The CiaBOT: a “circular” belvedere (Portacomaro, AT, Italy)

CiaBOT: the circular design of an experimental microarchitecture between material and immaterial values

Elena Montacchini, Silvia Tedesco*, Nicolò Di Prima

Department of Architecture and Design, Politecnico di Torino, Italy.
**Email: silvia.tedesco@polito.it*

Abstract: The transition to a circular economy entails new challenges for architects and designers. Among these, one challenge is to look at waste not only as new resources, from an environmental perspective, but also as bearers of information capable of communicating their history and origin. Moreover, waste can be considered as a means of activating unexpected knowledge and social connections. The article illustrates a circular design experimentation, conducted with architecture and design students and a wine farm, which led to the creation of the CiaBOT project, a belvedere aimed at enhancing the landscape and providing a temporary stopping point in the Monferrato hills (UNESCO World Heritage Site, Italy). CiaBOT is not only a belvedere but is a microarchitecture capable of conveying both material and immaterial cultural values. Its form and materials are intimately connected with the territory with and for which it was designed. These make CiaBOT a "space" of hybridization and dialogue between agricultural tradition and innovation. But it is also a "space" of fieldwork education and knowledge co-generation in which academic and non-academic stakeholders have measured themselves. Through the description of the different stages of the design process, the article is part of the debate on new sustainable ways of designing and building, reflecting on new models of circular economy based as much on design strategies and processes as on the enhancement of human labor and the use of technologies appropriate to the context and actors.

Keywords: Circular design experimentation; Waste as values; Self-construction; Co-design; Appropriate technologies; Belvedere microarchitecture.

Cite as: Montacchini, E., Tedesco, S., & Di Prima, N. (2024). 'CiaBOT: the circular design of an experimental microarchitecture between material and immaterial values'. *VITRUVIO - International Journal of Architectural Technology and Sustainability*, *9*(1), 42-55. https://doi.org/10.4995/vitruvio-ijats.2024.21492

1. Introduction

The theme of Circular Economy (CE), defined in the international scientific literature as an "umbrella-concept" (Blomsma and Brennan, 2017; Homrich et al., 2018), encompasses a very broad set of meanings, visions and scales (Kirchherr et al., 2017) that involve economic, environmental and social dimensions, and that are oriented to propose "regenerative and restorative system of production and consumption, which closes the input and output cycles of the economy" (Calisto Friant, et al., 2020). The transition to a Circular Economy poses several new challenges for architects and designers to look differently at waste and to move beyond traditional design methods (Dokter et al., 2020).

Among these, the first challenge is to look at waste not only as new resources to be considered from an environmental perspective, but also as bearers of information, imprinted in the materials themselves, capable of communicating their history, origin, and the relationship to the context they belong to (Condotta and Zatta 2019). In fact, waste can be a catalyst for information, a way to tell the story of an area, to preserve its cultural and intangible value (Massaro, 2023). "In some sense, waste is physically embodied information. Much of what we know about the past, we know from things thrown away, the discarded objects that record human activity and the passage of time. Historical dumpsites are of interest to archaeologists and anthropologists, just as contemporary landfills harbor a wealth of information about everyday consumption and behavior" (Rathje and Murphy, 2001).

The second challenge concerns the need to activate non-standardized processes that can be initiated through collaboration between different entities that share skills and knowledge to co-design new ways of valorizing waste.

In this perspective, waste can be considered as a means of activating unexpected social connection through processes of coproduction of knowledge, involving the collaboration of academics and non-academics actors by integrating different disciplines. This holistic approach is essential for developing innovative circular solutions (Irwin et al., 2018, Bolger et al., 2021).

Reasoning at the local scale, the design and architecture projects that follow the principles of CE and look differently at waste can become a real tool to stimulate forms of collaboration between sectors, institutions, and local stakeholders, to promote the sociocultural and economic development of an area, and to enhance social and cultural processes (Salvia et al., 2018). Designing with waste materials of a territory, telling the story of the productive world and agricultural tradition of a region, promoting local circularity practices and building new social relations, these are the ambitious goals of the circular design experimentation that led to the realization of the CiaBOT project, a microarchitecture of a viewpoint made to enhance the natural landscape and provide a temporary stopping point.

CiaBOT, however, is not only a microarchitecture, but is an object that has a high symbolic and representative power, capable of conveying both material and intangible cultural aspects of the territory.

