Renzo Piano & P. Rice Engineers and Architects, RIGO Housing State, Corciano, Italy, 1980–82. During the construction. © RPBW-Renzo Piano Building Workshop.

"EH, Evolutionary Building" Prototype Housing at Solomeo, by R. Piano & P. Rice Engineers and Architects with Gruppo Isovibro Perugia: Architectural Study and Guidelines for Conservation and Reuse

BY CARLO NOZZA

The prototype "EH, evolutionary building" at Solomeo by the design team Piano & Rice Engineers and Architects Vibrocemento Perugia s.p.a. is an example of the experimental design of residential buildings for emergency situations and represents a crucial phase of transition from traditional prefabrication to open prefabrication. Built on the basis of the project prepared for the competition held following the disastrous 1976 earthquake in Friuli, many of the ideas tested in the prototype were later used to construct the RIGO housing estate at Corciano. The text describes the architectural study and guidelines for the protection and reuse of this significant modernist building, today abandoned.

The prototype "EH, Evolutionary Building" at Solomeo, by the design team Piano & Rice Engineers and Architects Vibrocemento Perugia s.p.a. is an example of the experimental architectural design of residential buildings for emergency situations and represents a crucial phase of transition from traditional prefabrication to open prefabrication.

"In the field of industrialised construction, open systems make it possible to flexibly use, mix and match components made by different manufacturers"[1].

> *Unlike closed systems, in architecture open systems are not aimed at the production of a particular building, but allow for connections between prefabricated elements of different origins. When designing an open construction system, the architect establishes the function of the building elements and chooses the possible manufacturers. To avoid problems during assembly, the elements are typified in advance, produced in the workshop in accordance with the dimensional coordination and tolerances of manufacturing and assembly pre-established by the various schemes of combination envisaged.*[2]

"EH, Evolutionary Building" is a pioneering example of research in which the expandability of the *living space*,[3] supported by the rational hierarchy between structural and non-structural elements, was a field of research in harmony with the evolution of the cultural needs of the period. The scheme of aggregation of the residential units envisaged different combinations: single-storey, duplex, rising to double height or with two separate levels, or the overlapping of two separate modules rising to double height or duplexes distributed by an external staircase, so constituting urban aggregations characterized by the participatory activities of the residents.

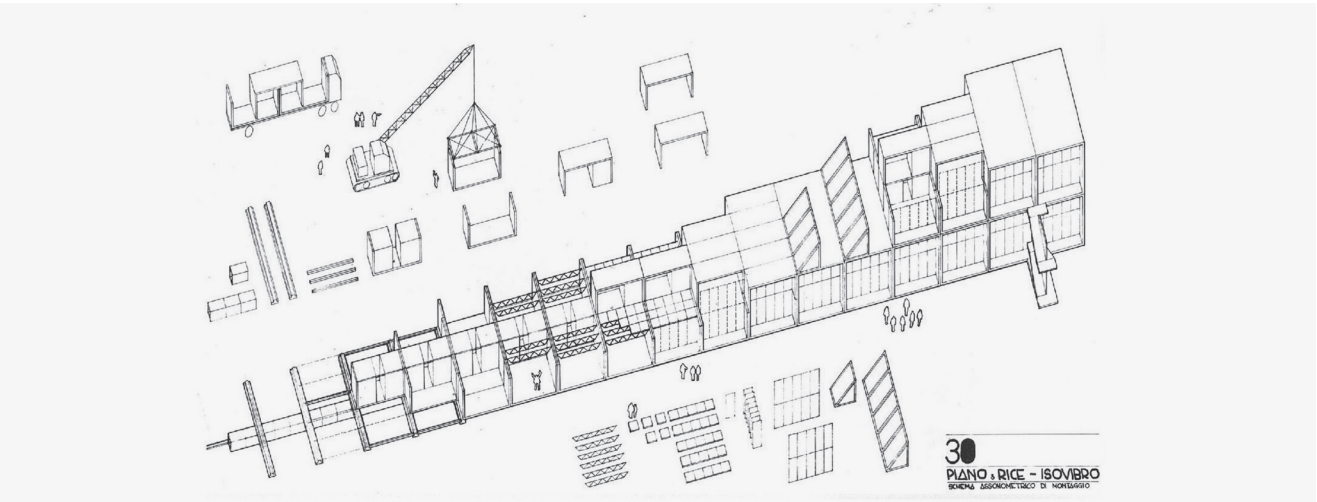
"Competition of Ideas for the Reconstruction of Friuli"

