Spacecraft for well-being. Heritage, design, renewable sources for new lifestyles

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Abstract. The paper describes the design method developed by the multidisciplinary research group comprising Heritage design, Ecodesign, Home Automation and Renewable Sources for the design of small demountable structures. The design process is characterised by attention to aspects related to health and well-being in order to orient contemporary habits through the use of spatial devices capable of distracting attention from the ways of continuous connection with the digital world. The "spacecraft", small dismountable structures, characterised by home automation systems, renewable energy and sustainable materials, can constitute a "joyful spatial system" for manual making, listening to stories between different generations, cultivating cultures and reading books. They are designed to support the functions carried out in public buildings with specific uses, such as hospitals, social centres and retirement homes.

Keywords: Spacecraft; Eco-design; Home automation; Renewable sources; Cultural heritage.

The systemic approach of eco-design

Eco (*ôikos*) is the prefix for the composition of words derived from Greek used in modern times, namely house, family and social organism. Hence the heterogeneity that characterises the definition of eco-design. It is the design of a product, a social or economic system, respecting the environment, both concerning dimension, having to deal with the territory, and subject, for the necessary knowledge and/or relationship with the environmental characteristics where the artefact will be located, up to the use of appropriate materials for the project (Morelli, 2024). In the early 1970s, the debate on environmental issues was characterised by heterogeneous expressions, including scientific studies, political activism, movements and associations. There was a growth in the attention of biologists, physicists, demographers, and doctors who quantitatively evaluate the unsustainability of urban development, besides the emergence of a political sentiment as a form of commitment to the defence of collective health, questioning the myth of progress and unlimited prosperity with respect to technological and scientific innovations. Indeed, already in the sixties the interest in the defence of the environment had shifted from nature conservation through Pro Natura, Italia Nostra and WWF Italy, to the fight against pollution, the impoverishment of natural resources, and the increase in population (Formia, 2023).

Current eco-design practices such as reduction, reuse, maintenance, recycling, dematerialisation of the product-service (Violano, 2024), use of renewable energy, minimisation of polluting emissions, choice of materials, analysis and their certification, contribute, among others, to the Bill of Rights for the Planet, developed during EXPO 2000 in Hanover (McDonough, 1992; McDonough and Braungart, 2010), namely the 17 Sustainable Development Goals. Eco-design observes how design has contributed to the implementation of these sustainability goals (Chou, 2021) and some manifesto-texts, giving a holistic vision of "making design in a sustainable way", from Pope Francis' Encyclical *For the Care of the Common Home* (2015) to *The Assisi Manifesto* (2020), which sees among the first signatories the Symbola Foundation, the Sacred Convent of Assisi, Institutions, Companies and Banks of international and national importance.

The echo of history

A reflection on the relationship between man and nature that follows Henry David Thoreau's pioneering reflections on green thought stems from the analyses G. Perkins Marsh presented in his book *Man and Nature*, published in America in 1864, translated and published in Italy in 1870 (Marsh, 1864). Looking at the American situation, Marsh described for the first time the enormous damage that had occurred in nature due to anthropic intensification, which was producing worrying phenomena of desertification and deforestation, launching his warning not to repeat similar destructions in the Mediterranean landscape, from which he hoped to draw a valuable lesson for future generations (Settis, 2017). Marsh, who settled for about two decades in Italy, defined the intensive exploitation of the land for the expansion of "land occupation in cities" a growing phenomenon that well described the significant repercussions in terms of landscape occupation and evident changes in the relationship between individual property and the common good. The macroscopic movement of land colonisation in America had been accompanied in Europe by massive industrialisation, with immediate consequences for air and water pollution, evoked in literature in the smoky and grey image of the imaginary city of Coketown in C. Dickens' 1854 masterpiece *Hard Times*. It would later be J. Ruskin who would prophesy the imminent dangers for nature and the need for a concerted effort in its defence. The fumes of the factories were changing the natural colours of the London sky, and in these artificial thickenings he glimpsed the bewilderment of an entire society in the making, identifying in the uncontaminated landscape, in the beauty of nature, and in the values of history the sources of a strong moral lesson in recalling a civic responsibility of the community, to which the new protectionist movements were turning (Beltramo, 2019).

