# Urban Doers Community

## Design Circular: Waste Reconsidered

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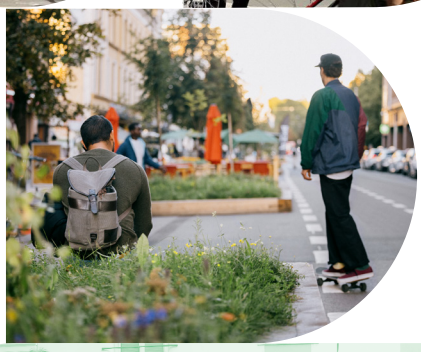


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**Design and Layout**
Front page: HAUS
Text: Tina Cihal

**Photo credit**
Front page: In order of appearance: Johannes Riegler, purchased image from iStock, Mariborska kolesarska mreža, Barkarby Science AB, Jan Khur, Julie Hrncirova, Supergrätzl Lichtental

November 2024

# Design Circular: Waste Reconsidered

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## Abstract

SUSDESIGN Sustainable Design Studio & Consultancy maintains expertise in sustainable design research, designing for the circular economy, and utilising sustainable natural materials to design furniture and interiors.

DESIGN CIRCULAR: WASTE RECONSIDERED is a collaborative project that aims to functionally and aesthetically design local public spaces into healthier human habitats, embracing social participation (utilising design thinking tools), and creating circular placemaking design solutions in the urban context. The project considers three cities: Lisbon, Istanbul, and Amsterdam, and explores the potentialities of local waste streams and state-of-the-art digital manufacturing.

The DeCiWaRe project aims to create more sociable, accessible, inclusive, comfortable, and sustainable public spaces in select neighbourhoods through a participatory placemaking approach. Our objective is to involve as good a representation as possible of local communities in the design process, and as such, design with, instead of design for. Therefore, we are collecting data from the locals of three cities (Lisbon, Istanbul, Amsterdam) towards placemaking proposals, as well as exploring the potential of unconventional materials derived from urban waste streams.

Within the Urban Doers programme, we have initiated the waste streams research, explored a participatory design-oriented approach, and conceptualised the first circular urban design solutions for the city of Lisbon, as well as planning the prototyping of select concepts with advanced digital manufacturing. Further activities are being planned for future DUT initiatives.


Key lessons:

1. Design and the design thinking process have the potential to structure intervention processes in the betterment of public spaces, while also increasing awareness on various subjects.

2. A well researched and developed design brief that empathises with stakeholders and users leads to the creation of integrated added value solutions that can promote good behaviour in the public, while also meeting their needs in the drive towards sustainable urban transitions.

3. Stakeholder participation is especially important in placemaking interventions, as empowering citizens to co-design solutions for public spaces helps foster a sense of belonging and ownership. It is essential to follow a democratic design process, with stakeholder engagement providing a rich pool of varied ideas based on their insights.

4. Thorough consideration of materials (and energy and water) is necessary for sustainable production. That being said, recycling materials requires better labelling, higher consumer awareness, and the restriction of toxic/harmful materials in industries where possible.

5. Digital manufacturing is well suited to address variations in design, and is becoming increasingly accessible. However, it needs a thorough understanding of the process, which in turn requires dedicated resources and know-how beyond the Makers' Movement. SMEs and startups offer a myriad of skills and know-how, while also having flexible structures, and are thus integral to R&D processes, especially in limited budget contexts.

## Circular Product Design Towards Sustainable Urban Spaces

The DESIGN CIRCULAR: WASTE RECONSIDERED (DeCiWaRe) project is contextualised in the circular design framework, as well as design thinking for creative placemaking, aiming for an applied design approach to contribute to regenerative urban spaces.

Circular product design (CPD) focuses on designing for the circular economy, building upon previous sustainable design concepts such as Cradle2Cradle, design for sustainability, and ecodesign. The circular product design multiple loops life cycle design approach [1] involves designing with material loops: bio-based materials that are absorbed into the biosphere with minimal impact, and technical materials that should be reused and recycled for as long as possible. The approach provides four strategy clusters in each of a product's life cycle stage (in accordance with Brezet and Hemel's life cycle design strategy wheel [2]): i) design to slow the loop (i.e. delay the end of life cycle); ii) design to close the loop (i.e. manage the end of life cycle); iii) design for bio-based loops (i.e. utilising bio-based materials); and iv) design for bio-inspired loops (e.g. biomimesis).

In this context, conventional recycling involves intensive labour and often long-distance transportation (at times between countries) of waste. Recent developments have opened up opportunities to tap into these waste flows, and to locally transform them into new (circular) products that benefit local communities. Localisation of recycling and manufacturing considerably shortens supply chains, and has the potential to reduce emissions, energy use, and the overall carbon footprint of the city. This is one of the aims of the Design Circular: Waste Reconsidered initiative.