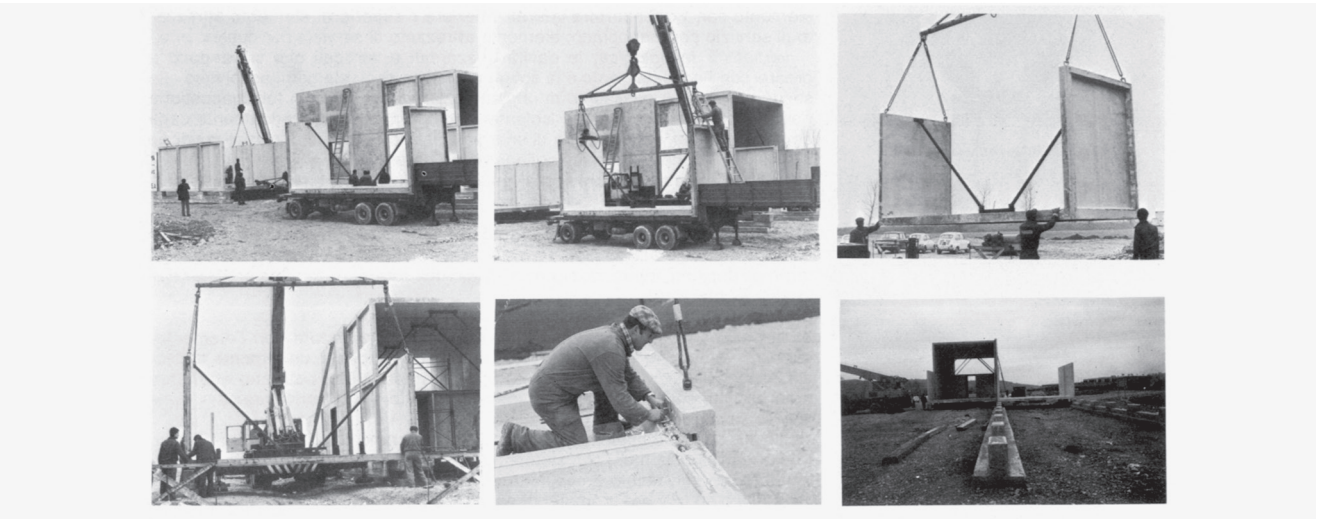
Between May and September 1976, a devastating earthquake struck the Province of Udine in north Italy. To cope with the urgent need for reconstruction, in the spring of 1977 the Italian Association for Industrialised Building Prefabrication and the Provincial Administration of Udine, in collaboration with the Chamber of Commerce, Industry and Agriculture of Udine, and the *Cassa di Risparmio di Udine e Pordenone*, announced a competition for the "Design of building systems for the reconstruction of Friuli while respecting the needs and housing traditions of its territory". Several design teams were invited to take part in the competition. They consisted of professionals and building contractors and/or manufacturers whose collaboration within each team was considered essential, because the purpose of the competition was to "achieve integrated proposals for viable solutions in terms of design, technology, construction, organization and finance, which will represent a sound basis for developing the subsequent plans of intervention by the commissioning bodies"[4].

The announcement of the "Competition for the Reconstruction of Friuli" proved to be of outstanding quality, since it embodied the design requirements of the architectural debate, intended to combine the theme of building with that of sociological analysis and the study of local traditions.