The article illustrates the project through:

- The purpose of the viewpoint, the actors involved in the project, and an overview of its special features and the values it expresses (section 2).
- The different stages and methodologies of the design process (section 3). The following are described from the first design concept to the details of the formal and material aspects of the executive design; the activities of self-construction carried out by architecture and design students, the building steps and how materials, elements, and components are connected; the legacy left to the territory and the current use of the belvedere.
- Finally, the lessons learned from this experience, rereading and reflecting on the degree of circularity of the project (section 4).

2. The CiaBOT: not just a belvedere

The CiaBOT project described below was realized in 2023 in Portacomaro, a village with a rural tradition in the province of Asti, which lies in the Piedmont hills of Monferrato in northern Italy. The project recalls in its title the "ciabot", the dialect term used by peasants to name a structure from local agricultural tradition, a small hut in the middle of the fields, used by farmers for storing tools, resting, and temporary shelter in places often far from their homes.

In this project, the traditional "ciabot", the shape and geometry of which are retained, is revisited to take on the function of a viewpoint and enhance the beauty of the Monferrato hills, a landscape recognised as an UNESCO World Heritage Site. The name CiaBOT also recall the disused wine barrels of which it is partly made ("botte" is the Italian world for "barrel") (Figure 1).

The project is the result of a circular design experimentation of research in action and fieldwork education, formalized in the framework of a Memorandum of

Figure 1 | The CiaBOT and the UNESCO World Heritage landscape of the Monferrato hills (AT, Italy).

Understanding among Politecnico di Torino (Department of Architecture and Design) and small and medium-sized Portacomaro's enterprises, interested in promoting land valorisation strategies based on a circular economy approach and the optimization of waste as a resource.

In particular, the CiaBOT project is the "space" of experimentation, meeting, and exchange of expertise and competencies, in which academic and non-academic stakeholders have measured themselves. It was promoted by Azienda Agricola Durando, specialized in the production of wine and operating in the field of hospitality and tourist accommodation, and carried out with the support of the Innovative Technological Systems Laboratory (LaSTIn, Politecnico di Torino). It involved researchers, professors, and students of architecture and design in the development and realization of the microarchitecture, in compliance with the principles of Circular Design (Moreno et al., 2016) and using an Appropriate Technology approach (Schumacher, 1973).

The intended use of the microarchitecture, a viewpoint offering an extensive view of the Monferrato hills, originated from the desire of the Azienda Agricola Durando to provide a public place where people – local community, tourists who are passing through, and customers of the farm – can stop and enjoy the panorama.

The concept for the project was developed in 2020 as part of a call for ideas proposed to students in the "Designing and Developing the Circular Economy" course (Montacchini, Tedesco and Di Prima, 2021a). It is based on various architectural circular design criteria such as: low carbon footprint; life-cycle extension of materials, repurposed before they can be defined as waste; durability and interchangeability of materials and components, to encourage their replacement with a view to preventive maintenance; reversibility of connections, in a logic of design for disassembly (Leising, Quist and Bocken, 2018) and reusability. Other design criteria refer to landscape enhancement: the belvedere had to be a distinctive element and a visual attraction, while being integrated and harmonized with the context and the environment, enhancing, and supplementing the view of the landscape and establishing an emotional link with it. Moreover, the overlook had to communicate, with its esthetical and formal language, the link among agricultural traditions, care for the land and sustainable, circular innovation.

After almost three years, the project was self-constructed by architecture and design students. Today it is accessible from the provincial road that runs alongside the firm site. The structure is a totemic microarchitecture, composed of eight wooden portals, which characterize the load-bearing structure and frame the view of the hills; used pallet planks, which form the floor covering and echo the footsteps of those who walk through; and decommissioned barrels, which border the exterior walls, filter light and colours, and sound in the wind.

CiaBOT is not just a belvedere: it is a symbol of material and immaterial values, the bearer of a vision of circular design in which end-of-life products are not only considered as new material resources for construction, but also as symbolic catalysts of circularity. The suspended horizontal staves of the used barrels intersect with the verticality of the minimal lines of the wooden portals with their history. Together they build a dialogue that actualizes the link between the past, the tradition, the agricultural vocation of the territory and the look towards its near future. The reused materials, their processing and installation, the "care" with which they have been cleaned and assembled, also tell the story of people, of time spent in the making, of exchanges of skills, of professional and human ties. These aspects refer to the social dimension and to the values of reciprocity linked to the circular economy visions (Mies and Gold, 2021). They are more intangible and perhaps less measurable values, but no less important in imagining more sustainable systems of production and exchange.