Design thinking is an iterative process based on the structuralisation of the design process, which includes: i) empathising - understanding users / stakeholders and their experiences; ii) defining - diagnosing and defining the problems and context; iii) ideation - conceptualising and designing solutions; iv) prototyping feasible concepts; v) testing (with user input), and, vi) implementation of solutions [3].

This iterative design thinking process is adopted in the Design Circular: Waste Reconsidered project in combination with the placemaking approach - an inclusive approach to the design of public spaces, as proposed by the Project for Public Spaces [4]: i) promoting accessibility & linkages (e.g., connections to surroundings and to other important locations in an area, including visual links); ii) comfort & image (e.g., emotional attractiveness and safety); iii) facilitation of activities & usage (e.g. recreational and commercial activities); and iv) sociability (e.g., be welcoming and promote social interactions and a sense of community, and attract people to visit / use repeatedly). Additionally, fundamental to successful placemaking interventions is the inclusion of the locals in the whole process: from design brief development, to design and testing, to post-intervention maintenance of the project.

To this end, Circular Product Design (CPD), Design Thinking (DT) and Placemaking are the core tools being tested and utilised in the Design Circular: Waste Reconsidered project, supported by 3D design simulation and digital manufacturing (for high fidelity prototyping), both aiming to explore future design scenarios of sustainable urban transitions utilising urban waste streams.

## Transforming Waste Into Functional Design Materials

As part of the DeCiWaRe project's methodology, we've analysed several examples of how to transform waste into functional design materials. Some of those inspiring examples were the Post Paper Studio, Precious Plastic Project, and our own SUSDESIGN studio design projects with waste.

Post Paper Studio [5] focuses on recycling paper and cardboard into usable composite materials in design. The studio researches and designs open-source tools and recipes enabling anyone anywhere to transform local paper waste into valuable design materials locally. The project was founded by the design studio BY THE END OF MAY. Figure 1 presents material samples developed by the studio in Lisbon (Portugal).

**Figure 1:** Various paper based materials. Source: https://bytheendofmay.com/

The Precious Plastic Project [6] launched in 2013, is an open-source plastics recycling project that involves collection, identifying and sorting plastic waste, building and assembling the hardware and tools required to process and injection mould plastic materials into usable products in small-scale production, as well as building knowledge and networks in communities towards plastic recycling. Figure 2 presents a tabletop designed with recycling plastics.

**Figure 2:** Precious Plastic table top. Source: https://www.preciousplastic.com/solutions/prods

SUSDESIGN studio [7] researches and designs products that utilise waste streams from different contexts, including industrial symbiosis with the cork agglomerates, paper, and forestry industries. Experiments with collecting and upcycling cork waste stoppers from Lisbon restaurants in furniture have also been conducted. Figure 3 presents SUSDESIGN's cork stopper lounge chair displayed at the Design Cork Initiative exhibition at the CCB (Portugal). Figure 4 presents SUSDESIGN's Forest Chair, developed for the 2021 Portuguese Presidency of the Council of the European Union, consisting of recycled wood fibres, upcycled pine wood from end-of-life cargo pallets, cork, and eucalyptus waste from the paper industry, as well as waste from the forest floors.

**Figure 3:** The cork stopper lounge chair. Source: susdesign.pt / susdesign.org

**Figure 4:** The Forest Chair. Source: susdesign.pt / susdesign.org

## Exploring Future Design Scenarios with Urban Waste Streams

Moving forward with the creativity-based methodology, the University of Lisbon's Product and Interior Design Masters programme students were involved in a design thinking process that spanned several weeks, tasked with utilising circular product design and placemaking strategies to develop design interventions in various locations of Lisbon.

The practical design projects aimed to create more sociable, accessible, inclusive, comfortable, and sustainable public spaces in selected neighbourhoods through a participatory approach. To this end, a first series of concepts was developed for various areas in Lisbon by four design teams, including: 1) floating gardens for Cais do Gas, 2) parklets for Arroios, 3) rain gardens for Olivais, and 4) floating gardens for Algés.

### Concept 1 - Blue Flo Floating Garden (Team 1)

The objective of the Blue Flo project [8] was to establish an intimate connection between people and nature through the development of floating gardens at Cais do Gás in Lisbon, Portugal, while also exploring ways in which to add value to waste beyond generic recycling. Additionally, the project aimed to foster biodiversity by providing a safe refuge for the flora and fauna of the Tagus river, and to promote sustainability and well-being by inviting residents to immerse themselves in these environments.

Given that placemaking is a multifaceted approach to the planning, design, and management of public spaces [9], it was decided to develop strategies to complement this study, in order to harness local resources and the potential of the local community, with the aim of creating public spaces that improve urban vitality and promote the health, happiness, and overall well-being of users. When applied correctly, placemaking transforms poorly designed environments into wholesome and fulfilling environments that improve the urban experience and develop positive habits amongst the local residents.

