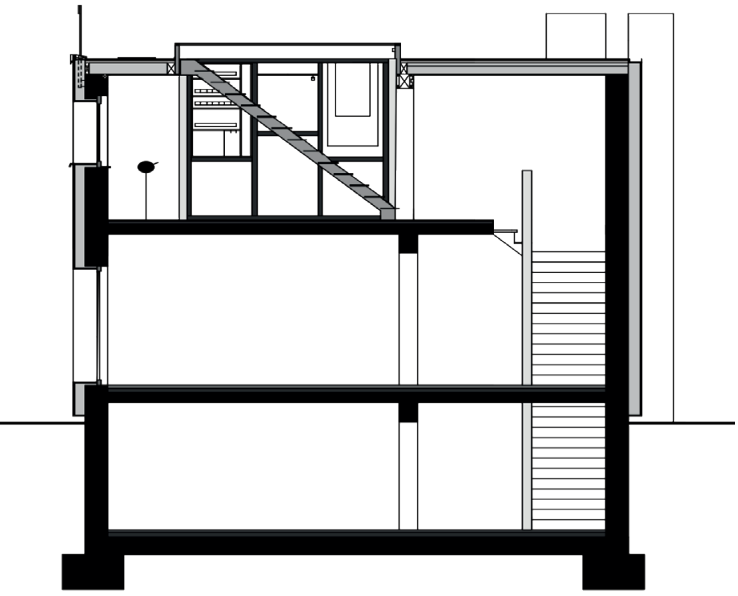
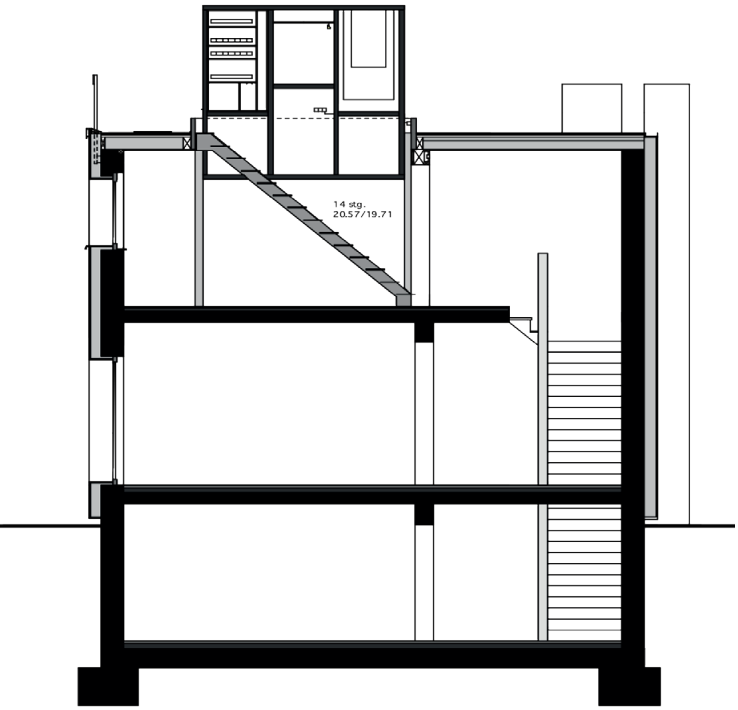


schnitt a-a
m. 1 :50



schnitt a-a
m. 1 :50

Room with view. Mobile terrace.

Environmental and technological flexibility for new housing needs

Gerhard Kalhoefer[1] and Donatella Radogna[2]

[1] Hochschule, University of Applied Sciences Mainz
[2] Department of Architecture, University G. D'Annunzio Chieti-Pescara
Email: dradogna@unich.it

Abstract: Over time, the economic and social conditions determined expansion and contraction processes of the domestic space (from the cave to the castle, from the castle to the studio flat) with important consequences on people's life quality. This evolution stimulated the development of cultural debates and design experiments on the theme of flexibility. In the contemporary scenario, flexibility has a big value because it represents an important design strategy to meet the needs of contemporary living in a sustainable dimension. For more than twenty years, the authors have been linked by a working relationship aimed at comparing theoretical scientific developments and design practice. This paper offers some reflections on the evolution of flexibility concept in residential construction by providing concrete examples through the reading of some projects. The variations of flexibility are debated with reference to the people's needs in the adaptive reuse of buildings. The writing faces the functional mix and the modifiability of interior spaces given by the design of flexible technological units (partitions, systems, furnishings) and mobile additions as well as the adaptability of the closures with respect to climatic and seasonal conditions. The theme of flexibility, too often "oversized" and not investigated in terms of feasibility, is presented in a possible and useful scale. Flexibility is also faced as a new way for showing the link between utility and beauty of the spaces.

Keywords: housing; changing needs; transformable architecture.

Cite as: Kalhoefer, G., Radogna, D. 2022. 'Environmental and technological flexibility for new housing needs'. *VITRUVIO - International Journal of Architectural Technology and Sustainability*, *7*(1), pp. 30-45. https://doi.org/10.4995/vitruvio-ijats.2022.17461

1. Introduction. More in less

The house is the place where the bond between man and architecture is strongest. The house "interacts" with the ways of living, defining the quality of life. Over the history, the houses character and configurations changed according to continuous processes of expansion and contraction of spaces, functions and ways of carrying out activities. In these extreme evolutions (from the cave to the castle, from the castle to the studio flat), the original essential refuge was enriched with closed and open spaces, not only private. In some periods, the residence included large spaces, now public, considered the main places of political and social life. This extreme expansion of the domestic space was followed by a process of progressive contraction, in which wars, economic crises and changes in lifestyles reduced the house to the basic domestic functions such as rest, food and personal hygiene care. However, the crisis conditions that led to these processes also led to the development of new ways of working and studying that made homes inadequate in terms of size and number of environmental units. Smart working and distance learning, for example, require spaces of which many of the houses built in the last thirty years are lacking. In addition to these new needs, there are also those of socialization. The inability of a child to invite friends to play at home, for example, is a social limitation that can determine conditions of marginalization as well as the difficulty of an adolescent to organize study groups or an adult to carry out activities of smart working (Arbizzani, Baratta, Cangelli, Daglio, Ottone, Radogna, 2021). Many elderly people often live in houses sized for a more numerous family unit years before, built when large environmental units were requested. This excessive oversizing of the domestic habitat gives a waste of resources and can negatively affect the quality of life.