3. The design process: from concept to construction and beyond

The belvedere design process is illustrated in the following paragraphs, highlighting the different phases, from concept to self-construction, underlining methodologies and approaches on which it is based, as well as the step-by-step outcomes, up to the final result and the legacy for the territory.

3.1 The project

As mentioned before, the belvedere first concept is the outcome of a selection from 19 projects developed as part of a student call for ideas, launched in 2020, in which 75 students of architecture and design at Politecnico di Torino participated. The call was based on requirements of circularity, sustainability, functionality, formal expressiveness, landscape enhancement, relationship between tradition and innovation. All the concepts, very different from a formal point of view, were developed in line with many of the principles of circularity from a technological point of view: use of local scraps and materials, such as disused vineyard posts, straw, hazelnut shells; use of accessible and reversible connections among the different elements, favouring the choice of nuts and bolts over welds, glues and nails; modular design approach, facilitating the possibility of reusing components at the end of their life (Montacchini, Tedesco, Di Prima, 2021b).

The final choice was based on the project that was not only more significant from a totemic and symbolic point of view in relation to the landscape, but also on the design most able to emphasize and communicate, from a formal point of view, the link between tradition and innovation, and to explicate, from an expressive point of view, the fact that the materials are living a second life, trying to 'tell' more about their history and their origin.

The belvedere project, selected by a jury of academic and non-academic actors including the Azienda Agricola Durando, is a structure composed of standardized elements such as wooden construction beams, or reused materials such as pallet boards, but also of custom-made components, such as clay bricks mixed with marc, a substantial waste from the winery's wine production. Based on the harvesting model proposed by Superuse Studio (Van Hinte et al., 2007), elements and components were identified from careful mapping of local resources and waste materials, such as production leftovers, end-of-life products, unsold inventory, and surplus. Grape marc bricks, on the other hand, were hypothesized based on scientific literature research that supports their feasibility (Muñoz et al., 2014) (Figure 2).

Once the winning project was identified, the Durando farm committed to pursuing it by financing its construction. The process of reworking the concept and defining the final design last almost three years and faced critical technological, economic, and bureaucratic obstacles. This led us to reflect on the challenges that characterize projects of this kind in the transition from classroom theory to field practice.

In terms of technological and economic obstacles, one of the most significant is related to the realization of the marc bricks, one of the most characterizing and symbolic elements of the project, with which the side walls of the structure were to be built. First, the timing of the experimental validation on the brick samples was incompatible with the farm's desire to implement the project in a relatively short time. Second, although a company had been identified to experiment with and supply the marc bricks, the costs of converting the traditional clay brick production chain would have greatly impacted the final cost of the semi-finished product.

Among the bureaucratic hurdles, the project had to contend with the municipality's Building Regulations, which did not provide for urban planning and building parameters that would regulate a structure such as the one proposed, as it does not fall within the usual types of building constructions. In addition, in that territory, new constructions are subject to approval by several public bodies, including the Soprintendenza Archeologia, Belle Arti e Paesaggio, which evaluates the project's consistency with the aesthetic and architectural canons that characterize the area. Along the way, this agency placed various aesthetic, formal, and project allocation constraints, which were also influenced by the discretionary judgment of different public functionaries.

