"), where he indicates that due to the variety of styles and the designers' efforts to distinguish themselves from others, a specific Spanish design cannot be precisely defined. It is precisely in this search for common attributes, rooted in origins and heritage, that the exhibition "From Spain with Design: Identity and Territory" emphasizes, touring since 2022 to vindicate creation from different parts of the Spanish geography.

In summary, it is observed that many and varied traits are used by leading authors to refer to Spanish design, which reflects the aforementioned eclecticism. However, although eclecticism can be beneficial from the perspective of diversity or globalization, it dilutes stylistic recognition and therefore the rational value of identity, complicating its emergence process, thus explaining the possible absence of identity in the case of Spanish design.

Conclusions

The use of identity in industrial design has been important in the social and economic development of different regions. Furthermore, achieving this identity is inherently related to obtaining and understanding a culture of design among various actors - designers, companies, and countries. From a historical perspective, beyond not achieving an identity for Spanish industrial design, the development of this discipline has not managed to penetrate business culture. In other words, a solid design culture has not been achieved, still in the process of consolidation today.

On the other hand, when characterizing design done in Spain, no common pattern is observed. Despite the existence of good examples internationally, it is not possible to list traits with the ease that occurs, for example, in the Scandinavian case.

It can be concluded that this happens because Spanish design does not share those premises that have allowed other countries to enjoy identity. Thus, the following reasons are proposed to underscore the absence of identity in Spanish design:

- - The historical development of the country has imposed a mindset that hindered the culture of innovation and design in particular. Consequently, there has traditionally been a low level of awareness among companies regarding

the value of innovation in general; in products, processes, and services. The creation of identity and business value through innovation and the consequent contribution of rational, cultural, and experiential values to the product (largely intangible values) have not been sufficiently present in the minds of companies. Therefore, throughout the 20th century, there has been no culture of innovation in general or design in particular.

- - There has been inadequate communication of design values. At times, the message that has reached society has been even negative, giving a superficial image instead of highlighting the contribution of design to the competitiveness of companies; as well as its economic value and the values of quality, functionality, and comfort transmitted to the user. The message has not been correct or sustained both internally and externally.

- - The much later and weaker industrial development, with the exception of some regions like Catalonia. There has not been, in general, a strong industrial bourgeoisie with its own companies to drive innovation and design. The industrialization of the second half of the 20th century was generally due to the establishment of foreign companies, which designed from abroad. Thus, there has not been a strong locomotive effect generated by domestic companies.

- - There have been no periods of sustained economic prosperity during the 20th century. The situation has reversed in the last decade and the early years of the 21st century, however, these outbreaks have been thwarted by a very deep crisis. This has not promoted either industrial development or domestic consumption of design.

- - The contribution to identity from rational values (tangible) has been scattered, and except for exceptions, there has not been sufficient valuation of these. Thus, eclecticism turns out to be the common denominator which comes to be the opposite of stylistic identity; however, it could well be considered a style in itself characteristic of Spanish design.

- - The enormous wealth of multiple cultural identities available in Spain (from the arts, literature, history, gastronomy, sports, traditions, the variety of cultures and peoples, or the legacy of one of the most spoken languages in the world) has not been exploited by companies when providing multiple positive, clearly identifiable values to their products and their identity as brands. In addition, Spanish design has never been linked to the identity of the country (the country brand has not been used).

- - Until a few years ago, there was no tradition of design schools. The incorporation of this discipline into the University itself has been very recent, so its creator and transmitter role of innovation is just beginning. For the same reason, the designer's vision as an integral product manager, communication skills, and strategy were simply limited by their training. As an addition, entrepreneurs did not have sufficient training and awareness - culture - about the use and importance of design.

- - Despite the important work of the so-called pioneers of Spanish design in the internal development of the discipline, there have been no world-class figures in the field of design and artistic avant-garde who, with their own success and that of their products, would have championed Spain's image as a design country.

- - The impulse of design from institutions throughout the 20th century has been erratic and inconsistent. Efforts to promote design have been made by the professional collective or by certain productive sectors. This lack of impetus is still notable today, with the absence of state public bodies

that oversee the interests of design, following the disappearance of the DDI (State Society for the Development of Design and Innovation).

These aspects have hindered the creation and dissemination of a design culture in Spain and therefore of its own identity in the field of design. Beyond small similarities and common aspects (formal or temporal), Spanish design shows an absence of identity and therefore does not enjoy its benefits.

In the current context of a global society, the benefits of using identity as a competitive strategy cannot be ignored. The task ahead is to propose the most successful strategy in the case of Spanish design, understanding the positive aspects of its eclecticism and diversity.

In summary, the best way to approach an identity will be to start by promoting design and by fostering this discipline in Spanish companies, taking as a reference the development of the discipline during the 20th century. Identity must go beyond stylistic recognition, and therefore its achievement is associated with the achievement of its own design culture.

Source of funding
This work has not received any funding.

Author contributions:
R. M.-Ro: Conceptualization, methodology, investigation, and writing of the article.
P.F.-G.: Conceptualization, writing of the article, and preparation of materials.

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proyecta 56

An industrial design journal

Disclosure

DOI:https://doi.org/10.24310/p56-idj1202420150

ISSN 2386-5414
e-ISSN: 2340-8391

proyecta 56
An industrial design journal

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Sara Lenzi is a researcher in data sonification and sound-driven design. She started her career as a sound designer in Italy, founding the first sound branding agency and winning Young Entrepreneur of the Year (2008). In 2012, she established Asia's first sound design studio, creating sound identities for spaces, products, and brands. Alongside, she continued her research and artistic activities through teaching and exhibitions worldwide. She earned a cum laude PhD in Design on Data Sonification from the Politecnico di Milano (2021).

She is a member of the International Advisory Board of the Design Research Society, a visiting researcher at Delft University of Technology, and an affiliate member of the Center for Design, Boston. She co-founded sounDesign.info and the Data Sonification Archive and has ongoing projects with MIT and City University of Hong Kong. An advocate for the importance of sound and listening, she emphasizes ethical responsibility in design. Her research focuses on data sonification for anomaly detection and design methods in sound design. Currently, she works at the Basque Foundation for Science Ikerbasque.

Spanish

Sara Lenzi es investigadora en sonificación de datos y diseño impulsado por el sonido. Comenzó su carrera como diseñadora de sonido en Italia, fundando la primera agencia de branding sonoro y ganando el premio a la Joven Emprendedora del Año (2008). En 2012, estableció el primer estudio de diseño de sonido en Asia, creando identidades sonoras para espacios, productos y marcas. Paralelamente, continuó su investigación y actividades artísticas a través de la enseñanza y exposiciones en todo el mundo. Obtuvo un doctorado cum laude en Diseño sobre Sonificación de Datos del Politecnico di Milano (2021).

Es miembro del Consejo Asesor Internacional de la Design Research Society, investigadora visitante en la Universidad Técnica de Delft y miembro afiliada del Center for Design de Boston. Cofundó sounDesign.info y el Data Sonification Archive, y tiene proyectos en curso con el MIT y la City University de Hong Kong. Defensora de la importancia del sonido y la escucha, enfatiza la responsabilidad ética en el diseño. Su investigación se centra en la sonificación de datos para la detección de anomalías y los métodos de diseño en el diseño sonoro. Actualmente, trabaja en la Fundación Vasca para la Ciencia Ikerbasque.

DOI:https://doi.org/10.24310/p56-idj1202420150

Hearing data: Combining sensory experiences for improved human-data relationships.

"In the past two decades, the collection, production and consumption of data has exponentially increased at all levels of human endeavours. As most of the infrastructures we use to deal with, from communications to public utilities, transportation, education transitioned from the physical towards the digital world - thanks to, for instance, the Internet of Things, smart networks, smart phones, smart devices, or social media - new challenges have arisen on how to make sense of this unprecedented amount of data and translate it into human-scale information, and thus knowledge (Masud et al., 2010).

Of all human senses, hearing is the first to develop. Even before birth we learn to distinguish the mother's voice and identify familiar sounds from within the womb. Our everyday relationship with sound keeps growing all over our lives. Human capability to gather environmental information from surrounding sound events is extremely sophisticated, as well explored and described since the 1960s by the research area of soundscape studies (Schafer 1977, Truax 2000) . Recently, the COVID pandemic has reminded us how much our everyday lives are impacted by the urban soundscape: In the absence of human-generated sounds such as car traffic, constructions, and voices of crowd's in the streets, cities around the world seemed empty and even eerie. In functional socio-technological environments, we use sound to gather information and perform tasks:

The coffee machine tells us that coffee is ready by the distinct sound it makes when it pours. Nurses monitor the patient's status by hearing the sounds of medical equipment. While driving, we know whether the car is correctly functioning by listening to the sound it emits - while we can still keep our eyes on the road. Although we are scarcely aware of it, the act of listening is a continuous act of knowing and interacting with the world around us (Lenzi et al., 2024). Over the decades, designers (and to some extent, artists) have used sound to create sonic experiences that not only convey information but also emotionally engage the public. At cinema or in digital gaming, sound is designed to shape and direct the experience of time, space, and narrative (Hilmann & Pauletto 2014). In product design, sound is more and more used both functionally - to provide feedback and guide interaction with a product - and aesthetically - to engage customers with a brand. In electric cars, the 'fake' engine sound originally added to alert pedestrians has become a key element of the user experience, with manufacturers working with sound designers and composers to shape their product's distinct identity (Misdariis et al., 2012).

In our data-intense society, data sonification - which uses sounds to represent and communicate large data sets - is gaining momentum as an alternative or a complement to data visualisation both as a tool for analysis and a means of mass-communication of complex phenomena.

Data Sonification: Listening is making sense

Although many readers might be familiar with one of the most successful cases of data sonification - the Geiger Counter, through which we can monitor in real-time the amount of radiations in the environments by listening to a pulsating sound which frequency over time increases proportionally to the amount of radiation - Data Sonification is a relatively young field of research. It was first officially defined after the 1992 International Conference on Auditory Display as a method for "the transformation of data relations into perceived relations in an acoustic signal" (Kramer 1994). Originally a field of research close to computer science and focussed on providing expert tools for data analysis (Hermann et al. 2011), in recent years sonification has grown to show a variety of other purposes - from public communication to data journalism and even activism (Lindborg et al. 2024). Besides being used to represent and communicate 'objective' (numerical) values, authors of sonifications are putting more effort on the aesthetic quality of the user experience - which might, in turn, support a deeper understanding of the phenomenon, especially when the data refer to socially relevant issues (Lenzi and Ciuccarelli 2020).

The Data Sonification Archive (DSA), the first online collection of sonification projects, is a crowdsourced initiative launched in early 2021 that collects more than 450 cases to date (Lenzi et al., 2021). A quick analysis of the DSA shows how sonification is more and more used to engage a non-specialised audience with socially relevant, complex phenomena such as climate change, the recent COVID pandemic, social inequality, human rights. Not only experts in sound computing, but also artists, journalists, and information designers are starting to integrate sound into their data experience to improve the understanding of the final user by engaging them with the complexity of the data (and the phenomenon they represent) at a more visceral level.

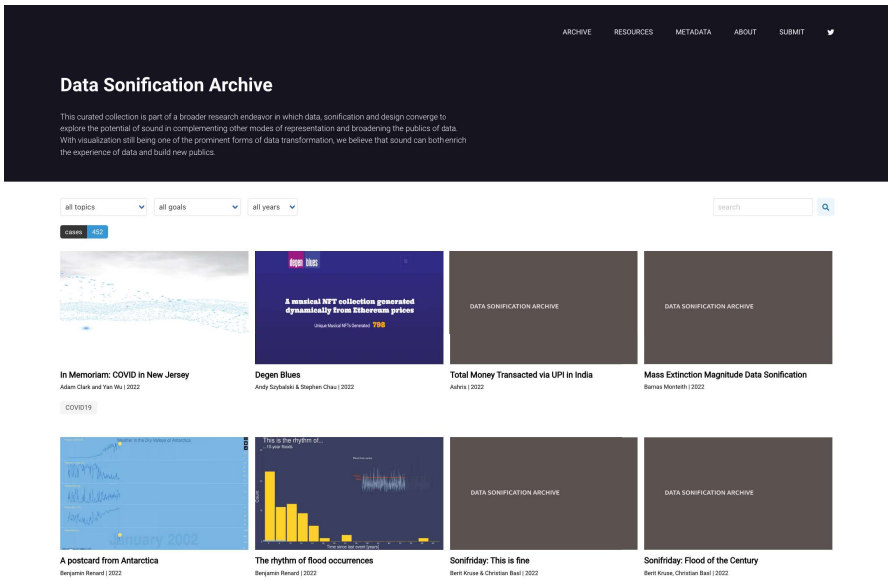


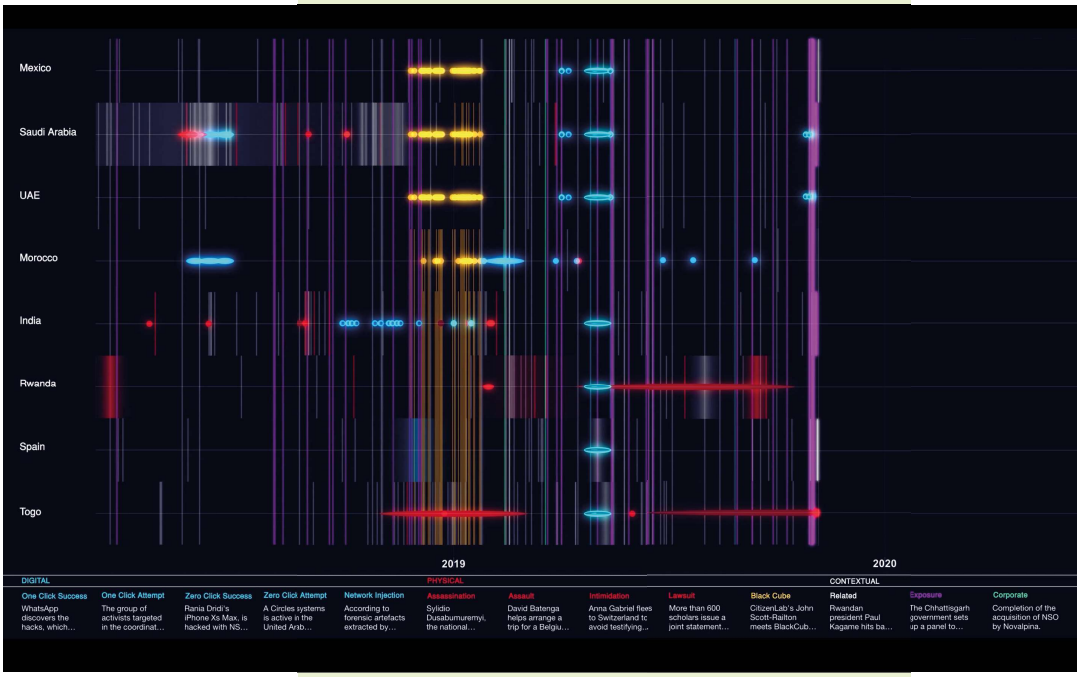
Figure 1. The Data Sonification Archive, the first online collection of sonification projects (https://sonification.design).

Figure 2. An image capturing the deadly wildfire season of 2023 in Canada, which burnt more than 15 millions hectares of wildforest. Photo by Duncan Rawlinson (CC Creative Commons 4.0). https://www.flickr.com/photos/thelastminute/

In Hold the Line, Miriam Quick and Duncan Geere - also authors of the Loudnumbers podcast where sonification projects are explained in detail, for non-experts - a piece of soundart was created to represent the loss of more than 5% of the Canadian forests over the course of 2023 due to the most tragic season of wildfires in the history of North America, fuelled by climate change. In the sonification, 'Every single fire that was reported by the Canadian Interagency Forest Fires Centre between 1 April and 30 November is represented by a click sound, with each real-world day playing out over 2.5 seconds of sound. A bass note drops at the start of each new day'.

In Digital Violence, the investigative team of Forensic Architecture teamed up with the musician Brian Eno to compose a piece that sonifies the data collected by Amnesty International on the Pegasus Project - the systematic surveillance and human rights violations conducted by the NSO group on activists and journalists worldwide. Through sound, people can 'experience a sonic rendering' that engages at a deeper level than the visual representation of the same data set through graphics and diagrams.

Figure 3. Digital Violence is a research and activism project by Forensic Architecture that traces and accounts for the illegal surveillance and human rights violation activity conducted by the company NSO worldwide. In the image we see an excerpt of the sonification of the same dataset by the composer Brian Eno. https://www.digitalviolence.org/#/soundmachine



In Requiem 488 by Nessun Dharma, data sonification and visualisation are combined in a threnody for the COVID victims in the Italian provinces of Bergamo and Brescia, where the pandemic was most deadly. In the piece, every second represents a day from January 1st 2020 to March 18rh 2022. Every death caused by COVID is simultaneously represented by a sound event and a visual dot to create a narrative where 'the dramatic development of the work follows moments of high intensity caused by the so-called "waves" and moments of relative calm'.

In collaboration with NASA, System SOUNDS is a sci-art project that has extensively worked to 'translate the rhythm and harmony of the cosmos into music and sound' for public outreach. Thanks to sonification and interactive sound experiences, science is brought closer to non-expert audiences and made accessible to visually impaired people.

Figure 4. In 'Requiem 488' by Nessun Dharma, data from the COVID deaths in the two most affected provinces of Italy are visualised and sonified in an immersive installation where each sound event and visual element represent a life that was lost due to the pandemic. https://www.youtube.com/

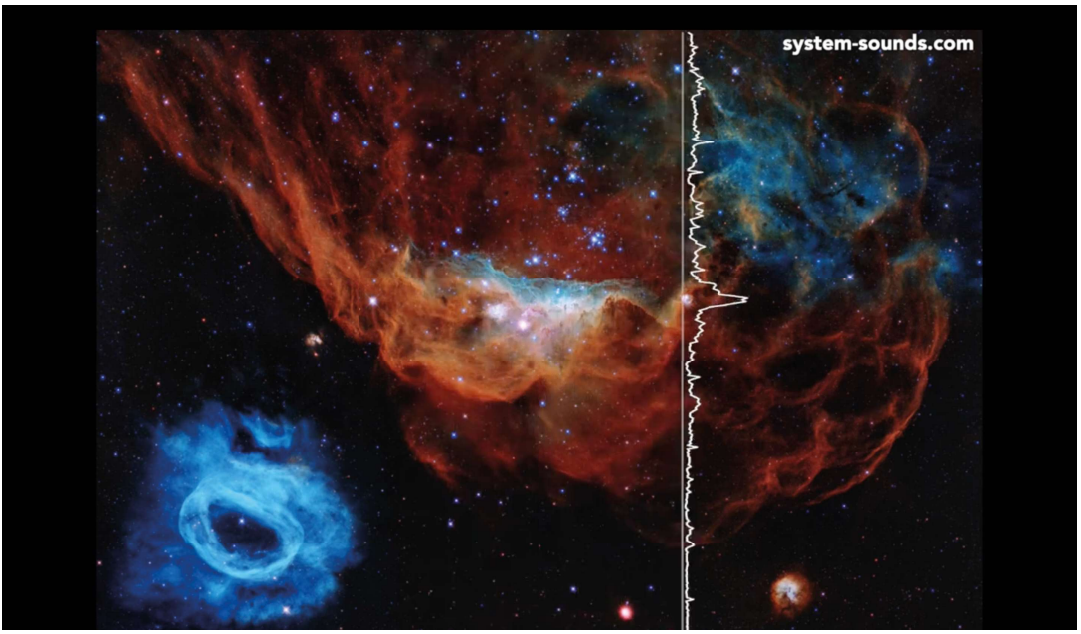


Figure 5. Sonification of images of the Cosmic Reef collected by the Hubble Space Telescope. In the sonification, colour is mapped to pitch (red=low, blue=high) and brightness controls volume. https://www.youtube.com/watch?v=kRkkHDEo0zQ

Open challenges and the role of designers

All the examples presented in this article leverage characteristics of sound that can add value to our understanding of a dataset. For instance, the human ear is very good at detecting changes in the acoustic patterns of sound events (Vickers 2011). Sound can attract our attention without requiring visual attention (Ballatore et al. 2018) so that we can keep focus on other - mainly visual - activities. Consequently, sound can provide a 'peripheral monitoring' system i.e. an alert system that stays at the background of our attention unless it is needed (Bakker et al. 2012), such as it happens with alarms emitted from medical equipment. Additionally, sound composition is inherently multivariate: different acoustic parameters (pitch, amplitude, rhythm, timbre) coexists in the same 'temporal unit' although they can be individually distinguished: For example, while listening to an orchestra we can distinguish a trumpet from a violin, or when in a natural soundscape we can identify different bird calls (Chion 2016).

While the use of sonification is growing among information designers, a series of critical open questions are still preventing the field from having a real-world impact. For instance, unlike data visualisation, whose long history has standardised the rules to translate specific data variable to visual variable to universal understanding (Muntzner 2015), in data sonification it is still unclear which 'data-to-sound' mapping works better. Can we use music that sounds 'happy' to represent a problematic issue such as income inequality - such as it happens in Two Trains by the Data Driven DJ - or is a 'wrong' choice of sound material misleading the listeners and even potentially spreading misinformation? Are blind listeners interpreting the changes in sound over time the same way as sighted listeners? A famous experiment by Walker and Lane (2001) - which showed how sighted and non-sighted users interpreted sonified data on growing economic value in opposite directions - suggests that is not the case. Could the introduction of shared design methods (such as the Data Sonification Canvas by Lenzi and Ciuccarelli, 2020) which include a thorough analysis of the use case and the evaluation of the impact help structure the field and uncover the full potential of sound for data representation?

As a young discipline, data sonification is still struggling to uncover its full potential. Perhaps design, as a structured discipline which fosters a multi-disciplinary approach to complex (wicked) problems, can provide the framework needed to create better, more engaging and inclusive data representations. As we move towards a world where humans will have to relate with non-human or more-than-human intelligences, sound can represent a truly embodied, visceral, pre-semantic means of communication towards better human-data relationships.

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An industrial design journal

ISSN 2386-5414
e-ISSN: 2340-8391

Escuchar datos: Combinando experiencias sensoriales para mejorar las relaciones humano-datos

Version traducida por la publicacion

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En las últimas dos décadas, la recopilación, producción y consumo de datos ha aumentado exponencialmente en todos los niveles de los esfuerzos humanos. A medida que la mayoría de las infraestructuras que usamos, desde las comunicaciones hasta los servicios públicos, el transporte y la educación, han pasado del mundo físico al digital. Gracias, por ejemplo, al "Internet de las Cosas", las redes, teléfonos y dispositivos inteligentes o las redes sociales, han surgido nuevos desafíos sobre cómo dar sentido a esta cantidad sin precedentes de datos y traducirlos en información a escala humana, y por ende en conocimiento (Masud et al., 2010).

De todos los sentidos humanos, el oído es el primero en desarrollarse. Incluso antes del nacimiento, aprendemos a distinguir la voz de la madre y a identificar sonidos familiares desde el útero. Nuestra relación cotidiana con el sonido sigue creciendo a lo largo de nuestras vidas.

La capacidad humana para recopilar información ambiental a partir de eventos sonoros circundantes es extremadamente sofisticada, como bien ha sido explorado y descrito desde la década de 1960 por el área de investigación de los estudios de paisajes sonoros (Schafer 1977, Truax 2000).

Recientemente, la pandemia de COVID nos ha recordado cuánto nuestras vidas cotidianas se ven afectadas por el paisaje sonoro urbano: En ausencia de sonidos generados por humanos, como el tráfico de automóviles, las construcciones y las voces de multitudes en las calles, las ciudades de todo el mundo parecían vacías e incluso inquietantes.

En entornos socio-tecnológicos funcionales, utilizamos el sonido para recopilar información y realizar tareas: La máquina de café nos indica que el café está listo por el sonido distintivo que hace al verterlo. Las enfermeras monitorean el estado del paciente escuchando los sonidos del equipo médico. Mientras conducimos, sabemos si el coche funciona correctamente al escuchar el sonido que emite, mientras mantenemos los ojos en la carretera.

Aunque apenas somos conscientes de ello, el acto de escuchar es un acto continuo de conocer e interactuar con el mundo que nos rodea (Lenzi et al., 2024). A lo largo de las décadas, los diseñadores (y hasta cierto punto, los artistas) han utilizado el sonido para crear experiencias sonoras que no solo transmiten información, sino que también involucran emocionalmente al público. En el cine o en los juegos digitales, el sonido se diseña para dar forma y dirigir la experiencia del tiempo, el espacio y la narrativa (Hilmann & Pauletto 2014). En el diseño de productos, el sonido se usa cada vez más tanto funcionalmente, para proporcionar retroalimentación y guiar la interacción con un producto, como estéticamente, para involucrar a los clientes con una marca. En los coches eléctricos, el sonido del motor 'falso' agregado originalmente para alertar a los peatones se ha convertido en un elemento clave de la experiencia del usuario, con los fabricantes trabajando con diseñadores de sonido y compositores para moldear la identidad distintiva de su producto (Misdariis et al., 2012).

DOI:https://doi.org/10.24310/p56-idj1202420150

En nuestra sociedad intensiva en datos, la sonificación de datos - que utiliza sonidos para representar y comunicar grandes conjuntos de datos - está ganando impulso como una alternativa o un complemento a la visualización de datos, tanto como una herramienta de análisis como un medio de comunicación masiva de fenómenos complejos.

Sonificación de datos: escuchar es comprender

Aunque muchos lectores pueden estar familiarizados con uno de los casos más exitosos de sonificación de datos - el contador Geiger, a través del cual podemos monitorear en tiempo real la cantidad de radiaciones en el entorno escuchando un sonido pulsante cuya frecuencia aumenta proporcionalmente a la cantidad de radiación - la sonificación de datos es un campo de investigación relativamente joven. Fue definido oficialmente por primera vez después de la Conferencia Internacional sobre Pantallas Auditivas de 1992 como un método para "la transformación de relaciones de datos en relaciones percibidas en una señal acústica" (Kramer 1994). Originalmente un campo de investigación cercano a la informática y enfocado en proporcionar herramientas expertas para el análisis de datos (Hermann et al. 2011), en los últimos años la sonificación ha crecido para mostrar una variedad de otros propósitos: desde la comunicación pública hasta el periodismo de datos e incluso el activismo (Lindborg et al. 2024). Además de ser utilizada para representar y comunicar valores "objetivos" (numéricos), los autores de sonificaciones están poniendo más esfuerzo en la calidad estética de la experiencia del usuario, lo cual podría, a su vez, apoyar una comprensión más profunda del fenómeno, especialmente cuando los datos se refieren a cuestiones socialmente relevantes (Lenzi y Ciuccarelli 2020).

El Archivo de Sonificación de Datos (DSA), la primera colección en línea de proyectos de sonificación, es una iniciativa de colaboración lanzada a principios de 2021 que recopila hasta la fecha más de 450 casos (Lenzi et al., 2021). Un análisis rápido del DSA muestra cómo la sonificación se utiliza cada vez más para involucrar a una audiencia no especializada con fenómenos complejos y socialmente relevantes, como el cambio climático, la reciente pandemia de COVID, la desigualdad social y los derechos humanos. No solo expertos en computación sonora, sino también artistas, periodistas y diseñadores de información están comenzando a integrar el sonido en su experiencia de datos para mejorar la comprensión del usuario final al involucrarlos con la complejidad de los datos (y el fenómeno que representan) a un nivel más visceral.

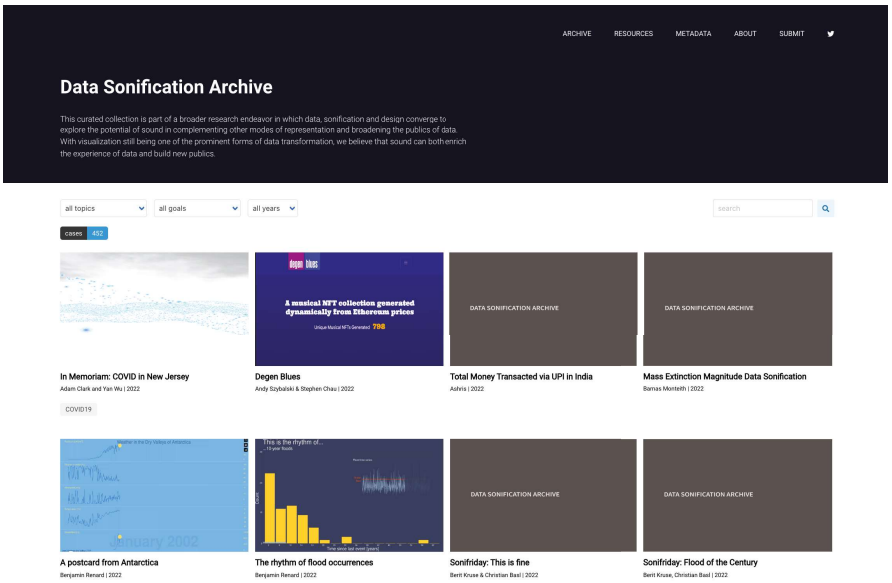

Figura 1. El Archivo de Sonificación de Datos, la primera colección en línea de proyectos de sonificación (https://sonification.design).

En “Hold the Line,” Miriam Quick y Duncan Geere - también autores del podcast Loudnumbers donde se explican proyectos de sonificación para no expertos - crearon una pieza de arte sonoro para representar la pérdida de más del 5% de los bosques canadienses durante 2023 debido a la temporada de incendios más trágica en la historia de América del Norte, alimentada por el cambio climático. En la sonificación, “Cada incendio reportado por el Centro Interagencial Canadiense de Incendios Forestales entre el 1 de abril y el 30 de noviembre está representado por un sonido de clic, con cada día real reproduciéndose durante 2.5 segundos de sonido. Una nota grave suena al comienzo de cada nuevo día”.

Figura 2. Una imagen que captura la mortal temporada de incendios de 2023 en Canadá, que quemó más de 15 millones de hectáreas de bosque salvaje. Foto de Duncan Rawlinson (CC Creative Commons 4.0). https://www.flickr.com/photos/thelastminute/

En “Digital Violence,” el equipo de investigación de Forensic Architecture se unió al músico Brian Eno para componer una pieza que sonifica los datos recopilados por Amnistía Internacional sobre el Proyecto Pegasus: la vigilancia sistemática y las violaciones de derechos humanos realizadas por el grupo NSO a activistas y periodistas en todo el mundo. A través del sonido, las personas pueden “experimentar una representación sonora” que involucra a un nivel más profundo que la representación visual del mismo conjunto de datos a través de gráficos y diagramas.