The recent pandemic has also underlined the importance of private open spaces, often missing in current housing solutions. The activities that disregard the basic ones represent the elements that can create new links between the private and collective dimensions and among the accommodations, he buildings and neighborhoods spaces. Residential buildings should be transformable systems according to the evolution of lifestyles (Radogna, 2020).

Contemporary society can be summarized in the word 'more'. If in doubt, go up a size, get in a bit more – just in case it turns out you don't have enough. It's a blend of prudence and avarice, the fear of not having enough crossed with the drive to keep acquiring more.

The automotive industry, for instance, thrives on the principle of 'Supersize me!' – a principle it is currently transferring particularly well to electric cars, where SUVs are also in the ascendency. Whether diesel or battery-driven, oversized four-wheel drives are guarantors of growth for car manufacturers, but drivers' desire for ever larger vehicles has not led to more use or better usability.

For an architect, small can feel like a deficiency. The larger the project, the higher the fees and the greater the prestige for the person behind it, who is also able to work with new technical ideas and in new design dimensions. As they grow, many bureaus become ever less willing to take on smaller projects. And yet as the projects get bigger, so do the constraints, and opportunities to be truly innovative dwindle. In smaller builds, the designer is much closer to the planning stages of the project and, since he may well interact with those who will use the completed building on a personal level, there is a better chance of understanding what everyday use will look like. In these smaller dimensions, prototypes offering new options for space are the order of the day.

In smaller projects, there is also an economical principle at work: making buildings smaller rather than larger means making savings.

In this sense, intelligent architecture is a question of compensation for savings or for the overall limitations of the project in such a way as there are no obvious deficiencies. Just because space is at a premium, there is no reason for said space to be less comfortable or less usable, and certainly not less emotionally charged.

The future of design will play out before a backdrop of optimising the use of resources, meaning that the overall imperative will be to use less of everything. This stands in contrast to the overall societal trend towards ever larger spaces. What is behind this conflict? Progress is expressed as the permanent differentiation of all societal areas, and architecture (like all other areas of design) is subject to the same pressure to innovate and evolve as all other disciplines. This is tied to the lasting tendency to specialize, specify, and multiply wherever possible: contexts are being deconstructed and redefined in ever more detail, and in spatial terms, this means offering more and more options for more and more needs. As a rule, catering to additional requirements requires additional space, which is found by expanding outside.

There are a variety of strategies which can be employed to limit this expansion. The classic approach is optimisation: to save space, any requirements which appears superfluous are ignored and planning is focussed wholly on the most important uses. Yet the consequence of weighing up competing options is always to limit options: 'either A or B' means losing one of the two.

Yet architecture should be about extending options, not minimising them. This maxim interacts with considerations of authenticity and with the importance of including new developments. So if expanding space is in conflict with the imperative to conserve resources. This means creating mobile or transformable spaces which replace 'either A or B' with 'both A and B'. The aim is to maximise what can be done with space without reducing its quality.

First and foremost, successfully densifying space requires a precise understanding of functions and a sharp analysis of how the people who will use the building perform these functions. Building on this, the next step is to examine potential spatial overlaps and thus potential savings: i.e. is there a way for functions which follow each other in time to, at least partially, cohabit in space? If so, to what extent can the functions of the building be densified and, in so doing, how much space can be saved?

Viewed from this perspective, mobility is not just a formal consideration, but a simple pragmatic imperative for how to use space. Mobility allows for options to be expanded – not outwards, but inwards, back into existing space. As such, mobile architecture is a riposte to the expansion of space inherent in today's planning processes. Architecture including mobile elements enables new connections between functions which, as a result of differentiation, have become separated, yet without dissolving the characteristics and benefits of these functions – and without needing more space. In this way, mobile architecture is a bracket within which functions of all kinds (even contradictory ones) can coexist. It is another strategy for responding to the permanent differentiation in all areas of society.

When afforded serious consideration in design, mobility, portability, and transformability always focus on how an extant space can be used in a compact, resource-economical way. Miniaturising space in such a way as options are not minimised is, of course, an art form of its own. When it succeeds, there is no loss of variety, complexity, or authenticity, however ambiguous or even contradictory such requirements may be.

So flexibility represents a key concept to be placed at the basis of design strategies oriented towards sustainable residential construction because homes are sustainable if they maintain their usefulness over time (however users' needs vary) without causing waste and conditions of dissatisfaction and unlivability (Radogna, 2008).

2. About the flexibility project

The basis for transformable architecture is always an overall use concept with various situations which change in a given timeframe; this timeframe may be short or long, may consist in regular cycles or in irregular repetitions. It should not be forgotten that analyzing these situations is always a somewhat speculative affair, and it is undoubtedly wisest to speak of 'probable situations'; the situationists, indeed, saw chance developments to a foreseen situation or even misuse of it as proof of truly human design. As such, it would be wrong to try and regulate every aspect of situations down to the last detail; instead, variations and free spaces for users must form part of planning, too.

Good planning starts by analyzing the relationship between the various uses of the space available and attempts to chart interaction between these uses and areas for movement or access in the most realistic and potentially adaptable way possible. There is no way this planning can take place without including the perspective of the person(s) who will be using the space as they move through their day and the various uses required of said space. It is helpful to see this as a rectangular network of relationships between four points: person(s), use, space, and access. A use may be accommodated in an object, a piece of furniture, or an area; the space itself is neutral and simply provides enough surface area for somebody to live in it.

The participants in this relationship have varying demands in terms of space, yet the starting point is always the maximum amount of space. It is the person using the space who has the maximum requirements here as their need to move and access it adds to the bare minimum surface area.