As such, the objectives were designated for the location under study, which included: providing comfort through shaded areas and the overall quality of the surrounding space; taking advantage of the landscape, including the locals in the design process; harnessing waste streams; promoting health and well-being by encouraging physical leisure activities; taking advantage of local businesses and the CNL (Lisbon Sailing Club); fostering accessibility via pedestrian and cycling paths, in addition to the location's proximity to public transportation; and, finally, to stimulate a social environment that encourages cultural events and social interaction.

Interviews with locals who used the riverside regularly (e.g. to commute, local residents who used it for walks and recreational activities) were conducted to determine needs and wants, as a basis for the design of the floating gardens.

Study visits to the Lisbon Sailing Club were conducted to collect relevant information including a survey of potential materials, equipment, tools, and any other potential eventual waste from the club. The items on the survey were then further evaluated in terms of life cycle, and their material components for potential use in the project (Figure, 5 below). The inventory included oars, kayaks, tires, metal weights, wooden items, and buoys.

As an example of the assessment, the buoys used at the club were made of polyvinyl chloride (PVC) - which is a plastic that is widely recycled. Oars and other items like some of the kayaks were made of wood. Metal oars, rubber tires and cast iron weights were also inventoried. A life cycle assessment was conducted for each item category to determine potential integration into the project at end of life.

A general strategy was formulated to collect waste materials from the Lisbon Sailing Club, with the inclusion of other sailing clubs throughout Portugal, as well as wood materials from demolition works from the surrounding areas.

The initial proposal took inspiration from the structure of the oars found at the CNL (Figure 6). With the intention of providing a versatile solution that integrates several spaces with different purposes, the suggestion includes the implementation of pedestrian paths. In addition, it offers strategically distributed living areas, in which it is proposed to install urban equipment, aiming to optimise the use of space (Figure 7 and 8).

The central area, designed to be the epicentre of convergence of all paths, is the key part of this composition, and refers to the place where the project is located. This central area not only serves as an organising element, but also triggers a unique visual and functional experience for users. As the name suggests, this

floating garden includes green areas, mainly around the interior lakes between the walkways. By enveloping vegetation with walkway structures, it is possible to consider plants that would not otherwise be possible, as they would be carried away by currents - thus providing ecosystem benefits.

The project proposal seeks to provide users with a harmonious, functional, and aesthetically appealing solution, while at the same time reinforcing interaction with nature, in this way establishing a coherent balance between urban and natural elements.