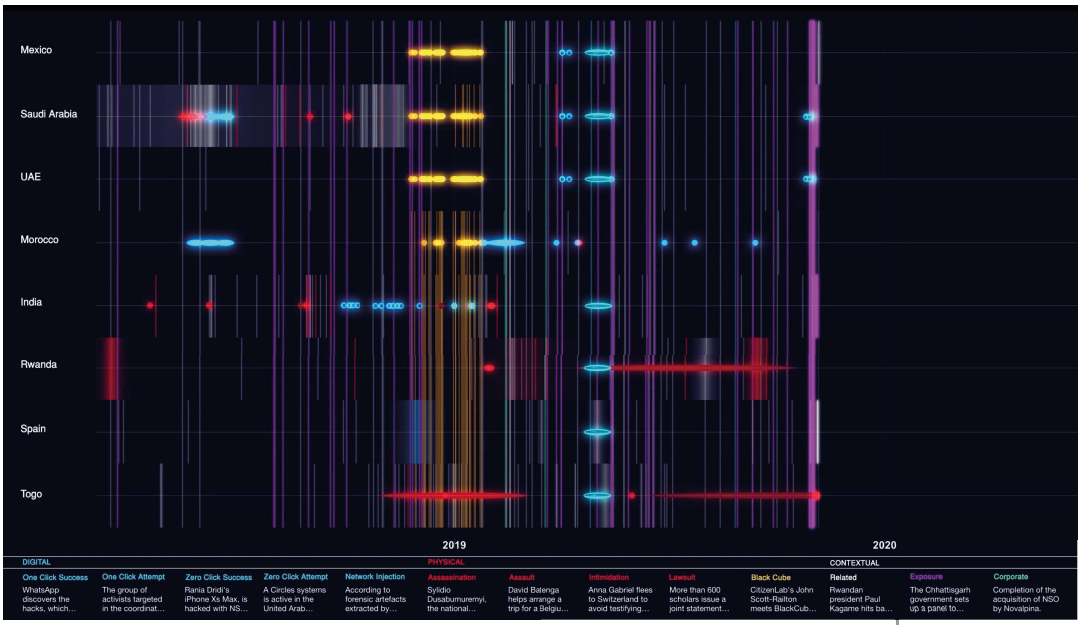

Figura 3. “Digital Violence” es un proyecto de investigación y activismo de Forensic Architecture que rastrea y documenta la actividad de vigilancia ilegal y violación de derechos humanos realizada por la empresa NSO en todo el mundo. En la imagen vemos un extracto de la sonificación del mismo conjunto de datos por el compositor Brian Eno. https://www.digitalviolence.org/#/soundmachine

En “Requiem 488” de Nessun Dharma, la sonificación y visualización de datos se combinan en un réquiem por las víctimas de COVID en las provincias italianas de Bérgamo y Brescia, donde la pandemia fue más mortal. En la pieza, cada segundo representa un día desde el 1 de enero de 2020 hasta el 18 de marzo de 2022. Cada muerte causada por COVID está representada simultáneamente por un evento sonoro y un punto visual para crear una narrativa donde “el desarrollo dramático del trabajo sigue momentos de alta intensidad causados por las llamadas ‘olas’ y momentos de relativa calma”.

Figura 4. En “Requiem 488” de Nessun Dharma, los datos de las muertes por COVID en las dos provincias más afectadas de Italia son visualizados y sonificados en una instalación inmersiva donde cada evento sonoro y elemento visual representan una vida perdida debido a la pandemia. https://www.youtube.com/watch?v=gkSHOZf4oiw&t=2s

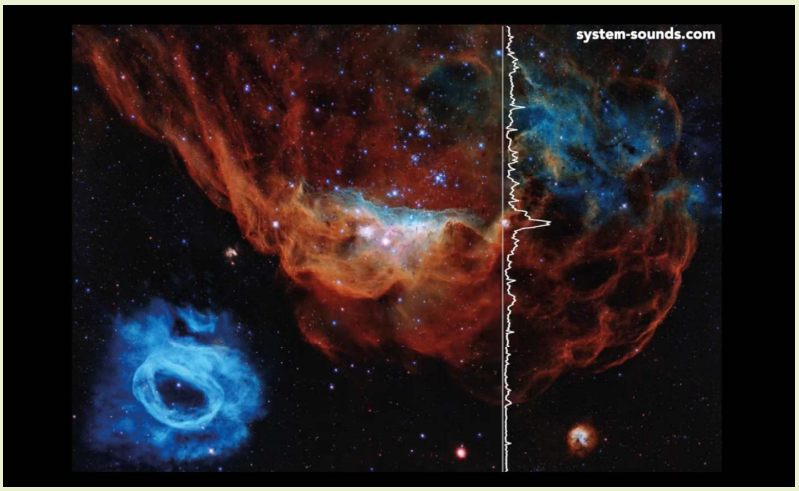

Figura 5. Sonificación de imágenes del Arrecife Cósmico recopiladas por el Telescopio Espacial Hubble. En la sonificación, el color se asigna a la altura del tono (rojo=bajo, azul=alto) y el brillo controla el volumen. https://www.youtube.com/watch?v=kRkkHDEo0zQ

En colaboración con la NASA, System SOUNDS es un proyecto de sci-art que ha trabajado extensamente para “traducir el ritmo y la armonía del cosmos en música y sonido” para divulgación pública. Gracias a la sonificación y a experiencias sonoras interactivas, la ciencia se acerca a audiencias no expertas y se hace accesible a personas con discapacidades visuales.

Desafíos abiertos y el papel de los diseñadores

Todos los ejemplos presentados en este artículo aprovechan las características del sonido que pueden agregar valor a nuestra comprensión de un conjunto de datos. Por ejemplo, el oído humano es muy bueno detectando cambios en los patrones acústicos de los eventos sonoros (Vickers 2011). El sonido puede atraer nuestra atención sin requerir atención visual (Ballatore et al. 2018), lo que nos permite mantener el enfoque en otras actividades principalmente visuales. En consecuencia, el sonido puede proporcionar un sistema de "monitoreo periférico", es decir, un sistema de alerta que permanece en el fondo de nuestra atención a menos que sea necesario (Bakker et al. 2012), como ocurre con las alarmas emitidas por equipos médicos. Además, la composición sonora es inherentemente multivariante: diferentes parámetros acústicos (tono, amplitud, ritmo, timbre) coexisten en la misma "unidad temporal" aunque pueden ser distinguidos individualmente: por ejemplo, mientras escuchamos una orquesta podemos distinguir una trompeta de un violín, o cuando estamos en un paisaje sonoro natural podemos identificar diferentes cantos de aves (Chion 2016).

Aunque el uso de la sonificación está creciendo entre los diseñadores de información, una serie de preguntas críticas aún están impidiendo que el campo tenga un impacto en el mundo real. Por ejemplo, a diferencia de la visualización de datos, cuya larga historia ha estandarizado las reglas para traducir una variable específica de datos en una variable visual de comprensión universal (Muntzner 2015), en la sonificación de datos aún no está claro qué "mapeo de datos a sonido" funciona mejor. ¿Podemos usar música que suene "feliz" para representar un problema como la desigualdad de ingresos - como ocurre en "Two Trains" del Data Driven DJ - o una "mala" elección de material sonoro está engañando a los oyentes y potencialmente propagando desinformación? ¿Los oyentes ciegos interpretan los cambios en el sonido a lo largo del tiempo de la misma manera que los oyentes videntes? Un famoso experimento de Walker y Lane (2001) - que mostró cómo los usuarios videntes y no videntes interpretaron datos sonificados sobre el crecimiento del valor económico en direcciones opuestas - sugiere que no es así. ¿Podría la introducción de métodos de diseño compartidos (como el Lienzo de Sonificación de Datos de Lenzi y Ciuccarelli, 2020) que incluyan un análisis exhaustivo del caso de uso y la evaluación del impacto ayudar a estructurar el campo y descubrir el potencial completo del sonido para la representación de datos?

Como una disciplina joven, la sonificación de datos todavía está luchando por descubrir su potencial completo. Quizás el diseño, como una disciplina estructurada que fomenta un enfoque multidisciplinario para problemas complejos (wicked problems), pueda proporcionar el marco necesario para crear representaciones de datos mejores, más atractivas e inclusivas. A medida que avanzamos hacia un mundo donde los humanos tendrán que relacionarse con inteligencias no humanas o más que humanas, el sonido puede representar un medio de comunicación verdaderamente encarnado, visceral y pre-semántico hacia mejores relaciones humano-datos.

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An industrial design journal

ISSN 2386-5414
e-ISSN: 2340-8391

Articolo di Ricerca | Research Article

Design e valorizzazione sostenibile di scarti e sottoprodotti agro-industriali per la circolarità del settore tessile | Design and Sustainable Valorization of Agro-Industrial Waste and By-Products for the Circularity of the Textile Sector

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Ricevuto: 9 aprile 2024 | Accettato: 3 giugno 2024 | Pubblicato: 29 guigno 2024

DOI: 10.24310/p56-idj1202419633

Resumen

Il dibattito teorico sul design si intreccia e viene alimentato dalle diverse teorie e approcci sviluppatisi a partire dalla seconda metà del Novecento in ambito economico e industriale, tra i quali si è affermato il concetto di Economia Circolare. Ciò che in un'economia lineare è normalmente considerato scarto o sottoprodotto, diventa ora risorsa di cui trattenere il valore. Nel dominio del design, ciò corrisponde a un progressivo allargamento della prospettiva dal livello del singolo prodotto al design del sistema complesso in cui esso è inserito e all'adozione di nuove strategie, tra cui la "chiusura del ciclo". In tal senso, il settore agroindustriale rappresenta un fertile terreno per l'innovazione sostenibile design-driven, anche a causa della significativa quantità di scarti generata ogni anno in tutte le fasi della filiera. La valorizzazione sostenibile di tali biomasse, infatti, rappresenta un feedstock alternativo per il recupero di sostanze e materiali ad alto valore, potenzialmente in grado di incrementare il livello di circolarità in diversi settori applicativi caratterizzati da un elevato consumo di risorse non rinnovabili, come quello tessile. Attraverso la selezione critica e l'analisi comparativa di tre casi studio, la ricerca si propone di definire il mutato ruolo del design nello scenario attuale e la natura delle interazioni tra il designer e gli altri attori rilevanti nella transizione verso modelli di produzione e consumo circolari, in particolare esplorando il tema della valorizzazione dei rifiuti e sottoprodotti agro-industriali per applicazioni nel settore tessile.

Parole Chiave: Design circulare; Valorizzazione dei rifiuti e dei sottoprodotti; Economia circolare; Settore tessile; Casi di studio; Ricerca nel Design

Abstract

The theoretical debate on design is intertwined with and fueled by the various theories and approaches that have developed since the second half of the twentieth century in the economic and industrial fields, among which the concept of the Circular Economy has emerged. In a linear economy, what is normally considered waste or by-product becomes a resource whose

value is to be retained. In the domain of design, this corresponds to a progressive broadening of perspective from the level of the individual product to the design of the complex system in which it is embedded and the adoption of new strategies, including "closing the loop." In this sense, the agro-industrial sector represents fertile ground for sustainable, design-driven innovation, partly due to the significant amount of waste generated annually at all stages of the supply chain. The sustainable valorization of such biomass represents an alternative feedstock for the recovery of high-value substances and materials, potentially increasing the level of circularity in various application sectors characterized by high consumption of non-renewable resources, such as the textile sector. Through the critical selection and comparative analysis of three case studies, this research aims to define the changed role of design in the current scenario and the nature of interactions between the designer and other relevant actors in the transition towards circular production and consumption models, particularly exploring the theme of valorizing agro-industrial waste and by-products for applications in the textile sector.

Keywords: Circular Design; Waste and by-products valorization; Circular Economy; Textile Field; Case studies; Design research

Introduzione

Nel corso della seconda metà del Novecento, il dibattito teorico sul design per la sostenibilità si evolve attraverso un progressivo allargamento della prospettiva dal livello del singolo prodotto alle dimensioni "insular" e "systemic" (Adams et al., 2016) porta a considerare l'attributo "sostenibile" non più come una proprietà riferibile ai singoli elementi all'interno di un sistema, bensì come una proprietà dell'intero sistema e una condizione dinamica che richiede l'adozione di un pensiero organico e non lineare (system thinking) (Hjorth & Bagheri, 2006).

La transizione della disciplina del design attraverso differenti definizioni e terminologie rappresenta un progressivo ampliamento della prospettiva sulla teoria e sulla pratica del design, nonché il tentativo di interfacciarsi con la complessità che un approccio "sostenibile" al design implica (Madge, 1997). Tuttavia, secondo van Dam et al. (2019) la variegata terminologia elaborata dalla ricerca nel corso degli anni (e.g., "green design", "ecodesign", "design for sustainability") presenta in molti casi concetti sovrapponibili e risulta controproducente poiché genera una frammentazione della conoscenza che porta a una dispersione dei risultati rilevanti. Viene proposto, invece, di collegare questi filoni di ricerca simili affinché la disciplina del design possa consolidare la conoscenza e produrre avanzamenti rispetto alla sostenibilità e alla circolarità.

I concetti di system thinking e di circolarità sono mutuati dalle teorie sviluppatesi in ambito economico e industriale ed entrambi sono ben radicati nei sistemi economici già da diversi decenni, traendo a loro volta ispirazione da idee sul metabolismo umano e agricolo risalenti al XVIII secolo (Reike et al., 2017). Tuttavia, acquistano popolarità in tempi più recenti grazie all'affermazione su vasta scala del concetto di Economia Circolare (Ekins et al., 2019). Oggi, una delle definizioni maggiormente accettate di Economia Circolare è quella sviluppata dalla Ellen MacArthur Foundation:

> *«A circular economy is an industrial system that is restorative or regenerative by intention and design. [...] It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models» (Ellen MacArthur Foundation, 2013)*

L'Economia Circolare si pone come modello alternativo al paradigma dominante "take-make-dispose", attraverso l'adozione di

cinque fondamentali principi: (1) Design out waste; (2) Build resilience through diversity; (3) Rely on energy from renewable sources; (4) Think in systems; (5) Waste is food (Ellen MacArthur Foundation, 2013).

Ekins et al. (2019) individuano i tre principali scopi della transizione verso un'economia circolare nel rallentamento del processo di esaurimento delle risorse naturali, nella riduzione dei danni ambientali causati dall'estrazione e la trasformazione dei materiali vergini e nella riduzione dell'inquinamento legato alla trasformazione, all'uso e alla dismissione dei materiali. Ciò è possibile attraverso l'adozione di nuovi modelli di business inseriti in una prospettiva sistemica sull'utilizzo delle risorse, al fine di rendere più efficiente l'utilizzo, incrementarne il valore complessivo ed estenderne il ciclo vita.

Nel dibattito teorico sul design, alcuni ricercatori si sono interrogati sul mutato ruolo del design nel contesto contemporaneo e hanno proposto di adottare il termine "Circular Design" per indicare un'area del design per la sostenibilità i cui obiettivi si intrecciano con quelli dell'Economia Circolare (e.g., Moreno et al., 2016; Medkova & Fifield, 2016; van Dam et al., 2019). Sebbene il Circular Design si basi su approcci consolidati, Asif et al. (2021) suggeriscono che esso differisca dalle pratiche del design per la sostenibilità e dall'ecodesign, che muovono perlopiù da una prospettiva di economia lineare. Secondo den Hollander et al. (2017), il ruolo del (circular) designer è quello di facilitare la transizione da un'economia lineare a un'economia circolare e prendere decisioni finalizzate a prevenire e invertire l'obsolescenza dei prodotti.

L'analisi della letteratura sul tema evidenzia un tentativo da parte della ricerca di sistematizzare principi, linee guida e strategie per il design circolare delle soluzioni che si inseriscono nel contesto dell'economia circolare. Diversi studi hanno cercato di sintetizzare il contributo del design alla transizione verso l'economia circolare attraverso un'identificazione sistematica degli approcci di "Design for X" (DfX) (Aguiar et al., 2021; Sassanelli, 2019; den Hollander et al., 2017; Moreno et al., 2016; De los Rios e Charnley, 2016). Le varie strategie identificate in letteratura possono essere ricondotte a quattro fondamentali approcci dell'innovazione circolare: narrow, slow, close, regenerate (Konietzko et al., 2019). "Narrow" si riferisce alla riduzione dell'uso di risorse, sia in termini di materiali che di energia impiegati durante l'intero ciclo di vita dei prodotti; "slow" si riferisce all'obiettivo di prolungare il ciclo vita di prodotti, componenti e materiali; "close" significa mantenere il valore di ciò che normalmente è considerato rifiuto o sottoprodotto in un'economia lineare. "Regenerate" si riferisce alla minimizzazione dell'uso di sostanze tossiche e all'aumento dell'uso di materiali ed energia rinnovabili in un'economia circolare. A queste quattro strategie, Konietzko et al. (2019) hanno aggiunto la strategia "inform", per sottolineare l'importanza delle nuove tecnologie nel supportare l'economia circolare. Ciascuna delle quattro strategie può essere applicata attraverso tre dimensioni e scale di intervento (prodotto, business, ecosistema) (Konietzko et al., 2019).

Una tassonomia esaustiva che indaga la transizione dal design orientato alla sostenibilità (approcci DfX) al Circular Design, sintetizzando le strategie esistenti in nuove categorie, è fornita da Moreno et al. (2016). Basandosi sulla precedente tassonomia di De los Rios e Charnley (2016), le autrici mappano le strategie di design che supportano l'economia circolare. Queste sono articolate in: (a) design for resource conservation; (b) design for slowing resource loops; e (c) whole systems design, che a loro volta includono cinque strategie del design circolare: (a1) design for circular supplies; (a2) design for resource conservation; (b1) design for long life use of products; (b2) design for multiple cycles; and (c1) design for systems change.

Nel dominio del design, la strategia della "chiusura del ciclo" equivale a trattenere il valore di ciò che in un'economia lineare è normalmente considerato scarto o

sottoprodotto. Bocken et al. (2016) individua due strategie per farlo: la prima, solitamente a livello di prodotto, è "estendere il valore della risorsa", ovvero raccogliere i materiali e le risorse scartate per trasformarle in nuove forme di valore, potenzialmente più appetibili per l'utente, riducendo al contempo i costi dei materiali e del prodotto finale; la seconda, a livello ecosistemico, è una soluzione process-oriented, che si basa sul trasformare gli output di un processo in feedstock per un altro processo o linea produttiva (industrial symbiosis).

Grandi volumi di rifiuti possono essere generati nei diversi livelli della catena del valore, dalla fase di estrazione delle risorse, alla fase di produzione (scarti di produzione) alla fase di consumo (rifiuti post-consumo). I percorsi di recupero delle risorse variano in base alla fase del ciclo vita in cui c'è necessità di recuperare il valore delle risorse e in base al tipo di scarto (Singh & Ordoñez, 2015). In generale materiali e prodotti possono essere recuperati per servire lo stesso scopo o nuove funzioni, all'interno della stessa value chain, in value chain differenti oppure per l'attivazione di value chain completamente nuove e/o innovative.

Sebbene in letteratura siano rintracciabili numerosi casi studio pratici di valorizzazione di scarti e sottoprodotti per la progettazione di prodotti e processi innovativi nei più disparati ambiti applicativi, mancano dei veri e propri riferimenti metodologici che possano guidare l'attività progettuale (Karana et al., 2013). A tal proposito, si rende necessaria la creazione di un collegamento tra ricerca accademica e pratica per l'attivazione di nuove sinergie nel contesto dell'economia circolare.

Nell'approccio del Design Sistemico la valorizzazione di scarti e sottoprodotti costituisce un tema fondamentale e viene affrontato attraverso una rinnovata attenzione alla dimensione locale. Gli output dei processi produttivi vengono sollevati dal loro status di rifiuti e considerati risorse per l'attivazione di nuovi processi produttivi e sistemi industriali che generano sviluppo economico e territoriale. In tale contesto, il nuovo ruolo assunto dal designer è quello di delineare e programmare il flusso di materia che scorre da un sistema ad un altro in una metabolizzazione continua, organizzare ed ottimizzare tutte le parti all'interno di un ecosistema in modo che evolvano coerentemente le une con le altre, accompagnare e gestire, in tutte le fasi di sviluppo del progetto, il dialogo vicendevole tra i vari attori su questo nuovo terreno culturale (Bistagnino, 2011).

La metodologia del design sistemico parte da una "diagnosi olistica" (Holistic Diagnosis), caratterizzata da una fase di ricerca in letteratura e sul campo al fine di definire e mappare tutti i componenti che definiscono lo scenario, considerando sia il contesto circostante che il flusso di energia e materia che caratterizza il sistema. Attraverso questa raccolta di dati complessi, è possibile sottolineare le criticità e le potenzialità e raccogliere linee guida per la definizione di nuovi sistemi. Il progetto sistemico è basato sullo sviluppo di un sistema in cui sono progettate le relazioni tra processi e attori, i flussi di materia ed energia ottimizzati e gli output valorizzati come risorse (Battistoni et al., 2019). Il risultato è un sistema autopoietico, in grado di auto-organizzarsi e di ridefinirsi continuamente in base alle relazioni (l'organizzazione del sistema) che esistono tra gli elementi che li compongono (la struttura del sistema) e in base alle reciprocità che regolano il rapporto con l'ambiente circostante (Bistagnino, 2011).

Uno degli ambiti maggiormente esplorati dal Design Sistemico è il settore agroindustriale, che si presta particolarmente a questo tipo di approccio e che possiede grande potenziale nel contesto dell'Economia Circolare, anche per via della grande quantità di scarti prodotti dalla filiera (Fiore et al., 2020). Secondo i dati Eurostat, infatti, nel 2016 complessivamente gli sprechi agroalimentari prodotti nell'Unione Europea (UE28) ammontavano a 400 milioni di tonnellate, di cui la categoria più rilevante (circa il 22%) era rappresentata dagli scarti organici di origine animale e vegetale, pari a circa 87 milioni di tonnellate. Di questi

ultimi, la fase di produzione agricola è responsabile del 20% (17 milioni di tonnellate); la trasformazione industriale del 28% (24 milioni di tonnellate); la fase di consumo del 38% (33 milioni di tonnellate); i servizi rappresentano il restante 14%, con circa 13 milioni di tonnellate (Intesa San Paolo, 2016).

A tal proposito, è stato messo in luce il potenziale di valorizzazione delle biomasse (termine generale applicabile a tutti materiali di derivazione vegetale e animale) ottenute da rifiuti alimentari non edibili e rifiuti agricoli, come feedstock alternativo alle risorse non rinnovabili e potenziale risorsa per il recupero di sostanze e materiali ad alto valore. Possibili usi delle biomasse plant-based includono applicazioni tradizionali, come mangime per il bestiame e fertilizzanti, e altri usi, come la progettazione e produzione di innovativi prodotti bio-based (Sherwood, 2020). Ciò può contribuire all'instaurazione di una "bioeconomia circolare", che si basa sulla valorizzazione sostenibile ed efficiente delle biomasse in catene di produzione integrate e multi-output (ad esempio bioraffinerie), utilizzando anche residui e rifiuti e ottimizzando il valore della biomassa nel tempo tramite processi a cascata (Stegmann & Junginger, 2020).

All'interno di tale contesto, il presente studio si propone l'obiettivo di esplorare il ruolo e il contributo del design nell'attivazione dei processi di valorizzazione sostenibile di scarti e sottoprodotti della filiera agro-industriale, con particolare riferimento alle applicazioni nel settore tessile e attraverso l'adozione di un approccio interdisciplinare e collaborativo. Attraverso l'esplorazione di tale tematica, viene investigata l'intersezione tra il design, l'economia circolare e l'innovazione in campo tessile, e viene studiato il contributo del design nella transizione del settore verso un modello di produzione e consumo circolare, rispondendo ai seguenti obiettivi specifici: a) Inquadrare il panorama dell'innovazione sostenibile in campo tessile in riferimento allo specifico ambito della valorizzazione di scarti e sottoprodotti agro-industriali, effettuando una mappatura delle principali aree di innovazione; b) Esplorare il contributo del design e le nuove competenze richieste alla figura del designer nel perseguimento delle strategie per la circolarità attraverso la selezione e l'analisi di casi studio applicativi; c) Esplorare il ruolo dell'interdisciplinarità e la collaborazione tra ricerca di design, accademica e industriale sulla base dei casi studio selezionati.

Circolarità del settore tessile

La potenziale valorizzazione delle biomasse ottenute da scarti e sottoprodotti agro-industriali rappresenta un feedstock alternativo e una potenziale fonte per il recupero di sostanze ad alto valore e materiali che possono essere applicati in altri settori. Al di là delle applicazioni tradizionali sintetizzate nelle "5F" (Koopmans & Koppejan, 1997), possibili usi includono il design e la produzione di materiali, prodotti e soluzioni innovativi attraverso un approccio di valorizzazione a cascata in grado di ottimizzare il valore della biomassa nel tempo, definendo scenari di utilizzo in altri settori produttivi caratterizzati da un elevato consumo di risorse non rinnovabili, come quello tessile, potenzialmente dal valore più elevato.

L'industria tessile globale è responsabile di un grave impatto ambientale lungo tutta la catena del valore, con ingenti emissioni di gas serra, un significativo consumo e inquinamento delle risorse idriche e una crescente produzione di rifiuti, con conseguenze negative sulla qualità degli ecosistemi e sulla salute umana (Quantis, 2018). Questo scenario è esacerbato dall'affermarsi di un modello di produzione e consumo caratterizzato da cicli di produzione veloci e dismissione precoce dei prodotti tessili, noto come "fast fashion". Il modello lineare del tipo "take-make-dispose" che caratterizza l'attuale industria tessile consuma notevoli quantità di risorse. Si stima che ogni anno il settore impieghi circa 98 milioni di tonnellate di risorse non rinnovabili (Ellen MacArthur Foundation, 2017) nelle diverse fasi della produzione.

A livello istituzionale, l'urgenza di trasformare in un'ottica sostenibile e circolare il settore tessile è stata recentemente affrontata attraverso la pubblicazione, nel marzo 2022, della Strategia dell'Unione Europea per i prodotti tessili sostenibili e circolari. Quest'ultima traccia un quadro comune per il settore tessile, mettendo a sistema normative già in atto con nuove iniziative e proposte di legge, con l'obiettivo di consolidare, entro il 2030, un ecosistema tessile circolare in cui l'incenerimento e il conferimento in discarica siano ridotti al minimo (Commissione Europea, 2022). Tra le azioni chiave annunciate vi è l'introduzione di requisiti obbligatori per la progettazione ecocompatibile in ambito tessile e calzaturiero, che avverrà entro il 2024 attraverso la normativa nota come Ecodesign for Sustainable Products Regulation con l'obiettivo di garantire che i prodotti tessili siano idonei alla circolarità, assicurando l'utilizzo di materie prime secondarie e limitando la presenza di sostanze chimiche pericolose (Commissione Europea, 2022). L'adozione dell'Ecodesign for Sustainable Products Regulation testimonia non solo il valore attribuito al processo di progettazione nel conseguimento della circolarità, ma anche il consolidamento di un approccio di prevenzione dell'impatto ambientale e degli scarti già a monte della supply chain, come opzione preferibile rispetto a un intervento a valle della catena orientato all'incremento della riciclabilità dei rifiuti tessili.

Nell'ottica di perseguire un'economia circolare e un approccio realmente sostenibile, il primo obiettivo da conseguire dovrebbe essere quello di ridurre quanto più possibile l'introduzione nella value chain di materie prime vergini. Ciò è possibile, in primo luogo, attraverso la massimizzazione dell'utilizzo dei tessili e l'estensione, per quanto possibile, della vita del materiale o del prodotto attraverso la riparazione o il riuso. In secondo luogo, ciò può avvenire rimpiazzando le risorse non rinnovabili con feedstock da materiali riciclati, rimettendo in circolo i materiali già disponibili senza intaccare nuove risorse, nel caso in cui questo possa essere fatto attraverso processi ecosostenibili (Ellen MacArthur Foundation, 2017). Tuttavia, adottare questa strategia attualmente non è sufficiente per sopperire alla necessità di materiali vergini. Laddove non fossero disponibili materiali da feedstock riciclati, la scelta dovrebbe cadere su materiali ottenuti da feedstock rinnovabili prodotti secondo un'ottica circolare e rigenerativa. Inoltre, la transizione a processi di produzione che necessitino di minori input in termini di risorse, che siano efficienti dal punto di vista energetico e che si basino sulle energie rinnovabili e generino meno scarti può ulteriormente contribuire a ridurre il bisogno di input non rinnovabili (Laudes Foundation, 2021).

In tal senso, il recupero degli scarti agroindustriali come materie prime secondarie e nuovi input in grado di inserirsi nella filiera tessile rappresenta un'opportunità non ancora del tutto esplorata, a cui il design può contribuire in maniera sostanziale attraverso i suoi approcci, strumenti e visioni.

Questo approccio di "cross-fertilization" rappresenta una risposta alle sfide della modernità e alla necessità di innovazione, che vede il numero di settori coinvolti in costante crescita e le competenze richieste sempre più specializzate (Cappellieri, 2006). Conti (2012) definisce la cross-fertilization un fenomeno di interdisciplinarità che riguarda la relazione e contiguità tra diverse aree del sapere umano e che interessa i confini e le zone di ricerca che si creano tra un'area disciplinare e un'altra. È proprio in questi "territori di confine" che si attivano dinamiche di trasferimento di conoscenza tra settori, facilitando la nascita di significativi processi di innovazione trasversale (Conti, 2012).