In a mobile approach, only space which is used and neutral space have specific requirements, as areas for movement and access are only required while the object is in use, and can thus be removed when it is not.

The goal of mobile architecture is to harness this difference in such a way as to provide the area required for each use by taking it away from the rest of the space; this saves space overall because space and function only coincide in the given use situation. What is key here is that each use only gets space for movement and access while it is active, and that several different uses all share the same space for movement and access.

In a use-densified space, uses are organized between two poles: functional zones and neutral areas. Louis Kahn

referred to this as the relationship between 'served' and 'servant' spaces.

In most cases, specific uses are stacked up in one zone in much the same way as produce is stacked in a warehouse, combined into a kind of service space and connected in structural terms to neutral areas. This 'stacking' of various uses in one zone, or in zones set in relation to each other in the layout, is done in the minimum possible space; this is achieved by saving the access space which would be required for each single use and combining it in the neutral areas. The higher the number of functions stacked, the greater the amount of space saved.

In this model, each use can then be initiated by the user at the right time by retrieving the use case out of the compressed stack and assigning it to the neutral space. As such, during each use, the neutral space becomes specific space; and as each use can then be returned to the service area on completion and replaced with another, the neutral room takes on a variety of specific uses over time.

It is useful to think of the relationship between the foreground and background, with the neutral space as a continuous presence which is the first to be seen. This is similar to the structure of a traditional Japanese house, in which a neutral space can be dedicated to various functional spaces to each side.

These cascading uses in a limited space are steered by introducing portability into objects or flexibility into how functions are assigned. Doing so compresses the functions into a small space without sacrificing any uses, indeed often expanding options for using the same space. Space saved by densifying uses can then either be reassigned to the neutral area or simply used to make an overall space saving. In both cases, expansion takes place inwards.

In addition to densifying use by applying intelligent spatial planning, organizational approaches represent a further path towards conserving resources. Here, it is not minimising space which is in focus, but rather densifying the amount of time during which space is in use.

In architecture, this option is a tool to prevent void periods. Software solutions offer the advantage of minimising the gaps in use intervals towards an ideal maximum of continuous uninterrupted use. The result of this can be space savings in as much as the densification of use within a space can render further space superfluous.

This approach first made an appearance as part of the 'non-territorial office' concepts of the 1980s, the premise of which is the idea that not everyone in an office needs a desk all of the time as, due to sickness, holiday, or out-of-house meetings, a certain proportion of the total staff will always be absent. This offers the potential to remove a corresponding number of desks, unlocking potential for office space savings of up to 30%. Given that staff do not have their own desks, however, these savings, are counter-balanced by an increased need for good communication areas and better furnishings. Nevertheless, these high-quality communications areas have the effect of making an overall improvement to the architectural environment as a whole.

The flexibility of the buildings technological and environmental systems is a fundamental requirement especially if we consider the circular transition that requires the possibilities of reusing the buildings. Housing flexibility should be designed in at least four directions. The first relates to the modifiability of partitions, systems and furnishings, for different uses of the interior spaces. The second concerns the adaptability of closures (vertical and roofing) to climatic conditions to improve comfort and promote life in the open air. The first two directions concern the single dwellings and are manageable by the inhabitants while the third direction refers to market and social dynamics. This direction in fact concerns the modifiability of the size of the dwellings, which can be managed by those who build and / or sell or rent the houses in the phases that precede or follow a living experience within them. The fourth direction refers to the ability of buildings to be destined for new uses, above all because they are equipped with easily replaceable or modifiable closures, partitions and systems (Radogna, 2012).

Tables 1 and 2 show a summary of an analysis carried out to guide the flexibility project for public housing in Pescara, considering the needs expressed by housing managers and inhabitants. In particular, the needs to be met with the 65 square meter apartments project were identified. The main requests relate to the need for adaptable domesticspaces for study, work, play and relaxation. The flexibility requirements were therefore defined as well as the correspondence between flexibility types, environmental units, classes of technical elements and devices. In this paper, the aspects the flexibility that can be governed by the inhabitants within their own accommodation will be explored.

3. The flexibility of the interior spaces

The interior spaces flexibility allows different uses of one or more environmental units through the adaptability of the partitions and systems. The possibility of dividing a

Table 1 | Flexibility needs and requirements for 65 m² accommodation.

Users	Needs	Flexibility requirements
	• 2 spaces for working • 1 space for playing or studying • 1 space for physical activity • 1 space for playing and relaxing	• Adaptability of the bedrooms and living rooms into 2 spaces for the home office and 1 for play or study • Adaptability of open / covered spaces to spaces for playing ,fitness and relaxation
	• 2 spaces for working • 1 space for distracting and relaxing • 1 space for physical activity	• Adaptability of the bedrooms and living rooms into 2 spaces for the home office and 1 for distracting and relaxing • Adaptability of open / covered spaces to spaces for fitness and relaxation
	• 1 space for working • 1 space for distracting ,relaxing and playing or studying • 1 space for distracting ,relaxing and playing outdoors • 1 space for physical activity	• Adaptability of the bedrooms and living rooms into 1 space for the home office and 1 for ,fitness ,relaxation and playing or studying • Adaptability of open / covered spaces to spaces for playing ,fitness and relaxation
	• 1 space for working • 1 space for playing • 1 space for distracting ,relaxing and playing outdoors • 1 space for physical activity	• Adaptability of the bedrooms and living rooms into 1 space for the home office and 1 or 2 for playing or studying • Adaptability of open / covered spaces to spaces for playing ,fitness and relaxation

Table 2 | The types of flexibility to be designed.