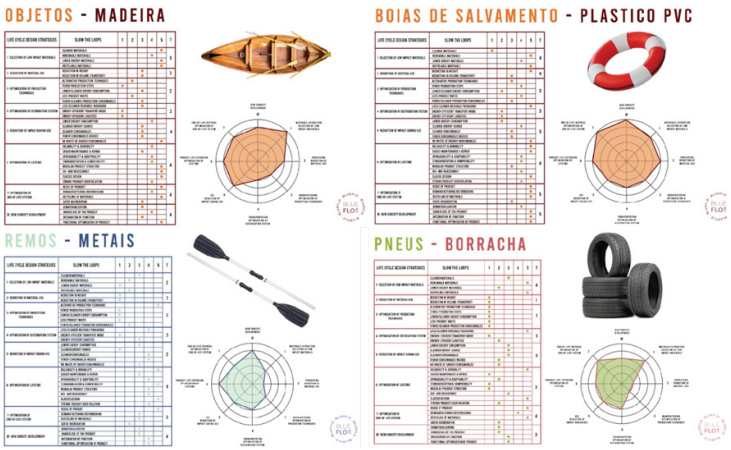


**Figure 5:** Life cycle analyses of waste streams at the CNL. Source: ULisboa

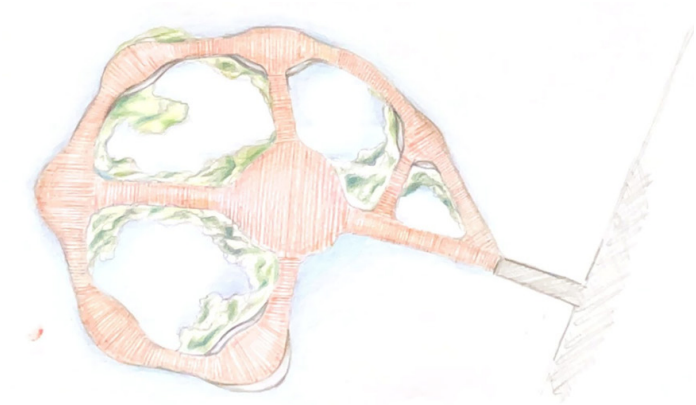

**Figure 6:** Cocnept sketch. Source: ULisboa

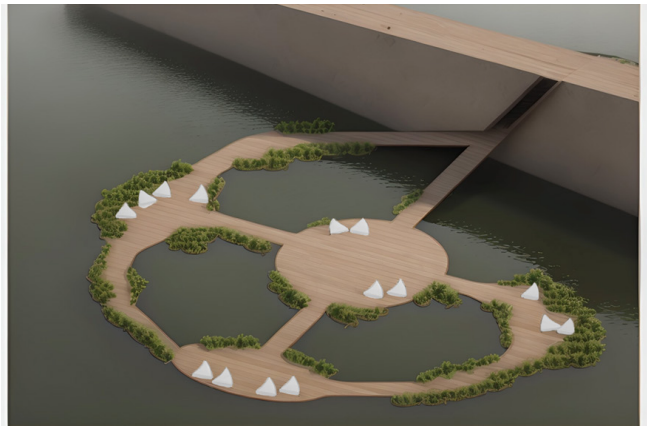

**Figure 7:** Cocnept render. Source: ULisboa

### Concept 2 - Lisbon Circular Parklets (Team 2)

Urban revitalisation has been a growing challenge globally, especially in densely populated areas, where the decrease in public spaces has become evident. In this context, the implementation of parklets can be an innovative placemaking solution, which not only aims to redefine the use of urban spaces, but also embracing the principles of design, which, in turn, is directly associated with the drive for environmental sustainability and the promotion of the circular economy.

Functionally, parklets are small structures, either permanent or temporary, located in public areas of cities that expand space for pedestrians by expanding sidewalks into places originally intended to accommodate parking for vehicles on public roads. Generally occupying two car parking spaces, parklets are usually a public-private partnership initiative, where the municipality allocates the space to a private entity (usually a cafe or restaurant), which is responsible for its maintenance. Parklets represent urban interventions that transform underutilised spaces into multifunctional ones, which simultaneously create opportunities for social interactions, leisure, and sustainable mobility.

Lisbon Circular Parklets [8] aimed to democratise and organise the use of urban space in densely populated urban areas in Lisbon, offering areas to pedestrians to rest, and engage in leisure activities and social interaction. Utilising applied design tools such as design thinking, placemaking, and life cycle thinking, and drawing upon urban waste streams, the project emphasised the crucial role of design and development of urban and interior furniture in the adoption of sustainable practices and the circular economy, considering aspects such as ease of (dis-) assembly, materials, and production methods. The project also used research and benchmarking of similar solutions, observations, and interviews with users of the spaces, as well as meetings with authorities.

The designated area of intervention was the avenue of Almirante Reis - an avenue that connects Lisbon's historic centre to the city's northern regions, and which is under assessment by the city council for renovation towards improving its inhabitants' quality of life and making it more pedestrian friendly. The 2.79km avenue is known for its high population density (18.360 inhabitants / km2 - triple the city's average), lack of pedestrian roads (60% is asphalted, with only 28% designated for pedestrians), lack of green areas and recreational areas, interruptions / obstructions in pedestrian traffic areas, and low air quality (due to vehicle emissions). An unrelated pilot parklet project was implemented in the Arrois neighbourhood in 2021 (comprising benches, artificial grass, and bicycle parking - Figure 9); however, it has become known as an example of poor implementation. Through interviews conducted with locals, the team found very low levels of satisfaction, and that the parklets were severely underutilised by the public - who generally questioned its utility.

The Lisbon Circle Parklets project goes beyond simple construction or renovation of physical spaces, emphasising the essentiality of considering the needs and identities of local communities, and promotes active participation by residents, commercial actors, and municipal authorities and other interested stakeholders in the design process, transformation, and after-intervention maintenance of said public spaces.

By adopting an approach based on 'placemaking' methodology with the aim of revitalising them by increasing their functionality, inclusivity, and attractiveness for the community, the Lisbon Circular Parklets project proposed standardised modular parklet solutions to problematic areas spread across Lisbon, with the aim of improving the quality of urban space and responding to some of the city's inhabitants' needs.

By using 'design thinking' strategies based on empathy with users, the team aimed to create innovative ideas through rapid prototyping and iterative testing. At the core of the methodology was understanding the needs and challenges of users in-depth, and to this end, the project followed the design thinking stages:

Empathy: Interviews were conducted with residents and pedestrians in intervention areas, enabling the team to clarify the needs of users and main problems of these spaces. This was supported by secondary research focusing on facts about the places.

Problem definition: Problem mapping, data synthesis, and definition of challenges were conducted to clearly define the problem. Lisbon, while poorly organised in terms of urbanism in many of its areas - with limited space for pedestrians (similar to many old, large cities), aims to pursue a policy of 'fewer cars, more people'. To this end, it was deemed crucial to integrate greenery elements into the project.

Ideation: Brainstorming, mind mapping, and multiple sketches were made to generate ideas.

Testing and iteration: Based on feedback, the solutions were further developed and refined, with consideration of materials, shapes, and dimensions.

Prototyping: Graphical representations in 3D were designed to provide tangible experimental concepts that embody the proposed solutions. The final iteration involved two modular concepts.