Nell'ambito del settore tessile, l'ultimo decennio ha visto lo sviluppo di numerosi materiali, prodotti e soluzioni basati sulla valorizzazione sostenibile di scarti e sottoprodotti agroindustriali. L'attuale panorama dell'innovazione è in rapida e continua evoluzione e fa leva su un'azione concertata di designer, ricerca accademica e industria (Laudes Foundation, 2021). In fig. 1 viene fornita una mappatura dello

stato dell'arte e illustrate le principali aree di innovazione sostenibile basate sulla valorizzazione di scarti e sottoprodotti agroindustriali, riconducibili alle seguenti tematiche:

- Processi: quest'area di innovazione include lo sviluppo di processi produttivi più efficienti dal punto di vista energetico e del consumo di risorse e con un minor impatto sugli ecosistemi. Include, inoltre, la messa a punto di tecnologie avanzate per il riciclaggio dei tessili e la gestione dei rifiuti. Nell'ambito della valorizzazione dei rifiuti, in letteratura sono presenti svariati esempi di impiego di scarti e sottoprodotti agricoli per il trattamento delle acque reflue dei processi tessili, in particolare come adsorbenti per la rimozione dei residui di tintura dalle acque (e.g., Amalina et al., 2022; Al-Gheethi et al., 2022; Gül & Bayazit, 2020).
- Materiali tessili: per mitigare la domanda di materie prime vergini, il ricorso a fonti alternative e rinnovabili per la produzione di materiali come fibre, filati e tessuti rappresenta una valida strategia. Numerose soluzioni già disponibili sul mercato si basano sulla valorizzazione degli output agroindustriali come feedstock per l'ottenimento di fibre naturali, artificiali e sintetiche.
- Prodotti per il trattamento dei tessili: include lo sviluppo di alternative maggiormente sostenibili ai prodotti per il pretrattamento, la tintura e il finissaggio dei tessili, con l'obiettivo primario di ridurre o eliminare l'utilizzo di sostanze chimiche potenzialmente dannose per l'uomo e l'ambiente. Esempi di prodotti "bio-based" sono rappresentati da tinture naturali, biomordenti o prodotti per il conferimento di proprietà funzionali (e.g., idrorepellenza, antimacchia).

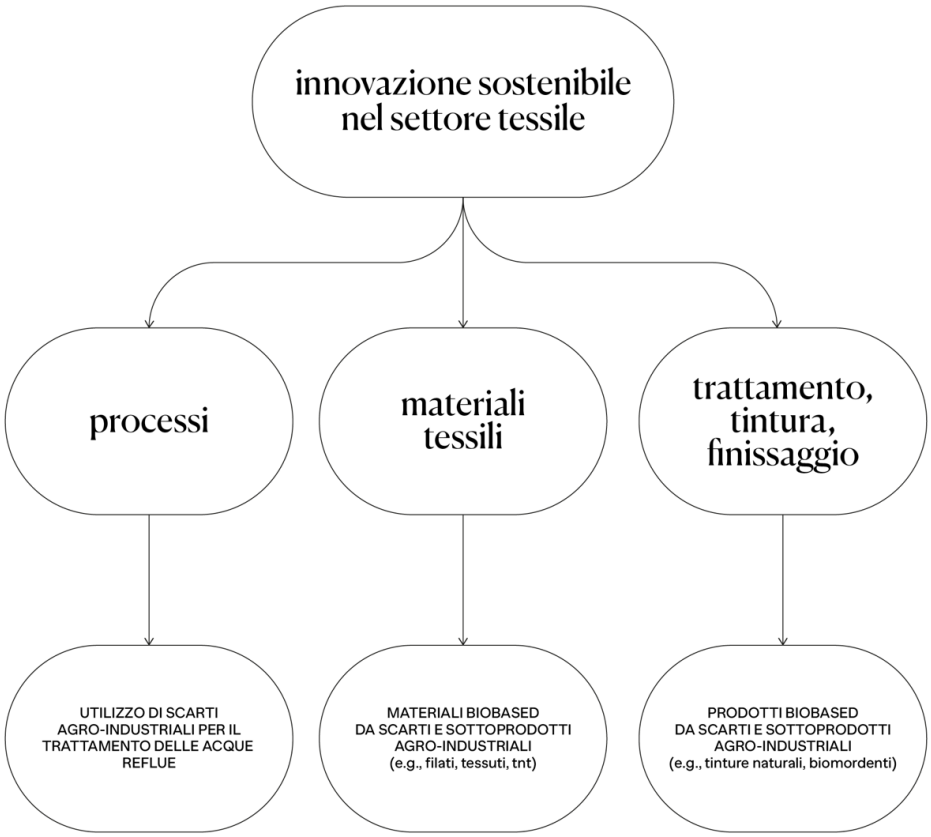


Figura 1. Innovazione sostenibile nel settore tessile attraverso la valorizzazione di scarti e sottoprodotti agro-industriali. Fonte: Elaborazione dell'autrice, 2024

Metodologia

All'interno del panorama dell'innovazione sostenibile tracciato, e con l'obiettivo di esplorare il ruolo e il contributo del design nell'attivazione dei processi di valorizzazione sostenibile di scarti e sottoprodotti della filiera agro-industriale, gestendo e indirizzando i flussi di risorse verso il settore tessile, l'utilizzo di casi studio è stato ritenuto utile a delineare considerazioni generali circa il contesto preso in esame (Eisenhardt, 1989). La selezione dei casi è stata condotta distinguendo due diversi contesti per la revisione della letteratura, ovvero un contesto accademico e uno pratico (Romani et al., 2021). Nel primo caso sono stati considerati database accademici, contributi in rivista e in volume; nel secondo caso, la ricerca è stata condotta tramite l'analisi di siti web e blog di design, includendo casi studio di successo implementati dall'industria.

La scelta dei criteri per la selezione dei casi studio è stata effettuata sulla base del framework teorico precedentemente delineato, includendo solo esempi di innovazione che mettessero a sistema il design, la valorizzazione di scarti agroindustriali e il settore tessile ed escludendo la valorizzazione di altri tipi di scarti (e.g., scarti tessili pre- o post-consumo). Sono stati presi in considerazione solo casi studio in cui la figura del designer fosse coinvolta nello sviluppo del progetto o della soluzione. Inoltre, al fine di presentare gli sviluppi più recenti dell'innovazione sostenibile in questa specifica area di ricerca, la selezione è stata limitata ai casi studio compresi fra il 2014 e il 2024.

In base a questi criteri, sono stati selezionati e approfonditi tre casi di valorizzazione ritenuti esemplificativi di tre approcci distinti: uno derivato dalla ricerca

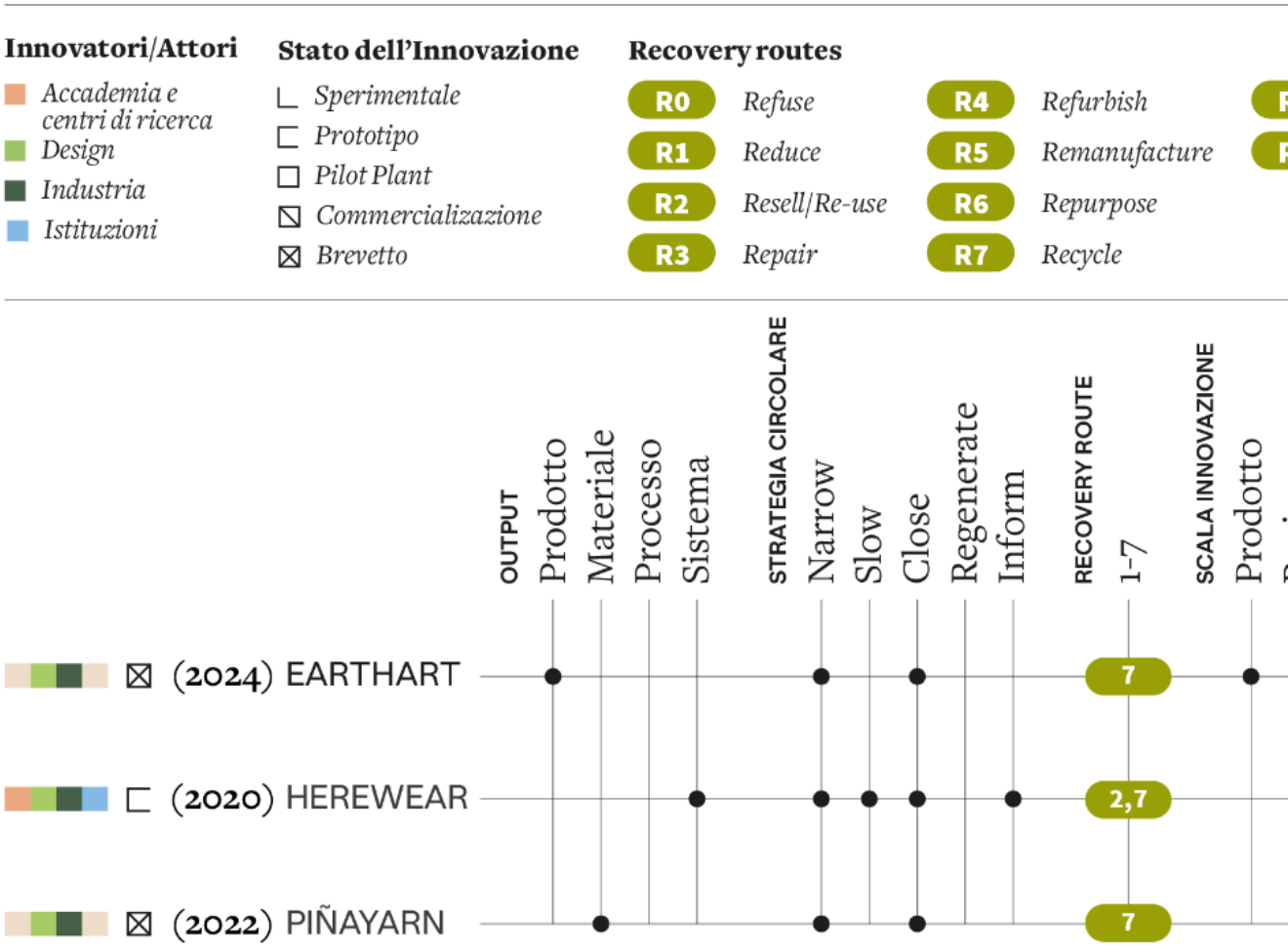
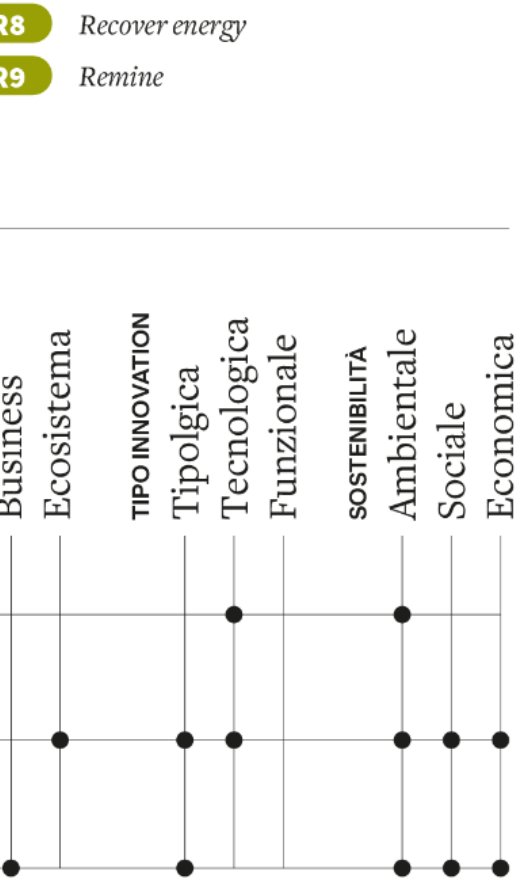


Figura 2. Innovazione sostenibile nel settore tessile attraverso la valorizzazione di scarti e sottoprodotti agro-industriali. Fonte: Elaborazione dell'autrice, 2024

industriale (EarthArt), uno proveniente dalla collaborazione fra centri di ricerca e ricerca accademica (Herewear) e uno prodotto dall'iniziativa imprenditoriale di una designer (Piñayarn).

I tre casi studio sono stati dapprima inquadrati schematicamente, con indicazione dei principali stakeholders coinvolti - designer, centri di ricerca e accademia, aziende o cluster industriali, istituzioni. La natura dell'innovazione è stata studiata e collocata nelle tre tipologie "tecnologica", "tipologica" o "funzionale". Inoltre, è stato identificato lo stato dell'innovazione, indicando se il progetto si trova in fase sperimentale, di prototipo, pilota, di commercializzazione o se include una soluzione brevettata. Viene, inoltre, preso in esame l'aspetto della sostenibilità, declinata nelle tre dimensioni ambientale, sociale ed economica. L'analisi dell'output descrive il tipo di output ottenuto.



L'imperativo del tipo "R" adottato viene, inoltre, indicato adottando la gerarchia di gestione dei rifiuti suggerita da Reike et al. (2017).

Successivamente, i tre casi studio sono stati approfonditi mediante il metodo suggerito da De los Rios & Charnley (2016) e basato sul Multilevel Design Model (MDM) proposto da Joore and Brezet (2015). Tale modello è stato sviluppato come strumento di analisi del sistema-innovazione utile a determinare potenziali contributi del design sia per quanto riguarda i risultati tangibili che intangibili (De los Rios & Charnley, 2016). L'analisi viene condotta considerando le seguenti quattro dimensioni: "reflection" descrive le caratteristiche del contesto iniziale in cui è inserito il caso studio; "analysis" descrive gli obiettivi e i requisiti che supportano la transizione verso un modello circolare; "synthesis" elenca e descrive le soluzioni sviluppate attraverso il design; "experimentation" descrive come le soluzioni prodotte rispondono e contribuiscono all'implementazione dell'EC. Infine, per ciascun caso il ruolo del design è stato evidenziato e tradotto in abilità e competenze utilizzando le evidenze ottenute dai casi studio e incrociando i requisiti di design in ogni scenario con il framework teorico esistente rispetto alle strategie di Design for X (DfX) (De los Rios & Charnley, 2016).

Risultati: Analisi delle strategie per l'EC

La raccolta di casi studio effettuata nella presente ricerca non vuole rappresentare una raccolta sistematica ed esauriente di tutte le soluzioni sviluppate nell'ambito d'interesse considerato, ma una selezione critica di progetti di valorizzazione con applicazione tessile in cui il design ha svolto un ruolo chiave. I tre casi studio selezionati —EarthArt, Herewear e Piñayarn — sono presentati schematicamente nell'infografica in fig. 2 e successivamente analizzati secondo la metodologia precedentemente descritta [tab. 1-3].

EarthArt [fig. 3] è una famiglia di tessuti denim nata dalla partnership industriale tra Nature Coatings e Soorty Enterprises e caratterizzata dall'utilizzo di tintura bio-based ottenuta da scarti agroindustriali in luogo delle tinture sintetiche. L'impatto ambientale del denim è legato principalmente alla coltivazione intensiva di cotone tradizionale, che richiede grandi quantità di acqua, pesticidi e fertilizzanti, e al rilascio di microfibre nell'ecosistema. Infatti, nonostante il denim derivi da una fibra naturale, esso viene ampiamente trattato con sostanze chimiche quali tinture sintetiche e altri additivi utili a incrementare la durabilità e le prestazioni del tessuto, ed è pertanto definito da Athey et al. (2020) come "anthropogenically modified cellulose". In risposta a queste sfide, Soorty Enterprises si dedica alla produzione del denim con un forte orientamento all'innovazione sostenibile, anche attraverso frequenti collaborazioni con altre realtà produttive e centri di ricerca, in un'ottica di riduzione dell'impatto ambientale dei processi produttivi attraverso l'integrazione de principi del design circolare e la sperimentazione e l'utilizzo di tecnologie all'avanguardia. Il partner del progetto, Nature Coatings, si occupa di produrre coloranti e finiture tessili bio-based ottenuti da scarti. In particolare, il colorante BioBlack TX si basa sulla trasformazione di scarti di legno provenienti da foreste certificate Forest Steward Council (FSC) in pigmenti neri bio-based, con elevata solidità del colore e competitivi in termini di costo rispetto alle alternative sintetiche basate su risorse non rinnovabili. Inoltre, secondo la carbon footprint analysis condotta da Accend, BioBlack TX ha un'impronta di carbonio inferiore dell'85% rispetto alle alternative derivate dal petrolio (Nature Coatings, n.d.).

Figura 3. Denim EarthArt con tintura BioBlack TX. Source: Nature Coatings [@naturecoatings]. (2024, Gennaio 10). https://www.instagram.com/p/C16kyHRofhu/?igsh=MTJhbDRyODlhY3A1MA=

Table 1. System analysis di EarthArt. Fonte: Elaborazione dell'autrice, 2024

	REFLECTION **Stato iniziale**	**ANALYSIS** **Requisiti e obiettivi**	SYNTHESIS Sviluppo delle soluzioni	**EXPERIMENTATION** **Implementazione dell'Economia Circolare**
SOCIETAL SYSTEM **Contextual Landscape**	Il denim consuma il 35% della produzione mondiale di cotone, legato all'utilizzo di pesticidi, fertilizzanti ed elevato consumo d'acqua. L'utilizzo di tinture sintetiche contribuisce al grave impatto	Necessità di attivare una nuova filiera per il denim eliminando l'uso di coloranti sintetici e sostanze chimiche dannose per l'uomo e per l'ambiente	Collaborazione industriale per lo sviluppo di denim caratterizzati da tintura/finitura ottenute dalla valorizzazione di scarti agroindustriali	Generazione di benefici per l'ambiente e per gli attori coinvolti nella creazione di una value chain circolare
SOCIO TECHNICAL SYSTEM **Innovazione sistemica e mercato**	La trasformazione in chiave sostenibile del processo denim potrebbe non essere economicamente sostenibile e vantaggiosa dal punto di vista commerciale	Superamento degli ostacoli alla commercializzazione e sviluppo di un prodotto competitivo	Partnership tra diversi attori industriali per lo sviluppo collaborativo di un processo sostenibile per la produzione del denim: ottimizzazione dei costi e riduzione dei tempi di innovazione	Attivazione di un sistema circolare basato sulla riorganizzazione della filiera produttiva attraverso la collaborazione degli stakeholders
PRODUCT-SERVICE SYSTEM **Business and process innovation**	La fase di tintura e finitura rappresenta una delle fasi più impattanti in termini di consumo e inquinamento di acqua ed emissioni di gas serra	Sviluppo di un processo maggiormente sostenibile per la produzione del denim	Processo produttivo e di tintura con meno impatto in termini di acqua, energia e sostanze chimiche utilizzate. Possibilità di adattare BioBlack TX alla tecnica "warp dyeing", usata per l'indaco	Integrazione di feedstock bio-based nel processo produttivo del denim attraverso un approccio collaborativo con altri attori
PRODUCT-TECHNOLOLOGY **Product innovation**	Le fibre di denim non biodegradabili a causa dei coloranti e dei trattamenti effettuati	Sviluppo di un tessuto denim maggiormente sostenibile e privo di sostanze chimiche dannose	Sviluppo di una famiglia di denim con filati certificati e ottenuta con processo a basso impatto e l'utilizzo di tintura BioBlack TX, ottenuta da scarti legno da foreste certificate FSC, priva di PAH cancerogeni e con carbon footprint negativa	Utilizzo di scarti agroindustriali in un'ottica circolare per la trasformazione in chiave sostenibile del prodotto denim

Herewear mira alla creazione di un ecosistema a livello europeo per la produzione di tessili circolari a partire da risorse bio-based. Il progetto di ricerca, avviato nel 2020, è stato finanziato dal programma europeo Horizon 2020 ed è portato avanti da un consorzio di attori comprendente centri di ricerca, università, aziende e realtà produttive.

Il progetto si fonda su tre pilastri: l'integrazione dei principi circolari nella catena produttiva tessile, l'utilizzo di fonti bio-based per la produzione di materiali tessili e il perseguimento della circolarità attraverso la valorizzazione della dimensione locale. Il contributo di Herewear copre l'intera filiera tessile [fig. 4] dalla produzione di filati a partire da scarti agro-industriali di diversa natura (biomasse agricole, algali e forestali) alla produzione del tessuto fino ad arrivare allo sviluppo di prototipi di capi di abbigliamento. Il processo prevede lo sviluppo e la sperimentazione di tecnologie emergenti per la filatura a umido e per l'estrusione di cellulosa da flussi di rifiuti e poliesteri biocompatibili su scala semi-industriale. Inoltre, la produzione di filati e tessuti include lo sviluppo di tinture, finiture e tecniche di stampa bio-based. La fase di utilizzo e di dismissione sono investigate attraverso l'individuazione di soluzioni innovative nel campo della riparazione, del riuso e del riciclo. Il progetto prevede lo sviluppo di strumenti digitali e software rivolti a designer e aziende per favorire l'integrazione dei principi del design circolare nel processo produttivo. Il concetto di località è promosso come strumento per l'attivazione di un sistema circolare "open loop" e viene sviluppato attraverso la costruzione di una rete di attori locali fondata sulla capacità di costruire processi innovativi e progetti di sviluppo per il territorio (Herewear, n.d.).

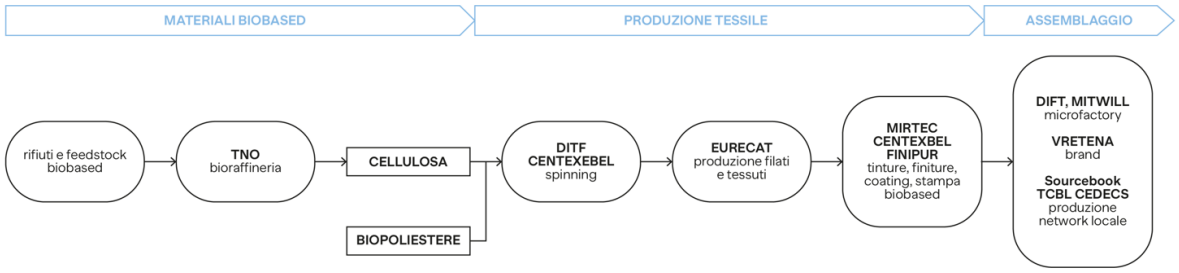


Figura 4. Rappresentazione della value chain proposta dal progetto Herewear.
Source: adattato da Herewear, (2020) https://herewear.eu/

Table 2. System analysis di Herewear. Fonte: Elaborazione dell'autrice, 2024

	REFLECTION **Stato iniziale**	**ANALYSIS** **Requisiti e obiettivi**	SYNTHESIS Sviluppo delle soluzioni	**EXPERIMENTATION** **Implementazione dell'Economia Circolare**
SOCIETAL SYSTEM **Contextual Landscape**	Frammentazione della catena del valore tessile come ostacolo alla circolarità	Riorganizzazione dell'intero ecosistema produttivo secondo i principi circolari	Utilizzo di un approccio sistemico per la creazione di sistemi locali "open loop" attraverso collaborazione fra stakeholders i	Applicazione pratica dei principi circolari; promozione dello sviluppo territoriale con benefici per tutti gli attori
SOCIO TECHNICAL SYSTEM **Innovazione sistemica e mercato**	Barriere economiche e tecnologiche allo sviluppo di soluzioni commercializzabili	Sviluppo e immissione sul mercato di soluzioni sostenibili attraverso collaborazione tra diversi attori e interdisciplinarità	Sviluppo network locali, realtà produttive collaborano per l'approvvigionamento di materie prime, l'ottimizzazione dei costi e la riduzione dei tempi di innovazione	Attivazione di un sistema circolare basato sulla riorganizzazione delle filiere produttive; importanza collaborazione stakeholders per la produzione di innovazione sostenibile
PRODUCT-SERVICE SYSTEM **Business and process innovation**	Ostacoli tecnologici all'integrazione degli scarti nella catena tessile o adattare tecnologie esistenti	Sviluppo di tecnologie per l'integrazione degli scarti nella catena tessile o adattamento tecnologie esistenti	Sperimentazione di nuovi processi produttivi basati su fonti bio-based e collaborazione con altri attori; sviluppo strumenti per designer e aziende per favorire l'integrazione di principi circolari nel processo	Promozione della collaborazione con altre realtà produttive e stakeholders in ottica sistemica. Importanza del design per l'applicazione dei principi circolari
PRODUCT-TECHNOLOLOGY **Product innovation**	Significativo consumo di risorse non rinnovabili e linearità della catena tessile	Sviluppo di materiali innovativi bio-based e circolari per una riduzione del carico ambientale	Intercettazione di flussi di scarto a livello locale e sviluppo di filati, tessuti e capi bio-based	Applicazione dei principi circolari all'intero ciclo vita del prodotto, incluso il fine vita

Piñayarn [fig. 5] è un filato prodotto dall'azienda Ananas Anam, fondata dalla designer tessile Carmen Hijosa. Il materiale è ottenuto dal recupero delle foglie di ananas, che rappresentano uno scarto della raccolta dell'ananas (Ananas comosus). Il processo di valorizzazione avviene nelle Filippine, contesto in cui la coltivazione dell'ananas riveste un'importanza fondamentale, generando ulteriori fonti di reddito per gli agricoltori e creando opportunità di lavoro nelle comunità rurali (Ananas-anam, 2024). Inoltre, il riutilizzo dei residui previene la scorretta gestione degli scarti, come la combustione delle foglie, pratica largamente utilizzata nel Sud Est asiatico (Laudes Foundation, 2021). Si stima che la produzione di Piñayarn consenta di evitare il rilascio di circa 6 kg di CO2 per ogni kg di filato prodotto (Ananas-anam, n.d.). Il processo di produzione della fibra non include l'utilizzo di sostanze chimiche e utilizza un pretrattamento enzimatico. Il restante processo è di tipo meccanico. La tecnologia dry-spinning utilizzata per ottenere il filato non richiede l'utilizzo di acqua e di sostanze chimiche. Il materiale risultante è definito "100% bio-based, biodegradabile e compostabile" e presenta buone caratteristiche meccaniche e prestazionali, con elevata resistenza a trazione, alta assorbenza e tingibilità. L'utilizzo del materiale in blend con altre fibre consente un ulteriore incremento delle performance. La tracciabilità del materiale è, inoltre, garantita attraverso un certificato di origine (Ananas-anam, n.d.).

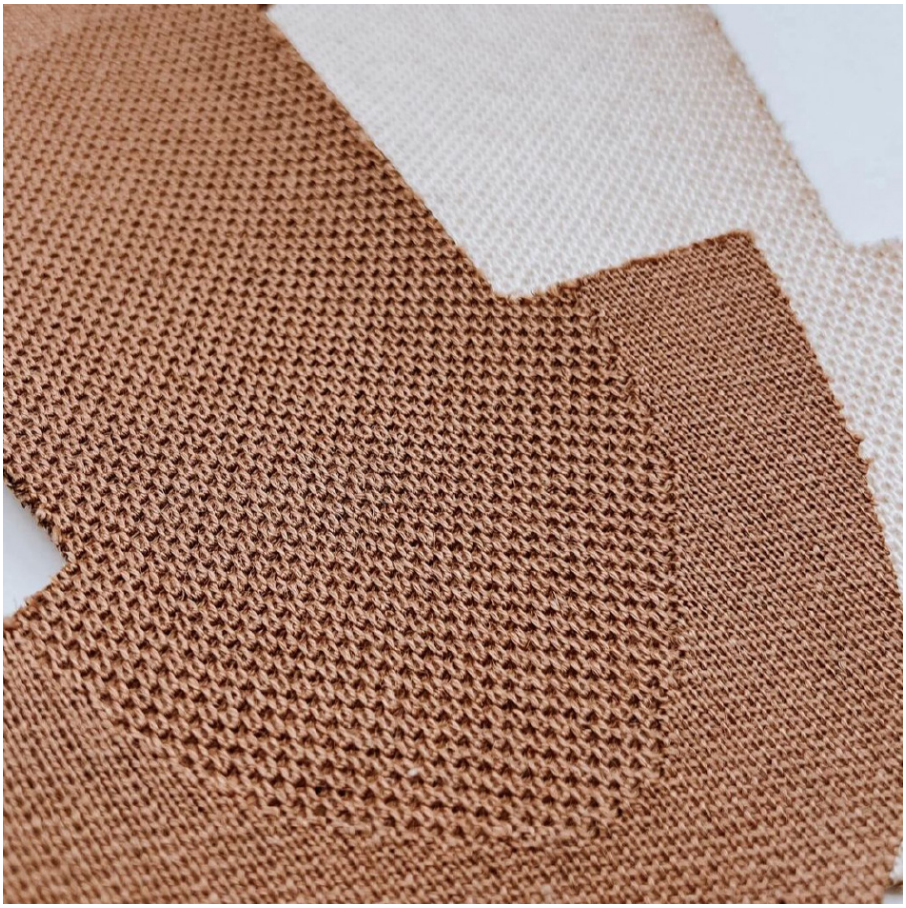


Figura 5. Campione di tessuto in Piñayarn. Source: Piñayarn [@ pinayarn]. (2024, Gennaio 12). https://www.instagram.com/p/ C16kyHRofhu/?igsh=MTJhbDRyODlhY3A1MA=

Table 3. System analysis di Piñayarn. Fonte: Elaborazione dell'autrice, 2024

	REFLECTION **Stato iniziale**	**ANALYSIS** **Requisiti e obiettivi**	SYNTHESIS Sviluppo delle soluzioni	**EXPERIMENTATION** **Implementazione dell'Economia Circolare**
SOCIETAL SYSTEM **Contextual Landscape**	Impatti ambientali negativi causati da scorrette pratiche di gestione delle foglie ottenute della coltivazione dell'ananas nelle Filippine, considerate scarto	Individuazione di utilizzi alternativi per gli scarti della coltivazione dell'ananas, tenendo in considerazione l'ecosistema locale	Sviluppo di una nuova value chain per la produzione di un filato bio-based per applicazione tessile a partire dalle foglie residue. Attivazione di un sistema closed loop.	Gli scarti diventano input per l'attivazione di una nuova filiera. Coinvolgimento delle comunità locali nello sviluppo di un nuovo sistema closed loop, che si integra nel contesto locale culturale ed economico
SOCIO TECHNICAL SYSTEM **Innovazione sistemica e mercato**	Lo sviluppo di materiali a partire da scarti spesso richiede elevati investimenti e tempi di innovazione lunghi	Superamento degli ostacoli alla commercializzazione e ottimizzazione dei costi attraverso la creazione di un sistema di partnership	Sviluppo di partnership con agricoltori e produttori locali nelle Filippine e di un sistema sostenibile dal punto di vista ambientale ed economico con benefici per tutti gli attori	Esempio di attivazione di un sistema circolare basato sulle specificità del contesto locale, riproducibile e adattabile in altri contesti
PRODUCT-SERVICE SYSTEM **Business and process innovation**	La maggior parte dei materiali bio-based ottenuti da scarti presentano basse perfomance	Sviluppo di un materiale bio-based e circolare attraverso un processo a basso impatto ambientale, che abbia perfomance adeguate all'industria tessile	Processo efficiente con minori emissioni di CO_2 rispetto ai filati tradizionali e "zero water technology" per il processo di filatura. Si adatta ai macchinari industriali per maglieria e tessitura. Utilizzo di blend per miglioramento performance.	Materiale competitivo dal punto di vista ambientale ed economico rispetto alle alternative meno sostenibili
PRODUCT-TECHNOLOLOGY **Product innovation**	Mercato dominato da materiali petroleum-based. Elevato utilizzo di risorse non rinnovabili e problema delle microplastiche	Sviluppo di materiali innovativi bio-based e circolari per una riduzione del carico ambientale	Sviluppo di un materiale bio-based con un approccio material-first. Biodegradabile e compostabile. Elevata resistenza a trazione, alta assorbenza e tingibilità. Prestazioni adatte a differenti applicazioni (footwear, apparel, accessori)	Promozione di un utilizzo efficiente delle risorse e del paradigma "da scarto a risorsa". Progettazione del fine vita del materiale in un'ottica circolare

Al fine di estendere i risultati al panorama generale dell'Economia Circolare, in tab. 4 sono stati confrontati i risultati dei tre casi studio presi in considerazione attraverso un'analisi cross-scale, secondo la metodologia individuata in letteratura (De Los Rios & Charnley, 2016). Il ruolo del design e le strategie per la sostenibilità del tipo "DfX" sono stati definiti in base al framework teorico riscontrato in letteratura (De Los Rios & Charnley, 2016; Go et al., 2015; Holt & Barnes, 2010).