Types of flexibility	Environmental units	Technical elements	Technical elements and devices
Flexibility of interior spaces (for the inhabitants) To have spaces for working, studying, playing, distracting/relaxing	• Living room • Bedrooms	• Vertical interior partitions	• Opaque, repositionable, folding, sliding or rotating walls
Flexibility of exterior spaces (for the inhabitants) To have spaces for working, studying, playing, distracting/relaxing	• Loggias	• Vertical closures	• Transparent, repositionable, folding, sliding or rotating walls.
Flexibility of accommodations sizes (for the accommodations owners/managers) To have bigger or smaller accommodations	• Living room • Bedrooms • Loggias	• Vertical closures • Vertical interior partitions	• Infill dry-connected to the supporting structure

room into one or more sectors or of joining two rooms requires partitions that can be easily removed or repositioned as well as a system predisposition that can be reached in any configuration. Depending on the type of the environmental units and the activities to be carried out, this type of flexibility can have different levels of complexity (Calcagnini, 2018). In the case of a bedroom capable of transforming itself into a space for studying or working, for example, flexibility is eminently concentrated on the furnishings. If, on the other hand, two areas for studying and working are to be obtained from a living room, it is necessary to design both suitable partition systems, to transform an environmental unit into two units, and to prepare the electrical system so that it can be used by both configured spaces. The flexibility project becomes more complex when it refers to environmental units that have multiple plant networks such as kitchen and bathroom (Radogna, 2013).

3.1 "Do it yourself" & "Le grand bleu"[1]

In the reuse project of a terraced urban villa, built in the 20s of the twentieth century and located in the historic center of a small town in the Bergisches Land, the building is reorganized according to the owners new needs. The interior spaces design takes on unique characteristics for the kitchen and bathroom environments in which the operations carried out are reversible and have high performance. The kitchen consists of a movable system - a large open and bright "universal platform" which, with the help of guide signs placed on the floor, allows different configurations and uses. No space-environment is defined, but it is proposed an open system that users configure based on use. Aesthetics are identified with the use and not with the appearance of the spaces. Three steel boxes covered with colored synthetic material, red, green and blue, indicate where in the kitchen the elements can be moved (a multipurpose worktop and a kitchen top with stove and

sink). The furnishing elements and functional equipment are not linked to a specific point but, standing on "wheels", they can be moved. The guides for the different possible positions are drawn on the parquet floor. The kitchen set-up is characterized by open and inspectable ducts, standard industrial production equipment and cheap materials. The kitchen elements consist of a skeleton structure covered with foils, all in stainless steel.

The connections for the kitchen elements (drainage and water supply, electricity, gas) are in three points, covered by elements in transparent colored plastic and in tarpaulin. These transparent protections are equipped with velcro strips that allow an easy connection of the kitchen elements. Also the lighting is variable. The opportunity to position the kitchen elements, in different ways of aggregation and in different areas of the environment, allows to use the living area of the house as a multipurpose space. For example, the kitchen elements can be moved from the center to the sides of the room or outside.

The bathroom set-up can be transformed by the user according to his needs thanks to mobile vertical partitions: a "screen" is the space organizing tool where, by moving some curtains that change the distribution, shape and atmosphere, one can create "his environment". The bathroom set-up "covers" the existing surfaces with blue panels, becoming its reversible and non-invasive transformation. The installation overlaps the existing structure, which remains unchanged as all the new elements are simply added and behind which the plant networks pass. Artificial light has the same flexibility as vertical partitions, the lighting elements are in fact installed on rails fixed to the ceiling, they can therefore be moved according to the different needs and areas of the bathroom used, allowing you to have the right quality and quantity of lighting. everywhere in the room.

Figures 1 | The kitchen plan.

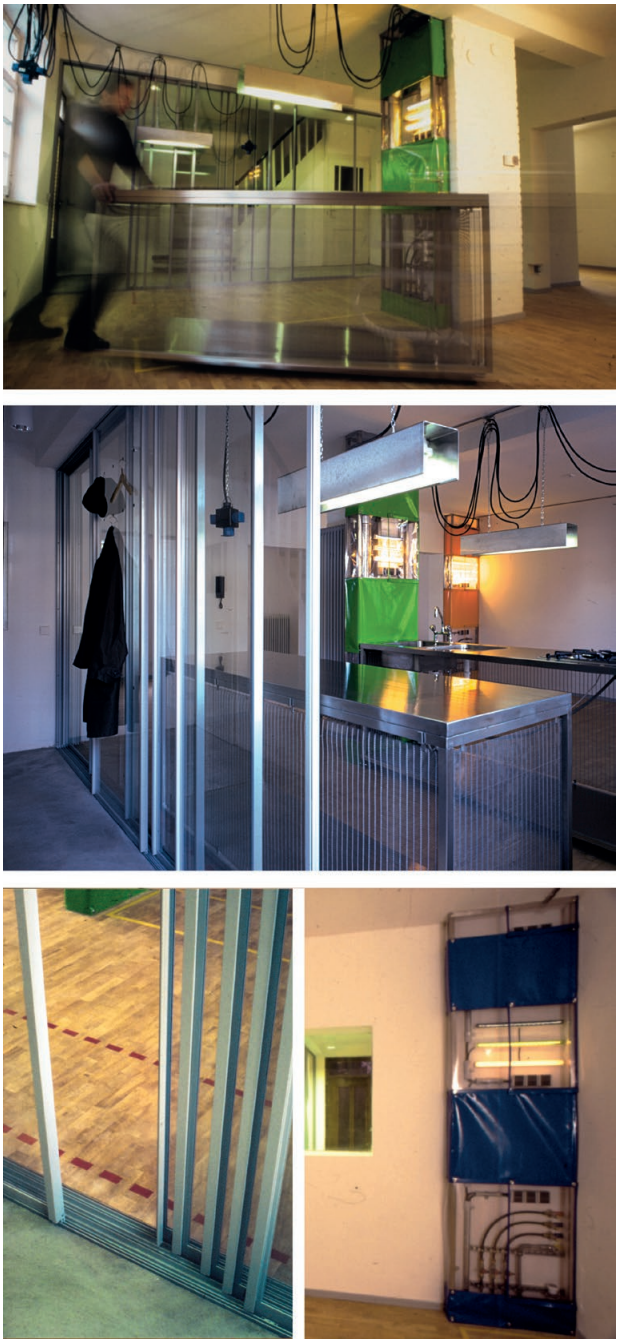


Figure 2 | Kitchen movements and positions.