Examples of socially progressive human interventions that did not prevail over nature, but on the contrary were in dialogue with it, were already to be attributed to the Shakers, a religious community active in the American Northeast in the eighteenth century. A great spirit of utility derived from the values of sim-

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plicity and commonality tended to enhance the sincerity of the materials available, cherry and maple woods, wicker and natural fabrics. It was the crisis of agriculture in the second half of the nineteenth century that directed the Shakers in the search for new forms of livelihood, similarly connected to nature, which pushed them towards the foundation of chair factories and the production of wooden objects (Vitta, 2011).

With a rare ability to align functionalism and transcendence, experimenting with an aesthetic code destined to last over time, the Shakers aimed to create heaven on earth, an earthly paradise within which the useful and the necessary aspired to embody both spiritual and physical beauty. However, the romantic idea of *homo faber*, capable of building objects of survival and drawing just enough on nature, was destined to vanish under the shock wave of modernisation, not only of production processes, but also of markets and economies on a global scale. With the division of labour, even the creative mind and the hand that makes are almost definitively dissolved. In the world of design, the solitary figure of the designer, who embodied art and technique in a single entity, would soon be replaced by that of multiple specialised actors who were entrusted with the task of generating projects intended to meet the generalised needs of a vast and unspecified audience of users. The transition from the handcrafted one-piece to the large series of industrial production would not only make the objects the result of a lucid design programme aimed at following the demands of the market, but would definitively remove them from the rationale, availability and times of nature. «From then on, designing the world», Vitta states, «meant above all building it, embodying it in matter and energy so that the human being could find satisfaction with it» (Vitta, 2011).

Within this evolutionary framework, the very origin of the dichotomy between design and eco-design can be traced back to Richard Buckminster Fuller for whom design integrated with technology could really revolutionise construction and, at the same time, improve human life. Fuller, a scientist and thinker beyond the boundaries of individual disciplines, paid attention to sustainability and the environment for the first time. In his projects he clearly identified the problem common to design, architecture and many other areas. The concept of "spaceship earth", the limited amount of earth's resources that can no longer be replenished, still has great relevance today, serving as a warning to humanity about its role in protecting the planet through intelligent design. Fuller explores the processes of mass production and industrialisation to rethink how living could evolve, namely through large-scale efficiency, waste reduction, and less use of resources (Fuller, 1969).

World War II interrupted the flow of reflections arising from these researches and, in the following season, that of the continuous growth of the city to be rebuilt in its primary infrastructures prevailed over the other lines of thought. The human home has played a primary role in the design processes, which have been entrusted with the task of instilling confidence and hope through new ultra-modern and functional domestic landscapes inspired by the great mirage of economic recovery. While the already fragile bond between man and nature was about to be definitively broken, removed and confined to the inaccessible dimension of the "reserve", there have been new attempts at reappropriation that through "Land art", an art form born in the United States of America in the mid-60s, has intervened on natural territories, deserts, salt lakes, grasslands, seas, etc. The definition of "Land art" and Earth Workers included all the artistic operations that, at the crossroads between New York and the boundless places of the American West, were carried out by a group of artists, proponents of nature, disillusioned with the society of rampant consumerism, crushed by the nuclear threat, and eager to evaluate the power of art outside the institutionalised environment of exhibition spaces and dedicated urban areas.

The numerous artistic movements dedicated to documenting the way in which time and natural forces have managed to change objects and gestures were born from a general concept of defiance of contemporary conventions, which resulted in a real countercultural revolution. The emerging artistic sensibility proved to be critical and nostalgic, alternating nihilistic aggressiveness with the shaping force of new material landscapes that expressed the sense of necessity and the desire to protect the territory, on a large scale.