The implementation of the design thinking process allowed the team to explore the problem and develop a solution, through a dynamic and broad-scoped process. The flexibility and collaboration that design thinking promotes proved to be essential to the process of understanding, continuous refinement, and adaptation in the process of addressing the topic.

The aim of the project was to design a standardised modular parklet concept that could be replicated and implemented in different areas of Lisbon, taking into account: ease of construction; urban organisation; environmental sustainability; promotion of healthy social habits; and, improving distribution and replication.

Parklets generally comprise a combination of information points, community art spaces, plantation / vegetation, shade, conditions for having meals, bins, lighting, accessibility features, and are usually made of a variety of materials including wood, steel, aluminium, recycled plastic, concrete, and fibreglass.

For the purposes of this proposal - minimising the negative impacts of waste, the team designated various material stocks from by-products and waste of industrial production processes. These include, metals, rubbers, construction and demolition waste, fabrics, glass, plastics, clay, and slag (the byproduct of ore smelting).

The final concept included:

- Recycled / upcycled wood from various sources (including construction / demolition waste) - an aesthetically appealing and comfortable material, that, while in exterior contexts needs to be treated to ensure longevity, has low environmental impact.

- Aluminium, which is a low-impact, light and soft, but chemically durable material (i.e. resistance to corrosion). Its recycling consumes much less energy than virgin production.

- Upcycled tires, which are objects fortified by a variety of materials, including (synthetic) rubber. Tires are often discarded because of safety issues due to wear or damage (punctures). They are also often incinerated, which releases a host of toxic chemicals. There are, however, options to reuse / recycle end-of-life tires in the form of carpets, playground flooring, rubber asphalt, and shock absorbers, etc. This made rubber a valuable material for the project, suitable for a variety of applications, while also helping reduce emissions.

The parklet concept incorporated a modular system. A simple temporary fixing mechanism should be preferred so as to not damage the ground on which it is installed, while also facilitating low impact (dis)assembly and transportation.

It would also be important to convene community meetings during the implementation phase, where residents could participate in advising towards the real contextual needs and everyday life, which in turn would determine the partnerships and financing, and help facilitate the construction and maintenance processes.

The ultimate objective was the integration of the concepts of sustainability and circular economy into the urban environment.


**Figure 8:** Parklet attempt by the municipality at Arroios Market in Lisbon. Source: ULisboa

**Figure 9:** Parklet concept developed by the project team. Source: ULisboa

### Concept 3 - Oliveiras Circular Rain Garden (Team 3)

This project aimed to address the revitalisation of a space in Rua Fernando Namora in Telheiras, Oliveiras, Lisbon [8], adopting a holistic approach that aimed to improve mobility, safety, and environmental sustainability through community participation, with the objective of transforming a physical environment while strengthening community ties and promoting sustainable practices.

The team chose the topic of rain gardens, due to recent flooding events in Lisbon in light of the changing climate and dense urban development.

"A rain garden is a depressed area in the landscape that collects rain water from a roof, driveway or street and allows it to soak into the ground. Planted with grasses and flowering perennials, rain gardens can be a cost effective and beautiful way to reduce runoff from your property. Rain gardens can also help filter out pollutants in runoff and provide food and shelter for butterflies, song birds and other wildlife. More complex rain gardens with drainage systems and amended soils are often referred to as bioretention." (EPA, United States Environmental Protection Agency [10]).

Thus, 'rain gardens' make use of a series of solutions that span from layouts (geometries) of gardens to the flora (and fauna) that inhabit it, in order to better manage rainwater (and thus, feed groundwater, which in turn influences the water cycles of an environment); in this way, rain gardens differentiate themselves from conventional gardens.

The Municipality of Lisbon already has plans in place for the renovation and improvement of several of the problematic areas of the capital (e.g., Martim Moniz) - both in terms of rainwater management, and in terms of improvement for pedestrians; thus, the team opted to find 'non-places' - areas overlooked and forgotten about by municipal councils.

Anthropologist Marc Augé [11] defines 'non-places' as spaces that lack a strong sense of identity, history, and social interaction. These areas generally comprise stores, service stations, and transport hubs - spaces where people pass through without forming lasting bonds or having meaningful experiences. In the context of the project Rua Fernando Namora in Telheiras was selected as the location of intervention.

The project street is located below the 2a Circular main road, and comprises a trail in the abandoned field that runs along the highway to the Galp bridge. On days of heavy rainfall, poor drainage of water from the road and expressway causes flooding of the road around the primary school. Between the school, the road, and the expressway is a slope that descends into an empty area where the trail is located. The proposal involved streamlining this space to promote community interaction and to aid in mitigating floods.

The concept of 'design thinking' was taken as an overarching approach to the process of the placemaking project - i.e., empathise, define, ideate, prototype, and test.

Observations and unstructured interviews were used to empathise with local residents - the primary users of the space.