Table 4. Analisi cross-scale dei risultati. Fonte: Elaborazione dell'autrice, 2024

Caso studio	Business model	Ruolo del design	Strategie DfX
EarthArt	Circular supplies	*Implementare le performance del materiale *Definire applicazioni e scenari di utilizzo *Facilitare l'uso e la manutenzione *Promuovere la durabilità *Comunicare la sostenibilità e generare desiderio	DfSupplyChain DfQuality DfMaintenance
Herewear	Circular supplies	*Riorganizzare a filiera e le relazioni sistemiche tra gli attori *Integrazione dei principi circolari *Promuovere il mantenimento del valore in fase d'uso e al fine vita * Sviluppo di prototipi	DfSupplyChain DfQuality DfMaintenance DfRecycling DfReuse DfRemanufacturing
Piñayarn	Circular supplies	* Riorganizzare la filiera e le relazioni sistemiche tra gli attori * Definire applicazioni e scenari di utilizzo * Implementare le performance del materiale * Facilitare il riciclo * Comunicare la sostenibilità e generare desiderio	DfSupplyChain DfQuality DfRecycling

Conclusioni

La ricerca si propone di esplorare il mutato ruolo del design nel contesto dell'economia circolare e l'interazione con gli altri attori rilevanti nella transizione verso modelli di produzione e consumo circolari, affrontando il tema del recupero di rifiuti e sottoprodotti agro-industriali per applicazioni nel settore tessile. A tal fine è stata condotta un'analisi comparativa di tre casi studio ritenuti rappresentativi di approcci diversi e in cui il design ha avuto un ruolo rilevante nel processo di valorizzazione: EarthArt, prodotto nato in ambito industriale; Herewear, progetto finanziato da fondi europei e portato avanti da un consorzio di centri di ricerca e università; e Piñayarn, prodotto di un'azienda nata dall'iniziativa di una textile designer.

Un primo dato rilevabile riguarda lo stato di avanzamento delle soluzioni – scala pilota nel caso di Herewear e soluzioni già in commercio nei restanti casi. Ciò riflette una tendenziale disparità tra ricerca accademica e industriale nella commercializzazione e nell'ampliamento delle soluzioni, che può essere attribuita a diversi fattori, tra cui gli obiettivi diversi - scoperta di nuove conoscenze e la comprensione dei meccanismi di base della ricerca accademica e applicazione pratica e sulla generazione di profitto nel caso della ricerca industriale (Mansfield, 1995). Inoltre, la ricerca accademica fa spesso affidamento su finanziamenti o sovvenzioni pubbliche, come nel caso del progetto Herewear, e può essere limitata e vincolata da specifici requisiti di ricerca, laddove la ricerca industriale ha accesso a risorse finanziarie più consistenti. Infine, la ricerca accademica può essere caratterizzata da tempi più lunghi e da una maggiore flessibilità nei programmi di sviluppo, mentre la ricerca industriale è spesso soggetta a pressioni commerciali e obiettivi a breve termine.

Per quanto riguarda il grado di innovazione, sebbene nel caso di EarthArt e Piñayarn essa riguardi soprattutto il prodotto, in tutti e tre i casi l'applicazione di una visione olistica e sistemica ha consentito al designer di ampliare la prospettiva e di investigare problemi e scale di progetto più ampi. Nei tre casi analizzati l'adozione di una prospettiva più ampia in cui l'attenzione non è limitata all'analisi dell'utente e della sua esperienza ma indaga l'intero contesto in cui le persone vivono e consumano, come esso si evolve, e i nuovi significati che gli utenti attribuiscono alle cose, consente di parlare di un approccio «design-driven» all'innovazione (Verganti, 2009). In tal senso, l'innovazione è il prodotto di una ricerca collettiva in cui differenti attori, quali aziende, organizzazioni culturali, designer, fornitori di tecnologia, istituzioni, enti di ricerca e formazione, sono impegnati in un continuo e reciproco dialogo (Verganti, 2009).

L'analisi dei casi studio ha messo in evidenza che il contributo del design appare significativo a più livelli e si esplicita in modi diversi, come, ad esempio, nell'implementazione delle performance dei materiali e nella comunicazione della sostenibilità. Tuttavia, nel contesto dell'Economia Circolare, esso è principalmente riconducibile alla capacità di applicare un pensiero sistemico in grado di affrontare la complessità e «tenere insieme elementi apparentemente lontani» (Lotti et al., 2020). In particolare, nei casi studio investigati, ciò è avvenuto attraverso:

- La riorganizzazione della filiera produttiva e gestione della complessità: attraverso l'adozione di un approccio sistemico, il designer può organizzare ed ottimizzare tutte le parti all'interno di un ecosistema in modo che evolvano coerentemente le une con le altre, programmare il flusso di input e output che scorre da un sistema ad un altro, gestire il dialogo vicendevole e la collaborazione tra i vari attori in tutte le fasi di sviluppo della ricerca.
- L'implementazione delle strategie di valorizzazione: attraverso il confronto con gli stakeholders e le altre figure professionali coinvolte nel processo, comprende l'implementazione delle strategie di valorizzazione, ottimizzando il valore della biomassa e utilizzando i

dati provenienti dalla caratterizzazione dei residui per individuare i settori applicativi più idonei.

- L'integrazione dei principi circolari: include la selezione e l'impostazione dei criteri per la valutazione della circolarità e l'impatto ambientale dei processi di valorizzazione e l'utilizzo di strumenti e indicatori di circolarità.

I contributi individuati attraverso l'analisi dei casi studio riflettono la necessità per il designer di sviluppare nuove competenze in linea con le cinque competenze per la sostenibilità descritte da Weik et al. (2011). Queste includono la "System-thinking competence", ovvero la capacità di analizzare collettivamente sistemi complessi attraverso diversi domini (società, ambiente, economia, ecc.) e su diverse scale (dal locale al globale) (Wiek et al., 2011; Meadows, 2008; Ellen MacArthur, 2013); la "Anticipatory Competence", ossia la capacità di prevedere come il sistema e le interazioni tra gli attori evolveranno nel tempo per garantire il soddisfacimento dei requisiti di sostenibilità e circolarità predefiniti; la "Normative Competence", legata alla capacità di selezionare e stabilire criteri per valutare la circolarità e l'impatto ambientale delle scelte progettuali e di utilizzare strumenti e indicatori di circolarità (Sumter et al., 2019); la "Strategic Competence", che riflette una prospettiva più ampia di sostenibilità connessa alle capacità di pianificazione, organizzazione e decision-making; e infine la "Interpersonal Competence", che include competenze avanzate in comunicazione, negoziazione, collaborazione, leadership, pensiero pluralistico e competenza transculturale (Wiek et al., 2011) per facilitare la collaborazione tra gli stakeholder lungo l'intera catena del valore (Bistagnino, 2011).

A tal proposito, l'analisi dei casi studio ha dimostrato la validità di un approccio interdisciplinare e collaborativo che contempli un continuo interscambio tra il design e le altre figure professionali. La cooperazione sinergica tra gli stakeholders è stata individuata come strumento fondamentale sia per lo sviluppo delle soluzioni sostenibili sia per il loro scale-up: le istituzioni, attraverso strategie e piani di azione efficaci; l'industria, attraverso l'implementazione di modelli di produzione e di business circolari; la ricerca accademica, fornendo supporto attraverso nuove tecnologie, strumenti, metodologie e approcci; i designer, come punto di giunzione tra l'accademia e l'industria, attraverso l'integrazione dei principi del design circolare nel processo di design e lo sviluppo di sistemi closed loop. Attraverso lo sviluppo di casi di studio pratici, il design può contribuire all'implementazione dell'economia circolare intervenendo a diversi livelli della filiera.

Il contributo rappresenta un punto di partenza per indagare il ruolo del designer nei processi di valorizzazione degli scarti agro-industriali, promuovendo l'esplorazione di nuove opportunità di applicazione nel settore tessile. Tuttavia, l'analisi della letteratura ha evidenziato una carenza di riferimenti metodologici per guidare l'attività progettuale. Possibili sviluppi della ricerca includono l'elaborazione di linee guida, best practices e tools in grado di fornire al designer una roadmap per l'implementazione efficace di strategie di valorizzazione sostenibile degli scarti agro-industriali.

Inoltre, la ricerca condotta sull'analisi del panorama dell'innovazione in campo tessile, in riferimento allo specifico ambito di studio, può costituire una base per l'esplorazione di nuove aree di innovazione, includendo nuove tipologie di scarto e nuove applicazioni in contesti ambientali, socioeconomici e culturali differenti.

Infine, l'importanza della collaborazione interdisciplinare tra attori diversi – quali designer, università, centri di ricerca e industrie – nella definizione delle strategie per la valorizzazione sostenibile degli scarti agro-industriali può essere ulteriormente indagata attraverso l'esplorazione di modelli di partnership e reti di innovazione che incoraggiano lo scambio di conoscenze e risorse tra diverse discipline e settori.

Finanziamenti

Questo contributo rientra nel progetto di ricerca “Processi e Tecnologie Innovative per la Circolarità nel Settore Tessile” condotto nell’ambito del corso di Dottorato in Ambiente, Design e Innovazione dell’Università degli Studi della Campania Luigi Vanvitelli e finanziato dai fondi del programma “V:ALERE 2020 - Vanvitelli per la Ricerca”.

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ISSN 2386-5414
e-ISSN: 2340-8391

Articolo di Ricerca | Research Article

Design e valorizzazione sostenibile di scarti e sottoprodotti agro-industriali per la circolarità del settore tessile | Design and Sustainable Valorization of Agro-Industrial Waste and By-Products for the Circularity of the Textile Sector

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Ricevuto: 9 aprile 2024 | Accettato: 3 giugno 2024 | Pubblicato: 29 guigno 2024

DOI: 10.24310/p56-idj1202419633

Abstract

The theoretical debate on design is intertwined with and fueled by the various theories and approaches that have developed since the second half of the twentieth century in the economic and industrial fields, among which the concept of the Circular Economy has emerged. In a linear economy, what is normally considered waste or by-product becomes a resource whose value is to be retained. In the domain of design, this corresponds to a progressive broadening of perspective from the level of the individual product to the design of the complex system in which it is embedded and the adoption of new strategies, including "closing the loop." In this sense, the agro-industrial sector represents fertile ground for sustainable, design-driven innovation, partly due to the significant amount of waste generated annually at all stages of the supply chain. The sustainable valorization of such biomass represents an alternative feedstock for the recovery of high-value substances and materials, potentially increasing the level of circularity in various application sectors characterized by high consumption of non-renewable resources, such as the textile sector. Through the critical selection and comparative analysis of three case studies, this research aims to define the changed role of design in the current scenario and the nature of interactions between the designer and other relevant actors in the transition towards circular production and consumption models, particularly exploring the theme of valorizing agro-industrial waste and by-products for applications in the textile sector.

Keywords: Circular Design; Waste and by-products valorization; Circular Economy; Textile Field; Case studies; Design research

Introduction

In the course of the second half of the twentieth century, the theoretical debate on sustainable design evolved through a progressive broadening of perspective from the level of individual products to "insular" and "systemic" dimensions (Adams et al., 2016). This shift led to considering the attribute "sustainable" not as a property of individual elements within a system, but as a property of the entire system

and a dynamic condition that requires the adoption of organic and non-linear thinking (system thinking) (Hjorth & Bagheri, 2006).

The transition of the design discipline through different definitions and terminologies represents a progressive broadening of the perspective on design theory and practice, as well as an attempt to engage with the complexity that a "sustainable" approach to design implies (Madge, 1997). However, according to van Dam et al. (2019), the varied terminology developed by research over the years (e.g., "green design", "ecodesign", "design for sustainability") often presents overlapping concepts and can be counterproductive by generating a fragmentation of knowledge that leads to a dispersion of relevant results. Instead, it is proposed to connect these similar research strands so that the design discipline can consolidate knowledge and make advancements in sustainability and circularity.

The concepts of system thinking and circularity are borrowed from theories developed in the economic and industrial fields and both have been well-established in economic systems for several decades, drawing inspiration from ideas on human and agricultural metabolism dating back to the eighteenth century (Reike et al., 2017). However, they have gained popularity more recently due to the widespread adoption of the concept of the Circular Economy (Ekins et al., 2019). Today, one of the most widely accepted definitions of the Circular Economy is that developed by the Ellen MacArthur Foundation:

> *«A circular economy is an industrial system that is restorative or regenerative by intention and design. [...] It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models» (Ellen MacArthur Foundation, 2013).*

The Circular Economy presents itself as an alternative model to the dominant "take-make-dispose" paradigm, through the adoption of five fundamental principles: (1) Design out waste; (2) Build resilience through diversity; (3) Rely on energy from renewable sources; (4) Think in systems; and (5) Waste is food (Ellen MacArthur Foundation, 2013).

Ekins et al. (2019) identify the three main purposes of the transition to a circular economy as the slowing down of the depletion of natural resources, the reduction of environmental damage caused by the extraction and transformation of virgin materials, and the reduction of pollution related to the transformation, use, and disposal of materials. This can be achieved through the adoption of new business models integrated within a systemic perspective on resource use, aimed at making utilization more efficient, increasing overall value, and extending the lifecycle of materials.

In the theoretical debate on design, some researchers have questioned the changing role of design in the contemporary context and have proposed adopting the term "Circular Design" to indicate an area of sustainable design whose objectives intertwine with those of the Circular Economy (e.g., Moreno et al., 2016; Medkova & Fifield, 2016; van Dam et al., 2019). Although Circular Design builds on established approaches, Asif et al. (2021) suggest that it differs from sustainable design and ecodesign practices, which predominantly move from a linear economy perspective. According to den Hollander et al. (2017), the role of the (circular) designer is to facilitate the transition from a linear to a circular economy and to make decisions aimed at preventing and reversing product obsolescence.

The analysis of the literature on the topic highlights an attempt by research to systematize principles, guidelines, and strategies for the circular design of solutions within the context of the circular economy. Various studies have sought to synthesize the contribution of design to the

transition towards a circular economy by systematically identifying "Design for X" (DfX) approaches (Aguiar et al., 2021; Sassanelli, 2019; den Hollander et al., 2017; Moreno et al., 2016; De los Rios and Charnley, 2016). The various strategies identified in the literature can be traced back to four fundamental approaches to circular innovation: narrow, slow, close, regenerate (Konietzko et al., 2019). "Narrow" refers to reducing resource use, both in terms of materials and energy, throughout the entire product life cycle; "slow" aims to extend the life cycle of products, components, and materials; "close" means retaining the value of what is typically considered waste or by-product in a linear economy; and "regenerate" refers to minimizing the use of toxic substances and increasing the use of renewable materials and energy in a circular economy. Konietzko et al. (2019) have added the "inform" strategy to these four strategies to emphasize the importance of new technologies in supporting the circular economy. Each of the four strategies can be applied through three dimensions and scales of intervention (product, business, ecosystem) (Konietzko et al., 2019).

A comprehensive taxonomy that investigates the transition from sustainability-oriented design (DfX approaches) to Circular Design, synthesizing existing strategies into new categories, is provided by Moreno et al. (2016). Building on the previous taxonomy by De los Rios and Charnley (2016), the authors map design strategies that support the circular economy. These are articulated into: (a) design for resource conservation; (b) design for slowing resource loops; and (c) whole systems design, which in turn include five circular design strategies: (a1) design for circular supplies; (a2) design for resource conservation; (b1) design for long life use of products; (b2) design for multiple cycles; and (c1) design for systems change.

In the design domain, the "closing the loop" strategy is equivalent to retaining the value of what is normally considered waste or by-product in a linear economy. Bocken et al. (2016) identify two strategies for doing this: the first, usually at the product level, is "extending resource value", which involves collecting discarded materials and resources to transform them into new forms of value, potentially more appealing to the user while reducing material and final product costs; the second, at the ecosystem level, is a process-oriented solution that involves transforming the outputs of one process into feedstock for another process or production line (industrial symbiosis).

Large volumes of waste can be generated at different levels of the value chain, from the resource extraction phase to the production phase (production waste), to the consumption phase (post-consumption waste). Resource recovery pathways vary depending on the life cycle stage at which there is a need to recover resource value and the type of waste (Singh & Ordoñez, 2015). In general, materials and products can be recovered to serve the same purpose or new functions, within the same value chain, in different value chains, or to activate entirely new and/or innovative value chains.

Despite the abundance in literature of practical case studies of waste and by-product valorization for the design of innovative products and processes in various application areas, there are no significant methodological references to guide design activities (Karana et al., 2013). In this regard, there is a need to create a link between academic research and practice to activate new synergies within the context of the Circular Economy.

In the Systemic Design approach, the valorization of waste and by-products is a fundamental theme and is addressed through renewed attention to the local dimension. The outputs of production processes are elevated from their status as waste and considered resources to activate new production processes and industrial systems that generate economic and territorial development. In this context, the new role assumed by the designer is to outline and program the flow of matter that moves from one system to another in a continuous metabolism, organize and optimize all parts within an ecosystem so

that they evolve coherently with each other, and accompany and manage the mutual dialogue among the various actors at all stages of project development on this new cultural ground (Bistagnino, 2011).

The systemic design methodology starts from a "holistic diagnosis", characterized by a phase of literature and field research to define and map all the components that define the scenario, considering both the surrounding context and the flow of energy and matter that characterizes the system. Through this collection of complex data, it is possible to highlight criticalities and potentialities and gather guidelines for the definition of new systems. The systemic project is based on the development of a system in which the relationships between processes and actors, optimized material and energy flows, and valorized outputs as resources are designed (Battistoni et al., 2019). The result is an autopoietic system, capable of self-organizing and continuously redefining itself based on the relationships (system organization) that exist between the elements that compose it (system structure) and based on the reciprocities that regulate the relationship with the surrounding environment (Bistagnino, 2011).

One of the most explored areas by Systemic Design is the agri-food sector, which is particularly suited to this approach and has great potential in the context of the Circular Economy, also due to the large amount of waste produced by the supply chain (Fiore et al., 2020). According to Eurostat data, in 2016 the total agri-food waste produced in the European Union (EU28) amounted to 400 million tons, with the most significant category (about 22%) being organic waste of animal and plant origin, amounting to about 87 million tons. Of these, the agricultural production phase is responsible for 20% (17 million tons); the industrial transformation for 28% (24 million tons); the consumption phase for 38% (33 million tons); and services account for the remaining 14%, with about 13 million tons (Intesa San Paolo, 2016).

In this regard, the potential for valorizing biomass (a general term applicable to all materials of plant and animal origin) obtained from inedible food waste and agricultural waste has been highlighted as an alternative feedstock to non-renewable resources and a potential resource for recovering high-value substances and materials. Possible uses of plant-based biomass include traditional applications, such as livestock feed and fertilizers, and other uses, such as the design and production of innovative bio-based products (Sherwood, 2020). This can contribute to the establishment of a "circular bioeconomy", which is based on the sustainable and efficient valorization of biomass in integrated and multi-output production chains (e.g., biorefineries), also using residues and waste and optimizing the value of biomass over time through cascading processes (Stegmann & Junginger, 2020).

Within this context, the present study aims to explore the role and contribution of design in activating sustainable valorization processes for waste and by-products from the agri-food supply chain, with particular reference to applications in the textile sector and through the adoption of an interdisciplinary and collaborative approach. By exploring this topic, the intersection between design, the circular economy, and innovation in the textile field is investigated, and the contribution of design in the sector's transition towards a circular production and consumption model is studied, addressing the following specific objectives: a) Explore the sustainable innovation landscape in the textile field, with reference to the specific area of valorization of agri-food waste and by-products, by mapping the main areas of innovation; b) Explore the contribution of design and the new skills required for the designer in pursuing circularity strategies through the selection and analysis of application case studies; c) Explore the role of interdisciplinarity and collaboration between design research, academia, and industry based on the selected case studies.

Circularity in the textile field

The potential valorization of biomass derived from agricultural and industrial waste and by-products represents an alternative feedstock and a potential source for the recovery of high-value substances and materials that can be applied in other sectors. Beyond the traditional applications summarized in the "5F" (Koopmans & Koppejan, 1997), possible uses include the design and production of materials, products, and innovative solutions through a cascading valorization approach that optimizes the value of biomass over time, defining usage scenarios in other production sectors characterized by high consumption of non-renewable resources, such as the textile sector, potentially of higher value.

The global textile industry is responsible for a significant environmental impact along the entire value chain, with substantial greenhouse gas emissions, significant consumption and pollution of water resources, and increasing waste production, with negative consequences on ecosystem quality and human health (Quantis, 2018). This scenario is exacerbated by the rise of a production and consumption model characterized by fast production cycles and early disposal of textile products, known as "fast fashion". The linear "take-make-dispose" model that characterizes the current textile industry consumes considerable amounts of resources. It is estimated that the sector annually uses about 98 million tons of non-renewable resources (Ellen MacArthur Foundation, 2017) across different production stages.

At the institutional level, the urgency to transform the textile sector into a sustainable and circular perspective has been recently addressed through the publication of the European Union Strategy for Sustainable and Circular Textiles, in March 2022. This strategy outlines a common framework for the textile sector, integrating existing regulations with new initiatives and legislative proposals, aiming to establish, by 2030, a circular textile ecosystem in which incineration and landfill disposal are minimized (European Commission, 2022). Among the key actions announced is the introduction of mandatory eco-design requirements for textiles and footwear, to be implemented by 2024 through the regulation known as the Ecodesign for Sustainable Products Regulation, with the objective of ensuring that textile products are fit for circularity, using secondary raw materials and limiting the presence of hazardous chemicals (European Commission, 2022). The adoption of the Ecodesign for Sustainable Products Regulation highlights not only the value attributed to the design process in achieving circularity but also the consolidation of a preventive approach to environmental impact and waste at the upstream of the supply chain, as a preferable option compared to downstream interventions aimed at increasing textile waste recyclability.

In pursuing a circular economy and a genuinely sustainable approach, the first objective should be to reduce as much as possible the introduction of virgin raw materials into the value chain. This can be achieved firstly through the maximization of textile use and the extension of the material or product's life through repair or reuse. Secondly, it can be done by replacing non-renewable resources with feedstock from recycled materials, recirculating already available materials without depleting new resources, provided that this can be done through eco-sustainable processes (Ellen MacArthur Foundation, 2017). However, adopting this strategy is currently insufficient to meet the need for virgin materials. Where recycled feedstock materials are unavailable, the choice should fall on materials obtained from renewable feedstocks produced with a circular and regenerative approach. Additionally, transitioning to production processes that require fewer resource inputs, are energy-efficient, based on renewable energy, and generate less waste can further contribute to reducing the need for non-renewable inputs (Laudes Foundation, 2021).

In this regard, the recovery of agro-industrial waste as secondary raw materials and new

inputs that can be integrated into the textile supply chain represents an opportunity not yet fully explored, to which design can substantially contribute through its approaches, tools, and visions.

This "cross-fertilization" approach responds to modern challenges and the need for innovation, involving an increasing number of sectors and increasingly specialized skills (Cappellieri, 2006). Conti (2012) defines cross-fertilization as an interdisciplinary phenomenon concerning the relationship and contiguity between different areas of human knowledge, affecting the boundaries and research areas created between one disciplinary area and another. It is precisely in these "border territories" that dynamics of knowledge transfer between sectors are activated, facilitating the emergence of significant processes of transversal innovation (Conti, 2012).

In the textile sector, the last decade has seen the development of numerous materials, products, and solutions based on the sustainable valorization of agro-industrial waste and by-products. The current innovation landscape is rapidly and continuously evolving, leveraging concerted action by designers, academic research, and industry (Laudes Foundation, 2021). In Fig. 1 a mapping of the state of the art is provided, illustrating the main areas of sustainable innovation based on the valorization of agro-industrial waste and by-products, related to the following themes:

• Processes: this area of innovation includes the development of production processes that are more energy-efficient and resource-efficient, with a lower impact on ecosystems. It also encompasses the refinement of advanced technologies for textile recycling and waste management. In the realm of waste valorization, the literature presents various examples of utilizing agricultural waste and by-products for the treatment of textile wastewater, particularly as adsorbents for the removal of dye residues from water (e.g., Amalina et al., 2022; Al-Gheethi et al., 2022; Gül & Bayazit, 2020).

• Textile Materials: to mitigate the demand for virgin raw materials, the use of alternative and renewable sources for the production of materials such as fibers, yarns, and fabrics represents a viable strategy. Numerous solutions already available on the market are based on the valorization of agro-industrial outputs as feedstock for obtaining natural, artificial, and synthetic fibers.

• Products for textile treatment, dyeing and finishing: this includes the development of more sustainable alternatives to products for pre-treatment, dyeing and finishing of textiles, with the primary objective of reducing or eliminating the use of chemicals that are potentially harmful to humans and the environment. Examples of bio-based products include natural dyes, bio-mordants or products that confer functional properties (e.g., water repellency, stain resistance).

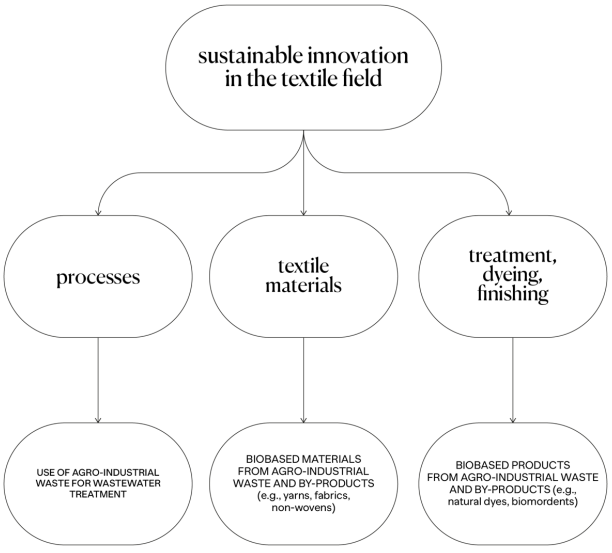


Figure 1. Sustainable innovation in the textile sector through the valorization of agricultural and industrial waste and by-products. Source: own elaboration, 2024

Methodology

Within the framework of sustainable innovation, and with the aim of exploring the role and contribution of design in activating sustainable valorization processes for agro-industrial waste and by-products, thereby managing and directing resource flows toward the textile sector, the use of case studies has been deemed useful for delineating general considerations about the examined context (Eisenhardt, 1989). The selection of cases was conducted by distinguishing two different contexts for literature review: an academic context and a practical context (Romani et al., 2021). In the first case, academic databases, journal articles, and book chapters were considered; in the second case, the research was conducted through the analysis of design websites and blogs, including successful case studies implemented by the industry.

The criteria for selecting the case studies were based on the previously outlined theoretical framework, including only examples of innovation that integrated design, the valorization of agro-industrial waste and the textile sector, while excluding the valorization of other types of waste (e.g., pre- or post-consumer textile waste). Only case studies where the designer was involved in the development of the project or solution were considered. Additionally, in order to present the most recent developments in sustainable innovation in this specific area of research, the selection was limited to case studies conducted between 2014 and 2024.