The sanitary facilities, the toilet, the appliances (such as washing machine and dryer) are recessed (and not visible) behind the new cladding wall, while elements such as wardrobe and shelves are an integral part of the surface of the "facing". The central feature of the bathroom are the two "screens": the blue one that "covers" the pre-existing perimeter walls and divides the actual areas of the bathroom (bathtub, shower, sink and toilet) from

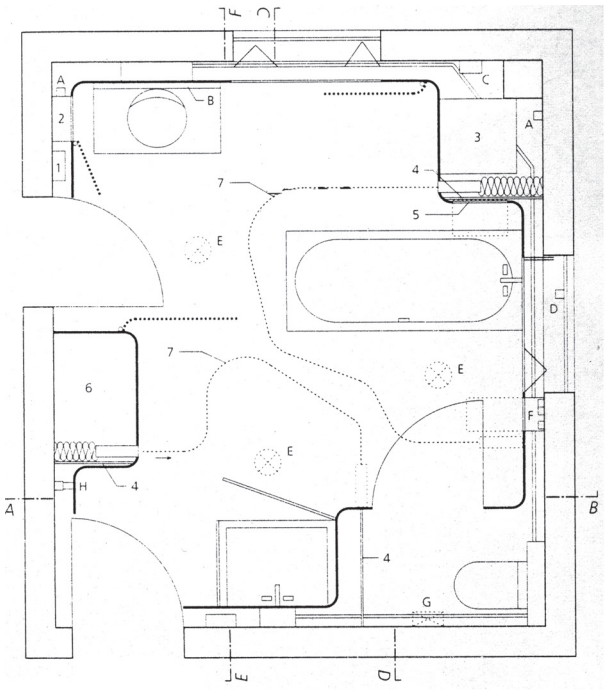


Figure 3 | The bathroom plan.

Figures 4 | The bathroom elementary spaces.

the service areas (which house the domestic appliances); the other consists of the white curtain which, according to the specific needs of each user, allows for adequate conditions of confidentiality. The insertion is planned as a new layer above the old structure. Every attachment should be visually distinguishable from the existing fabric, the floors and walls are left in the state they were found. A kind of screen is folded along the existing walls. It follows the walls, leaves them for an instant in order to come back to join them again. The space is divided into a front and a back side of this screen. Sanitary ducts or special, spatially undesirable areas are hidden behind the new wall. The screen is lighting wall as well as depository device and media for varied functions. It is an intelligent object and also an atmospheric medium for the space. Wardrobes with curtains are integrated within the screen. They can be pulled out and contribute to the separation of the bathing zone. Thus spaces of special atmospheres can be created individually. The space begins to flow, the harsh edges of the space are softened. The "screens" form small spaces in the single space of the bathroom which takes on different configurations in relation to the uses. The white curtain is inserted into the environment as an ordering element, which divides and separates the space, already divided, into other smaller spaces with a blue coating.

4. Flexibility with respect to the climate

The lock down condition that we experienced in recent times underlined the importance of being able to change the relationship between indoor and outdoor spaces according to the climatic conditions. The transformability of a closed environment into an open one is a possibility that first of all satisfies the psycho-physical needs of people rather than the functional ones. Being able to sunbathe, exercise or read a book outdoors in your home when the weather is good but you can't or don't want to go out, is an option of considerable value. As is being able to expand the covered area, by closing an open space when temperatures drop. In the following paragraphs three projects are presented which, through horizontal roofing or flexible vertical closures, represent a concrete example of the possibilities just described.

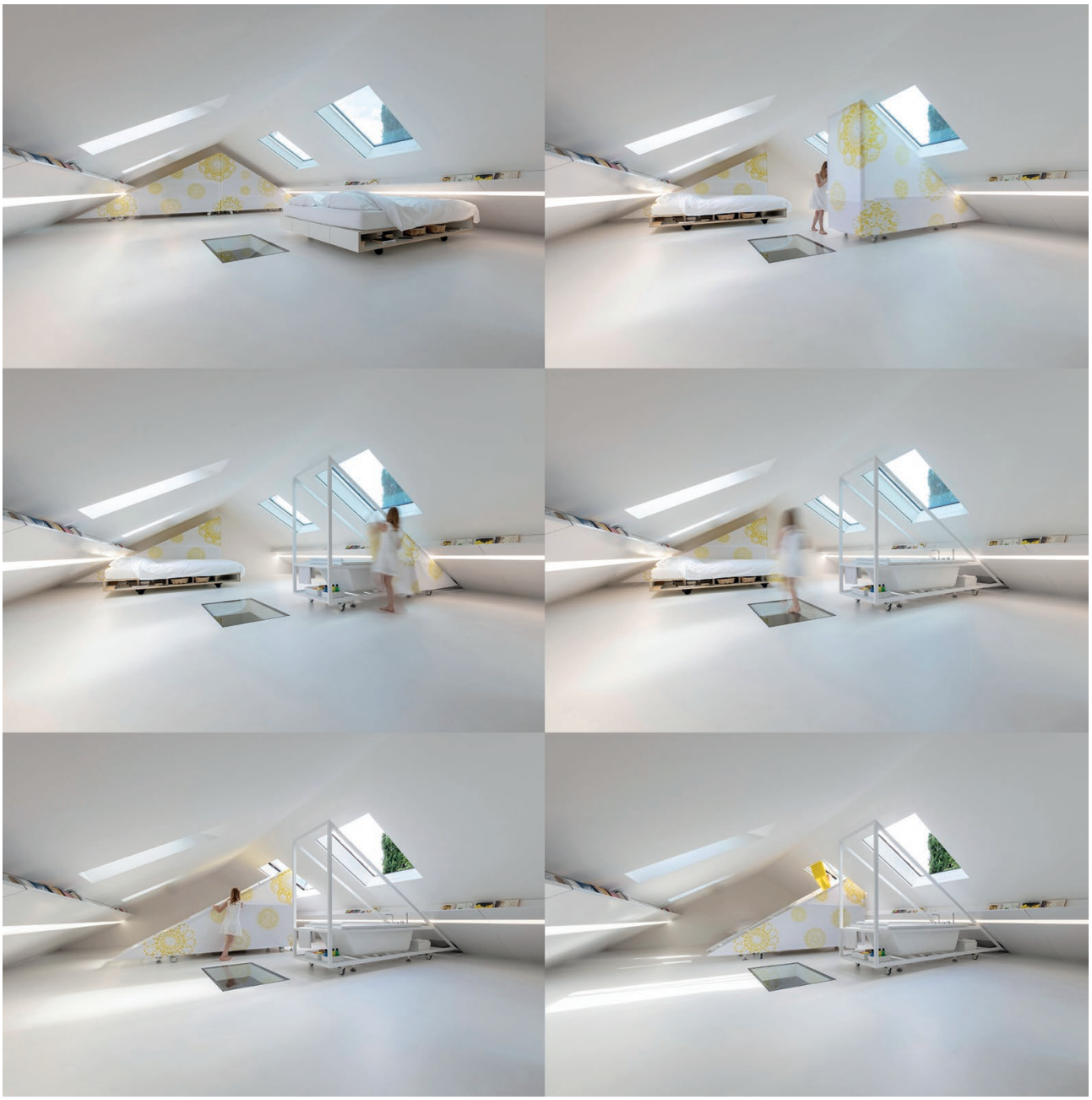
Figures 5 | Outdoor.