The project was initiated with an on-site visit. The grass in the area had not been cut for months, growing over the existing trail. The water ditch that was meant to channel water from the expressway was also clogged with organic material and trash. Parts of the barriers separating the expressway from the area were also broken and missing, which posed a serious danger to those below in case of an accident. Towards the end of the trail, the land was much better looked after, as it connects with the Galp bridge, and has office buildings across the road. The rest of the (overgrown) area is bordered by a residential zone and a primary school, which indicates a strong community presence.

Unstructured interviews were conducted with the local community (e.g. residents and school staff), allowing for participants to freely express their needs and concerns regarding the space. This method was chosen over semi-structured or structured interviews in order to capture the diversity and complexity of local perceptions. Participants confirmed the existence of floods and stated that the overgrown trail was used mostly by elderly people due to their age, and despite the poor conditions, to get to the Galp bridge, as it was a shorter route that didn't require climbing up to the expressway.

This interaction with the community provided valuable insights fundamental to shaping a project more aligned to placemaking principles. Two mind maps, one based on what was wanted and the other on what was not wanted, were developed to help organise the data and define the scope and objectives of the project.

Brainstorming sessions were organised to further develop ideas, which were then visualised with the use of sketches. The local community was again consulted during the ideation phase to receive feedback on ideas.

Materials play an integral role in the eco-efficiency of a product or interior design intervention. Initially, the team considered the use of recycled plastic and glass as base materials. Glass was, however, not found to be a viable material both in terms of its durability / safety and the practicality of recycling and processing glass in the intended functions. Mixing glass with cement was also considered, but abandoned due to the significant emissions and pollution associated with cement.

Thus, it was decided to use recycled plastics, wood from demolitions/building renovations and from end-of-life urban furniture of the municipality's existing stock, and recycled aluminium.

The project, in line with the principles of placemaking, aimed to redesign the space of intervention into a pleasant one, where the community could take the opportunity to rest and enjoy a moment with family and friends, while also fulfilling its function as a rain garden.

The final design incorporated a green area organised around the trail. Benches were designed to allow visitors to rest. Two types of benches were designed - one that enables users to sit looking away from the school (to facilitate interaction with the garden), and a second version placed in relevant areas that allows for seating on both sides, while also providing bicycle parking slots. An aviary with songbirds was also incorporated to provide ambient sounds and an attraction to observe, while also incentivising the City Council's frequent presence (to maintain it). The space was split between a canal and the recreation / passage area, which was demarcated by a wooden fence at waist level (1.2m high) to stop pedestrians from falling in. A wooden planking system was considered to create a walkway, in order to help pedestrians traverse the area while also allowing for rainwater to get through.

The proposed flora consisted of indigenous hydrophilic plant species to contribute to water absorption, providing a haven for local fauna, and for aesthetic purposes. A lighting infrastructure solution was also proposed to both extend the use of the space to beyond daylight hours, and to provide security. Strategic arrangement of waste bins, using the standard municipal options, was made to limit maintenance of the space's cleanliness. A noise reduction barrier was also proposed to cut off the area from the expressway and to reduce noise in the garden.

Finally, the proposal also included a children's play area with swings, which would attract parents to come for a walk and to play with their children after school.

**Figure 10:** Flooding in the project area after rainfall. Source: ULisboa

**Figure 11:** Bench Concept render for project. Source: ULisboa

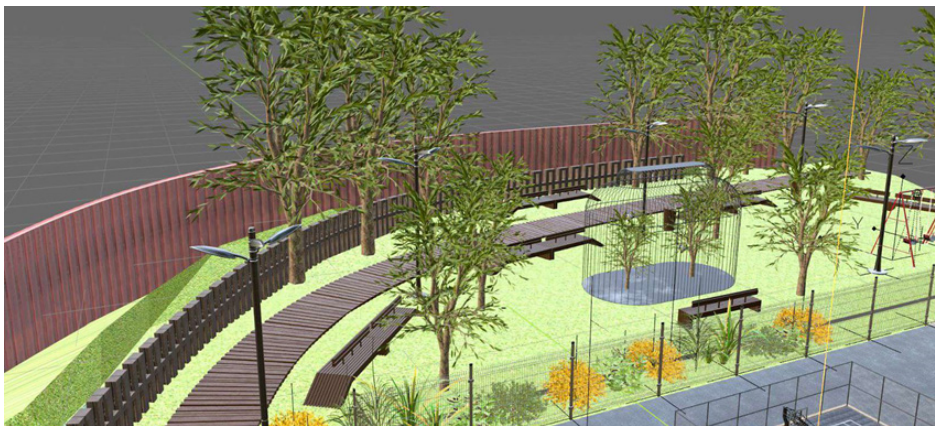

**Figure 12:** Render of project concept. Source: ULisboa

### Concept 4 - ALGÉS IN THE MIDDLE GROUND (CIRCULAR FLOATING GARDEN) (TEAM 4)

The Algés in the Middle Ground project [8] comprised the development of a floating garden concept for the riverside area of Algés in Lisbon, with the objective of providing a comfort and recreation area for locals, and making use of recycled materials.