Based on these criteria, three valorization cases were selected and examined, deemed exemplary of three distinct approaches: one derived from industrial research (EarthArt), one stemming from collaboration between

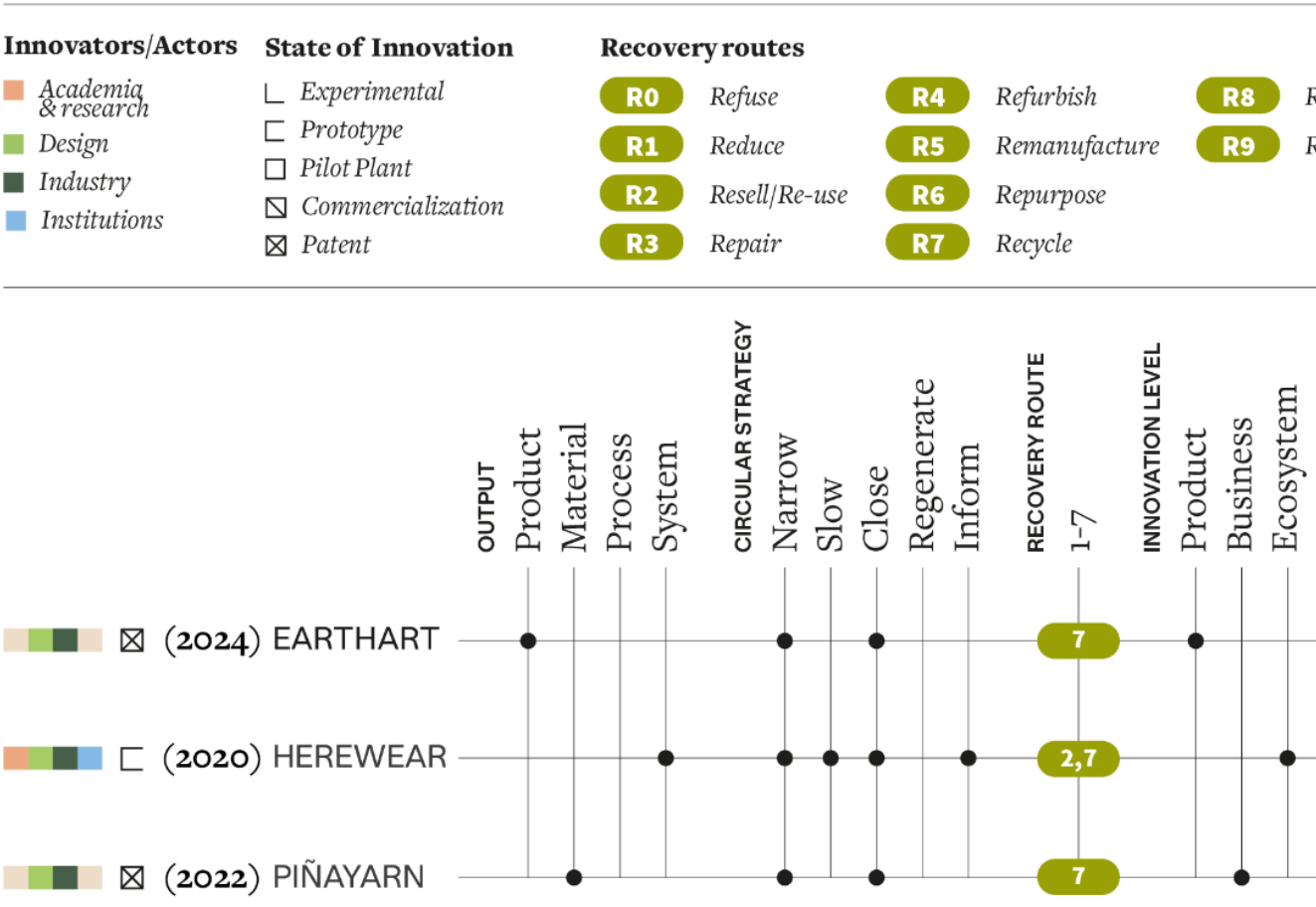
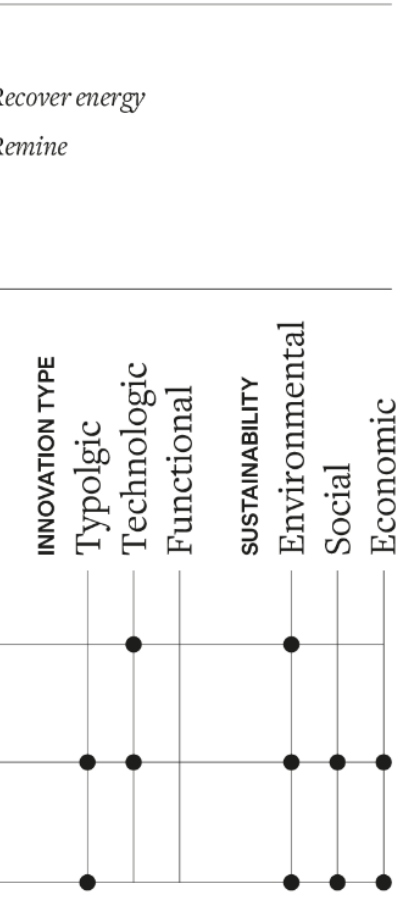


Figure 2. Overview of the three case studies selected. Source: own elaboration, 2024

research centers and academia (Herewear) and one resulting from the entrepreneurial initiative of a designer (Piñayarn).

The three case studies were first schematically framed, indicating the main stakeholders involved—designers, research centers and academia, companies or industrial clusters and institutions. The nature of the innovation was studied and categorized into three types: "technological", "typological" or "functional". Additionally, the state of the innovation was identified, indicating whether the project is in the experimental, prototype, pilot, commercialization phase or includes a patented solution. The sustainability aspect was also examined, categorized into three dimensions: environmental, social and economic. The analysis of the output describes the type of output obtained. The type "R" imperative adopted is also indicated by adopting the waste management hierarchy suggested by Reike et al. (2017).

Subsequently, the three case studies were further examined using the method suggested by De los Rios & Charnley (2016) and based on the Multilevel Design Model (MDM) proposed by Joore and Brezet (2015). This model was developed as a tool for analyzing the innovation system, useful for determining potential contributions of design in terms of both tangible and intangible results (De los Rios & Charnley, 2016). The analysis is conducted considering the following four dimensions: "reflection" describes the characteristics of the initial context in which the case study is embedded; "analysis" describes the objectives and requirements that support the transition towards a circular model; "synthesis" lists and describes the solutions developed through design; "experimentation" describes how the produced solutions respond to and contribute to the implementation of the Circular Economy. Finally, for each case study, the role of design was highlighted and translated into skills and competences using the evidence obtained from the case studies and cross-referencing the design requirements in each scenario with the existing theoretical framework concerning Design for X (DfX) strategies (De los Rios & Charnley, 2016).



Results: Analysis of CE Strategies

The collection of case studies presented in this research does not aim to be a systematic and exhaustive compilation of all solutions developed within the area of interest. Instead, it is a critical selection of valorization projects with textile applications where design has played a key role. The three selected case studies—EarthArt, Herewear, and Piñayarn—are schematically presented in the infographic in Fig. 2 and subsequently analyzed according to the previously described methodology [Tables 1-3].

EarthArt is a family of denim fabrics born from the industrial partnership between Nature Coatings and Soorty Enterprises, characterized by the use of bio-based dye derived from agro-industrial waste instead of synthetic dyes. The environmental impact of denim is primarily linked to the intensive cultivation of traditional cotton, which requires large amounts of water, pesticides, and fertilizers, and the release of microfibers into the ecosystem. Despite denim being derived from a natural fiber, it is extensively treated with chemicals such as synthetic dyes and other additives to enhance the durability and performance of the fabric, leading Athey et al. (2020) to define it as "anthropogenically modified cellulose". In response to these challenges, Soorty Enterprises is dedicated to producing denim with a strong focus on sustainable innovation, frequently collaborating with other manufacturers and research centers to reduce the environmental impact of production processes through the integration of circular design principles and the experimentation and use of cutting-edge technologies. The project partner, Nature Coatings, specializes in producing bio-based dyes and textile finishes obtained from waste. Specifically, the BioBlack TX dye is based on transforming wood waste from Forest Steward Council (FSC)-certified forests into bio-based black pigments, which offer high colorfastness and are cost-competitive with synthetic alternatives derived from non-renewable resources. Additionally, according to a carbon footprint analysis conducted by Accend, BioBlack TX has an 85% lower carbon footprint compared to petroleum-derived alternatives (Nature Coatings, n.d.).

Figure 3. EarthArt denim dyed with BioBlack TX. Source: Nature Coatings [@naturecoatings]. (2024, January 10). https://www.instagram.com/p/C16kyHRofhu/?igsh=MTJhbDRyODlhY3A1MA=

Table 1. EarthArt System analysis. Source: own elaboration, 2024

	REFLECTION Initial state	**ANALYSIS Requirements and targets**	**SYNTHESIS Developments**	**EXPERIMENTATION Implementation of Circular Economy**
SOCIETAL SYSTEM Contextual Landscape	Denim accounts for 35% of the global cotton production, associated with the use of pesticides, fertilizers and high water consumption. Synthetic dyes contribute to the severe impact	Need to establish a new supply chain for denim by eliminating the use of synthetic dyes and harmful chemicals detrimental to human health and the environment	Industrial collaboration for the development of denim characterized by dyeing/finishing obtained from the valorization of agro-industrial waste	Generation of environmental benefits and benefits for the stakeholders involved in the creation of a circular value chain
SOCIO TECHNICAL SYSTEM System innovations and market	Transforming the denim process sustainably may not be economically viable and advantageous from a commercial standpoint	Overcoming hurdles to commercialization and fostering the development of a competitive product	Partnership among various industrial actors for the collaborative development of a sustainable process for denim production: cost optimization and reduction of innovation lead times	Activation of a circular system based on the reorganization of the production chain through stakeholder collaboration
PRODUCT-SERVICE SYSTEM Business and process innovation	The dyeing and finishing phase represent one of the most impactful stages in terms of water consumption and pollution, as well as greenhouse gas emissions	Developing a more sustainable process for denim production	Production and dyeing process with reduced impact in terms of water, energy, and chemicals used. Possibility to adapt BioBlack TX to the "warp dyeing" technique, commonly used for indigo dyeing	Integration of bio-based feedstock into the denim production process through a collaborative approach with other actors
PRODUCT-TECHNOLOLOGY Product innovation	Denim fibers are non-biodegradable due to the dyes and treatments applied	Developing a denim fabric that is more sustainable and free from harmful chemicals	Development of a denim collection with certified yarns and obtained through a low-impact process, using BioBlack TX dye derived from FSC-certified wood waste, free from carcinogenic PAHs, and with a negative carbon footprint	Utilization of agro-industrial waste in a circular perspective for the sustainable transformation of denim products

Herewear aims to establish a European-level ecosystem for the production of circular textiles from bio-based resources. Initiated in 2020, the research project is funded by the European Horizon 2020 program and is carried out by a consortium of stakeholders including research centers, universities, companies and manufacturers. The project is based on three pillars: the integration of circular principles into the textile production chain, the use of bio-based sources for textile production and the pursuit of circularity through the valorization of the local dimension. Herewear's contribution covers the entire textile value chain [Fig. 4], from the production of yarns obtained from various types of agro-industrial waste (agricultural biomass, algae and forestry) to fabric production and the development of clothing prototypes. The process involves the development and testing of emerging technologies for wet spinning and the extrusion of cellulose from waste streams and biocompatible polyesters on a semi-industrial scale. Additionally, yarn and fabric production include the development of bio-based dyes, finishes and printing techniques. The use and end-of-life phases are investigated through the identification of innovative solutions in repair, reuse and recycling. The project includes the development of digital tools and software for designers and companies to facilitate the integration of circular design principles into the production process. The concept of locality is promoted as a tool for activating an "open-loop" circular system and is developed through the construction of a network of local actors based on the ability to build innovative processes and development projects for the territory (Herewear, n.d.).

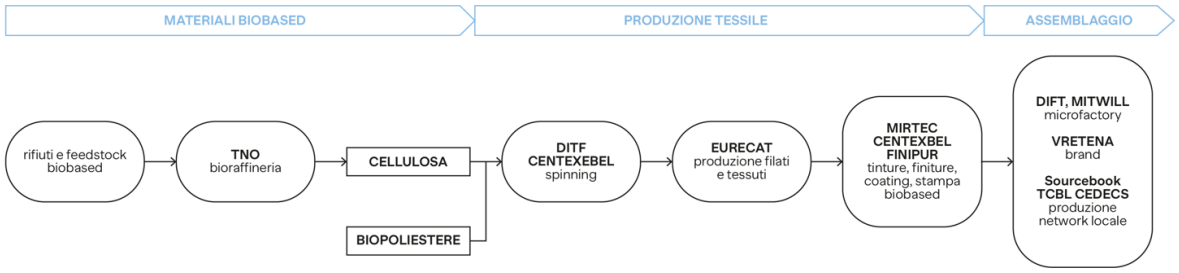


Figure 4. Representation of the value chain proposed by the Herewear project. Source: adapted from Herewear, (2020) https://herewear.eu/

Table 2. Herewear System analysis. Source: own elaboration, 2024

	REFLECTION Initial state	ANALYSIS Requirements and targets	SYNTHESIS Developments	EXPERIMENTATION Implementation of Circular Economy
SOCIETAL SYSTEM Contextual Landscape	Fragmentation of the textile value chain as a barrier to circularity	Reorganization of the entire production ecosystem according to circular principles	Utilization of a systemic approach to create "open loop" local systems through collaboration among stakeholders	Practical application of circular principles; promotion of territorial development with benefits for all stakeholders
SOCIO TECHNICAL SYSTEM System innovations and market	Economic and technological barriers to the development of commercially viable solutions	Development and market introduction of sustainable solutions through collaboration among various stakeholders and interdisciplinary approaches	Development of local networks where production entities collaborate for raw material sourcing, cost optimization, and innovation time reduction	Activation of a circular system based on the reorganization of production chains; importance of collaboration among stakeholders for the production of sustainable innovation
PRODUCT-SERVICE SYSTEM Business and process innovation	Technological obstacles to integrating waste into the textile chain or adapting existing technologies	Development of technologies for integrating waste into the textile chain or adapting existing technologies	Experimentation with new production processes based on bio-based sources and collaboration with other actors; development of tools for designers and companies to facilitate the integration of circular principles into the process	Promotion of collaboration with other companies and stakeholders in a systemic perspective. Importance of design for the application of circular principles
PRODUCT-TECHNOLOLOGY Product innovation	Significant consumption of non-renewable resources and linearity of the textile chain	Development of innovative bio-based and circular materials for a reduction in environmental burden	Interception of waste streams at the local level and development of bio-based yarns, fabrics and garments	Application of circular principles throughout the product lifecycle, including end-of-life considerations

Piñayarn [Fig. 5] is a yarn produced by the company Ananas Anam, founded by textile designer Carmen Hijosa. The material is obtained from the recovery of pineapple leaves, which represent a by-product of pineapple harvesting (Ananas comosus). The valorization process takes place in the Philippines, where pineapple cultivation is of fundamental importance, generating additional sources of income for farmers and creating job opportunities in rural communities (Ananas-anam, 2024). Furthermore, the reuse of residues prevents improper waste management, such as the burning of leaves, a practice widely used in Southeast Asia (Laudes Foundation, 2021). It is estimated that the production of Piñayarn avoids the release of approximately 6 kg of CO2 for every kg of yarn produced (Ananas-anam, n.d.). The fiber production process does not include the use of chemicals and utilizes an enzymatic pretreatment. The remaining process is mechanical. The dry-spinning technology used to obtain the yarn does not require the use of water and chemicals. The resulting material is defined as "100% bio-based, biodegradable, and compostable" and exhibits good mechanical and performance characteristics, with high tensile strength, high absorbency and dyeability. The use of the material in blends with other fibers allows for further performance enhancement. The traceability of the material is also ensured through a certificate of origin (Ananas-anam, n.d.).

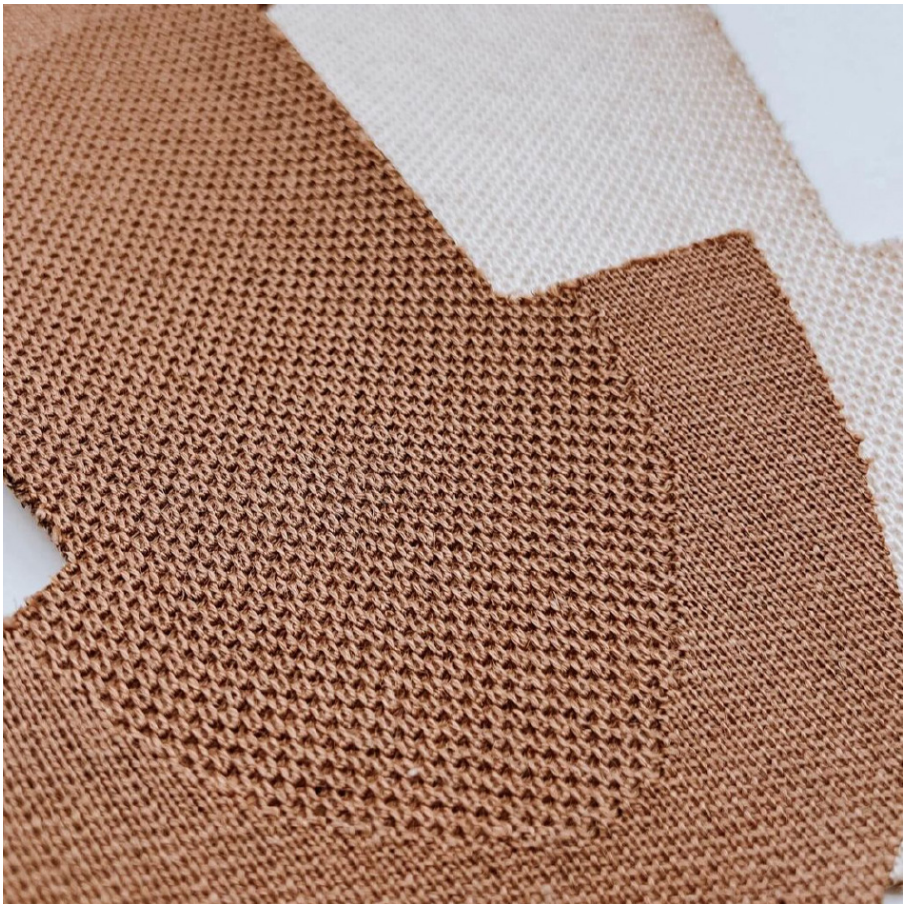


Figure 5. Piñayarn fabric sample. Source: Piñayarn [@pinayarn]. (2024, January 12). https://www.instagram.com/p/C16kyHRofhu/?igsh=MTJhbDRyODlhY3A1MA=

Table 3. Piñayarn System analysis. Source: own elaboration, 2024

	REFLECTION Initial state	ANALYSIS Requirements and targets	SYNTHESIS Developments	EXPERIMENTATION Implementation of Circular Economy
SOCIETAL SYSTEM Contextual Landscape	Negative environmental impacts caused by improper management practices of leaves obtained from pineapple cultivation in the Philippines, considered waste	Identification of alternative uses for pineapple cultivation waste, considering the local ecosystem	Development of a new value chain for the production of a bio-based yarn for textile applications from residual leaves. Activation of a closed-loop system	Waste becomes an input for the activation of a new supply chain. Involvement of local communities in the development of a new closed-loop system, integrating into the local cultural and economic context
SOCIO TECHNICAL SYSTEM System innovations and market	The development of materials from waste often requires significant investments and long innovation periods	Overcoming commercialization barriers and optimizing costs through the creation of a partnership system	Development of partnerships with local farmers and producers in the Philippines, creating an environmentally and economically sustainable system with benefits for all stakeholders	Example of activating a circular system based on the specificities of the local context, reproducible and adaptable in other contexts
PRODUCT-SERVICE SYSTEM Business and process innovation	Most bio-based materials derived from waste exhibit low performance	Development of a bio-based and circular material through a low environmental impact process, with performance suitable for the textile industry	An efficient process with lower CO2 emissions compared to traditional yarns and “zero water technology” for the spinning process. It adapts to industrial knitting and weaving machinery. Use of blends to enhance performance	Material competitive both environmentally and economically compared to less sustainable alternatives
PRODUCT-TECHNOLOLOGY Product innovation	The market is dominated by petroleum-based materials, leading to high usage of non-renewable resources and the issue of microplastic	Development of innovative bio-based and circular materials to reduce environmental burden	Development of a bio-based material with a material-first approach. Biodegradable and compostable, with performance suitable for various applications (footwear, apparel, accessories)	Promotion of efficient resource use and the “waste to resource” paradigm. Design of the material’s end-of-life from a circular perspective

In order to extend the results to the general panorama of the Circular Economy, the results of the three case studies considered have been compared in Table 4 through a cross-scale analysis, following the methodology identified in the literature (De Los Rios & Charnley, 2016). The role of design and sustainability strategies of the "DfX" type were defined based on the theoretical framework found in the literature (De Los Rios & Charnley, 2016; Go et al., 2015; Holt & Barnes, 2010).

Table 4. Cross-scale analysis of the results. Source: own elaboration, 2024

Case study	Business model	Role of design	DfX strategies
EarthArt	Circular supplies	* Implementing material performance * Defining applications and usage scenarios * Facilitating use and maintenance * Promoting durability * Communicating sustainability and generating desire	DfSupplyChain DfQuality DfMaintenance
Herewear	Circular supplies	* Reorganizing the supply chain and systemic relationships among stakeholders * Integrating circular principles * Promoting value retention during use and end-of-life * Prototyping development	DfSupplyChain DfQuality DfMaintenance DfRecycling DfReuse DfRemanufacturing
Piñayarn	Circular supplies	* Prototyping development * Redefining applications and usage scenarios * Implementing material performance * Facilitating recycling * Communicating sustainability and generating desire	DfSupplyChain DfQuality DfRecycling

Conclusions

The research aims to explore the evolving role of design within the context of the circular economy and its interaction with other relevant actors in transitioning towards circular production and consumption models, specifically addressing the theme of recovering agro-industrial waste and by-products for applications in the textile sector. To this end, it was conducted a comparative analysis of three case studies considered representative of different approaches, where design played a significant role in the valorization process - EarthArt, a product born in an industrial setting; Herewear, a project funded by European funds and carried out by a consortium of research centers and universities; and Piñayarn, a product of a company initiated by a textile designer.

A preliminary observation can be made regarding the development status of the solutions - a pilot scale in the case of Herewear and solutions already available on the market in the remaining cases. This reflects a tendency towards disparity between academic and industrial research in the commercialization and expansion of solutions, which can be attributed to various factors, including differing objectives - the discovery of new knowledge and understanding of basic research mechanisms in academic research and practical application and profit generation in industrial research (Mansfield, 1995). Additionally, academic research often relies on public funding or grants, as in the case of the Herewear project, and may be limited and constrained by specific research requirements, whereas industrial research has access to more substantial financial resources. Furthermore, academic research may be characterized by longer timelines and greater flexibility in development programs, while industrial research is often subject to commercial pressures and short-term objectives.

Regarding the degree of innovation, although in the case of EarthArt and Piñayarn, it primarily concerns the product, in all three cases the application of a holistic and systemic vision allowed the designer to broaden the perspective and investigate broader project problems and scales. In the analyzed cases, adopting a broader perspective, where attention is not limited to the analysis of the user and their experience but investigates the entire context in which people live and consume, as it evolves, and the new meanings users attribute to things, allows for a “design-driven” approach to innovation (Verganti, 2009). In this sense, innovation is the product of collective research in which different actors, such as companies, cultural organizations, designers, technology providers, institutions, academia and research are engaged in continuous and mutual dialogue (Verganti, 2009).

The analysis of case studies has highlighted that the contribution of design appears significant at multiple levels and manifests in various ways, such as in implementing material performance and sustainability communication. However, in the context of the Circular Economy, it is mainly attributable to the ability to apply systemic thinking capable of addressing complexity and “bringing together seemingly distant elements” (Lotti et al., 2020). In particular, in the investigated case studies, this occurred through:

- The reorganization of the production chain and management of complexity: through the adoption of a systemic approach, the designer can organize and optimize all parts within an ecosystem so that they evolve coherently with each other, program the flow of input and output flowing from one system to another, manage mutual dialogue and collaboration between various actors in all stages of research development.
- The implementation of valorization strategies: through comparison with stakeholders and other professional figures involved in the process, this includes the implementation of valorization strategies, optimizing the value of biomass and using data from the characterization of residues to identify the most suitable application sectors.

- The integration of circular principles: includes the selection and setting of criteria for evaluating circularity and the environmental impact of valorization processes and the use of circularity tools and indicators.

The contributions identified through the analysis of case studies reflect the need for designers to develop new skills in line with the five competencies for sustainability described by Weik et al. (2011). These include the "System-thinking competence", i.e., the ability to collectively analyze complex systems across different domains (society, environment, economy, etc.) and on different scales (from local to global) (Wiek et al., 2011; Meadows, 2008; Ellen MacArthur, 2013); the "Anticipatory Competence", which is the ability to predict how the system and interactions between actors will evolve over time to ensure the satisfaction of predefined sustainability and circularity requirements; the "Normative Competence", linked to the ability to select and establish criteria for evaluating circularity and the environmental impact of design choices and to use circularity tools and indicators (Sumter et al., 2019); the "Strategic Competence", which reflects a broader perspective of sustainability connected to planning, organization and decision-making abilities; the "Interpersonal Competence", which includes advanced skills in communication, negotiation, collaboration, leadership, pluralistic thinking and transcultural competence (Wiek et al., 2011) to facilitate collaboration among stakeholders along the entire value chain (Bistagnino, 2011).

In this regard, the analysis of case studies has demonstrated the validity of an interdisciplinary and collaborative approach that includes continuous interchange between design and other professional figures. Synergistic cooperation among stakeholders has been identified as a fundamental tool for the development of sustainable solutions and their scale-up: institutions, through effective strategies and action plans; industry, through the implementation of circular production and business models; academic research, by providing support through new technologies, tools, methodologies, and approaches; designers, as a junction point between academia and industry, through the integration of circular design principles into the design process and the development of closed-loop systems. Through the development of practical case studies, design can contribute to the implementation of the circular economy by intervening at various levels of the supply chain.

The contribution represents a starting point for investigating the role of the designer in the valorization processes of agro-industrial waste, promoting the exploration of new opportunities for application in the textile sector. However, the literature analysis has highlighted a lack of methodological references to guide design activity. Possible research developments include the development of guidelines, best practices and tools to provide designers with a roadmap for the effective implementation of sustainable valorization strategies for agro-industrial waste.

Furthermore, research conducted on the analysis of innovation in the textile field, in reference to the specific study area, can serve as a basis for exploring new areas of innovation, including new types of waste and new applications in different environmental, socioeconomic, and cultural contexts.

Finally, the importance of interdisciplinary collaboration among different actors - such as designers, universities, research centers, and industries - in defining strategies for the sustainable valorization of agro-industrial waste can be further investigated through the exploration of partnership models and innovation networks that encourage the exchange of knowledge and resources across different disciplines and sectors.

Funding source

This contribution is part of the research project "Processes and Innovative Technologies for Circularity in the Textile Field" conducted within the PhD program in Environment, Design, and Innovation at the

University of Campania Luigi Vanvitelli and funded by the "V:ALERE 2020 - Vanvitelli per la Ricerca" program.

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ISSN 2386-5414
e-ISSN: 2340-8391

Artículo de investigación | Research Article

De la teoría a la práctica. Un protocolo para la caracterización experiencial de las cualidades expresivo-sensoriales de las maderas nativas de Chile |From theory to practice. A protocol for the experiential characterization of the expressive-sensory qualities of (native) woods (from Chile)

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Recibido: 5 de junio 2024 | Aceptado: 26 de junio 2024 | Publicado: June 29, 2024
DOI. 10.24310/p56-idj1202420095

Resumen

Este artículo expone la definición teórica inicial y posterior implementación de un protocolo experimental aplicado en un estudio realizado en Chile entre 2019 y 2022. El estudio tuvo como objetivo caracterizar las cualidades expresivo-sensoriales de 15 especies nativas de madera. Este tipo de caracterización, que complementa las definiciones de propiedades técnicas (como dureza o resistencia), es significativa para la disciplina del Diseño. Proporcionando a los profesionales información sobre las percepciones, emociones y significados que las personas atribuyen a los materiales, lo que se conoce como "materials experience".

A través de revisión de literatura, consulta a expertos y una selección de métodos utilizados previamente en este campo, se desarrolló una experiencia de caracterización realizada por más de 200 participantes, entre estudiantes y profesionales del diseño, la arquitectura, la decoración y la artesanía. Estos participantes, de una muestra estratificada proporcional a la población por región de Chile, interactuaron multimodalmente con muestras físicas de madera para informar sus percepciones a través de una encuesta. Además, se capturaron datos biométricos de sus expresiones faciales y posición de su mirada.

Los resultados permitieron la elaboración de fichas y gráficos comparativos en los que se muestran las cualidades de cada especie y que son de acceso libre.

El artículo aborda el concepto de caracterización experiencial de materiales, enfocándose en la madera y detalla la definición y puesta en práctica de la experiencia, documentando el proceso por sobre los resultados, como conocimiento valioso para investigadores y profesionales del diseño.

Palabras clave: Madera, Diseño Industrial, experiencia material, Diseño y emociones, Chile, Investigación en Diseño.

Abstract:

This paper presents the initial theoretical definition and subsequent implementation of an experimental protocol applied in a study conducted in Chile between 2019 and 2022. The study aimed to characterize the expressive-sensory qualities of 15 native wood species. This type of characterization, which complements the definitions of technical properties (such as hardness or strength), is significant for the Design discipline. Providing professionals with information on the perceptions, emotions and meanings that people attribute to materials, known as "materials experience".

Through literature review, expert consultation and a selection of methods previously used in this field, a characterization experience was developed by more than 200 participants, including students and professionals in the fields of design, architecture, decoration and craftsmanship. These participants, from a stratified sample proportional to the population by region of Chile, interacted multimodally with physical samples of wood to report their perceptions through a survey. In addition, biometric data were captured on their facial expressions and gaze position.

The results allowed the elaboration of comparative graphs showing the qualities of each species, which are freely accessible.

The article addresses the concept of experiential characterization of materials, focusing on wood and details the definition and implementation of the experience, documenting the process over the results, as valuable knowledge for researchers and design professionals.

Keywords: Wood, Industrial Design, materials experience, Design and emotions, Chile, Design research

Introducción

Caracterizando "los otros" aspectos de los materiales.

En la disciplina del Diseño de productos, donde el proceso de selección de materiales es un tema relevante en cada uno de los proyectos que se lleva a cabo, los aspectos sensoriales, semánticos o afectivos suelen ser prioritarios. Ello debido a que los futuros usuarios de un producto lo evaluarán no solamente por su capacidad para realizar una función concreta, sino también por su apariencia, comodidad y significados socioculturales entre otros. Estos últimos aspectos son, habitualmente, los más relevantes para generar relaciones de mayor profundidad entre personas y productos (Camplone, 2024; Haug, 2019).

En esa línea, Ashby & Johnson (2014) afirman que la una adecuada selección de los materiales a partir de criterios técnicos tales como la resistencia o dureza, o el desempeño de la función básica de un producto son importantes, pero finalmente el diseño industrial y la definición de sus cualidades estéticas determinarán, en mayor medida, la preferencia de las personas por un producto u otro. Consistentemente, diversos autores (Camplone, 2024; Karana et al., 2009; Rognoli & Ayala García, 2018; Zuo et al., 2016) han documentado la relación existente entre los aspectos sensoriales y la creación de significados en los productos y también de forma más directa, entre materiales y emociones (Bertheaux et al., 2023; Crippa et al., 2012; Rognoli & Levi, 2004).

Caracterización de la madera.

En el caso de la madera, en su rol de material importante para el diseño de productos y espacios habitables, esto no es diferente. Por ejemplo, se ha realizado investigación sobre las características y propiedades de este material y de diferentes especies, la que documenta, desde la perspectiva de la biofilia, los efectos beneficiosos para

el ser humano que se producen con su uso en interiores, o incluso con el simple contacto visual con la madera (Ikei et al., 2017; Lipovac & Burnard, 2021; Nakamura et al., 2019; Nyrud & Bringslimark, 2010).