Figures 6 | Indoor.

4.1 Urban Beach[2]

Attic space in a typical 1950s mid-terrace house was going unused, yet the owners could not carry out a full loft conversion as the property was part of an estate listed as a site of architectural importance. As such, the pitch of the roof had to remain unchanged, limiting the ceiling height, and only small openings were permitted in the form of swing windows (e.g. Velux). This limited the scope for designing the space to conventional attic solutions.

One way to think of the initial situation was Jacques Tati's film *Les vacances de Monsieur Hulot*, in which the eponymous protagonist, the last to reach a hotel, is given the only available room in the eves, cramped, but with a view.



Figures 7 | Movements, functions, spaces.

The challenge was, in spite of the planning constraints, to create an open and atmospheric space orientated towards the sky. This meant reconceiving deficiencies as potential sources of qualities, turning negatives into positives, and applying humorous interpretations.

Specially-constructed compact-format skylight windows opening to 90° provide a free view up into the sky, while the elements which can be moved through the attic space and out of it transcend the limits of the location, creating unexpected moments far from everyday life.

Items familiar from holidays such as a lounger and sun umbrella, as well as sun-related motifs on fabric coverings, give the user a sensory experience similar to taking a break to the seaside. Thanks to rooftop exposure, the user can soak up the last rays of sun into the evening.

What is more, the fact that the loft has not been fully converted leaves it as a space full of potential and possibilities for counterbalancing the functional deficiencies of the house as a whole: everything the house is otherwise lacking can be accommodated here. The brief was for a heterogeneous mix of master bedroom, storage space, and dressing room combined with a WC and an airing cupboard; also, the space was to include a bathtub as this was missing from the house's existing bathrooms.

The dressing room is located in an access space open to the loft on the first floor, while the WC and the airing cupboard are separated from the rest of the loft by partitions. The remainder of the loft space is left for two mobile elements, geometrically matched to the pitch of the roof, which can be pushed along the eves as part of a variable layout. The mobile components can quickly be repositioned to create different room sizes and floor plans, turning a generous open space across the whole expanse into a zoned suite with various areas. The new attic space becomes a polyvalent room whose uses change during the day: a room with a balcony, a bathroom with a view of the sky, a bedroom; if required, storage space can be created to the exact size required, hidden from view by the two mobile elements.

This large space is kept purposefully ambiguous, as if out of focus. The wall formed by the mobile components, too, is a blurred line, a border which can be renegotiated at any point to the advantage of either the living or the storage space. Beyond the partitions, more space is available as required either for storage or as a sleeping area.

The starting point for the space is open, and it can then be changed as required by the user, who can move the partitions and specify the function of the room as a whole.

4.2 The house and the house that was[3]

A typical house in France's Hérault, situated in a narrow alleyway in a listed village, is more like an ensemble of two houses, one of which is now only a remnant. The whole set-up only works because one of the two buildings is more or less absent, leaving the other with a courtyard that it would otherwise not have in the middle of the village. Strangely, however, this free space is not at ground level, and can only be reached via a stairwell into what used to be the top floor. The primary project focus is to renovate the property in a way which conforms with the village listing, retaining the historical substance of the building, with modifications permitted only to add technical infrastructure and sanitation. The idea is to cover the courtyard with a new terrace on the second floor, from where a view of the château can be had. The courtyard is where the other buildings once stood; all that remains of it is the front of the street-level vaulted cellar with an arched covered stairwell leading into the first floor and the façade. Through this stairway and the frontage fragments, the presence of the missing building remains visible in spite of the void.

Figures 8 | Movements, functions, spaces.

Taking this ambivalence as a starting point, the new terrace is conceived as a mobile element in this space. When let down, it bridges the gap left by the missing building, underlining the fact that this space was once residential; raised, it reopens the space, leaving it free as a passage. This mobile approach is not the central goal of the project: rather, the key aim is to visualise the different states the house has passed through in a time sequence.

As such, the project weaves together the differing states of the space as lived-in building on the one hand and as a passageway on the other; each remains as a shadow behind the real status quo.

This layering of both possibilities, this fading in and out of snapshots in time from an intact past to a torn present is what makes visible and explains the building's journey. Without action in space, this history cannot be understood.

4.3 Room with View[4]

The search for light, warmth, and a good view can bring movement into an interior as the inside space is turned outwards: the result is a room which, with a picnic basket, some foldaway garden chairs, and a table cloth, can become an excursion.

When they set out, the party is hemmed in by the four walls around them – until, that is, a new vista is opened up.

The project took place as part of a refurbishment of a 1970s semi-detached house, during the course of which a staircase was fitted to access the flat roof.