In general, the design teams were invited to reflect on the themes concerning settlement and housing, technology and funding. The theme of settlements was involved in the requests for an evaluation of the overall spatial standards for the housing, their general dimensions, distributional principles, and the technical solutions for the systems and

01 Renzo Piano & P. Rice Engineers and Architects with Gruppo Isovibro Perugia, EH, Evolutionary Building, Solomeo, Italy, 1977. Base module of 6×6meters. Assembly steps. © Studio Piano & Rice, 1978.





02 Renzo Piano & P. Rice Engineers and Architects with Gruppo Isovibro Perugia, EH, Evolutionary Building, Solomeo, Italy, 1977. Base module of 6x6meters. Assembly of elements. © RPBW-Renzo Piano Building Workshop. Photo by Ishida Shunji.

principal subsystems for the buildings. The theme of housing also involved the composition of the home units, calling for a broad variety and flexibility in the solutions proposed, in order to provide units whose composition and distribution would enable them to accommodate different groups of users.

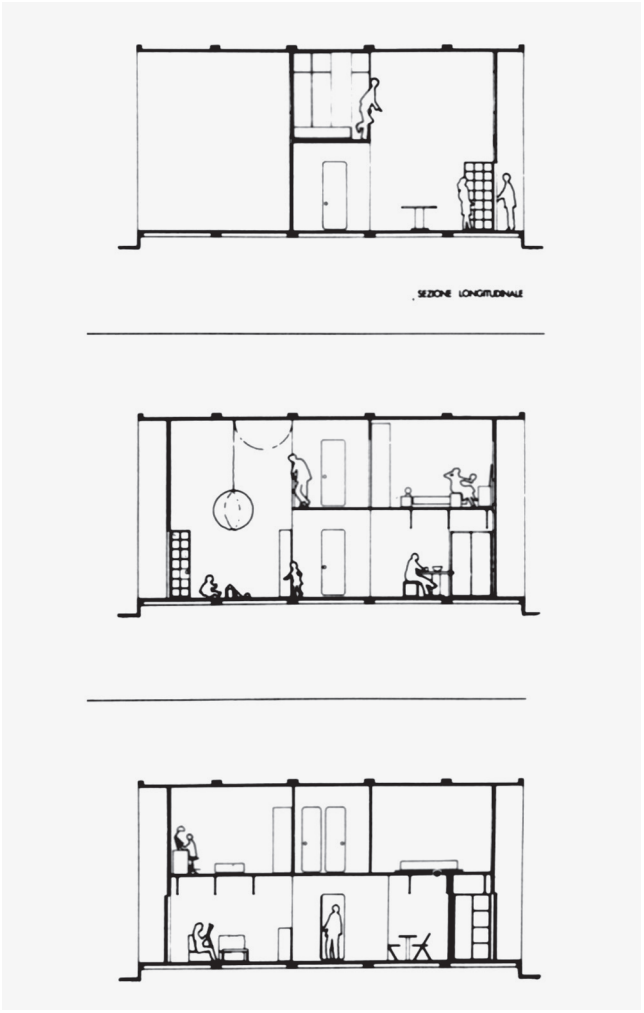
As for the issue of innovation, the competition guidelines were explicit:

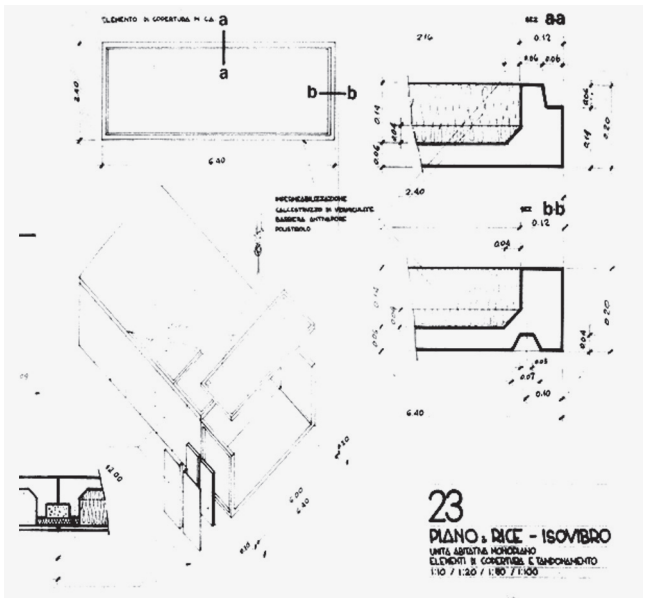
> *Participants are required to make an effort to interpret and renew the typologies by seeking to adapt the projects as far as possible to the needs expressed by the various cultural contexts in the territory, in which the traditional rural culture is accompanied by different realities represented by urban development and the industrial sector. In particular, the concept of privacy or individuality that characterizes individual housing, for which strong demand is expected, can be a source of innovative typological ideas, highly stimulating in proposing buildings of a collective kind. In this respect, reference should be made to the results of recent international examples, such as the 'Modèles-Innovation' promoted by the French government in 1972 and the TÆT LAV competition sponsored by the Danish government in 1974.*[5]

As for the issue of flexibility in the home units, three possible meanings were indicated, as previously defined by I. Diotallevi and F. Marescotti. "*Flexibility of use*, which relates to the interior space of housing and is the ability to vary its layout; *flexibility of extension*, which is a feature of single-family houses and should allow the house to be extended and its layout varied according to the needs of the occupants; and finally *flexibility between home units* understood as characteristic of collective housing, which has to make allowance over time for possible variations in the layout and size of the home units"[6]. In the proposal "EH, Evolutionary Building" the effects of this demand for flexibility became apparent on the typological level, with the homes being divided into a service area, defined by the presence of units with the termination points for the utilities, and an open home space to be subsequently defined in collaboration with the occupants and on the technological level, with the provision of subsystems of structural components, independent of the intermediate floor and ceiling slabs, the system of internal divisions and the non-load bearing external infill walls.

03 Renzo Piano & P. Rice Engineers and Architects with Gruppo Isovibro Perugia, EH, Evolutionary Building, Solomeo, Italy, 1977. Interior of the house. It is possible to create a second level with light slabs supported by secondary truss-beam. © RPBW- Renzo Piano Building Workshop. Photo by Ishida Shunji.

04 Renzo Piano & P. Rice Engineers and Architects with Gruppo Isovibro Perugia, EH, Evolutionary Building, Solomeo, Italy, 1977. EH typological evolution in section from: R. Piano & P. Rice, *Rapporto sul progetto a tipologia evolutiva E.H.*, © "Vibrocemento s.p.a."today "Generale Prefabbricat s.p.a.". Perugia, 1979.