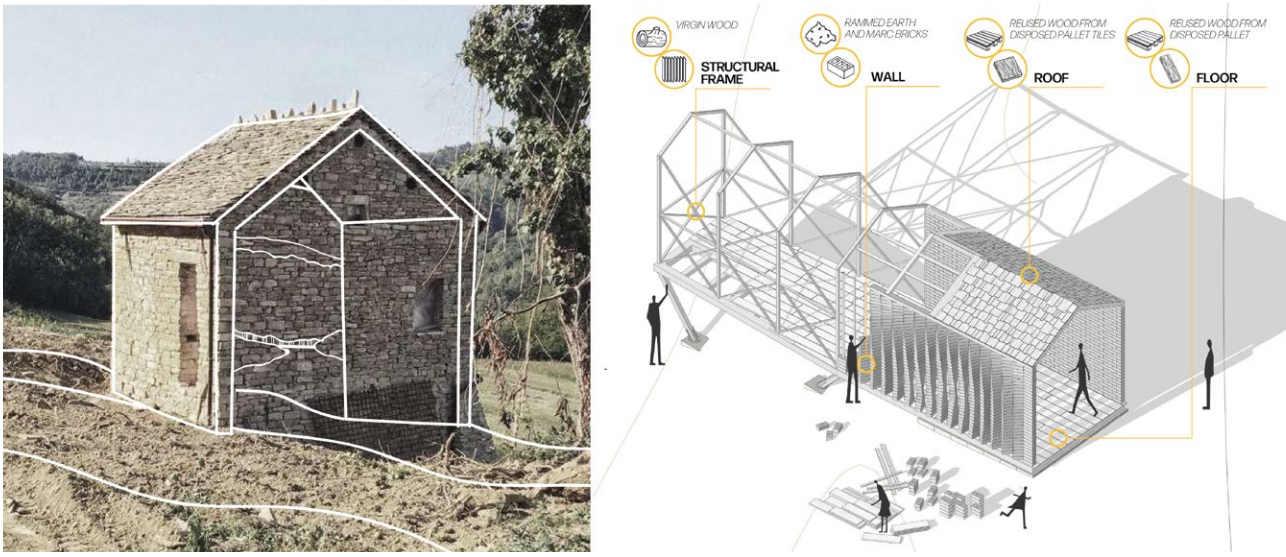

Figure 2 | Winner concept of the belvedere call for ideas (M. Gherardi, C. Goia, A. Marchesi, M. Puglielli, W. Tonelli).

Thanks to the determination and commitment of two of the former student authors of the selected project, arch. M. Gherardi and arch. C. Goia, the belvedere was revised and redesigned to overcome the technological and authorization obstacles, in collaboration with the faculty team and the initiative's promoter, and thanks to the continuous discussion with local stakeholders. As mentioned, after three years it was possible to proceed with the construction of the microarchitecture, classified by the municipality as a temporary installation.

The time dilation and energies expended were also influenced by the fact that adopting non-traditional design solutions, based on a circular design approach, require quite a long time for technical processing but also for cultural understanding and acceptance. In fact, in order to define the final design, it was necessary to revise some of the material choices initially assumed, reduce the number of components, and simplify the shape and volumes.

In particular, since it was not possible to use marc bricks for the walls, in order to maintain the expressive and symbolic value, it was decided to use the staves of end-of-life wooden barrels that are very common in the area characterized by a strong presence of wineries and suppliers and manufacturers of winemaking products.

From a material point of view, the final belvedere features a wooden structure provided by a local sawmill; anchorage to the ground with reversible steel foundations, sourced from a local supplier; walls made from old barrel staves, owned by Azienda Agricola Durando, and mounted on metal cables; flooring made from planks salvaged from discarded pallets of Durando.

Overall, the belvedere is only partially built with salvaged materials, but with high evocative value. In particular, the staves of barrels for the barrique, used in their original form, are clearly recognizable and characterizing the entire architecture. For reasons of safety certification, the glulam fir beams for the structure are new instead, but the material chosen is zero kilometre in order to reduce transport.

From a formal point of view, the belvedere is presented as a light, modular microarchitecture with simple geometries, consisting of independent layers. The rectangular base has a width of 2.38 m × 4.08 m and cantilevers into the void with a jump of about 1 m above ground level, immersing itself in the landscape. The gabled wooden portals are arranged in sequence with a height of 2.79 m at the ridge and allow unobstructed views across the front. The side walls, punctuated by the slats, filter the landscape with an ambiguous boundary between inside and outside, between architecture and nature.

Lastly, from a technical point of view, the architecture is completely disassembly as the connections are dry fitted with joints and screws (Figure 3).