Contesting the idea that the designer's task was to constantly create new needs, even at the cost of introducing poor quality, useless or harmful products to the market, Victor J. Papanek emphasised the importance of democratisation of design work and a responsible approach to design. This approach would be able to address the problems and contradictions of development, such as the uncontrolled exploitation of the environment and natural resources, the destruction of local cultures and traditions due to globalisation, growing social inequalities and neocolonial dynamics generated by "advanced capitalism". Only by integrating a clear vision of current reality and a utopian drive for change would industrial design carry out its mission in an innovative and effective way (Papanek, 1971).

It was E. Sottsass who sensed and made the state of crisis his own, entering into a close relationship with the codes of Land art through landscape photography, reworked with the elementary sign of architectural traces. Ephemeral structures he composed by wandering through plains, deserts, mountains and valleys. Minimal constructions to be lived in metaphorically in which man was placed in direct connection with the environment, without either mediation

01 | Drawings for the destinies of man, photograph by E. Sottsass, 1972 (from Ettore Sottsass Design Metaphors, Milan exhibition, 29 September 2023 – 15 September 2024)

02 | Virtual architecture, 1973; Boyfriends. I designed a vase for my girlfriend, 1977, photographs by E. Sottsass (from Ettore Sottsass Design Metaphors, Milan exhibition, September 29, 2023 – September 15, 2024)

or filters. The posthumous book *C'è il Pianeta* re-proposes the photographic collections of forty years of Sottsass' travels (Figs. 1, 2). A visual and conceptual portrait of a catalogue that blends the observation of nature with that of human experience, capturing not only physical scenarios, but also emotions, reflections and deeper connections. Sottsass treats every element, whether natural or artificial, as part of a larger design, intertwined with the human condition, within a poetic and cosmic dimension at the same time (Sottsass, 2017).

Within this historical reconnaissance, Marsh's premonitions take on particular significance in relation to the current environmental crisis. His appeal to civic responsibility and landscape protection, which are proposed as places for the reactivation of the connection between man and nature, directly inspires the spacecraft project. The echo of this vision is reflected in the choice of local and natural materials and in the pedagogical approach that orients the project towards a regenerative function, both social and environmental. However, the reference to Marsh is not to be understood as directly attributable to specific material choices, such as those made by Aalto with the use of wood. The two positions are not assimilable. Indeed, Aalto develops an aesthetic of sensory well-being through form and materials, while Marsh elaborates a systemic and pre-ecological vision of the balance between man and the environment. It is, therefore, an ethical rather than a disciplinary consonance that binds these approaches, and it is useful for tracing a value horizon for the project.

In the vision of eco-design, the comparison with the territory is central, both from a dimensional and multidisciplinary point of view. The project looks at the specificities of the local context, traditions, materials, including future problems and potential. A holistic approach, spanning a variety of disciplines, allows for the development of more conscious and innovative solutions to contemporary challenges, from design to eco-design, both from an ecological and social point of view (Antonelli, 2021).

Spacecrafts, definitions and models

The multidisciplinary research group characterised by historical, design and technical skills, starting from the assumption of a necessary change in contemporary habits, designs and conforms spatial devices for manual skills. They favour intergenerational relationships, defined as "spacecraft", small demountable structures, "laboratories of doing", featuring home automation systems and renewable energy, eco-sustainable materials, "joyful space systems" suitable to improve the quality, well-being and lifestyle of people. The term "spacecraft" should not be understood exclusively in the sense of vehicles built to operate in space and re-enter the Earth's atmosphere, therefore associated with temporary structures. The objectives and functions of the project appear clearer by referring to the two separate terms "space" and "crafts". The principles of "Arts & Crafts", a movement whose purpose was the revaluation of craftsmanship against the overwhelming industrial production and the decline of taste observed in the latter half of the nineteenth century (Vitta, 2011), place the manual skills of man, his needs and the value of time at the centre. They hover as an incipit in the conformation of these small spaces designed to trigger disconnection from the digital world, favouring, instead, a concrete connection with the environment and people, grafting themselves next to and in support of public buildings, such as hospitals, social centres and retirement homes.