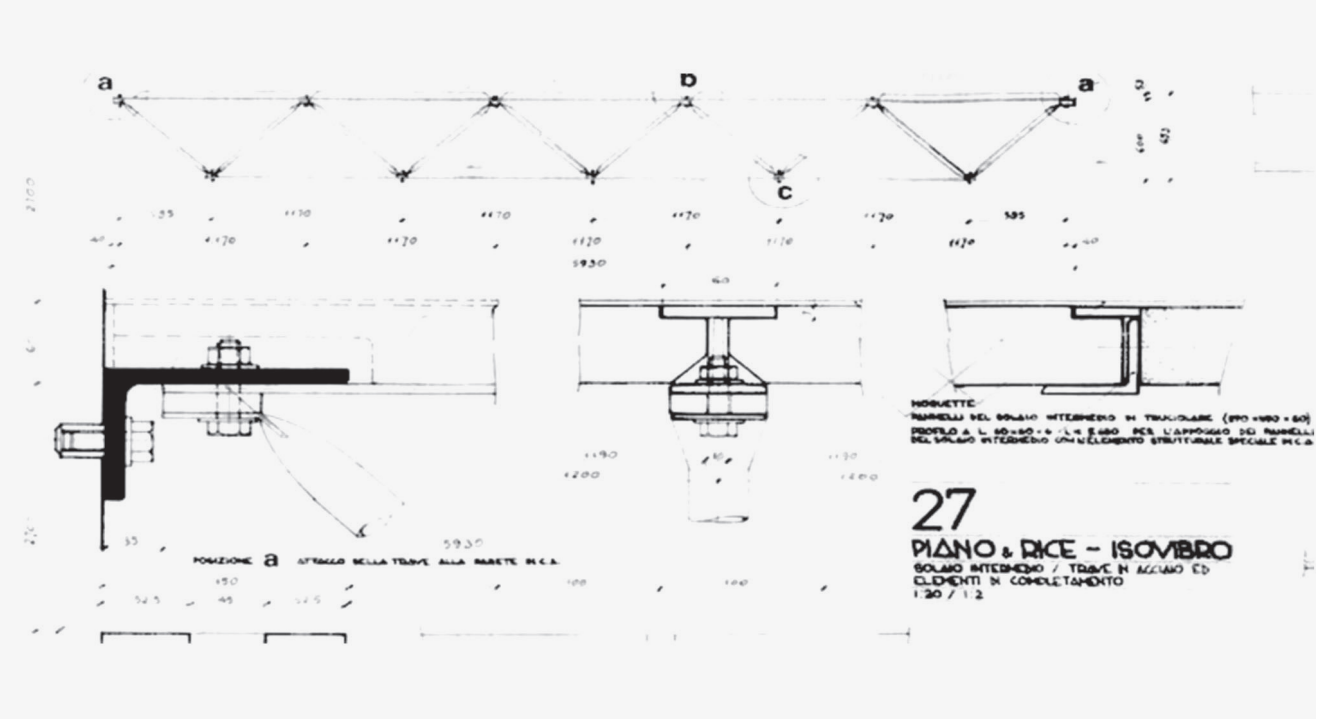




05 Renzo Piano & P. Rice Engineers and Architects with Gruppo Isovibro Perugia "EH, Evolutionary Building", Solomeo, Italy, 1977 EH assembly system and typical details from: R. Piano & P. Rice, *Rapporto sul progetto a tipologia evolutiva E.H.*, © "Vibrocemento s.p.a."today "Generale Prefabbricati s.p.a.". Perugia, 1979.

06 Renzo Piano & P. Rice Engineers and Architects, RIGO Housing State, Corciano, Italy, 1980–82. Diagram of units aggregation. © Studio Piano & Rice, 1978.

07 Renzo Piano & P. Rice Engineers and Architects with Gruppo Isovibro Perugia "EH, Evolutionary Building", Solomeo, Italy, 1977. EH assembly system and typical details from: R. Piano & P. Rice, *Rapporto sul progetto a tipologia evolutiva E.H.*, © "Vibrocemento s.p.a."today "Generale Prefabbricati s.p.a.". Perugia, 1979.



Design and construction of the Prototype "EH Evolutionary-Type Home Unit"

In response to the guidelines and requirements contained in the competition regulations, in 1978 and 1979 the Piano & Rice Engineers and Architects Design Team prepared a "Report on the E.H. type evolutionary project"[7], with the presentation dossier organized according to precise "statements".

Among the various principles advanced on the *organizational plane*, two phases of construction were envisaged. In the first were installed the primary load-bearing structures and sanitary facilities, produced industrially within a short time frame, with guaranteed quality and affordability. In the second, the specific future occupants could draw on the services of a "neighborhood production unit" (a kind of workshop), in which the occupants themselves or local craftsmen would produce the elements necessary to the complete the home unit. The function of this "neighborhood workshop" was to provide the appropriate technology, not on the spontaneous level typical of self-build, but in terms of modern techniques and materials, making them available even to untrained operators. In this way the users were given an opportunity to customize the layouts of the interiors of the units, to make the non-structural partitions, to install the accessories and apply the interior finishes. These social and ethical motivations characterized the whole project, making it possible for the initial costs to be kept low and enabling the users to carry out some of the work and spread their cost over the medium-to-long term. On the *plane of composition*, each home unit was designed in an evolutionary way, with the potential to expand and contract in successive stages within the primary shell, which was capable of providing the structural, sanitary, acoustic and thermal performance attained from the outset in conformity to the maximum volume. Within this basic element, each home unit was expected to be able to "evolve" from a minimum area of 56m² up to a maximum of 131m². The composition of the development was entrusted to the primary structural supports, as well as a specific use and regulation of land plots.