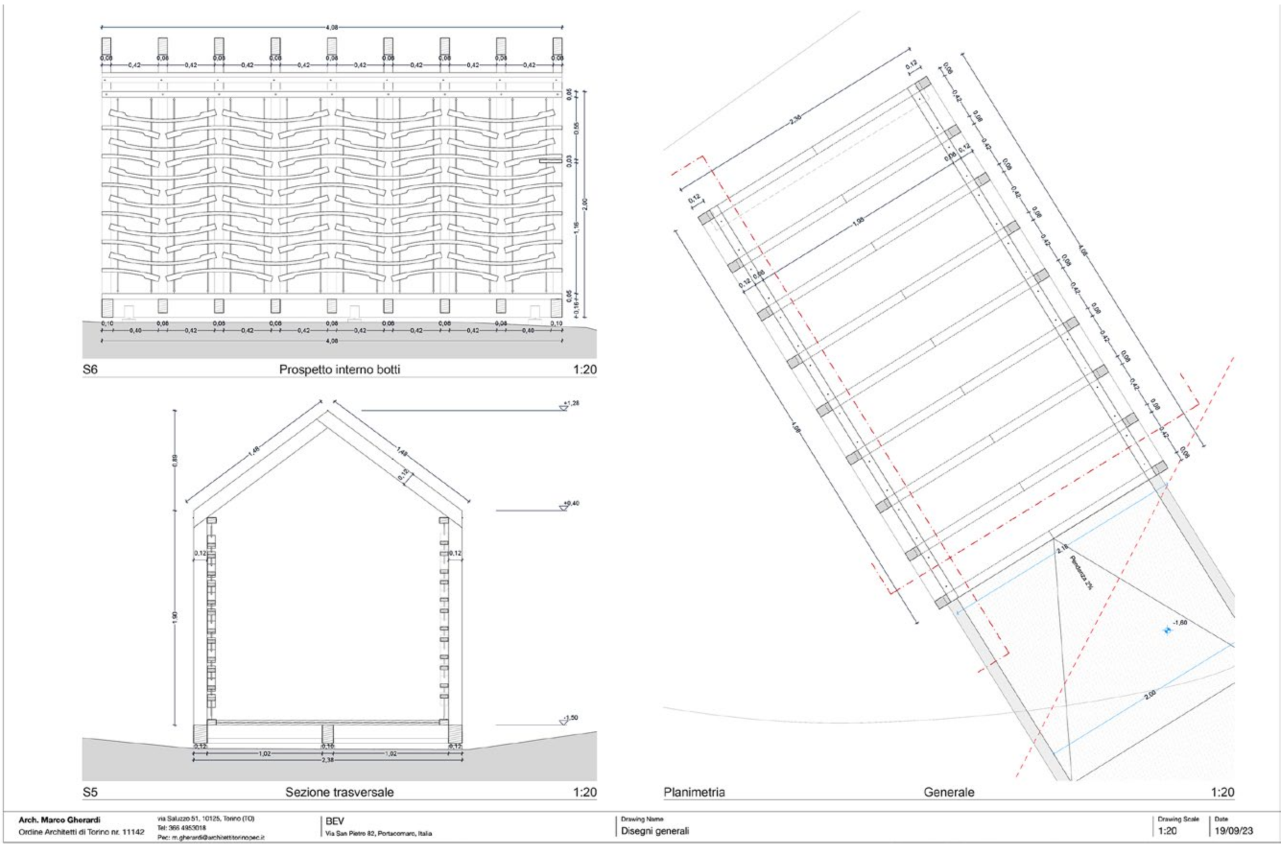

Figure 3 | Final design of CiaBOT: plan, elevation, and section (M. Gherardi, C. Goia).

3.2 Prototyping, experimentation, and self-construction

As anticipated, the realization of the belvedere took place in September 2023 through a self-construction teaching workshop. The participants were 10 students selected from the bachelor's and master's degree programs in architecture and design, the two former student architects who conceived the project, us teachers and researchers, technicians from the LaSTIn laboratory, and the Durando family: a multidisciplinary team in which participants learned to collaborate, exchange experiences, sensitivities, and knowledge.

The involvement of students was not only essential in the most concrete phases of the project, but was a cultural choice, a tool for education, training, and teaching. A participatory design opportunity to work in groups and practice practical skills in a real project context.

The workshop was structured in four days: two days in the LaSTIn's laboratory for the preparatory stages of prototyping and experimentation; two days of self-construction at the project site. The laboratory prototyping and experimentation phase is crucial in self-construction projects like this because it allows for verification of non-standardized solutions, identification of simple connection modes, testing of custom crafts that goes beyond traditional construction methods, measuring lead times to be efficient on the construction site, allowing students to practice with tools and equipment and become familiar with the project.