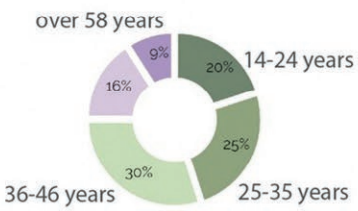
Design suggestions come to us from interventions carried out at the service of structures with already consolidated typologies, such as the project by Padilla Nicás Arquitectos (2021), "Rooftop Garden of the O'Donnell Maternity Hospital" in Madrid, Spain, where the roof of the hospital was transformed into a recreational garden for inpatient children, or the project for the internal courtyard of the Sheffield hospital, curated by artist and designer Morag Myerschough (2022), where the space can host laboratories, workshops and performances, involving families and hospital staff. The nursery school in Guastalla, designed by Mario Cucinella Architects, presents a sequence of wooden frames in the shape of a "whale" with the function of orienting the child toward the different educational spaces (Fig. 3).

The innovative contribution of spacecraft lies in the fact that they are models formally developed according to the place and needs; typologically, small buildings of a seasonal nature;

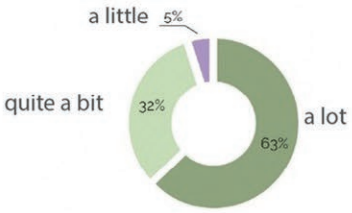
03 | Case studies: Roof garden of O'Donnell Maternity Hospital, Padilla Nicás Arquitectos, 2021; Garden of Joy Courtyard, Myerscough M., 2022; Nursery School, Mario Cucinella Architects, Guastalla, Italy, 2012; Bloc Salle de Bains Les Arcs 1800, Perriand C., Centre Pompidou. 1975

topologically, grafted offshoots, inclusions, derivations, at the service of the users of the buildings adjacent to them to promote people's well-being and introduce a new lifestyle. This approach, although fuelled by a set of design intentions, is based on a structured methodology, which starts from the analysis of the environmental, urban and social context – conducted through metric surveys, inspections, interviews and questionnaires, according to the rationale of co-design. It defines the objectives, the structuring of the activities, the evaluation of results, analysing objective data of measured parameters, finally reaching the selection of materials according to sustainability criteria, which can be verified with tools such as Life Cycle Assessment (LCA), up to the possibility of disassembly at the end of their life. Indeed, the critical issues related to the heterogeneous composition of the modules are recognised, and design solutions are envisaged for the separability of components, their reuse or correct disposal according to the principles of circular economy.