Además, se ha corroborado una actitud positiva hacia la madera por parte de una amplia mayoría de personas, más allá de su cultura, asociándola de modo consistente con descriptores como cálido, confortable, relajante o natural (Browning et al., 2022; Rice et al., 2006). Los estudios que abordan la caracterización de aspectos diferentes a los técnicos en este material se han realizado desde hace ya bastante tiempo (Blomgren, 1965; Broman, 2000a, 2001; Ratnasingam et al., 2007) y se continúan realizando en la actualidad (Burnard & Kutnar, 2020; Lipovac et al., 2022; Wan et al., 2021).

Creando una experiencia para la caracterización de maderas nativas chilenas.

A través de la definición y valoración de las cualidades expresivo-sensoriales (Rognoli & Ayala García, 2018) de 15 de las maderas nativas chilenas más utilizadas y disponibles comercialmente (más el Pino Radiata que se sumó como especie foránea de control al ser la madera más utilizada y conocida en Chile), y de la identificación de las percepciones que éstas provocan en las personas, la investigación en que se enmarca este artículo tuvo por objetivo principal contribuir a la optimización del proceso de selección de materiales para el Diseño, con la incorporación de las cualidades expresivas y sensoriales a la información con que cuentan los Diseñadores.

Para el logro de lo anterior fue necesario construir una "experiencia de caracterización" aplicable a diferentes personas, y tipos de madera. Para ello se estableció, a partir de la revisión de la literatura asociada y los métodos ya existentes, un protocolo de acciones y tareas que las personas debían realizar, por ejemplo, explorando muestras de materiales, documentando sus sensaciones, emociones, etc.

Este protocolo debió, posteriormente, implementarse en la práctica. Un proceso que no estuvo exento de dificultades y que determinó modificaciones respecto del plan trazado inicialmente. Se considera entonces, de gran importancia para la difusión del conocimiento adquirido en este desarrollo, el que pudiera ser útil a investigadores y profesionales del Diseño que deseen caracterizar otras especies madereras, u otros materiales, documentar el proceso de definición de esta experiencia de caracterización.

Para lo anterior, este artículo presenta al lector el concepto de caracterización experiencial de materiales y su estado del arte actual, específicamente en relación con la madera.

Posteriormente, describe en detalle el proceso de definición de la experiencia realizada y sus diferentes etapas y dimensiones. Esta experiencia se llevó a cabo con más de 200 personas y sus resultados, disponibles a todo público en la web www.maderanativachile.cl serán presentados a la comunidad académica en futuros trabajos. Este apartado define los argumentos utilizados para definir cada uno de los parámetros de esta experiencia. Finalmente, se plantea una discusión y conclusiones generales.

La experiencia creada es así considerada uno de los primeros resultados del proceso de investigación. Este enfoque, emparentado con el concepto de Research through Design (Redström, 2020; Stappers & Giaccardi, 2018) posee relevancia para el Diseño y la investigación propia de la disciplina, al poner en valor no solamente los resultados finales de investigación, sino también tratar como resultados de interés académico estos "productos intermedios" implementados para llegar a ellos. Estos son a menudo de gran riqueza metodológica, nacidos desde la práctica, y valiosos por sí mismos, más aún para una disciplina que todavía se encuentra definiendo sus propias maneras de investigar y crear nuevo conocimiento.

Marco teórico

La caracterización experiencial de materiales.

Es posible hallar referencias desde los años 40' del siglo pasado respecto a estudios de caracterización experiencial, principalmente de análisis sensorial u organoléptico en la industria de la alimentación (Heymann, 2019). Sin embargo, la aparición de este tipo de estudios en el campo del Diseño (y los materiales) resulta más actual y aún algo escaso. En una reciente revisión, Veelaert (2022) documenta sólo 50 artículos publicados entre el año 2000 y el 2019 que abordaban esta temática desde el área del Diseño.

Estos diversos conceptos y niveles de interpretación de los materiales han sido denominados de distintas maneras, y por diferentes autores, mientras han ido adquiriendo interés por parte de la comunidad académica del Diseño (Jacob-Dazarola et al., 2019).

Un estándar más transversalmente aceptado al respecto se ha establecido a partir del concepto central materials experience (Karana et al., 2014; Karana & Hekkert, 2008). Ello considera también un método y herramientas específicas para la caracterización experiencial de materiales (Camere & Karana, 2018), donde las personas experimentan de forma directa la interacción con muestras del material en evaluación. Posteriormente reportan a los investigadores sus percepciones e interpretaciones.

Giaccardi & Karana (2015) definen cuatro niveles experienciales en que los materiales pueden ser caracterizados:

El nivel performativo refiere a aquellas acciones que el material "invita a realizar", tales como apretarlo, rascarlo, golpearlo, según su naturaleza y apariencia. El nivel sensorial aborda aquellos aspectos subordinados a la valoración realizada a través de los sentidos. El nivel interpretativo corresponde a los significados otorgados a los materiales, mediados habitualmente por la cultura y el contexto de los usuarios, mientras que el nivel afectivo alude a las emociones y afectos que las personas experimentan. Estos cuatro niveles interactúan y se influencian entre sí, por lo cual no es posible aislarlos completamente en la interacción habitual entre las personas y los materiales.

La caracterización experiencial de la madera.

Considerando estos cuatro niveles, la madera es un material que difiere de los metales o los polímeros. Cada especie es diferente, y cada pieza de madera, aún proveniente del mismo árbol, es también diferente de otra. Su veta, espaciado entre los anillos, colores, grano, textura, peso, sonido, aroma, crean infinitas posibilidades de variación, que percibimos a través de los sentidos, y nos cuentan la historia del árbol del que formaron parte alguna vez (Fujisaki et al., 2015).

Las personas reconocen en la madera un material sustentable, natural y cercano, que no requiere complejos procesos industriales para llegar al consumidor final. Incluso cuando está procesada o pintada su impronta natural persiste para recordar que estuvo viva alguna vez.

Según Browning, Ryan & DeMarco (2022) y en coincidencia parcial con los cuatro niveles de la caracterización experiencial definidos por Camere & Karana, (2018), la preferencia biofílica natural que se registra por la madera proviene de una experiencia háptica, olfativa y visual (que conformaría el nivel sensorial) y de un procesamiento asociativo (semántico) e interpretativo (nivel del mismo nombre). De acuerdo con los autores, esta aproximación al material provocaría las emociones positivas que se relacionan con el material (en asociación al nivel afectivo).

Valoración de atributos sensoriales y cualidades expresivas.

Los estudios que abordan la caracterización de las cualidades expresivo-sensoriales de la madera consideran, en general,

un número pequeño de especies. Entre los consultados para este proceso de investigación se analizaban entre tres a seis especies, siendo el más numeroso revisado el de Fujisaki et al. (2015) con 14 especies.

Además, los hallazgos son dependientes, en cierta medida, del contexto, es decir de la cultura del lugar donde fueron realizados. Por ejemplo, la nudosidad de la madera es valorada de formas muy diferentes según la cultura en que se realicen los estudios. Høibø & Nyrud (2010) mencionan una preferencia universal por una cierta homogeneidad en las superficies de madera. Broman (2000) dice que las superficies sin nudos se definen como más armoniosas en relación con aquellas más irregulares.

Masuda (1992) había planteado previamente que mientras en Japón los nudos son interpretados como defectos, asociándolos con madera de baja calidad, en Europa, Estados Unidos y Canadá son asociados con descriptores como natural o rústico, interpretándolos positivamente.

De acuerdo con Wan et al. (2021) la percepción visual de una superficie de madera está definida mayormente tres factores: el color, el veteado y el brillo. Estos autores plantean que, en general, se prefiere la madera oscura (café oscuro, rojizo oscuro) a la más clara (amarillenta) o de color medio (café claro, rojo claro), y la madera mate o definitivamente brillante a aquellas semibrillantes.

En estudios previos se han obtenidos resultados equivalentes y planteado que existe una tendencia a valorar las maderas de forma similar según el color predominante. Bumgardner & Bowe (2002) de forma coincidente con Wan et al. (2021) señalaban que las maderas más oscuras habían sido descritas como caras, formales, antiguas y señoriales, mientras que las claras como baratas, informales, modernas y modestas.

Caracterizando para el Diseño.

Karana (2010) plantea que las concepciones que las personas tienen sobre los materiales, donde habitualmente consideran la madera como acogedora, los metales fríos y los plásticos contaminantes o de baja calidad, no son verdaderamente útiles para la disciplina del Diseño de productos dada su excesiva generalidad.

De forma similar, debido a la enorme variabilidad existente entre las diferentes especies madereras y especialmente, el rol que tienen el contexto y la cultura en la valoración sus cualidades, parece posible sostener que, para efectos de aportar objetivamente en los procesos de selección de materiales en el marco proyectual del Diseño, la caracterización experiencial de la madera debe ser mucho más específica. Cuando los diseñadores seleccionan materiales, no resulta suficiente saber que las personas prefieren las maderas oscuras o las superficies con pocos nudos. Se requiere conocer las especies que podrían ser útiles a efectos de, por ejemplo, evocar una emoción definida, ser asociadas con ciertos conceptos, o provocar una percepción determinada en los usuarios de un producto o los habitantes de un espacio (Jacob-Dazarola et al., 2019).

Otro aspecto para tener en cuenta, respecto a los estudios existentes, es que los procesos de investigación utilizados, así como los métodos y herramientas difieren notablemente. Por ejemplo, los descriptores utilizados para evaluar los niveles interpretativo o sensorial varían entre un estudio y otro. Lo anterior dificulta asociar los resultados para construir una base de datos común, que reúna diferentes especies, incluso de zonas geográficas diversas, y permita a los diseñadores seleccionar maderas con una perspectiva más amplia e informada.

Caracterización de la madera en Chile.

En lo que respecta a estudios llevados a cabo sobre las especies madereras chilenas, la situación es similar a la descrita previamente respecto a los materiales en general.

En repositorios y bibliotecas digitales abiertas a todo público, propiedad de

entidades dedicadas al ámbito de la madera, tales como CORMA o INFOR resulta posible hallar, con facilidad, numerosos estudios de caracterización físico-mecánica de prácticamente todas las especies nativas relevantes para la industria de la madera (Baradit et al., 2013; Karsulovic C. et al., 2000).

No obstante, cuando se trata de la caracterización de aspectos sensoriales, semánticos o afectivos se encontraron escasas publicaciones (Alarcón Castro et al., 2019; Alarcón Castro & Di Bartolo, 2013; Brañes Alarcón et al., 2023; Briede W. & Alarcón Castro, 2012), sólo disponibles en repositorios académicos y que, en conjunto, consideran cinco especies nativas.

Materiales y métodos.

Para poder establecer una experiencia de caracterización aplicable a 15 maderas nativas chilenas, cuyos resultados fueran realmente útiles a los diseñadores en sus procesos de selección de materiales, esta debía ser consistente y repetible en diferentes momentos y escenarios e incorporar los aspectos más relevantes en cuanto a los niveles y dimensiones definidos en este tipo de caracterizaciones.

La definición de esta experiencia involucró un extenso proceso que se llevó a cabo entre 2017 y 2022 en dos proyectos de investigación consecutivos.

Para ello, se siguió un proceso lineal en las etapas iniciales, el que posteriormente se volvió iterativo. Se inició con una revisión bibliográfica exhaustiva, reflejada en un artículo publicado previamente (Jacob-Dazarola et al., 2019) y el actual marco teórico aquí presentado. Posteriormente, se llevó a cabo una consulta a expertos del mundo del Diseño, la madera y los materiales y se elaboró una primera versión de la experiencia, la que se aplicó en el marco del primer proyecto.

A raíz del conocimiento adquirido, y en el marco de un nuevo proyecto de investigación, se planteó una nueva experiencia más extensa y compleja. Esta resguardaba aspectos que habían resultado relevantes o inadecuadamente resueltos previamente: la uniformidad en la iluminación, la interacción con los estímulos, el formato de estos, etc.

Esta segunda experiencia fue testeada por los propios ejecutores del proyecto, modificada nuevamente en diversos aspectos, e implementada en una etapa de marcha blanca con 18 voluntarios, donde se corrigieron los últimos aspectos en conflicto.

Posteriormente fue puesta en marcha, primeramente, bajo condiciones controladas en la Facultad de Arquitectura y Urbanismo de la Universidad de Chile y posteriormente en diversos lugares del país, con la participación total de 311 personas.

Un referente metodológico relevante que se utilizó como punto de partida fue el Toolkit Ma2E4 (Camere & Karana, 2018) pues, más allá de sus sólidos fundamentos teóricos, presenta instrumentos concretos que permiten obtener información desde las personas mientras interactúan con diversos materiales, evaluándolos en los cuatro niveles ya señalados.

Complementariamente, el trabajo de Chen et al. (2009), Veelaert et al. (2020) y Veelaert (2022) permitió acceder a sistematizaciones previas de los diferentes parámetros experimentales involucrados en los procesos de caracterización de materiales. A éstos, se incorporaron algunos aspectos que se consideraron relevantes dada la experiencia previa.

Siguiendo los apartados propuestos por estos autores (tablas 1 y 2) a continuación se detalla el proceso de definición para cada parámetro de la experiencia creada.

Estímulos. Tipo, tamaño, forma, acabados.

Un aspecto importante en la caracterización experiencial de materiales se refiere a los estímulos utilizados, es decir las muestras que permitirán a las personas interactuar con el material a través de uno (unimodal) o más de sus sentidos (multimodal). Estos estímulos pueden ser tangibles (muestras

Tabla 1. Parámetros experimentales de la caracterización experiencial de materiales. Desarrollado por el autor basado en Veelaert et al. (2020).

ESTÍMULOS		VARAIBLES EXPERIENCIALES		MODALIDAD DE INTERACCIÓN	PARTICIPANTES
TANGIBLES	INGANGIBLES	DEPENDIENTES	INDEPENDIENTES	Unimodal guiado	Cantidad
Materiales	Renders	Sensorial	Técnicas	Multimodal guiado	Demografía
Texturas	Fotografías	Interpretativa	Del producto	Multimodal libre	Formación
Productos	Imágenes	Afectiva	Del usuario		Expreincia
MÉTODOS					
ESCALAS		DISCRIMINACIÓN		ASOCIACIÓN LIBRE	
Diferencial semántico		Sorted napping		Palabras asociadas	
Unipolares		Análisis comparativo pareado		Emociones evocadas	
Binarias		Agrupación jerárquica		Usis sugeridos	
Ránking					

reales, planas o volumétricas) o intangibles (fotografías, representaciones, imágenes en una pantalla, realidad virtual) (Bertheaux et al., 2023; Veelaert et al., 2019a, 2020a).

Para iniciar la definición de este aspecto se llevó a cabo una nueva revisión de literatura, más específica, que consideró diez artículos publicados entre 2001 y 2019 sobre la caracterización de madera. Esta revisión permitió constatar que, respecto a los estímulos, existen solo dos aspectos comunes entre las experiencias de caracterización realizadas: La utilización de muestras físicas de las maderas en estudio definidas por tres aspectos fundamentales: dimensiones, forma y acabado superficial y el uso de fotografías de productos, o de representaciones informáticas de las diferentes especies de madera, como complemento.

Nordvik & Broman (2009) señalan que a pesar de la complejidad implícita que tiene representar la madera, pues implica la pérdida de muchos atributos importantes y sutiles como el aroma o textura, las diferencias de sonido o temperatura al tacto, la utilización de estos recursos permite ampliar los alcances de los estímulos. Es posible ilustrar diversos productos fabricados con diferentes tipos de madera, objetos de grandes dimensiones, interiores o exteriores de casas o edificios sin costo añadido. En estudios recientes la realidad virtual se ha mostrado efectiva como recurso para la evaluación sensorial unimodal de algunos aspectos de los materiales como el brillo o la suavidad percibida (Bertheaux et al., 2023).

Para definir las dimensiones, y ante la falta de un acuerdo claro de los expertos o de la literatura existente al respecto, se testearon tres alternativas de tamaño entre el equipo del proyecto y diez estudiantes de la carrera de Diseño de la Universidad de Chile, a través de una interacción libre y multimodal. Acciones como levantar la pieza de madera desde una superficie plana, extraerla desde un compartimento y manipularla con facilidad resultaron claves para definir finalmente un tamaño de 200x120mm. El espesor, de 20mm., fue definido atendiendo los mismos aspectos, tomando además en cuenta la relación existente entre el espesor de las piezas de madera y la percepción de su calidad (Pérez Mejía, 2010).

Respecto a la forma de las muestras, los expertos consultados sugirieron alternativas irregulares, circulares o volumétricas, no obstante, la forma más mencionada fue rectangular. Por otra parte, los estudios consultados utilizaron sólo formas rectangulares o cuadradas. Complementariamente, Veelaert et al. (2019) señalan la importancia de estímulos neutros, carentes de valor semántico, para poder realizar una caracterización realmente objetiva. Señalan también la posibilidad de llegar a esa neutralidad a través de dos estrategias: la simpleza o la complejidad. Planteando que la última aumenta las posibilidades de exploración en la interacción con los materiales.

Considerando lo anterior, se definió una pieza rectangular como base, la que fue modificada mediante la aplicación de procesos utilizados habitualmente en la fabricación de productos de madera, como aserrado y fresado, según muestra la figura 1. Esto generó una muestra, aun reconocible como rectangular, pero capaz de remitir a varias de las geometrías más habituales de los productos de madera, como ángulos de 90° y 45°, esquinas y aristas redondeadas y vivas, o caras continuas perpendiculares.

Bhatta et al. (2017) plantean que las superficies de madera natural y lisa se perciben más positivamente que las superficies con un acabado o recubrimiento. Sugieren, además, la importancia de preservar la naturalidad de la textura. Sin embargo, en la relación cotidiana de las personas con productos de madera, estos habitualmente ya poseen recubrimientos o tratamientos superficiales como lacas, barnices o aceites. Las ocasiones en que las personas interactúan con la madera desnuda son en la práctica minoritarias, especialmente en el caso de los productos de interior (Scrinzi et al., 2011).

Con esto en cuenta y para permitir una valoración de las diferentes opciones de acabado más habituales, cada especie de madera estuvo representada por tres piezas de igual forma y tamaño, una sin recubrimiento alguno, la segunda de acabado satinado otorgado por un tratamiento con aceite, y una tercera recubierta con barniz brillante. La cara inferior se dejó sin recubrimiento en todas las piezas para que las personas percibieran las diferencias sensoriales entre la madera desnuda y los diferentes recubrimientos aplicados (figura 1, imágenes superiores).

Respecto a las imágenes complementarias, se crearon imágenes de renderizado fotorrealista mediante el software 3D Max y el motor de render VRay. Se realizaron dos láminas de imágenes para cada una de las 15 especies, aplicando texturas digitales basadas en el material denominado Advanced Wood, a escenas que contaban con modelos 3D y parámetros de iluminación idénticos. De esta manera, la única variable era la madera representada. Tanto para productos como espacios se buscó ofrecer alternativas que permitieran ampliar la mirada respecto de las posibilidades de aplicación del material (figura 1, imágenes inferiores).

Variables experienciales y métodos.

Aunque el objetivo de este estudio fue obtener una caracterización lo más completa posible, que comparara las maderas en sus diferentes niveles y a través

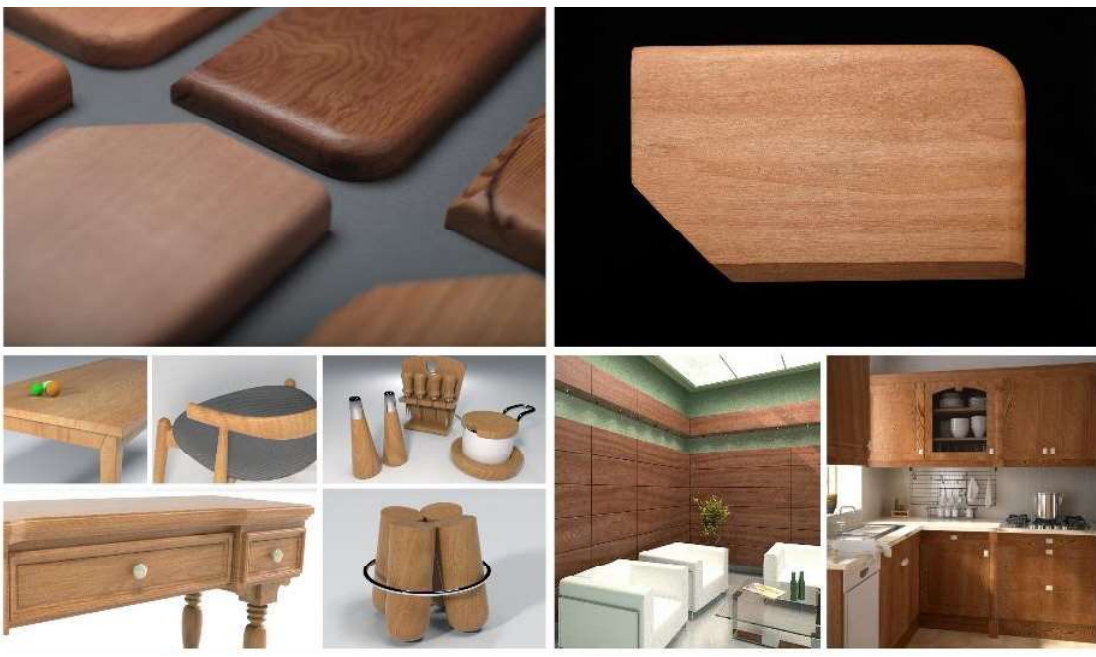

Figura 1. Estímulos físicos e informáticos presentados a los participantes. Fotografías e imágenes de elaboración propia

de todos los sentidos, una vez definidos los estímulos se optó por descartar la evaluación del nivel performativo. Ello debido a que, al ser las muestras iguales en acabado, tamaño y forma, las personas tendían a interactuar con ellas de modo prácticamente idéntico. No obstante, se observaron algunas pequeñas diferencias en especies con características muy distintivas respecto a su peso, porosidad superficial y aroma, las que pudieran ser objeto de estudio en futuras investigaciones.

Respecto a los demás niveles, cada uno fue asociado a métodos y técnicas concretas que se establecieron en la etapa de diseño inicial de la experiencia, los que, en base a la revisión literaria y experiencia adquirida en el proyecto previo, fueron determinados como los más idóneos en cada caso.

El nivel sensorial fue evaluado mediante una herramienta habitualmente usada en la caracterización experiencial de materiales, la escala de diferencial semántico, que presenta distintos pares de palabras con significados opuestos para que las personas puedan definir su percepción (Choi, 2016; Kelly & Stephenson, 1967; Osgood et al., 1957). Esto es similar a lo planteado en el toolkit propuesto por Camere & Karana (2017) pero los pares de palabras originales fueron modificados debido a la especificidad del material. En todos los casos en que se modificaron los términos semánticos se mantuvieron las dimensiones asociadas a estos para no variar la significancia estadística de la herramienta y su coherencia interna (Aros Beltrán et al., 2009; Osgood & Suci, 1969), la que ya había sido evaluada durante su desarrollo.

El nivel afectivo se evaluó mediante escalas de diferencial semántico y también asociación libre de palabras. Esta asociación de palabras buscó que las personas mencionaran las emociones evocadas por cada madera. Para ello, se les presentó una lámina con diversas emociones, basada en la teoría de Scherer (2000), sirviendo como punto de partida para que los participantes escogieran algunas de ellas, pero pudiendo también, mencionar emociones que no aparecían en la lámina.

Los pares de adjetivos del diferencial semántico se basaron también en los propuestos en el mismo toolkit, pero fueron significativamente modificados siguiendo los criterios expresados por los expertos y la revisión literaria realizada específicamente sobre caracterización de maderas.

Uno de los objetivos secundarios de la investigación buscaba comparar, validar y/o descartar métodos utilizados habitualmente para la realización de caracterización experiencial de materiales en un contexto local. Por ello, el nivel afectivo se evaluó complementariamente mediante biometría (medición de parámetros fisiológicos del cuerpo humano) a través del uso del módulo de “Facereading” del software “Imotions”, capaz de medir, a partir del análisis las expresiones faciales, la intensidad de siete emociones básicas (alegría, asco, tristeza, ira, sorpresa, miedo y desprecio). Esto fue realizado mediante una cámara que capturaba el rostro de los participantes durante la primera interacción con las muestras físicas de madera.

El nivel interpretativo también se evaluó mediante diferencial semántico y asociación libre. Los adjetivos del diferencial semántico al igual que en el nivel afectivo se basaron en el toolkit, pero se modificaron en base a los mismos criterios.

Todas las escalas semánticas y asociaciones libres de palabras se presentaron a los participantes en una pantalla de 30 pulgadas (y se recopilaron así automáticamente sus respuestas) con un cuestionario interactivo creado a través del módulo Survey del software Imotions.

A la evaluación de los tres niveles mencionados se sumaron preguntas de asociación libre relacionadas con los usos y aplicaciones posibles para cada especie y otras enfocadas en los procesos y acabados asociados a cada una de ellas, siempre desde un punto de vista expresivo, sensorial y perceptual en lugar de técnico.

Además, se incorporaron dos aspectos que contribuyen al conocimiento que requieren los diseñadores cuando seleccionan especies específicas para sus proyectos: un ranking de preferencia general de especies y una valoración del reconocimiento de cada especie, es decir, si las personas eran capaces de asociar su nombre común con la muestra física.

Complementariamente, esta potencial preferencia por algunas especies fue evaluada utilizando tecnología de seguimiento ocular o eyetracking para establecer la posición y permanencia de la mirada de las personas cuando observaban todas las especies al mismo tiempo. Para la implementación de la tecnología de eyetracking se intentó inicialmente utilizar lentes "Pupil Labs" modelo Core y el software nativo que provee el fabricante, no obstante, el complejo proceso de calibración requerido para cada participante hacía inviable su utilización masiva y en terreno. Se reemplazaron entonces por el modelo Invisible del mismo fabricante, que no requiere calibración previa, pudiendo así realizarse el procedimiento expeditamente y eliminando la experiencia "de laboratorio".

Modalidades, etapas y tiempos de interacción.

El tiempo es un factor clave en este tipo de experimentos al estar directamente relacionado con la capacidad de atención de los participantes. Veelaert et al.(2020) definen una media de 37 minutos en base a la revisión de literatura que realizan. Ellos concluyen que los experimentos de caracterización experiencial poseen un límite de concentración de 40 minutos.

Los autores apuntan estrategias utilizadas para optimizar el tiempo y la participación de las personas. Por ejemplo, la separación de los individuos por modalidad (visual, táctil o mixta) o la división de las muestras en grupos de encuestados con perfil similar. Estos grupos evalúan diferentes materiales, pero las caracterizaciones son comparables entre sí.

En este caso, la experiencia contempló una interacción inicial multimodal y libre con el material, pero restringida a un tiempo de 30 segundos, y con la posibilidad de continuar la interacción libremente durante toda la realización de la experiencia.

Una medida fundamental para salvaguardar la duración adecuada del procedimiento fue evitar que cada participante estuviera obligado a caracterizar las 16 maderas en estudio. Para ello, las especies se dividieron en cuatro grupos, considerando el color predominante como atributo para dividirlas (cada grupo fue conformado por una especie de tonos rojizo oscuro, rojizo claro, amarillenta y grisácea-verdosa).

Así, cada participante debía evaluar solamente cuatro especies. Como el tiempo empleado por las personas en evaluar la primera especie que se les presentaba era mucho mayor que en la segunda y este tiempo a la vez menor que la tercera y cuarta especies, se aleatorizó el orden en que eran evaluadas y se rotaron los cuatro grupos de especies cada diez participantes.

Esto generó que, en la práctica, hubiese cuatro experiencias diferentes posibles de realizar. Como muchos de los participantes dieron a conocer su interés por evaluar más de un grupo de maderas, se optó por que un mismo individuo pudiera participar hasta en cuatro ocasiones si así lo deseaba, dejando un intervalo de una hora entre cada experiencia. Este descanso le permitía retomar los niveles de atención. El tiempo de ejecución de la experiencia realizada por segunda o tercera vez era notoriamente menor que la primera vez.

Luego del testeo realizado con el equipo del proyecto y durante la marcha blanca, se decidió separar la etapa correspondiente al ranking de preferencias y reconocimiento de las especies, siendo esta etapa llamada experiencia 2. La experiencia de caracterización guiada por el cuestionario interactivo pasó entonces a denominarse experiencia 1. A cada persona se le consultaba inicialmente si quería realizar una de las experiencias o ambas, si optaba por ambas, al concluir con la primera se le

volvía a consultar si quería continuar con la segunda luego de un descanso de 15 minutos.

La prioridad fue siempre la realización de la experiencia 1, que era más extensa, entregaba más información y presentaba mayor complejidad. Además, esta experiencia consideraba solo cuatro especies por ejecución, mientras que la experiencia 2 era realizada con la totalidad de las maderas al mismo tiempo, requiriendo de menos participantes para lograr la misma cantidad de respuestas por especie. La experiencia 1 tuvo una duración media de 33 minutos y la experiencia 2 de sólo 12.

Una tercera parte de la experiencia estuvo constituida por el uso del equipo de eyetracking, que se realizó en un proceso independiente, donde en sólo tres minutos cada uno, los participantes registraron la posición de su mirada utilizando el mismo layout de la experiencia 2.

Participantes.

Para definir la muestra de participantes se utilizaron los parámetros planteados por Veelaert et al. (2020) referentes a cantidad, actividad o profesión, demografía y experiencia con los materiales. Otro criterio importante fue que los participantes correspondieran a personas vinculadas al trabajo con la madera, tales como estudiantes avanzados y profesionales de las áreas del Diseño y la Arquitectura, decoradores, artesanos, carpinteros.

De esta manera contaban con alguna familiaridad con el material, lo que facilitaba significativamente la comprensión de la experiencia planteada.

Se estableció una muestra estratificada, proporcional respecto de los habitantes de las diferentes regiones de Chile, seleccionándose habitantes de las regiones Metropolitana, por su volumen de habitantes y movimiento en el mercado de la madera, así como las regiones del Biobío (Concepción), de los Ríos (Valdivia) y de los Lagos (Chiloé) por su tradición maderera ampliamente conocida en el país.