In this phase, for example, the serial drilling of wooden staves was experimented and a full-scale portion of the wall was prototyped from the working drawings. A full-scale model of the entire belvedere was then made from scrap materials available at the LaSTIn laboratory (Figure 4). Prototypes and physical models were also functional in planning the best sequence of activities and times during the construction phase. Finally, lab days were essential for sharing knowledge and building relationships among students of different ages, from different backgrounds and with different degrees.

Figure 4 | Scale model of the micro-architecture. The realization of the model was functional to learn how to read the project, to understand its construction phases and to experiment with some of the processes that would be carried out in situ.

The workshop then moved from the LaSTIn laboratory to the project site at Portacomaro. As it was scheduled, the construction site lasted two days and was carried out in two construction phases: the off-site production stage and the on-site production stage.

The first phase took place in the outdoor and indoor spaces owned by the farm, where the students stocked and prepared the material.

The task consisted of carrying out preliminary work such as: disassembling the staves of the old barrels, cleaning and drilling the staves, unbolting the pallets to obtain planks to be cut, sanded, and waterproofed by surface carbonization, and pre-assembling the structural frames of the belvedere (Figure 5).

The second phase started on the second day. The working site moved to the project area where the students started to install the frames. The impact on the ground was kept to a minimum. The sloping ground was slightly levelled, but the construction surface was, in fact, achieved through piles driven into the ground. The bulldozer and the machinery for planting the piles were the only large vehicles that passed through the construction site, and for a short time. All the rest of the materials were transported by hand, impacting the green soil as little as possible.

The construction, entirely dry-assembled with self-threading screws, developed as follow: firstly, the floor beams were anchored to the foundations, made from double-T steel piles driven into the ground; second, the vertical modular portals were assembled and attached one by one in sequence to the floor beams. In order to maintain the distance between the portals and prevent misalignment and swaying of the structure, four cross-beams of 8 cm × 5 cm section were installed along the entire length of the walls. To these was then attached the mesh of barrique staves mounted on steel cables.

Lastly, the previously cut pallet planks were nailed to the plinth to make the floor laid in a brick bond pattern, adapting the strips widths to the different size of the recovered planks (Figures 6 and 7).

Regarding the technologies used, simple workings were chosen to be carried out with the tools available at the LaSTIn laboratory so that students were able to rapidly learn how to use them and carry out the operations in a short time, according to a concept of appropriate technology. Hammers to drive the nails, crowbars, and tongs to disassemble the pallets, circular saws to cut the planks and a gas torch to char the surface, drills to perforate the staves of the barrels, and screwdrivers to tighten the screws securing the beams of the structure. In addition to this, the work of assembling the beams was facilitated by a tenon-and-mortise interlocking system carried out by machine by the sawmill that supplied the material.

Figure 5 | Some activities of the off-site production phase: above, disassembly of the staves of the old barrels and anchoring on steel cables; middle and below, unnailing, selecting, cutting, and burning the planks recovered from the decommissioned pallets).

3.3 Releasing the project to the territory

The result is CiaBOT, a new viewpoint for public use that frames the surrounding landscape, capable of conveying material messages - thanks to the scraps it is made of, the recognizability of their provenance, and the history they are imbued with - and immaterial ones, thanks to the people who built it and the network of actors who revolved around the project.

From the first portal raised during the self-construction workshop we experienced a lot of curiosity and questions about our work from passers-by: the belvedere immediately became a landmark for the territory and the first sign for the people of a new cultural message.

People currently use this small architecture informally, enjoying its privileged view on the Monferrato hills: locals use it for leisure, as a resting space during

Figure 6 | On-site production phase: above, positioning of the floor beams on the foundations, assembly of the modular portals, anchoring of the barrique walls; below, the completed belvedere.

Figure 7 | Detail of the connections between barrel staves, steel cables and structure.

walks or bicycle rides, for a picnic or to celebrate events, tourists as a vantage point for taking photographs, and children like to dangle their legs by sticking them out from the side of the slope (Figure 8). An official opening with a public event is planned for May 2024 to acquaint a wider audience with the broader significance of this micro-architecture (of its high symbolic and representative power) and the replicability of a design model that can be extended to other territories and other networks of actors.

4. Lessons learned on circular design and conclusions

At the end of our experience, we went back to reflect on the project's circularity level with respect to circular economy paradigms - environmental, technological, economic, social - and what value it could have for the actors involved and for the territory. In our reflection, we considered the feedback from the students who participated in the self-construction workshop, whom we asked to answer a series of open-ended questions with the aim of bringing out their views as young designers and architects on the perceived degree of sustainability and circularity of the CiaBOT project.