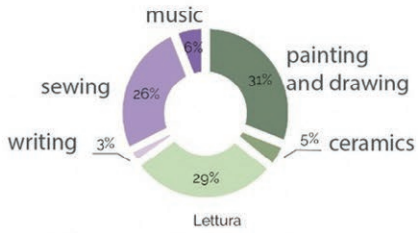
04 |



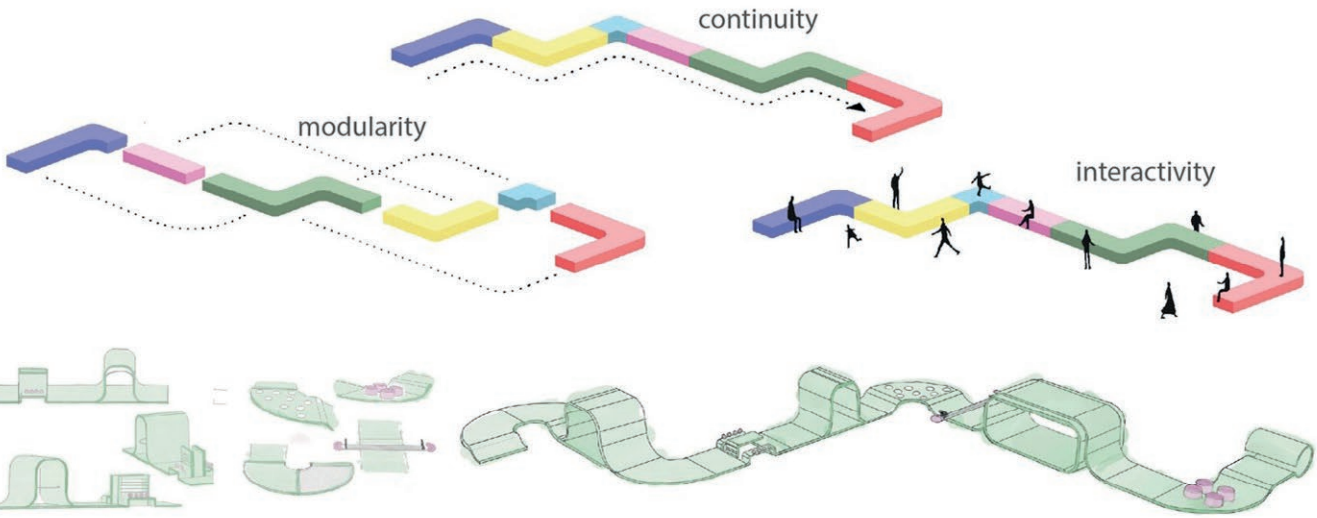
age group



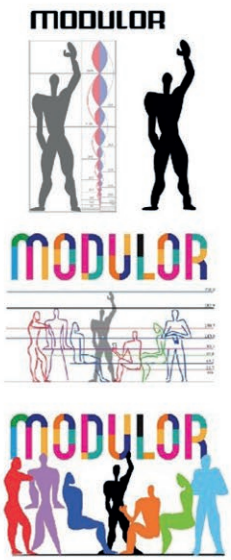
How important do you think the presence of play areas near the hospital is?



would you prefer laboratory activities on



Hence, the eco-design process starts from the investigation of the natural, cultural, economic, social resources of the place, surveying topographies and urban structures, followed by an environmental and sensory analysis, up to the detection of local economic resources. The second phase of analysis concerns the area in which the installation of the artefacts was hypothesised, detected through metric and photographic inspections, followed by the morphological and typological investigation of the surrounding buildings, with an in-depth analysis of the needs and criticalities of the local inhabitants, the administration of questionnaires, in order to propose innovative solutions to improve the stay and experience inside the spacecraft (Figs. 4, 5).
Two spacecraft proposals are described below: a linear model placed around the hospital in Foligno (PG); a block model inserted between a primary school and a multipurpose centre in Montebello (PG).
In the first case, the intervention is placed around the hospital complex, designed in the '70s, whose semantic matrix is that



INTERVIEWS

"comfort space"

"everyone must share spaces"

"enrich the city of Montebello"

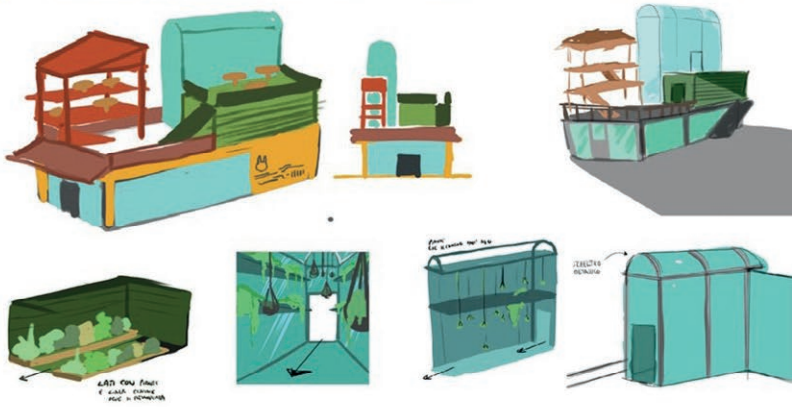
"a place in harmony with the landscape"