The parish of Algés has an area of 7.18 km2 and is home to 47,936 inhabitants. The region is peripheral to the metropolitan area of Lisbon, but is quite busy with a lot of movement through. The area of intervention is located close to several hubs and gathering points, namely, the train station, the bus station, and a beach. However, the area is also quite degraded and desolate, with the few people who do interact with the place doing so only as a commuting route.

Floating gardens can take many different forms, including bridges and floating platforms. They vary in size from small individual platforms to large systems. In urban areas, they can be placed in locations such as dock systems, lakes, canals, or large lagoons - relatively calm bodies of water that are not affected by strong waves or tides. Some are built with a layer of floating plants (e.g. hyacinths), with other fauna on top. These gardens use buoyant materials like wood or plastics as the main structure.

Design thinking was used as an approach to facilitate the project process, which started with social context research. An online questionnaire was developed and sent out to locals through social networks and the Faculty of Fine Arts of the University of Lisbon, in order to empathise with users and to understand their needs. The questionnaire answers included problems, ideas, and possible solutions. Based on the questionnaire, the team defined possible innovations and developed the concept for the floating gardens, including communications and strategies to implement the project. In addition to the questionnaire, an on site visit was also conducted to investigate the location and determine possible problems and improvements, with a focus on the needs felt by the people who regularly used the riverside area of Algés. This was achieved through interviews with people found on site.

It was determined that the area of intervention is heavily degraded and isolated from the more popular spots in Algés, with only one riverside restaurant to provide any kind of activity. The area has a cycle path, some electric scooters, and tables and benches for leisure activities, but is generally dirty and unkept, and has poor signposting and lighting at night. The majority of residents confirmed that the area was generally used for short walks or to do spots, rather than relaxation and enjoyment. The small beach (located in the intersection of the river and the ocean) was also unkempt, dirty, and disused.

The new design concept aimed to utilise waste from civil construction/demolition, as well as making use of the existing municipality fablabs (digital manufacturing) for its production. Wood constitutes one of the main waste streams from the construction industry, albeit requiring waterproofing to be usable in the context of a floating garden. To this end, a low-density recycled wood-plastic composite with a recycled plastic coating was proposed. This compound would be highly resistant to environmental conditions, and would not absorb moisture. Additionally, a similar material that combines bamboo and activated charcoal was also proposed. This solution represents a low-cost eco-friendly option that is also water-proof.

The final concept was developed during the ideation phase. The proposal brought together several characteristics that ensure a commitment to a more sustainable future, not just focusing on the material elements of the floating garden, but also aiming to create links between innovation and environmental responsibility, and between the area's inhabitants and the ecosystem that surrounds them.

Future steps will involve the individual design of furniture that both furnish the floating garden and the surrounding area, including bins, recycling containers, benches, tables, and other leisure objects utilising waste materials. Sun loungers and benches for the beach will also be designed to facilitate its use. Lighting - both for the floating garden and the surrounding area, is another issue that needs to be addressed, and will increase the use of the area by locals after dusk.

**Figure 13:** Aerial view of the proposed area of intervention. Source: ULisboa

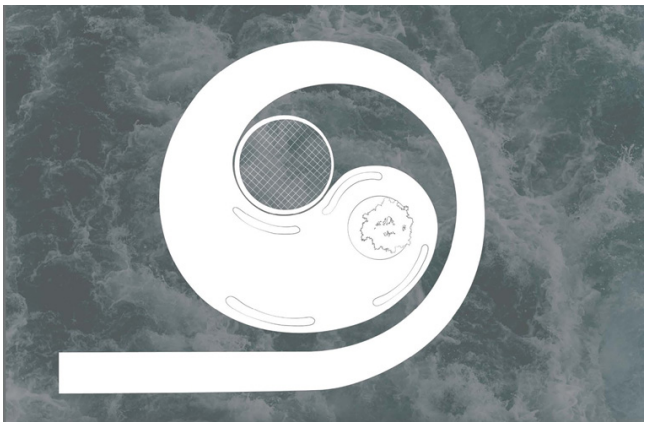

**Figure 14:** Top view sketch of project concept. Source: ULisboa

# Final Reflections on the Waste Reconsidered Project

As discussed, the Design Circular: Waste Reconsidered project aims to explore the potentialities of urban waste streams as material stock for (circular) urban furniture solutions produced via digital manufacturing, as well as for the aesthetical and functional betterment of local public spaces, supported by a participatory placemaking approach. The project aims to contribute to urban transformation by developing a methodology for a democratic and inclusive approach to the betterment of public spaces, while also coming up with creative ways to locally transform some of the locally generated waste into added-value public furniture solutions - thus demonstrating novel ways in which waste can be managed locally without long recycling or waste disposal supply chains.