The aspects that meet the project's circularity requirements are many: disassemblability with a view to replacement repair and second life of materials; use of standard and dry connections; mono-materiality of components; as little material use as possible; use of waste material; km0 raw material; and surface finishes with low environmental impact, as in the case of carbonization of pallet boards.

For safety certification issues, also given the public use of the belvedere, the materials used for the dry foundations and those used for the supporting structure were purchased new. In percentage terms, these are

Figure 8 | People currently using CiaBOT. On the left a cyclist at a rest, on the right a young man meditating 'embracing' the landscape.

the materials with the greatest impact on the project. The pallet planks for the floor were mainly used in a functional/technical way. In this case, replacing the used planks with a new material would have further affected the environmental cost of the project. However, these do not communicate their original origin and therefore, on a communicative level they contribute less to explicitly convey the idea of circularity and sustainability to the users of CiaBOT.

About the staves of the barrels, by contrast, these have an aesthetic, symbolic and narrative function central to the project. The staves, in fact, by maintaining their original shape, color, and surface treatment, have the capacity to narrate their previous provenance and origin also in expressive, communicative, and not only functional terms. Elsewhere, we have defined this communicative capacity of some materials as the "visibility" of circularity (Montacchini, Tedesco, Di Prima, 2021 a). This has particular value in a project such as this that also intends to communicate and raise awareness of the issues of circularity and sustainability.

Another aspect of circularity, also covered in the CE literature, concerns the priority given to harnessing human energy through appropriate technologies. Wherever possible, processes have been devised to enhance the use of technologies and tools that are easy to learn and sufficiently effective. Moreover, recovering materials to give them a second life involves taking care of the materials themselves, both in the disassembly phase of the original product and in the reassembly phase. In particular, to disassemble barrels and pallets, the use of hammers, pliers, and picks made it possible to ruin the material as little as possible and recover as much as possible. Since the availability of end-of-life barrels and pallets was given (finite resources), it was necessary to maximize their value. Using "slow" and manual tools made it possible to devote more attention to the available resources and not waste them.

Appropriate technologies and slow times, together with the design study of the different manufacturing processes, also made it possible to "interpret" the available used semi-finished products -similar to each other, but not identical in terms of thicknesses, widths, and lengths -and assemble and juxtapose them in order to achieve a harmonious and aesthetically optimal final effect.

Moreover, we believe that the degree of circularity of the project can be measured not only by considering the percentage of new or reused materials, but also by the project's ability to have activated a network of actors whose relationships are based on mechanisms of exchange, reciprocity and conviviality rather than purely commercial transactions.

In fact, the project was completed mainly thanks to the willingness of collaboration among the different actors (students, teachers, and farm) who donated resources, skills, energy and time to the project, not from a monetary perspective, but from the perspective of learning and training, of co-generation of knowledge. In particular, the workshop days were enlivened by the principle of conviviality, which, as Illich states, means replacing the purely technical and material value of exchange with an ethical value of collective achievement (1973). Thus, the sustainability of the project can also be measured by the social and socializing value of the processes that are chosen to bring it to fruition.

In conclusion, each actor united efforts and availability with the aim of working together for a project that can be considered a common good for public use that benefits the territory and its inhabitants. A project that fits coherently into the defined mandate of the University's Third Mission, marked by a strong methodological contribution and the replicability of the model, an experience that can be exported to other territories and with other actors, disseminating circular economy practices that are sustainable and accessible to all.

Acknowledgments

The authors would like to thank arch. Marco Gherardi and arch. Chiara Goia for their determination during the design phase; Angela Lacirignola, LaSTIn self-construction section contact person, for her support during the realization phase; Sara and Alessandro Durando who, like us, believed in this project to the end; arch. G. Sottero for the technical support in the building practices; the students who enthusiastically participated in the self-construction workshop: E. Alabrese, S. Favatà, N.A. Montenero, M. Navaro, T. Poles, S. Re, S. M. Re, F. Scaglione, A. Scamuzzi, G.B. Vettorello, C. Fasano, J. Gasparotto; the winning team of the belvedere first concept: M. Gherardi, C. Goia, A. Marchesi, M. Puglielli, W. Tonelli.

The paper is the result of a common reflection and is written jointly by the authors.