Entre los criterios originalmente definidos para la muestra estaba también una edad en que las personas participaran activamente de actividades laborales. Por ello, se intentó mantener una media de edad mayor a 30 años, pero dada la elevada cantidad de estudiantes que participaron, no se pudo lograr. Se priorizó la cantidad de participantes, obteniéndose finalmente una media de 26 años. El detalle de la muestra se registra en la tabla 2.

La experiencia 1 fue realizada finalmente por 211 personas que aportaron 52 respuestas para cada especie. La experiencia 2 fue llevada a cabo por 211 personas con igual número de respuestas por especie, ambas experiencias se llevaron a cabo en un período de siete meses. La experiencia de eyetracking fue realizada por 100 personas en sólo dos jornadas.

Configuración. Instrumentos, entorno y equipamiento.

Un aspecto que tampoco cuenta con una definición totalmente clara en los estudios revisados es todo aquello vinculado al equipamiento, herramientas e instrumentos utilizados en las experiencias de caracterización realizadas. Pese a que son comunes las fotografías de los estímulos, pocos estudios presentan algún detalle respecto del layout experimental como el de Veelaert et al.(2020).

Para la realización de esta experiencia se definió la utilización de dos cabinas fotográficas desmontables de 800x800x800 mm de material textil y esqueleto de aluminio, tipo Led studio marca CAIM modelo □201803.

Las cabinas estaban equipadas con dos luminarias de luz blanca led (T°4000-4500K) con un índice de reproducción cromática 92 y capacidad de 12000 lúmenes. Estas luminarias permitieron una iluminación uniforme, independiente de las condiciones de luz del entorno, y una visualización natural del color de las maderas. Las maderas estaban iluminadas con 1575 lux medidos en el punto central de la cabina.

Tabla 2. . Segmentación de la muestra según género, región, rango etario y actividad.

GÉNERO		REGIÓN		RANGO EDAD		ACTIVIDAD	
M	95	Metropolitana	157	20-25	48	estudiante / profesional diseño	139
F	115	Biobío	32	25-30	48	estudiante / profesional arquitectura	30
O	0	Los Ríos	12	30-35	6	estudiante/ profesional ingeniería	10
NS/ NR	0	Los Lagos	10	+35	26	otra profesión / actividad	32

La cabina de la experiencia 1 contenía los siguientes elementos:

- 1 monitor Xiaomi de 24" donde aparecían las diversas instrucciones y preguntas de la experiencia. El software Imotions (módulo Survey) permitió preparar esto de acuerdo con tiempos específicos o a instrucciones interactivas en pantalla según se requería.
- 1 cámara web Logitech C922 Pro, Full HD, que grababa las expresiones faciales durante 30 segundos, durante el primer contacto con las maderas.
- Un teclado y un ratón inalámbricos que permitían a los participantes responder a lo requerido en pantalla y avanzar en la experiencia.
- Una caja soporte semi-rígida construida especialmente y que ocultaba 12 piezas de madera 3 de cada una de las cuatro especies en proceso de caracterización (mate sin tratamiento alguno, semi-brillo tratada con aceite y brillante recubierta con barniz). Cada especie estaba identificada por un número sobre ellas.
- Una lámina A3 con un circunflejo de emociones para ayudar a los participantes a escoger las emociones experimentadas

La cabina de la experiencia 2 contenía:

- 16 muestras de las especies posicionadas en un panel rígido e inclinado 20 grados.
- 16 placas numeradas que permitían a los participantes establecer un ranking de preferencias ubicando manualmente las placas junto a cada muestra.
- 16 placas con los nombres comunes de las maderas, que permitían establecer el reconocimiento de cada especie al posicionarlas junto a cada especie.

Resultados.

Los resultados que aquí se presentan podrían ser considerados, en el contexto total del proyecto de investigación realizado, solamente un paso intermedio para obtener los resultados finales, correspondientes a la caracterización experiencial propiamente tal. Si bien esto es cierto, desde un proceso planteado como cercano a la investigación a través del diseño, los protocolos definidos para el desarrollo de las experiencias deben también, ser vistos como resultados de la investigación mientras sean registrados bajo cánones académicos como se ha buscado hacer aquí.

Los protocolos obtenidos se presentan en las tablas 3, 4, y 5, desagregando cada uno en etapa, acciones y materiales requeridos, de tal forma que puedan ser replicados en otros procesos de caracterización de materiales, ya sea madera u otros, y de ser modificados, estos cambios puedan implementarse gradualmente, etapa por etapa, sin alterar las demás. Las etapas se han establecido iguales para las tres experiencias creadas, siendo finalmente cuatro: preparativos de la experiencia, el inicio, el desarrollo y la finalización.

Las acciones describen entonces cronológicamente cada paso necesario para llevar a cabo la experiencia y los materiales, que remiten a elementos de fácil implementación o al equipamiento específico listado previamente.

Junto a los protocolos presentados, se necesita además una preparación rigurosa de cada elemento y experiencia, y la práctica, a través de una etapa de pruebas con personas ajenas a la investigación, para lograr una fluidez y dominio necesarios,

por parte de las personas facilitadoras, para optimizar cada paso. Los protocolos son independientes, pues si bien la experiencia completa fue necesaria en el proyecto realizado, los intereses de cada investigador pueden diferir respecto al objetivo de la caracterización realizada y la búsqueda de datos sobre los diferentes niveles y dimensiones de cada material.

Protocolos de desarrollo de las experiencias.

Tabla 3. .Protocolo de la experiencia 1. Elaboración propia.

Experiencia 1 – Caracterización experiencial

Etapa	Acciones	Materiales
Preparativos de la experiencia	* Disposición de todos los elementos del layout definido (Fig. 2A) * Recepción de participante * Breve reseña de la experiencia * Entrega de instrucciones * Firma de consentimiento informado * Resolución de posibles dudas * Posicionamiento de participante frente a la cabina	* Elementos de la experiencia 1 señalados previamente * Persona facilitadora de la experiencia * Consentimientos informados (físicos, * formato A4, validados por el comité de ética de la facultad) * Silla * Computador con experiencia creada con Imotions Survey (fuera de la cabina, controlado por el facilitador)
Inicio de la experiencia	* Inicio de las pantallas que guían la experiencia * Instrucción de tomar las 3 piezas que corresponden a la primera especie en evaluación * Exploración multisensorial y libre de las piezas (Fig. 2B)	
Desarrollo de la experiencia	* Seguimiento de las instrucciones en pantalla * Respuesta a diferenciales semánticos, escalas, preguntas abiertas y de asociación libre que abarcan los 3 niveles a caracterizar * Nueva exploración multisensorial de la siguiente especie (ciclo de 4 especies en total)	* Lámina A3 con circunflejo de emociones se utilizaba en una de las pantallas de preguntas para identificar con mayor precisión las emociones experimentadas
Finalización de la experiencia	* Confirmación de la finalización * Solicitud de la percepción general de la actividad realizada * Resolución de dudas Invitación a realizar la experiencia nuevamente con otras especies o realizar la experiencia 2, siempre luego de un descanso * Registro de la voluntad de recibir información sobre los resultados del proceso	* Computador para registro de comentarios finales, registro de la participación completa, manifestación de interés por seguir participando y recibir información posterior (registro llevado a cabo de modo online en * Hojas de cálculo de Goog

Discusión

Los protocolos obtenidos han tomado en cuenta para su construcción la mayoría de los estudios citados previamente, que han dado soporte y valor académico a los procesos de decisión presentados en la sección materiales y métodos. Existen, por lo tanto, aspectos comunes con algunos de los estudios. Particularmente el trabajo de Camere y Karana (2018) y Veelaert (2022; 2020) ha servido como referencia para el establecimiento inicial de las directrices experimentales. Pese a ello, desde la teoría a la práctica se han debido implementar una serie de nuevos procedimientos y cambios que permitieran realizar la experiencia de forma exitosa. Es justamente ese trabajo, complejo y que requiere numerosas instancias de pruebas muchas veces tediosas y repetitivas, el que se busca simplificar para próximas investigaciones del área con el registro aquí presentado.

Figura 2. Layout de las Experiencias de caracterización 1 (A y B), 2 (C y D) y 3 (Fotografía inferior)
Elaboración propia

Como se esbozó previamente, existen muy pocos estudios que entreguen detalles del proceso experimental al nivel que se ha procurado hacerlo, dificultando la repetición de los experimentos en condiciones al menos similares a las ya probadas por otros investigadores. La definición del tamaño de los estímulos, sus acabados, los niveles o dimensiones de interés que serán caracterizadas tampoco aparecen como aspectos completamente estandarizados. Estudios que pueden ser considerados piedras angulares del área, específicamente en cuanto a la caracterización de la madera (Broman, 2000; Høibø & Nyrud, 2010) dan poca información sobre cuáles fueron los parámetros considerados. A ello se suman las diferencias culturales y las especies madereras mismas, ya que la mayoría de estos estudios han sido realizados en países nórdicos o Norteamérica, lo que aumenta la cantidad de variables a tener en cuenta y la definición de un diseño experimental efectivo, que permita disminuirlas o controlarlas para centrar los resultados en la caracterización que se busca.

En cuanto a los participantes, en su mayoría los estudios declaran solamente la cantidad de éstos y algunos analizan las diferencias entre la percepción por edad o género (Bumgardner & Bowe, 2002;

Tabla 4.. .Protocolo de la experiencia 2. Elaboración propia.

Experiencia 2 – Ranking y reconocimiento de especies

Etapa	Acciones	Materiales
Preparativos de la experiencia	* Disposición de todos los elementos según el layout definido (Fig. 2C) * Breve reseña de la experiencia * Entrega de instrucciones * Firma de consentimiento informado * Resolución de posibles dudas * Posicionamiento del participante, de pie frente a la cabina cerrada	* Elementos de la experiencia 2 señalados previamente, considerando las muestras tratadas con aceite por cada especie (La posición se modificó cada 30 participantes con el criterio de no agrupar maderas demasiado similares o llamativas) * Consentimientos informados (físicos, formato A4, validados por el comité de ética de la facultad)
Inicio de la experiencia	* Apertura de la cabina * Observación inicial de las muestras	
Desarrollo de la experiencia	* Posicionamiento de los números para definir ranking de preferencia (Fig. 2C) * Posicionamiento de los letreros para conocer el nivel de reconocimiento de cada especie (Fig. 2D)	
Finalización de la experiencia	* Confirmación de la finalización * Solicitud de la percepción general de la actividad realizada * Resolución de dudas * Invitación a realizar la experiencia 1 nuevamente con otras especies, siempre luego de un descanso * Registro de la voluntad de recibir información sobre los resultados del proceso	Computador para el registro online de las preferencias manifestadas por cada participante Cámara para capturar las preferencias en una foto de confirmación

Experiencia 3 - Eyetracking

Etapa	Acciones	Materiales
Preparativos de la experiencia	* Disposición de todos los elementos según el layout definido. (Fig. 2, fotografía inferior) * Breve reseña de la experiencia * Entrega de instrucciones * Firma de consentimiento informado * Resolución de posibles dudas * Posicionamiento de los lentes de eyetracking en el participante * Posicionamiento del participante, de pie frente a la cabina cerrada a distancia exacta predefinida	* Una muestra de cada especie tratada con aceite (La posición se modificó cada 50 participantes con el criterio de no agrupar maderas demasiado similares o llamativas que concentraran la atención visual) * Consentimientos informados (físicos, formato A4, validados por el comité de ética de la facultad) * Lentes de eyetracking modelo Pupil Labs Invisible y dispositivo de control y registro automático de datos de estos (celular con software incluido por el fabricante) * 4 códigos QR targets de 10x10 cm, predefinidos por el fabricante de los lentes, impresos en alto contraste y pegados en una superficie dura de acrílico
Inicio de la experiencia	* Apertura de la cabina * Observación libre de las muestras durante 45 segundos (Fig. 2, fotografía inferior)	
Desarrollo de la experiencia	* Confirmación de la finalización * Resolución de dudas y registro de la voluntad de recibir información sobre los resultados del proceso.	

Mynttinen, 2009). Se ha preferido aquí entregar la mayor cantidad posible de datos respecto a las personas que participaron de la experiencia creada para que próximos estudios puedan tomar en cuenta dicha información, estableciendo adecuados criterios de selección de muestra según la caracterización requerida.

Respecto de los estímulos de carácter virtual, relevantes para otorgar a los participantes de la experiencia una variedad de productos y espacios donde cada tipo de madera es la única variable a considerar, estudios más recientes otorgan mayor cantidad de información (Lipovac & Burnard, 2021; Nakamura et al., 2022), y es posible argumentar que el proceso para obtener cada imagen (tipo de software usado, parámetros de renderizado o iluminación, entre otros) no resulta demasiado relevante para la caracterización en si misma, más allá de la calidad de imagen necesaria en cuanto a realismo, nitidez de la imagen y sobre todo, de la fidelidad de la representación de la madera misma.

Los parámetros entregados a partir de este estudio entonces deben entenderse como guías iniciales para quienes se involucren en el desafío de caracterizar materiales, ya sea madera u otros, pues debe entenderse que las particularidades de cada situación, y como se ha mencionado previamente, el contexto, especialmente el cultural y social, determinará diferencias en cada caso. Aun así, se espera contribuyan significativamente a estandarizar este tipo de procedimientos en aquello que puede ser común, quedando las personas y los materiales mismos como únicas variables relevantes. Esto permitirá también el desarrollo de bases de datos universalmente válidas, al menos parcialmente, que puedan ser consultadas en línea por diseñadores desde cualquier lugar del mundo.

Conclusiones y proyecciones.

La experiencia con los materiales y las cualidades expresivo-sensoriales que se buscó caracterizar en esta investigación son considerados a menudo de carácter puramente subjetivo y no suele haber gran cuidado en sus procesos de definición por parte de la comunidad profesional y también académica del Diseño. Resulta habitual que los diseñadores conceptualicen los significados, emociones e interpretaciones de los materiales que utilizan en sus proyectos bajo sus propios criterios individuales o realizando pequeños sondeos informales entre colegas o personas cercanas.

Al respecto, los participantes de la experiencia, a la vez representantes directos de la comunidad vinculada al Diseño y en particular al material madera, reportaron apreciaciones notoriamente positivas luego de participar de dicha experiencia. La mayoría de los participantes a menudo se declaró sorprendido por la rigurosidad del proceso, su uniformidad cada vez que se realizaba, la diversidad de ámbitos abordados y los métodos utilizados que integraban lo tradicional con nuevas tecnologías de forma armónica y fácilmente entendible.

Es importante destacar que al realizar estos procedimientos debe abandonarse cualquier prejuicio o estereotipo respecto a la comprensión que las personas pueden llegar a tener de los aspectos en evaluación, pero al mismo tiempo, debe simplificarse la experiencia para que sea fluida y rápida de realizar. El diseño de esta experiencia, estructurada y clara en su planteamiento, así como su difusión en la comunidad profesional y académica, busca también contribuir a la adopción de estas experiencias para la caracterización de materiales como un recurso más habitual para la disciplina del Diseño, tendiente a su incorporación a los planes de estudio de los programas de pregrado del área, algo hoy apenas incipiente (Papile et al., 2022; Pedgley et al., 2016; Zhou, 2021). La formación de profesionales del diseño que tengan una mayor conciencia de la relevancia de estos ámbitos parece necesaria en un contexto donde nuevos materiales, artificiales y naturales, aparecen cada día en el mercado y se vuelven opciones para el diseño y desarrollo de nuevos productos, y donde al mismo tiempo tecnologías como la inteligencia artificial podrían reemplazar en gran medida a los expertos en materiales que solamente consideren sus aspectos técnicos (Maqsood et al., 2024).

Conectado a lo anterior, parece posible, a la luz de la experiencia creada y los resultados obtenidos, establecer criterios que tiendan a una estandarización y unificación de estas

experiencias en un nivel más global. Ello, aunque no está exento de complejidades muy relevantes, como las diferencias culturales o la necesidad de contar con un mínimo de recursos tecnológicos para optimizar y uniformar algunos aspectos de la experiencia, resulta necesario para entregar a los profesionales del Diseño bases de datos más universales, tales como aquellas que agrupan las características físico-mecánicas o técnicas de diferentes materiales. En el caso de bases de datos de cualidades expresivas y sensoriales debieran, además, incorporar aspectos como la colaboración, asociatividad o el acceso abierto entre académicos, profesionales e instituciones, que permita su mejora continua y un proceso orgánico de crecimiento. En esa línea cabe señalar que la experiencia definida ya ha sido utilizada exitosamente, con mínimas modificaciones, para la caracterización experiencial de materiales artificiales y naturales, distintos a la madera, en otros países de Latinoamérica. Si bien probó ser adecuada en dicha instancia, un área importante, aún poco explorada y por desarrollar en futuras investigaciones se relaciona con la definición y la presentación estandarizada de los resultados obtenidos luego de la realización de la experiencia misma.

Finalmente, y desde la perspectiva de la investigación y el nuevo conocimiento surgido desde la disciplina resulta destacable la puesta en valor de los procesos proyectuales y empíricos que siempre han caracterizado la profesión y que, en su transición hacia una disciplina académica, no sería deseable perder. Como señala Findeli et al. (2008) en la investigación a través del diseño se produce una comunión entre teoría y práctica que ayuda a construir una auténtica teoría del diseño capaz de adoptar una postura epistemológica consecuente con aquello que es distintivo del Diseño: el proyecto. Este conocimiento tácito que surge del hacer no es registrado habitualmente por los medios convencionales de la academia y por ende no es fácilmente reconocido como valioso por la misma. Por ello, y en la búsqueda de un cambio de paradigma en este aspecto, el presente artículo busca dejar registro del proceso realizado para llegar a definir un procedimiento, convirtiéndolo así, se espera, en conocimiento útil a los diseñadores, al mismo nivel de relevancia que pueden tener los resultados finales surgidos de la aplicación del procedimiento mismo y que pueden ser revisados en la web del proyecto.

Fuente de financiación
ANID, FONDECYT Iniciación, folio 11190132. Este artículo surge a partir del trabajo llevado a cabo en el proyecto FONDECYT de iniciación 2019, N°11190132, el que fue financiado por la Agencia Nacional de Investigación (ANID) del Ministerio de Ciencia, Tecnología, Conocimiento e Innovación del gobierno de Chile y su programa FONDECYT.

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ISSN 2386-5414
e-ISSN: 2340-8391

Research Article | Artículo de investigación

From theory to practice. A protocol for the experiential characterization of the expressive-sensory qualities of (native) woods (from Chile) | De la teoría a la práctica. Un protocolo para la caracterización experiencial de las cualidades expresivo-sensoriales de las maderas nativas de Chile

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Received: June 5, 2024 | Accepted: June 26, 2024 | Published: June 29, 2024
DOI. 10.24310/p56-idj1202420095

Abstract

This paper presents the initial theoretical definition and subsequent implementation of an experimental protocol applied in a study conducted in Chile between 2019 and 2022. The study aimed to characterize the expressive-sensory qualities of 15 native wood species. This type of characterization, which complements the definitions of technical properties (such as hardness or strength), is significant for the Design discipline. Providing professionals with information on the perceptions, emotions and meanings that people attribute to materials, known as "materials experience".

Through literature review, expert consultation and a selection of methods previously used in this field, a characterization experience was developed by more than 200 participants, including students and professionals in the fields of design, architecture, decoration and craftsmanship. These participants, from a stratified sample proportional to the population by region of Chile, interacted multimodally with physical samples of wood to report their perceptions through a survey. In addition, biometric data were captured on their facial expressions and gaze position.

The results allowed the elaboration of comparative graphs showing the qualities of each species, which are freely accessible.

The article addresses the concept of experiential characterization of materials, focusing on wood and details the definition and implementation of the experience, documenting the process over the results, as valuable knowledge for researchers and design professionals.

Keywords: Wood, Industrial Design, materials experience, Design and emotions, Chile, Design research

Introduction

Characterizing “the other” aspects of the materials.

In the discipline of Product Design, where the material selection process is a relevant issue in each of the projects carried out, sensory, semantic or affective aspects are usually a priority. This is because the future users of a product will evaluate it not only for its ability to perform a specific function, but also for its appearance, comfort and socio-cultural meanings, among others. The latter aspects are usually the most relevant to generate deeper relationships between people and products (Camplone, 2024; Haug, 2019).

Along these lines, Ashby & Johnson (2014) state that the proper selection of materials based on technical criteria such as strength or hardness, or the performance of the basic function of a product are important, but ultimately the industrial design and the definition of its aesthetic qualities will determine, to a greater extent, people’s preference for one product or another. Consistently, several authors (Camplone, 2024; Karana et al., 2009; Rognoli & Ayala Garcia, 2018; Zuo et al., 2016) have documented the relationship between sensory aspects and the creation of meanings in products and also more directly, between materials and emotions (Bertheaux et al., 2023; Crippa et al., 2012; Rognoli & Levi, 2004).

Characterization of wood.

In the case of wood, in its role as an important material for the design of products and living spaces, this is no different. For example, research has been conducted on the characteristics and properties of this material and of different species, which documents, from the perspective of biophilia, the beneficial effects for humans that occur with its use in interiors, or even with simple visual contact with wood (Ikei et al., 2017; Lipovac & Burnard, 2021; Nakamura et al., 2019; Nyrud & Bringslimark, 2010).

In addition, a positive attitude towards wood has been corroborated by a large majority of people, beyond their culture, consistently associating it with descriptors such as warm, comfortable, relaxing or natural (Browning et al., 2022; Rice et al., 2006). Studies addressing the characterization of non-technical aspects in this material have been conducted for quite some time (Blomgren, 1965; Broman, 2000a, 2001; Ratnasingam et al., 2007) and continue to be conducted today (Burnard & Kutnar, 2020; Lipovac et al., 2022; Wan et al., 2021).

Creating an experience for the characterization of Chilean native woods.

Through the definition and assessment of the expressive-sensory qualities (Rognoli & Ayala García, 2018) of 15 of the most used and commercially available Chilean native woods (plus Radiata Pine which was added as a foreign control species as it is the most used and known wood in Chile), and the identification of the perceptions that these provoke in people, the research in which this article is framed had the main objective of contributing to the optimization of the selection process of materials for Design, with the incorporation of the expressive and sensory qualities to the information available to Designers.

In order to achieve the above, it was necessary to build a “characterization experience” applicable to different people and types of wood. For this purpose, a protocol of actions and tasks that people had to perform, for example, exploring samples of materials, documenting their sensations, emotions, etc., was established based on a review of the associated literature and existing methods.

This protocol had to be implemented in practice. A process that was not free of difficulties and that determined modifications with respect to the initial plan. It is therefore considered of great importance for the dissemination of the knowledge acquired in this development, which could be useful to researchers and design professionals who wish to characterize other wood species, or other

materials, to document the process of defining this characterization experience.

For the above, this article introduces the reader to the concept of experiential characterization of materials and its current state of the art, specifically in relation to wood.

Subsequently, it describes in detail the process of defining the experience carried out and its different stages and dimensions. This experience was carried out with more than 200 people and its results, available to the public at www.maderanativachile.cl, will be presented to the academic community in future works. This section defines the arguments used to define each of the parameters of this experience. Finally, a discussion and general conclusions are presented.

The experience created is thus considered one of the first results of the research process. This approach, related to the concept of Research through Design (Redström, 2020; Stappers & Giaccardi, 2018) has relevance for Design and the discipline's own research, by placing value not only on the results of research, but also treating as results of academic interest these "intermediate products" implemented to reach them. These are often of great methodological richness, born from practice, and valuable in themselves, even more so for a discipline that is still defining its own ways of researching and creating new knowledge.

Theoretical framework

Experiential characterization of materials.

It is possible to find references since the 40's of the last century regarding experiential characterization studies, mainly sensory or organoleptic analysis in the food industry (Heymann, 2019). However, the emergence of such studies in the field of Design (and materials) is more current and still somewhat scarce. In a recent review, Veelaert (2022) documents only 50 articles published between 2000 and 2019 that addressed this topic from the area of Design.

These various concepts and levels of materials interpretation have been referred to in different ways, and by different authors, while they have been gaining interest from the Design academic community (Jacob-Dazarola et al., 2019).

A more transversally accepted standard in this respect has been established from the core concept materials experience (Karana et al., 2014; Karana & Hekkert, 2008). This also considers a specific method and tools for the experiential characterization of materials (Camere & Karana, 2018), where people directly experience interaction with samples of the material under evaluation. They subsequently report their perceptions and interpretations to the researchers.

Giaccardi & Karana (2015) define four experiential levels in which materials can be characterized:

The performative level refers to those actions that the material "invites to perform", such as squeezing it, scratching it, hitting it, according to its nature and appearance. The sensory level deals with those aspects subordinated to the valuation made through the senses. The interpretative level corresponds to the meanings given to the materials, usually mediated by the culture and context of the users, while the affective level refers to the emotions and affections that people experience. These four levels interact and influence each other, so it is not possible to isolate them completely in the usual interaction between people and materials.

The experiential characterization of wood.

Considering these four levels, wood is a material that differs from metals or polymers. Each species is different, and each piece of wood, even from the same tree, is also different from another. Their grain, ring spacing, colors, grain, texture, weight, sound, aroma, create infinite possibilities of variation, which we perceive

through the senses, and tell us the story of the tree they were once part of (Fujisaki et al., 2015).

People recognize in wood a sustainable, natural and close material, which does not require complex industrial processes to reach the final consumer. Even when it is processed or painted, its natural imprint persists to remind us that it was once alive.

According to Browning, Ryan & DeMarco (2022) and in partial coincidence with the four levels of experiential characterization defined by Camere & Karana, (2018), the natural biophilic preference registered for wood comes from a haptic, olfactory and visual experience (which would make up the sensory level) and from an associative (semantic) and interpretive processing (level of the same name). According to the authors, this approach to the material would provoke the positive emotions that relate to the material (in association with the affective level).

Assessment of sensory attributes and expressive qualities.

Studies that address the characterization of the expressive-sensory qualities of wood generally consider a small number of species. Among those consulted for this research process, between three to six species were analyzed, the most numerous reviewed being that of Fujisaki et al. (2015) with 14 species.

In addition, the findings are dependent, to a certain extent, on the context, i.e. the culture of the place where they were made. For example, the knottiness of wood is valued in very different ways depending on the culture in which the studies are conducted. Høibø & Nyrud (2010) mention a universal preference for a certain homogeneity in wood surfaces. Broman (2000) says that surfaces without knots are defined as more harmonious relative to those that are more irregular.

Masuda (1992) had previously stated that while in Japan knots are interpreted as defects, associating them with low quality wood, in Europe, the United States and Canada they are associated with descriptors such as natural or rustic, interpreting them positively.

According to Wan et al. (2021) the visual perception of a wood surface is mainly defined by three factors: color, grain and gloss. These authors state that, in general, dark wood (dark brown, dark reddish) is preferred to lighter (yellowish) or medium color (light brown, light red), and matte or definitely glossy wood is preferred to semi-glossy wood.

Previous studies have obtained equivalent results and suggested that there is a tendency to value woods similarly according to the predominant color. Bumgardner & Bowe (2002) in agreement with Wan et al. (2021) noted that darker woods have been described as expensive, formal, old and stately, while lighter woods have been described as cheap, informal, modern and modest.

Characterizing for Design.

Karana (2010) states that the conceptions people have about materials, where they usually consider wood as cozy, metals as cold and plastics as polluting or of low quality, are not really useful for the discipline of Product Design given their excessive generality.

Similarly, due to the enormous variability that exists among the different wood species and, especially, the role that context and culture play in the evaluation of their qualities, it seems possible to argue that, in order to contribute objectively to the material selection process in the design framework, the experiential characterization of wood must be much more specific. When designers select materials, it is not enough to know that people prefer dark woods or surfaces with few knots. It is necessary to know the species that could be useful in order to, for example, evoke a defined emotion, be associated with certain concepts, or provoke a certain perception in the users of a product or the inhabitants of a space (Jacob-Dazarola et al., 2019).

Another aspect to keep in mind, with respect to existing studies, is that the research processes used, as well as the methods and tools, differ significantly. For example, the descriptors used to evaluate the interpretative or sensory levels vary from one study to another. This makes it difficult to associate the results to build a common database that brings together different species, even from different geographical areas, and allows designers to select woods with a broader and more informed perspective.

Characterization of wood in Chile.

Regarding studies carried out on Chilean timber species, the situation is similar to that described above for materials in general.

In repositories and digital libraries open to the public, owned by entities dedicated to the field of wood, such as CORMA or INFOR it is possible to find, with ease, numerous physico-mechanical characterization studies of practically all native species relevant to the wood industry (Baradit et al., 2013; Karsulovic C. et al., 2000).

However, when it comes to the characterization of sensory, semantic or affective aspects, few publications were found (Alarcón Castro et al., 2019; Alarcón Castro & Di Bartolo, 2013; Brañes Alarcón et al., 2023; Briede W. & Alarcón Castro, 2012), only available in academic repositories and, together, considering five native species.

Materials and methods.

To establish a characterization experience applicable to 15 Chilean native woods, whose results would be really useful to designers in their material selection processes, it had to be consistent and repeatable at different times and in different scenarios and incorporate the most relevant aspects in terms of the levels and dimensions defined in this type of characterization.

The definition of this experience involved an extensive process that took place between 2017 and 2022 in two consecutive research projects.

To this end, a linear process was followed in the initial stages, which subsequently became iterative. It began with a comprehensive literature review, reflected in a previously published article (Jacob-Dazarola et al., 2019) and the current theoretical framework presented here. Subsequently, a consultation with experts from the world of Design, wood and materials, was carried out and a first version of the experience was elaborated, which was applied in the framework of the first project.

As a result of the knowledge acquired, and within the framework of a new research project, a new, more extensive and complex experience was proposed. This new experience included aspects that had been previously relevant or inadequately resolved: lighting uniformity, interaction with the stimuli, their format, etc.

This second experience was tested by the project executors themselves, modified again in several aspects, and implemented in a white march stage with 18 volunteers, where the last aspects in conflict were corrected.

Subsequently, it was implemented, first under controlled conditions at the Faculty of Architecture and Urban Planning of the Universidad de Chile and later in various places in the country, with the total participation of 311 people.

A relevant methodological reference used as a starting point was the Ma2E4 Toolkit (Camere & Karana, 2018) because, beyond its solid theoretical foundations, it presents concrete instruments that allow obtaining information from people as they interact with various materials, evaluating them at the four levels already mentioned.