"we expect it to improve local well-being"

"spaces as a meeting point"

"a place that can bring together people of all ages"

"keep in mind people with disabilities and the elderly"



of the fortified 'citadel', a tribute to the history of Foligno. The hospital is surrounded by a green belt along which a panoramic promenade unfolds, with a view of the Church of St. Paul the Apostle by M. Fuksas and D. Mandrelli (2009). "Craftiroll" is a "ribbon" street furniture system (cf. "Kontinuität" by M. Bill, 1966) composed of modules that together allow different compositions of a playful path, characterised by games and gymnastic equipment, and small laboratories that host different reading, resting and manual skills. The frame of the structure is made of steel, the flooring and the external cladding is made of recycled rubber, memory foam for the seat padding, Alcantara fabric for the internal covering, cork for thermal insulation, GL24H laminated wood, corkpan, rice husk and paracord, high intensity polyethylene and mineral fibre panels (Fig. 6).

The second "Modulor" model is located in Montebello. Its historical fabric consists of two units located near the parish church and the Colonnetta. The intervention area is located between an elementary school, a multipurpose room with ad-

06 | Models of the eco-design process, "Craftiroll" project

07 | Models of the eco-design process, "Modulor" project

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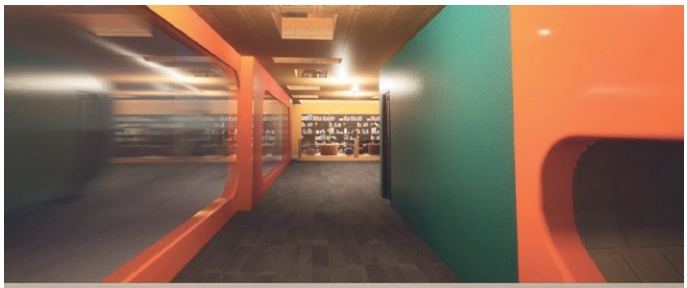

joining recreational club, and two small equipped green areas. To acquire in-depth knowledge of the desires of future users of spacecraft, didactic-exploratory workshops were organised with students of the school, structured in three phases, namely "historical", "natural" and "creative". The first two featured cognitive inspections on the history and environmental characteristics of the area of intervention. The third, thanks to the contribution of an empathic tutor, addressed graphic and material restitution by the children of possible usable environments desired by them. "Modulor" spans two floors. On the ground floor there are stairs used both to access the upper floor, such as urban steps, block toilets, a laboratory area and an elevating room-library, which allows everyone to reach the upper floor, which houses a vegetable garden, a greenhouse and a large terrace. In this case, steel and tempered glass were used for the frame and the greenhouse, Polyethylene terephthalate (PET) for the windows, Wood Plastic Composite (WPC) for the external steps, solid wood for the garden structure (Faresin A., 2012) (Fig. 7).

Home automation systems for the well-being of users

Spacecrafts have been imagined as innovative cockpits where, thanks to home automation systems designed and included within the various experiments, it is possible to ensure comfort and guarantee regeneration to the users of the spaces (Racha-Pacheco *et al.*, 2023). This is followed by a series of solutions adopted within the projects and concerning energy conversion systems, lighting, sound diffusion, tools for controlling the temperature and air quality of the environments, tools for physical well-being and support tools for inclusion (Wang, 2010).

To cover the electrical needs of the rooms, photovoltaic films were opted for, very flexible devices suitable for different applications thanks to their low environmental impact, during the operational phase of the life cycle, and their lightness and structural thinness.