On the *structural plane*, resistance to earthquakes and the overall stability of the buildings was ensured by the elements constituting its primary structure. This was to consist of C-shaped three-dimensional elements and prefabricated median-size panels for transverse bracing and stiffening linked by means of connections cast *in-situ*. The secondary elements, such as the metal beams supporting the intermediate floors made from prefabricated wooden panels, the internal partitions in plasterboard and the glazed curtain walls of the façade, were not required to make any contribution to the strength and stability of the buildings.

To complete the construction, the basic load-bearing elements were then combined with prefabricated panels for the external finish of the building envelope. In the case of duplex units, non-load-bearing infill glazing rising to double-height in a painted metal frame could be installed, being assembled in the workshop complete with all the accessories and ready to be slide into the tracks on the wall. Finally a battery of photovoltaic panels could be installed on the roof to produce electricity for lighting and heating, with access provided by a naval-type ladder located on the south-east elevation.

Later, in 1979–80, based on the principles set out in the report, the Piano & Rice Engineers and Architects office, in collaboration with the prefabrication company Vibrocemento Perugia s.p.a., built the prototypes of the structure portion of a standard simplex unit, leaving it in the unfinished state, and a duplex unit complete with services

08 Renzo Piano & P. Rice Engineers and Architects with Gruppo Isovibro Perugia "EH, Evolutionary Building", Solomeo, Italy, 1977. Exterior of the house. Current situation. © Carlo Nozza, 2012.

and finishes, with the exception of the array of solar panels on the roof, which was replaced by an external gas boiler and connection to the electricity grid. The duplex unit was then lived in for many years and through various vicissitudes until 2010.

Interpretation and broader application of the Prototype "EH Evolutionary Type Home Unit"