References

Blomsma, F., & Brennan, G. (2017). The Emergence of Circular Economy – A New Framing Around Prolonging Resource Productivity. *Journal of Industrial Ecology*, *21*, 603-614. https://doi.org/10.1111/jiec.12603

Bolger, P., Brereton, P., Grant, O., & Torney, D. (2021). *Better together: knowledge co-production for a sustainable society*. Royal Irish Academy.

Calisto Friant, M., Vermeulen, W.J.V., & Salomone, R. (2020). A typology of circular economy discourses: Navigating the diverse visions of a contested paradigm. *Resources, Conservation and Recycling, 161*, 104917. https://doi.org/10.1016/j.resconrec.2020.104917

Condotta, M., & Zatta, E. (2020). Reusing Time in architecture: The practice of reusing building products and components. *Techne*, *10*(20),113-121. https://doi.org/10.13128/techne-8209

Dokter, G., Thuvander, L., & Rahe, U. (2020). How circular is current design practice? Investigating perspectives across industrial design and architecture in the transition towards a circular economy. *Sustainable Production and Consumption, 26*, 692–708. https://doi.org/10.1016/j.spc.2020.12.032

Homrich, A.S., Galvão, G., Abadia, L.G., Carvalho, M.M., Homrich, A.S., Galv, G., Galvão, G., Abadia, L.G., & Carvalho, M.M. (2018). The circular economy umbrella – Trends and gaps on integrating pathways. *Journal of Cleaner Production*, *175*, 525-543. https://doi.org/10.1016/j.jclepro.2017.11.064

Illich, I. (1973). *Tools for Conviviality*. Harper & Row, New York.

Irwin, E.G., Culligan, P.J., Fischer-Kowalski, M. et al. (2018). Bridging barriers to advance global sustainability. *Nature Sustainability, 1*, 324–326. https://doi.org/10.1038/s41893-018-0085-1

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy – An analysis of 114 definitions. *Resources, conservation and recycling, 127*, 221-232. https://doi.org/10.1016/j.resconrec.2017.09.005

Leising, E., Quist, J., & Bocken, N. (2018). Circular Economy in the building sector – Three cases and a collaboration tool. *Journal of Cleaner Production,* 176, 976-989. https://doi.org/10.1016/j.jclepro.2017.12.010

Massaro, S. (2023). *Abitare Circolare. Reimmaginare gli scarti come beni comuni e futuri asset culturali.* D Editore, Roma.

Mies, A., & Gold, S. (2021). Mapping the social dimension of the circular economy. *Journal of Cleaner Production,* 321, 128960. https://doi.org/10.1016/j.jclepro.2021.128960

Montacchini, E., Tedesco, S., & Di Prima, N. (2021a). Designing Circularity. The circular economy for landscape and territory. *A new life for landscape, architecture and design,* 158-173. Palermo University Press.

Montacchini, E., Tedesco, S., & Di Prima, N. (2021b). *Progettare e sviluppare l'economia circolare. Un'esperienza didattica sulla trasformazione di rifiuti in nuove risorse per l'architettura e il design.* Anteferma edizioni, Conegliano (TV).

Moreno, M., De los Rios, C., Rowe, Z., & Charnley, F. (2016). A conceptual framework for circular design. *Sustainability, 8*(9), 937. https://doi.org/10.3390/su8090937

Muñoz, P., Morales, M.P., Mendívil, M.A., Juárez, M.C., & Muñoz, L. (2014). Using of waste pomace from winery industry to improve thermal insulation of fired clay bricks. Eco-friendly way of building construction. *Construction and Building Materials, 71*, 181-187. https://doi.org/10.1016/j.conbuildmat.2014.08.027

Rathje, W.L., & Murphy, C. (2001). *Rubbish!: the archaeology of garbage.* University of Arizona Press.

Salvia, R., Andreopulou, Z.S., & Quaranta, G., (2018). The Circular Economy: A Broader Perspective for Rural Areas. *Rivista di studi sulla sostenibilità,* 87–105. https://doi.org/10.3280/RISS2018-001008

Schumacher, E.F. (1973), *Small is beautiful – Economics as if people mattered.* Harper & Row, New York.

Van Hinte, E., Peeren, C., & Jongert, J. (2007). *Superuse: constructing new architecture by shortcutting material flows.* Oio Publishers, Rotterdam.