Recessed LED systems with a colour temperature of 4000K and equipped with infrared presence sensors were used for uniform artificial indoor lighting. The motion sensor can detect the presence of a moving body up to two metres away, and turn off after a set number of seconds of no detection, thus saving energy and improving nighttime safety. The sensor is sensitive to both motion and the amount of infrared energy it detects. Similar systems were also used for the exterior of artefacts, such as decorative light or lighting. Daylighting, if properly designed, can provide a wide range of benefits, including improving the visual environment, circadian rhythm, as well as occupant satisfaction and productivity, reducing the energy load for electric lighting. This is why it was decided to insert electrically activated chromogenic glass capable of transforming from transparent to opaque, and to control the passage of heat and light by switching from bidirectional to unidirectional. The heating requirement is guaranteed by electrically powered refrigeration machines/heat pumps.

Another aspect common to all spacecraft concerns the systems for measuring temperature, humidity, noise levels and air quality. For the latter, sensors are able to detect the presence of pollutants such as fine dust, carbon dioxide and harmful gases. The systems send signals when concentration levels exceed attention or danger levels.

As far as the piped sound system is concerned, there are speakers resistant to external agents and water. The acoustic system allows music and sounds to be distributed evenly in all environments, creating an immersive sound experience.
The areas dedicated to physical well-being have been equipped with specific intelligent furnishings. The stretching roll in the "Craftiroll" spacecraft is a Body Pressure Measurement System that measures and detects contact pressure distribution between the human body and a support surface. The Muscular Switch sensor has been inserted in the same environments, capable of perceiving very weak and short-lived muscle contractions from any part of the body. An activity tracker sensor has also been placed to measure heartbeats, besides an oxygen meter capable of measuring the heart rate thanks to a pair of LEDs and photodetector. The volume of blood inside an artery changes during heartbeats. This fluctuation can be detected through an optical system, applied to a part of the body rich in blood vessels, such as the fingers.
In the passages of entry and exit of the spacecraft there are thermal stress meters, capable of detecting important quantities for climatic comfort, such as the temperature of the wet bulb and the dew point. Heat stress indices provide tools for assessing hot environments and predicting the likely thermal stress on the body. The automated systems include the automatic irrigation system, connected to soil moisture sensors that guarantee optimal irrigation. The system has a container for collecting rainwater, thus helping to reduce water waste.
Equally interesting is the microLED screen that allows to create displays of any format, customising the size and ratio of the screens to fit any space.
In addition to automated intelligent home automation systems, tools managed directly by users are installed to improve the performance and comfort of the environments. Among these, the voice assistant allows you to control the various devices, lighting, heating, air conditioning and irrigation, through voice commands.
Inside the spacecraft there are "finger readers", electronic rings that allow the blind to read a book. The prototype, developed by the MIT Media Lab, converts text visible on the screen into an accessible form, such as text-to-speech or braille playback.

Conclusions

The theme of well-being in a holistic sense, starting from people to the environment and/or *vice versa*, is made possible only through an innovative and co-evolving look, allowing the development of new spatial solutions, such as those illustrated. Spacecrafts are innovative, shared spatial models, oriented towards the well-being of the community, to encourage human relationships, manual skills, collaboration, creativity, and the sharing of ideas. Designed to serve buildings or public spaces through a "kit-of-parts" system, they do not require interventions on the existing heritage for installation, and provide sustainable solutions, verified through the LCA. Indeed, they assess environmental impacts that could potentially derive throughout the lifecycle of the artefact, from the initial phase, to its use and final disposal of the structure. In addition to environmental aspects, the project pursues social objectives by promoting inclusion, participation and intergenerational cohesion. The home automation module integrates numerous smart devices (sensors, voice assistants, photovoltaic films, automatic irrigation systems, microLEDs, etc.), which contribute to innovation, accessibility of spaces and energy sustainability, in a project that aims to encourage disconnection and reconquest of slow time. The project assessed the limits and potential risks related to digitisation, assessing its consistency with the general objectives of reconnection with nature, promotion of manual skills, and psychophysical well-being. In this sense, cautious design has oriented the choices towards a balance between technological innovation and functional sobriety, preserving the principle of the centrality of the human being in space.

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