Additionally, a mobile roof terrace can be raised up to the rooftop, where it serves as an atmospheric yet functional backdrop to time spent outdoors.

The rear of this moveable component provides space for garden furniture, which can be unpacked on the roof, and when not in use outside, it is a partition between two spaces on the top floor and a space-saving storage option for garden furniture, The front of the partition wall is finished as 're-writeable wallpaper' covered in magnetic rose cut-outs which the clients can position and reposition themselves.

This vertically mobile partition was constructed using standard sliding door mechanisms which were turned 90° and are operated using a hand crank and a weighted cable winch; once raised to maximum height, the partition is locked in place using a pole. Motorised options and automatic sliding door solutions were also

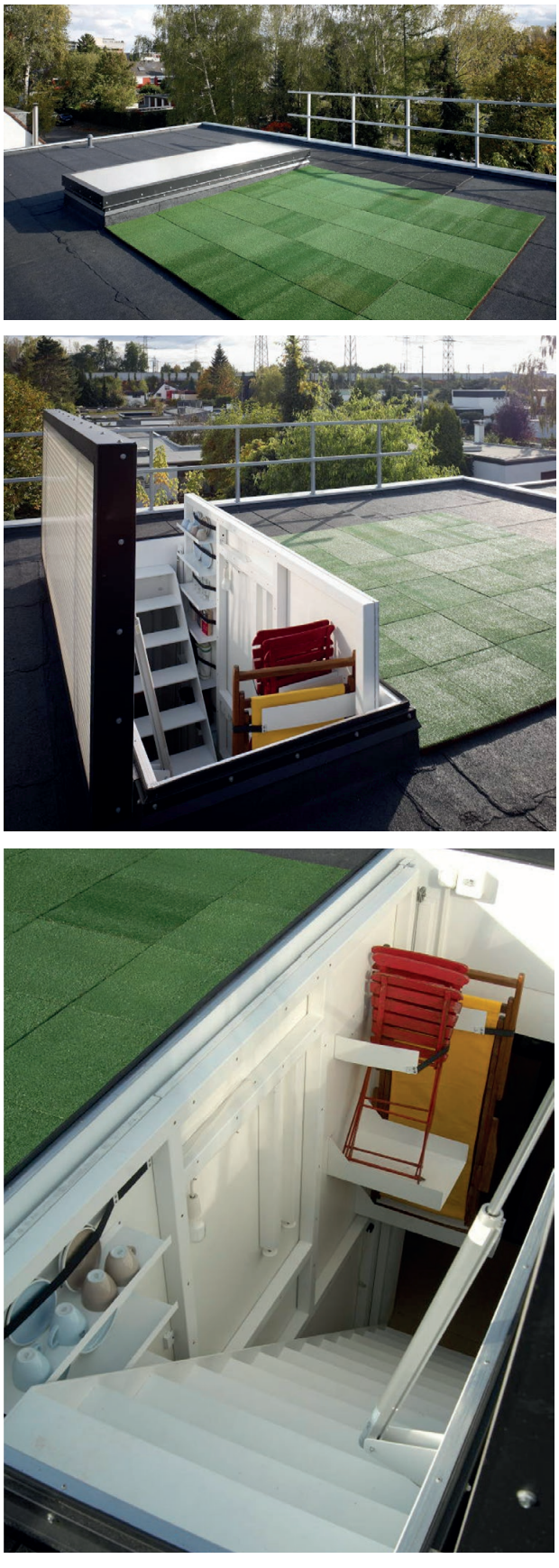


Figure 9 | Opening the room.

Figure 10 | Creating the room.

Figure 10 | Furnishing and living the room.

examined and included as alternatives in the request for proposals, but the clients preferred a low-tech solution and this seemed appropriate to the scale of the project.

5. Flexible additions

In the interventions on the existing building, flexibility can also be expressed with the addition of new volumes. Especially in adaptive reuse projects of masonery ancient buildings (far from being flexible) the addition of light and mobile volumes determines a significant improvement through higher performance levels, especially in terms of usability and well-being.

5.1 A nous de choisir[5] [5]

In "a nous de choisir" project, an old farmhouse, to be recovered and put back into use, was joined by a frame containing a series of light, colored boxes (kitchen, sink, toilet, shower, and gas supply) and furniture. Each block is distinguished by a color: green for the kitchen, blue (shower and sink) and red (toilet) for the internal bathroom, yellow for the external shower cubicle, the natural color of the wooden plank for the external toilet.

Materials, texture, colors and movement distinguish the added body from the pre-existing farmhouse, giving it a new functionality.

The new body offers the dual possibility of having a kitchen, shower, sink and toilet indoors or outdoors. From this double possibility derives the name "a nous de choisir».

Figure 12 | The ancient and the new systems.

Figures 13 | The functional cabins.

5.1 A Trip to the Countryside[6]

The client's original brief was to create an additional office room in the house, with the garage space earmarked as the area to be converted.

The slate-façade half-timber house with a large garden is located in an area of protected landscape. The clients lived on the ground floor of the house, yet the garden, where they spend a lot of time, was only accessible through a cellar door. In developing the concept, therefore, the client's desire for more space was expanded to include structural deficiencies in the house, notably a lack of direct access from the living area to the garden.

The design proposed an additional terrace level offering direct access to the garden. The proportions were matched exactly to those of an existing extension from the 1950s, using materials to distinguish the new extension and create 'non-identical twins'.