The project addresses two fundamental urban challenges: municipal waste and placemaking.

Municipal waste comes in all sizes and materials, from discarded wooden furniture to food waste (e.g. uneaten foodstuffs, pits, cores, and seeds of fruit, and peels), to traditionally recycled plastics, paper, cardboard, metals, and glass.

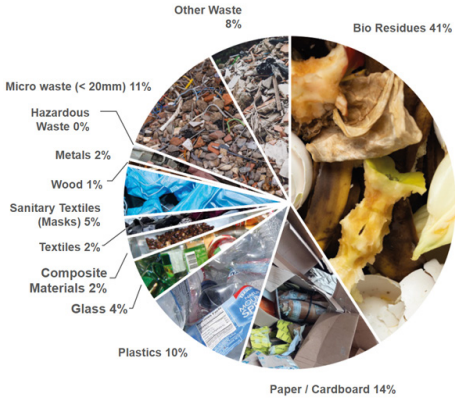


**Figure 15:** Waste streams of Lisbon in 2019. Source: Valorsul

In most countries, most of these materials are either processed for "energy recovery" - a misleadingly optimistic term for incineration (releasing carbon and other chemicals into the atmosphere), or landfilled, where hazardous materials leak and poison the soil and groundwater, and where organic waste gets entombed within piles and piles of waste, resulting in anaerobic decomposition that releases methane - a much more potent greenhouse gas than carbon dioxide.

Recycling, once touted as the solution to the waste problem, has been shown to be highly inefficient [12], as sorting through the many different recyclable materials is labour intensive, profit margins extremely tight, and often requiring long-distance logistics (oftentimes between countries, sometimes across the globe). Recent developments in technology have opened up opportunities to tap into these waste streams, and to locally transform them into new (circular) products that benefit the local communities from which they have emerged. Localisation of manufacturing considerably shortens supply chains, and has the potential to reduce emissions, energy use, and the overall carbon footprint of the city.

Public space, on the other hand, is a fundamental need of society - especially in European countries, where residential spaces are small and much of an individual's time is spent outside of their residence. However, most municipal interventions in the betterment of public spaces, as is the case with most policy structures, is quite hierarchical, and often do not sufficiently include input from the locals - the actual users of said spaces.

Ultimately, the Design Circular: Waste Reconsidered project ambitions to develop a replicable methodology for an inclusive placemaking approach, utilising design thinking methods in order to create a more horizontal process to the betterment of public spaces, while also experimenting with various waste-derived materials and digital manufacturing. Processes being tested include both subtractive (e.g. routing/milling) and additive (e.g., 3D printing and injection moulding) manufacturing technologies amongst others. The project also aims to catalogue the necessary equipment and processes for the reclamation of said waste materials.

Over the course of the project, our initiative has been inspirational in several ways:

A series of workshops with segments of the public were conducted, based on circular design and design thinking. Brainstorming sessions asking how design could intervene in various contexts were created.

The project is in the process of (co)designing furniture for a public space renovation project in Lisbon, which will be utilising the tools mentioned above, as well as waste-based materials. We are conducting durability tests for the materials, taking into consideration their carbon footprints, to see which ones are most suitable.

SUSDESIGN, is in the process of concluding agreements towards possible intervention points in Lisbon. In the mid-term, the project aims to inspire creative collaboration in other European cities to further develop both the methodology and material and product development processes.

In light of the Driving Urban Transitions partnership joining the Mission Innovation series, the future of the DeCiWaRe project will include the integration of new renewable technologies and smart systems into the furniture pieces, as well as aspects that promote good behaviours in the public - both in terms of health and in terms of sustainability practices. Furthermore, integration of the concept of regenerative urbanism will be explored. To this end, the project team will be developing a design brief 2.0 for the purposes of meeting these new requirements. Furthermore, as mentioned above, the project is aimed to be integrated into new urban renovation projects in the city Lisbon.

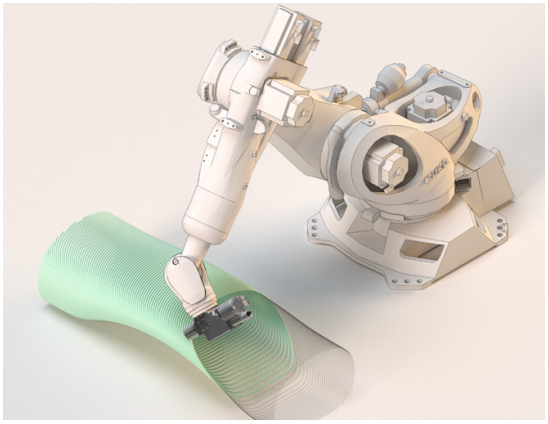

**Figure 16:** Simulation render of bench printed with robot arm and recycled PETG. Source: Fabb

**Figure 17:** Ergonomic study of bench concept. Source: Fabb

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