Complementarily, the work of Chen et al. (2009), Veelaert et al. (2020) and Veelaert (2022) allowed access to previous systematizations of the different experimental parameters involved in the materials characterization processes. To

these, some aspects that were considered relevant given the previous experience were incorporated.

Following the sections proposed by these authors (tables 1 and 2), the definition process for each parameter of the experience created is detailed below.

Table 1. Experimental parameters of experiential characterization of materials. Developed by the author based on Veelaert et al. (2020).

STIMULI		EXPERIMENTAL VARIABLES		MODE OF INTERACTION	PARTICIPANTS
Tangibles	Intangibles	Dependents	Independent	Unimodal guided	Quality
Materials	Renders	Sensory	Techniques	Multimodal guided	Demographics
Textures	Photographs	Interpretive	Of the product	Free muiltimodao	Training
Products	Images	Affective	Of the user		Experience
METHODS					
Scales		Discrimination		Free association	
Semantic differential		Sorted napping		Associated words	
Unipolar		Paired comparative analysis		Emotions evoked	
Binary		Hierarchical grouping		Suggested uses	
Ranking					

Stimuli. Type, size, shape, finish.

An valuable aspect in the experiential characterization of materials refers to the stimuli used, i.e. the samples that will allow people to interact with the material through one (unimodal) or more of their senses (multimodal). These stimuli can be tangible (real, flat or volumetric samples) or intangible (photographs, representations, images on a screen, virtual reality) (Bertheaux et al., 2023; Veelaert et al., 2019a, 2020a).

To start defining this aspect, a new, more specific literature review was carried out, which considered ten articles published between 2001 and 2019 on wood characterization. This review showed that, with respect to the stimuli, there are only two common aspects among the characterization experiments carried out: the use of physical samples of the woods under study defined by three fundamental aspects: dimensions, shape and surface finish, and the use of photographs of products, or computer representations of the different wood species, as a complement.

Nordvik & Broman (2009) point out that despite the implicit complexity of representing wood, since it implies the loss of many important and subtle attributes such as aroma or texture, differences in sound or temperature to the touch, the use of these resources allows to expand the scope of the stimuli. It is possible to illustrate various products made of different types of wood, large objects, interiors or exteriors of houses or buildings without added cost. In recent studies, virtual reality has been shown to be effective as a resource for unimodal sensory evaluation of some aspects of materials such as gloss or perceived softness (Bertheaux et al., 2023).

To define the dimensions, and in the absence of a clear agreement from experts or existing literature, three size alternatives were tested between the project team and ten students from the Design program at the Universidad de Chile, through a free and multimodal interaction. Actions such as lifting the piece of wood from a flat surface, extracting it from a compartment and manipulating it easily were key to finally define a size of 200x120mm. The thickness,

20mm, was defined considering the same aspects and the relationship between the thickness of the wood pieces and the perception of their quality (Pérez Mejía, 2010).

Regarding the shape of the samples, the experts consulted suggested irregular, circular or volumetric alternatives; however, the most frequently mentioned shape was rectangular. On the other hand, the studies consulted used only rectangular or square shapes. Complementarily, Veelaert et al. (2019) point out the importance of neutral stimuli, devoid of semantic value, to be able to perform a truly objective characterization. They also point out the possibility of reaching this neutrality through two strategies: simplicity or complexity. They argue that the latter increases the possibilities of exploration in the interaction with the materials.

Considering the above, a rectangular piece was defined as a base, which was modified by applying processes commonly used in the manufacture of wood products, such as sawing and milling, as shown in Figure 1. This generated a sample, still recognizable as rectangular, but capable of referring to several of the most common geometries of wood products, such as 90° and 45° angles, rounded and sharp corners and edges, or continuous perpendicular faces.

Bhatta et al. (2017) posit that natural, smooth wood surfaces are perceived more positively than surfaces with a finish or coating. They further suggest the importance of preserving the naturalness of the texture. However, in people's everyday relationship with wood products, these usually already have coatings or surface treatments such as lacquers, varnishes or oils. The occasions when people interact with bare wood are in practice rare, especially in the case of interior products (Scrinzi et al., 2011).

With this in mind, and to allow an assessment of the most common finishing options, each wood species was represented by three pieces of equal shape and size, one without any coating, the second with a satin finish given by an oil treatment, and the third coated with gloss varnish. The underside was left uncoated on all pieces so that people could perceive the sensory differences between the bare wood and the different coatings applied (Figure 1, images above).

For the complementary images, photorealistic rendering images were created using 3D Max software and the VRay rendering engine. Two image sheets were made for each of the 15 species, applying digital textures based on the Advanced Wood material to scenes with identical 3D models and lighting parameters. In this way, the only variable was the wood represented. For both products and spaces, we sought to offer alternatives that would allow us to broaden our view of the material's application possibilities (Figure 1, images below).

Experiential variables and methods.

Although the objective of this study was to obtain as complete a characterization as possible, comparing the woods at different levels and through all the senses, once the stimuli were defined, it was decided to discard the evaluation of the performative level. This was because, as the samples were the same in finish, size and shape, people tended to interact with them in virtually identical ways. However, some small differences were observed in species with very distinctive characteristics in terms of weight, surface porosity and aroma, which could be studied in future research.

With respect to the other levels, each one was associated with specific methods and techniques that were established in the initial design stage of the experience, which, based on the literature review and experience acquired in the previous project, were determined to be the most suitable in each case.

The sensory level was assessed using a tool commonly used in the experiential characterization of materials, the semantic differential scale, which presents different pairs of words with opposite meanings so

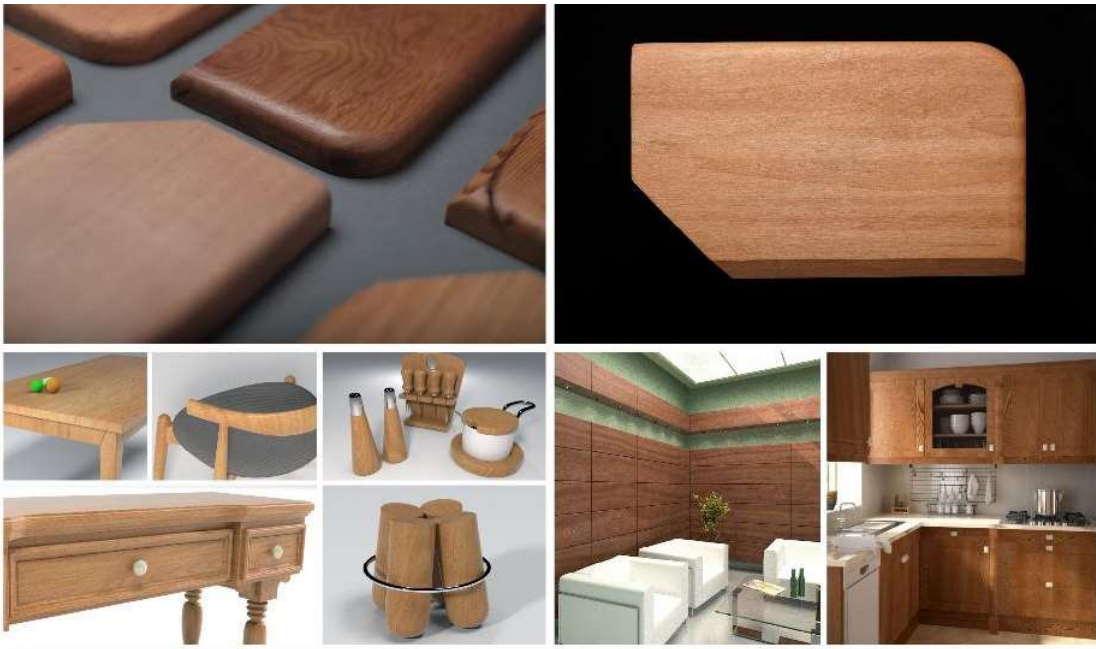

Figure 1. Physical and computer stimuli presented to participants. Photographs and images prepared by the authors.

that people can define their perception (Choi, 2016; Kelly & Stephenson, 1967; Osgood et al., 1957). This is similar to what was put forward in the toolkit proposed by Camere & Karana (2017) but the original word pairs were modified due to the specificity of the material. In all cases in which the semantic terms were modified, the dimensions associated with them were maintained so as not to vary the statistical significance of the tool and its internal consistency (Aros Beltrán et al., 2009; Osgood & Suci, 1969), which had already been evaluated during its development.

The affective level was evaluated by means of semantic differential scales and free word association. This word association sought to get people to mention the emotions evoked by each wood. For this purpose, they were presented with a poster with various emotions, based on Scherer's theory (2000), serving as a starting point for the participants to choose some of them, but they could also mention emotions that did not appear on the poster.

The adjective pairs of the semantic differential were also based on those proposed in the same toolkit but were significantly modified following the criteria expressed by the experts and the literature review conducted specifically on wood characterization.

One of the secondary objectives of the research was to compare, validate and/or discard methods commonly used for the experiential characterization of materials in a local context. Therefore, the affective level was additionally evaluated by means of biometry (measurement of physiological parameters of the human body) using the Facereading module of the Imotions software, capable of measuring, from the analysis of facial expressions, the intensity of seven basic emotions (joy, disgust, sadness, anger, surprise, fear and contempt). This was done by means of a camera that captured the participants' faces during the first interaction with the physical wooden samples.

The interpretative level was also assessed by semantic differential and free association. The adjectives of the semantic differential, as in the affective level, were based on the toolkit, but were modified based on the same criteria.

All semantic scales and free word associations were presented to participants on a 30-inch screen (and their responses automatically collected) with an interactive questionnaire created through the Survey module of the Imotions software.

To the evaluation of the three levels mentioned above, free association questions were added related to the

possible uses and applications for each species and others focused on the processes and finishes associated with each of them, always from an expressive, sensory and perceptual point of view rather than a technical one.

In addition, two aspects were incorporated that contribute to the knowledge required by designers when selecting specific species for their projects: a general preference ranking of species and an assessment of the recognition of each species, i.e., whether people were able to associate its common name with the physical sample.

Complementarily, this potential preference for some species was evaluated using eyetracking technology to establish the position and permanence of people's gaze when observing all species at the same time. For the implementation of the eyetracking technology, we initially tried to use Pupil Labs Core model lenses and the native software provided by the manufacturer; however, the complex calibration process required for each participant made its massive use in the field unfeasible. They were then replaced by the Invisible model from the same manufacturer, which does not require prior calibration, thus allowing the procedure to be performed expeditiously and eliminating the "laboratory" experience.

Sense modality, stages and times of interaction.

Time is a key factor in this type of experiments as it is directly related to the attention span of the participants. Veelaert et al.(2020) define an average of 37 minutes based on their literature review. They conclude that experiential characterization experiments have a concentration limit of 40 minutes.

The authors point out strategies used to optimize the time and participation of individuals. For example, separating individuals by modality (visual, tactile or mixed) or dividing samples into groups of respondents with similar profiles. These groups evaluate different materials, but the characterizations are comparable.

In this case, the experience contemplated an initial multimodal and free interaction with the material, but restricted to a time of 30 seconds, and with the possibility of continuing the interaction freely throughout the experience.

A fundamental measure to safeguard the adequate duration of the procedure was to avoid each participant being obliged to characterize the 16 woods under study. For this purpose, the species were divided into four groups, considering the predominant color as an attribute to divide them (each group was formed by a species of dark reddish, light reddish, yellowish and grayish-greenish tones).

Thus, each participant had to evaluate only four species. As the time spent by people evaluating the first species presented to them was much longer than the second and this time was shorter than the third and fourth species, the order in which they were evaluated was randomized and the four groups of species were rotated every ten participants.

This meant that, in practice, there were four different experiences possible. Since many of the participants expressed their interest in evaluating more than one group of woods, it was decided that the same individual could participate up to four times if he/she wished, leaving an interval of one hour between each experience. This break allowed him/her to resume attention levels. The execution time of the experience performed for the second or third time was notoriously shorter than the first time.

After testing with the project team and during the white march, it was decided to separate the stage corresponding to the ranking of preferences and recognition of species, this stage being called experience 2. The characterization experience guided by the interactive questionnaire was then called experience 1. Each person was initially asked if he/she wanted to do one or both experiences, if he/she opted for both,

at the end of the first one, he/she was asked again if he/she wanted to continue with the second one after a 15-minute break.

Priority was always given to experience 1, which was more extensive, provided more information and was more complex. In addition, this experience considered only four species per execution, while experience 2 was carried out with all the woods at the same time, requiring fewer participants to achieve the same number of responses per species. Experience 1 had an average duration of 33 minutes and experience 2 only 12 minutes.

A third part of the experience was constituted using the eyetracking equipment, which was performed in a separate process, where in only three minutes each, participants recorded their gaze position using the same layout as in experience 2.

Participants.

To define the sample of participants, we used the parameters proposed by Veelaert et al. (2020) regarding quantity, activity or profession, demographics and experience with the materials. Another important criterion was that the participants corresponded to people linked to working with wood, such as advanced students and professionals in the areas of Design and Architecture, decorators, craftsmen, carpenters. In this way, they had some familiarity with the material, which significantly facilitated the understanding of the proposed experience.

A stratified sample was established, proportional to the inhabitants of the different regions of Chile, selecting inhabitants from the Metropolitan region, due to its volume of inhabitants and movement in the timber market, as well as the regions of Biobío (Concepción), Los Ríos (Valdivia) and Los Lagos (Chiloé) due to their timber tradition, widely known in the country.

Among the criteria originally defined for the sample was also an age at which people were actively participating in work activities. Therefore, an attempt was made to maintain an average age greater than 30 years, but given the high number of students who participated, this could not be achieved. Priority was given to the number of participants, finally obtaining an average of 26 years of age. The details of the sample are shown in Table 2.

Experience 1 was finally carried out by 211 people who provided 52 responses for each species. Experience 2 was carried out by 211 people with an equal number of responses per species, both experiences were carried out over a period of seven months. The eyetracking experiment was carried out by 100 people in only two days.

Configuration. Instruments, environment and equipment.

An aspect that is also not clearly defined in the studies reviewed is everything related to the equipment, tools and instruments used in the characterization experiments carried out. Although photographs of the stimuli are common, few studies present any detail regarding the experimental layout, such as that of Veelaert et al. (2020).

For the realization of this experience, the use of two detachable photographic booths of 800x800x800 mm of textile material and aluminum skeleton, Led studio type CAIM model 201803, was defined.

Table 2. Sample segmentation according to gender, region, age range and activity.

GENRE		REGION		AGE RANGE		ACTIVITY	
M	95	Metropolitan	157	20-25	131	student/professional design	139
M	95	Metropolitar	157	20-25	13	student/professional design	139
F	115	Biobic	32	25-30	48	architecture student/professional	30
O	0	Los Ríos	12	30-35	6	engineering student/professional	10

The cabins were equipped with two white LED luminaires (T°4000-4500K) with a color rendering index of 92 and a capacity of 12,000 lumens. These luminaires allowed a uniform illumination, independent of the surrounding light conditions, and a natural visualization of the color of the woods. The timbers were illuminated with 1575 lux measured at the center point of the booth.

The cabin of experience 1 contained the following elements:

- 1 Xiaomi 24" monitor where the various instructions and questions of the experience were displayed. The Imotions software (Survey module) allowed this to be set up according to specific times or interactive on-screen instructions as required.
- 1 Logitech C922 Pro webcam, Full HD, which recorded facial expressions for 30 seconds during the first contact with the woods.
- A wireless keyboard and mouse allowed participants to respond to on-screen prompts and advance through the experience.
- A specially constructed semi-rigid support box concealed 12 pieces of wood, 3 of each of the four species under characterization (matte without any treatment, semi-gloss treated with oil and glossy coated with varnish). Each species was identified by a number on them.
- An A3 sheet with a circumflex of emotions to help participants choose the emotions experienced.

The cabin of experience 2 contained:

- 16 samples of the species positioned on a rigid panel and inclined 20 degrees.
- 16 numbered plates that allowed participants to establish a preference ranking by manually placing the plates next to each sample.
- 16 plaques with the common names of the woods, which made it possible to establish the recognition of each species by positioning them next to each species.

Results.

The results presented here could be considered, in the total context of the research project carried out, only an intermediate step to obtain the outcomes, corresponding to the experiential characterization itself. Although this is true, from a process proposed as close to research through design, the protocols defined for the development of the experiences should also be seen as research results if they are registered under academic canons as we have tried to do here.

The protocols obtained are presented in tables 3, 4, and 5, disaggregating each one in stage, events and materials required, so that they can be replicated in other material characterization processes, whether wood or others, and if modified, these changes can be implemented gradually, stage by stage, without altering the others. The stages have been established the same for the three experiences created, being finally four: preparations for the experience, the beginning, the development and the end.

The events then describe chronologically each step necessary to carry out the experience and the materials, which refer to elements of easy implementation or to the specific equipment previously listed.

Along with the protocols presented, a rigorous preparation of each element and experience is also needed, as well as practice, through a stage of testing with people outside the research, to achieve the necessary fluency and mastery by the facilitators to optimize each step. The protocols are independent, because although the complete experience was necessary in the project carried out, the interests of each researcher may differ with respect to the objective of the characterization carried out and the search for data on the different levels and dimensions of each material.

Experience development

Table 3. Protocol of the experience 1.

Experience 1 - Experiential characterization

Stage	Events	Materials
Preparations for the experience	* Layout of all the elements of the defined layout (Fig. 2A) * Participant reception * Brief review of the experience * Delivery of instructions * Signature of informed consent * Resolution of possible doubts * Positioning of the participant in front of the booth	* Elements of experience 1 previously mentioned * Person facilitating the experience * Informed consents (physical, A4 format, validated by the ethics committee of the faculty) * Chair * Computer with experience created with Imotions Survey (outside the booth, controlled by the facilitator). This experience can be created with any questionnaire creation software.
Beginning of the experience	* Home of the screens that guide the experience * Instruction to take the 3 pieces corresponding to the first species to be evaluated * Multisensory and free exploration of the parts (Fig. 2B).	
Development of the experience	* Follow the instructions on the screen * Response to semantic differentials, scales, open-ended and free-association questions covering the 3 levels to be characterized * New multisensory exploration of the following species (cycle of 4 species in total)	* A3 sheet with emotion circumflex was used in one of the question screens to more accurately identify the emotions experienced.
Completion of the experience	* Confirmation of completion * Request for the general perception of the activity performed * Resolution of doubts * Invitation to perform the experience again with other species or to perform experience 2, always after a break. * Record of the willingness to receive information on the results of the process)	* Computer for registration of final comments, registration of full participation, expression of interest in further participation and receiving further information (registration carried out online in Google Spreadsheets)

Figure 2. Layout of Characterization Experiences 1 (A and B), 2 (C and D) and 3 (Bottom picture). Own elaboration.

Table 4. Protocol of experience 2.

Experience 2 - Ranking and recognition of species		
Stage	**Events**	**Materials**
Preparations for the experience	* Arrangement of all the elements according to the defined layout (Fig. 2C) * Brief review of the experience * Delivery of instructions * Signature of informed consent * Resolution of possible doubts * Positioning of the participant, standing in front of the closed booth	* Elements of experience 2 previously indicated, considering the samples treated with oil for each species (The position was modified every 30 participants with the criterion of not grouping woods that were too similar or too striking). * Informed consents (physical, A4 format, validated by the ethics committee of the faculty)
Beginning of the experience	* Cabin opening * Initial observation of samples	
Development of the experience	* Positioning of the numbers to define the preference ranking (Fig. 2C) * Positioning of signs to determine the level of recognition of each species (Fig. 2D).	
Completion of the experience	* Confirmation of completion * Request for the general perception of the activity performed * Resolution of doubts * Invitation to perform experience 1 again with other species, always after a break * Record of the willingness to receive information on the results of the process	Computer for online registration of preferences expressed by each participant Camera to capture preferences in a confirmation photo

Table 5. Protocol of experience 3. Own elaboration

Experiencia 3 - Eyetracking		
Stage	**Events**	**Materials**
Preparations for the experience	* Arrangement of all elements according to the defined layout (Fig. 2, photo below). * Brief review of the experience * Delivery of instructions * Signature of informed consent * Resolution of possible doubts * Positioning of the eyetracking lenses on the participant * Positioning of the participant, standing in front of the closed booth at the exact predefined distance	* One sample of each species treated with matte finish oil (The position was modified every 50 participants with the criterion of not grouping woods that were too similar or too conspicuous to focus visual attention). * Informed consents (physical, A4 format, validated by the ethics committee of the faculty) * Pupil Labs Invisible eyetracking lenses and a device to control and automatically record data (cell phone with software included by the manufacturer). * 4 QR codes 10x10 cm targets, predefined by the lens manufacturer, printed in high contrast and glued on a hard acrylic surface
Beginning of the experience	* Cabin opening	
Development of the experience	* Free observation of the samples for 45 seconds (Fig. 2, lower photograph). * Confirmation of completion * Resolution of doubts and registration of the willingness to receive information on the results of the process	

Discussion

The protocols obtained have considered for their construction most of the previously cited studies, which have given support and academic value to the decision processes presented in the materials and methods section. There are, therefore, common aspects with some of the studies. Particularly the work of Camere and Karana (2018) and Veelaert (2022; 2020) has served as a reference for the initial establishment of experimental guidelines. Despite this, a series of new procedures and changes had to be implemented from theory to practice to complete the experiment successfully. It is precisely this complex work, which requires numerous instances of often tedious and repetitive tests, that we seek to simplify for future research in the area with the registry presented here.

As previously outlined, there are very few studies that provide details of the experimental process at the level that has been attempted, making it difficult to repeat the experiments in conditions at least similar to those already tested by other researchers. The definition of the size of the stimuli, their finishes, the levels or dimensions of interest to be characterized also do not appear as completely standardized aspects. Studies that can be considered cornerstones of the area, specifically regarding wood characterization (Broman, 2000; Høibø & Nyrud, 2010) give little information on which parameters were considered. Added to this are the cultural differences and the timber species themselves, since most of these studies have been carried out in Nordic countries or North America, which increases the number of variables to be considered and the definition of an effective experimental design, which allows to reduce or control them to focus the results on the characterization sought.

As for the participants, most studies report only the number of participants and some analyze the differences in perception by age or gender (Bumgardner & Bowe, 2002; Mynttinen, 2009). It has been preferred here to provide as much data as possible regarding the people who participated in the experience created so that future studies can take this information into account, establishing adequate sample selection criteria according to the required characterization.

Regarding the virtual stimuli, relevant to provide the participants of the experience with a variety of products and spaces where each type of wood is the only variable to consider, more recent studies provide more information (Lipovac & Burnard, 2021; Nakamura et al., 2022), and it is possible to argue that the process to obtain each image (type of software used, rendering or lighting parameters, among others) is not too relevant for the characterization itself, beyond the necessary image quality in terms of realism, image sharpness and above all, the fidelity of the representation of the wood itself.

The parameters provided from this study should therefore be understood as initial guidelines for those involved in the challenge of characterizing materials, whether wood or others, since the particularities of each situation, and as previously mentioned, the context, especially the cultural and social context, will determine differences in each case. Even so, it is expected that they will contribute significantly to standardize this type of procedures in what can be common, leaving the people and the materials themselves as the only relevant variables. This will also allow the development of universally valid databases, at least partially, that can be consulted online by designers from anywhere in the world.

Conclusions and projections.

The experience with materials and the expressive-sensory qualities that we sought to characterize in this research are often considered purely subjective in nature and there is not usually great care in their definition processes by the professional and academic design community. It is common for designers to conceptualize the meanings, emotions and interpretations of the materials they use in their projects according to their own individual criteria

or by conducting small informal surveys among colleagues or people close to them.

In this regard, the participants in the experience, who were also direct representatives of the design community and of the timber material, reported very positive feedback after participating in the experience. Most of the participants were often surprised by the rigorousness of the process, its uniformity each time it was carried out, the diversity of areas addressed, and the methods used, which integrated the traditional with new technologies in a harmonious and easily understandable way.

It is important to emphasize that when performing these procedures, any prejudice or stereotype regarding the understanding that people may have of the aspects under evaluation should be abandoned, but at the same time, the experience should be simplified so that it is smooth and quick to perform. The design of this experience, structured and clear in its approach, as well as its dissemination in the professional and academic community, also seeks to contribute to the adoption of these experiences for the characterization of materials as a more common resource for the discipline of Design, tending to its incorporation into the curricula of undergraduate programs in the area, something today just incipient (Papile et al., 2022; Pedgley et al., 2016; Zhou, 2021). The training of design professionals who have a greater awareness of the relevance of these areas seems necessary in a context where new materials, artificial and natural, appear every day in the market and become options for the design and development of new products, and where at the same time technologies such as artificial intelligence could largely replace materials experts who only consider their technical aspects (Maqsood et al., 2024).

Connected to the above, it seems possible, allowing for the experience created and the results obtained, to establish criteria that tend to standardize and unify these experiences at a more global level. Although this is not free of very relevant complexities, such as cultural differences or the need to have a minimum of technological resources to optimize and standardize some aspects of the experience, it is necessary to provide design professionals with more universal databases, such as those that group the physical-mechanical or technical characteristics of different materials. In the case of databases of expressive and sensory qualities, they should also incorporate aspects such as collaboration, associativity or open access among academics, professionals and institutions, allowing their continuous improvement and an organic process of growth. In this line, it should be noted that the defined experience has already been successfully used, with minimal modifications, for the experiential characterization of artificial and natural materials, other than wood, in other Latin American countries. Although it proved to be adequate in that instance, an important area, still little explored and to be developed in future research, is related to the definition and standardized presentation of the results obtained after carrying out the experience itself.

Finally, and from the perspective of research and new knowledge arising from the discipline, it is important to highlight the value of the projective and empirical processes that have always characterized the profession and that, in its transition to an academic discipline, it would not be desirable to lose. As Findeli et al. (2008) point out, in research through design there is a communion between theory and practice that helps to build an authentic design theory capable of adopting an epistemological stance consistent with what is distinctive of Design: the project. This tacit knowledge that arises from doing is not usually registered by the conventional means of the academy and therefore is not easily recognized as valuable by it. For this reason, and in the search for a change of paradigm in this aspect, this article seeks to record the process carried out to define a procedure, thus converting it, it is hoped, into useful knowledge for designers, at the same level of relevance as the results arising from the application of the procedure itself,

which can be reviewed on the project's website.

Source of funding
Acknowledgements to ANID FONDECYT Initiation folio 11190132. This article arises from work carried out in the 2019 FONDECYT initiation project, N°11190132, funded by the National Research Agency (ANID) of the Ministry of Science, Technology, Knowledge and Innovation of the government of Chile and its FONDECYT program.

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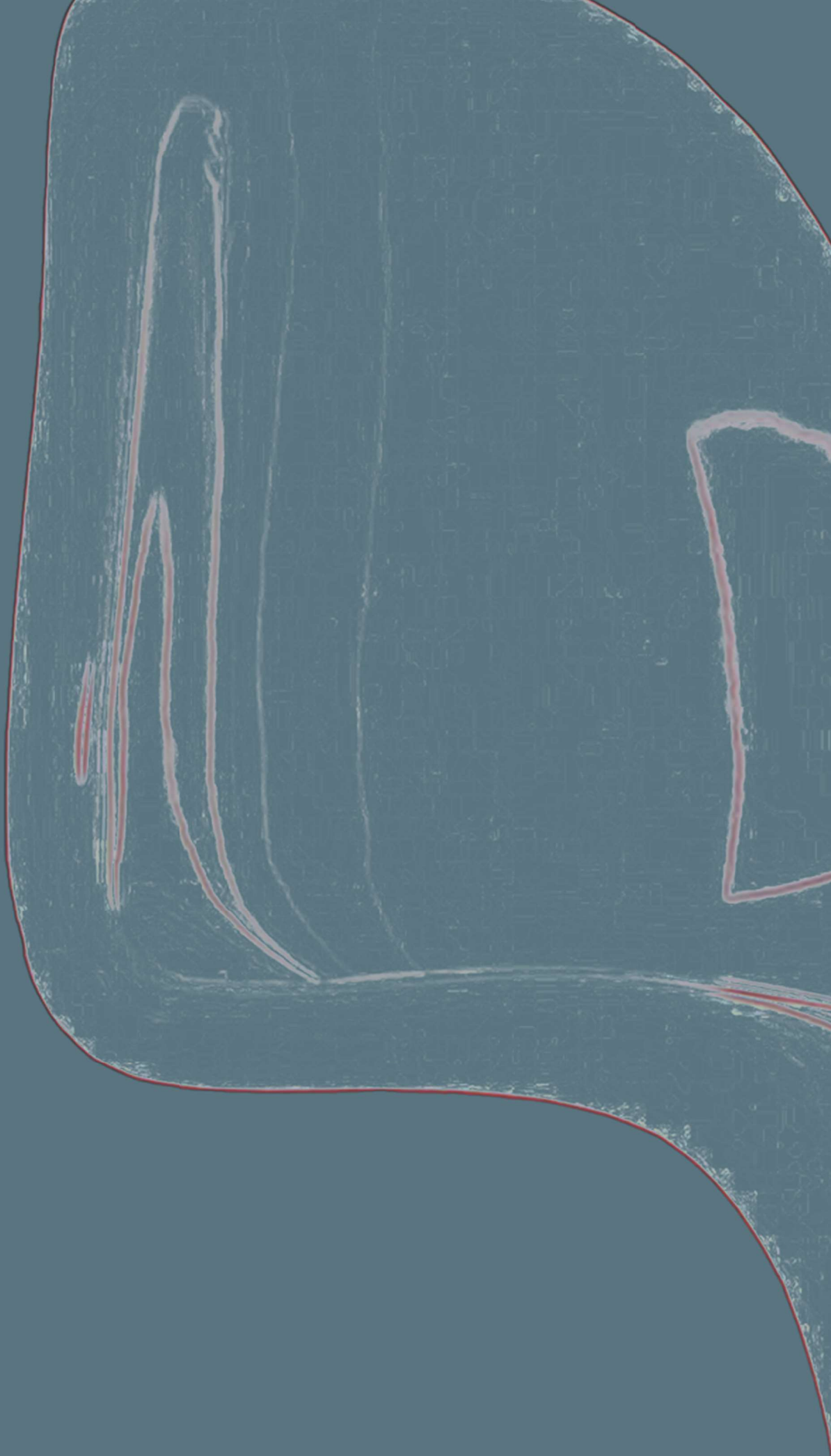

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