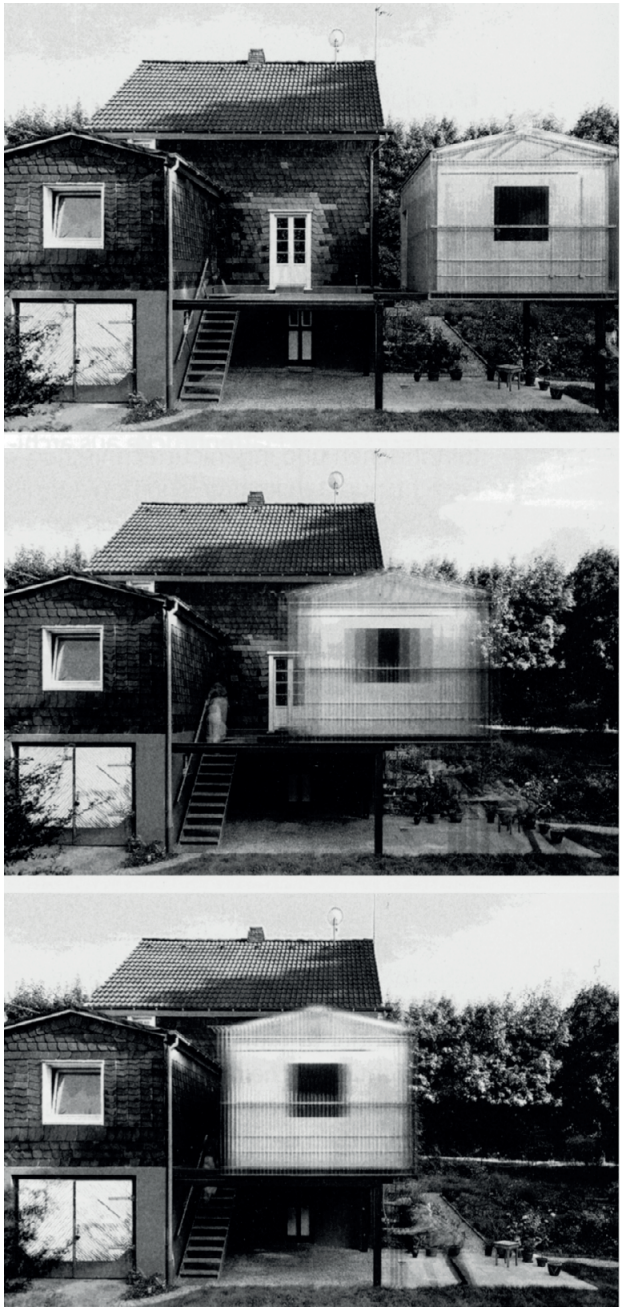
The extension, which can be moved to reflect and react to the seasons, creates a complex interplay between the house, the garden, and the terrace.

In summer, the extension moves into the garden, opening up a terrace for outdoor living. In winter, the extension returns to the house, covering the terrace and creating a direct connection between the house and the extension.

The structure is steel-framed and the terrace fitted with lattice in order to let light through onto the area below it; the terrace balustrade can be removed in a few easy steps.

Consisting of back-ventilated transparent corrugated boards made of hard-PVC, the visible exterior of the room covers a shell which is a low-budget singly-insulated wooden construction fitted with plywood boards as interior walls. The outer planking was covered with nylon-reinforced reflector foil of the kind usually employed in greenhouse construction in order to prevent the interstice from overheating.

Figures 14 | The ancient and the new volumes.



Figures 15 | The added volume movements.

This multi-layered progression from the interior to exterior shell offers an additional depth in which the various surfaces can react to the natural light and the building's surrounding by how it reflects light and casts shadows. The interstice also includes various connections (internet, TV aerial, electrics), which are visible from the outside.

Figures 16 | Some added volume details.

Industrial-strength load-bearing rollers in parallel U-rails are the solution for making the extension moveable.

6. Flexibility, so what?

The described architectures reveal the ability of flexibility to improve the livability of homes by expanding the usability of the interior spaces and a "lively" and changing relationship between the internal and external environments. The ability to move and reposition partitions, closures, connections to systems and furnishings give "life" to houses because they allow to establish a symbiotic relationship between people, the needs of use, the climatic conditions and the organization of spaces.

So flexibility represents a way to improve the relationship between buildings, people and nature as it can improve the resilience and sustainability of buildings and return an architecture aimed at ensuring the quality of human life.

Notes

1 Conversion of a 1920s House (1997). Project team: Gerhard Kalhöfer, Stefan Korschildgen.

2 Mobile loft conversion (2018). Project team: David Ebel, Johannes Haucke, Gerhard Kalhöfer.

3 Mobile terrace (2022). Project team: Johannes Haucke, Gerhard Kalhöfer.

4 Mobile terrace (2008). Project team: Gerhard Kalhöfer, Philip Braselmann, Marc Rogmans.

5 Conversion of a Farmhouse (1995), Project team: Gerhard Kalhöfer, Christèle Jany.

6 Mobile office room (1997). Project team: Gerhard Kalhöfer, Stefan Korschildgen, Andreas Hack.

References

Arbizzani, E., Baratta, A., Cangelli, E., Daglio, L., Ottone, F., Radogna, D. (2021), *Architettura e Tecnologia per l'abitare. Upcycling degli edifici ERP di Tor Bella Monaca a Roma*, Studi e progetti Serie, Maggioli, Santarcangelo di Romagna (Rn).

Calcagnini L. (2018) *Flessibilità. Una dimensione strategica per l'architettura*, Cultura tecnologica e linguaggio architettonico Serie, Edizioni ETS, Pisa.

Radogna, D. (2008) Kalhöfer & Korschildgen. Flessibilità ed esigenze d'uso. Soluzioni progettuali per un quadro prestazionale variabile, Sala Editori, Pescara.

Radogna, D. (2012) La flessibilità per un Social Housing sostenibile: il caso di Preturo (AQ). TECHNE, Journal of Technology for Architecture and Environment, vol. 4, Social Housing.

Radogna D. (2013) Flessibilita' spaziale e tecnologica. In: Di Giulio R., Boeri A., Forlani M. C., Gaiani A., Manfron V., Pagani R. (ed.), Paesaggi periferici. Strategie di rigenerazione urbana, Quodlibet, Macerata

Radogna D. (2020) Sistemi costruiti in via di sviluppo. In: Arbizzani E., Cangelli E., Daglio, L., Ginelli, E., Ottone, F., Radogna D. (ed.) *Progettare in vivo la rigenerazione urbana*, Studi e progetti Serie, pp. 39-42, Maggioli, Santarcangelo di Romagna (Rn).