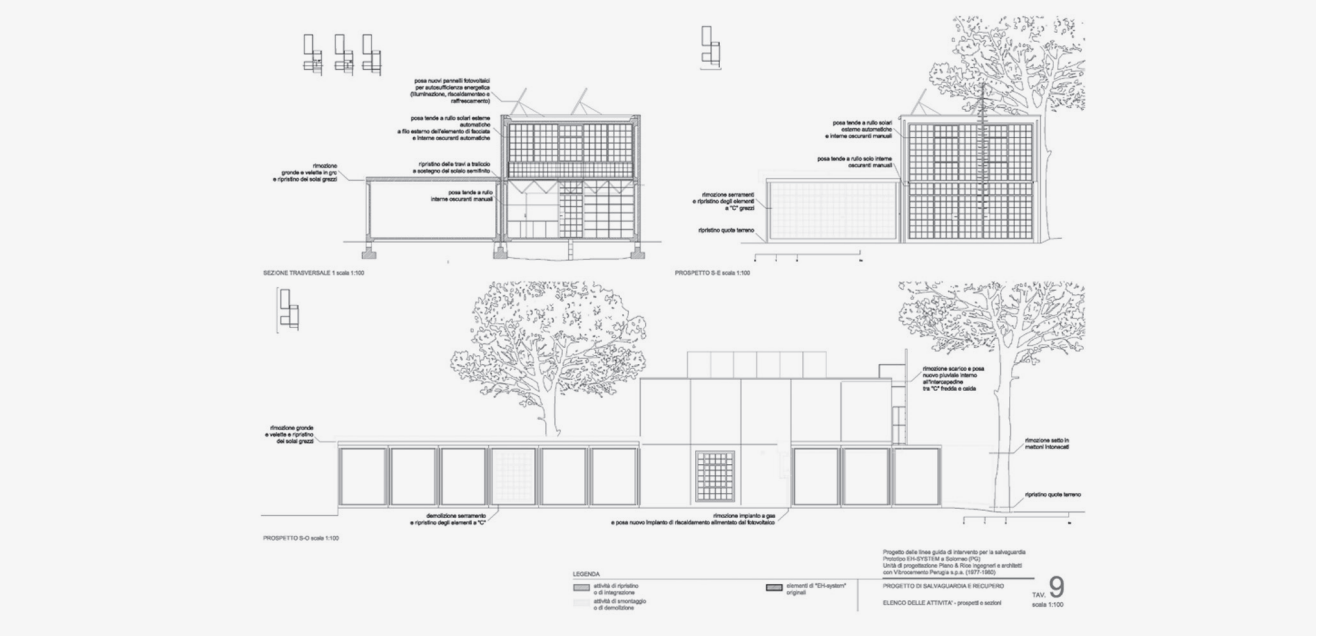
Following the completion of the prototype in Solomeo, Piano & Rice Engineers and Architects received a commission to design the RIGO housing estate in the municipality of Corciano, built between 1980 and 1982. The initial project envisaged a combination of the EH evolutionary home unit in different typologies to form clusters on one or two levels of units adaptable over time, in accordance with the principle of the articulation of the three-dimensional load-bearing elements with non-load-bearing walls largely glazed and moveable, as well as removable interior floors. Later, once the preliminary plans had been approved and when it was no longer a question of an emergency intervention, but of social housing at a controlled cost, it was decided to use the tried and tested 2S building system produced by Vibrocemento Perugia s.p.a., in order to keep costs down in the construction phase. The 2S construction system did not include the C-shaped three-dimensional prefabricated elements proposed for the prototype, which were difficult to transport. It consisted of simple insulated prefabricated concrete elements made of slabs, which comprised the load-bearing side walls and floor slabs connected to each other at the construction site by means of metal joints embedded in the cast concrete. Of the "EH evolutionary typology" there remained the dimensions and proportions of the internal spaces and the concept of non-bearing infill panels in the façade. However, these were originally designed as largely glazed and moveable but were replaced with fixed modular prefabricated panels, lightened and insulated, consisting of largely opaque panels and always positioned so as to immediately exploit the whole available volume.

Guidelines for strategies of protection and recovery of the Prototype "EH Evolutionary Typology Home Unit"

The building clearly expresses its aesthetic, as well as the technological and social achievements of a pioneering age, of which it remains a historical record. The project to devise guidelines for preserving the building were developed at the *Accademia di Architettura di Mendrisio* of the *Università della Svizzera Italiana*, interpreting the method of work with a multi-disciplinary character already tested at the TSAM-EPFL Laboratory in Lausanne for restoring notable examples of modern architecture.

In this specific case, the recovery project began with careful research and an overview of the existing documents by consulting the files of the Renzo Piano Foundation in Genoa and the archive of Vibrocemento s.p.a., today Generale Prefabbricati s.p.a. in Perugia. These preliminary activities made clear the cultural value of the building and enabled it to be contextualised in its historical period. Then a detailed instrumental geometric survey was carried out and a dynamic energy analysis and structural analysis were conducted in collaboration with the University of Engineering of Perugia,[8] for a preliminary assessment of the condition of the structure at the present time and possible consolidation to enhance its earthquake-resistance as well as upgrading the envelope's energy efficiency. Finally, the data collected

09 Renzo Piano & P. Rice Engineers and Architects with Gruppo Isovibro Perugia "EH, Evolutionary Building", Solomeo, Italy, 1977 Guideline for EH protection and reuse – general design by USI-AAM Franz Graf and Carlo Nozza, 2013. © USI-AAM – CN.



were analysed and a detailed description of its current situation and the state of degradation of all the original elements and materials were made. This was followed by the final project proposal guidelines for intervention to protect and reuse the building which was in the form of detailed charts describing the specific forms of intervention for each material or component.

The project, coordinated and finalised by the Department of Construction at the USI—*Accademia di Mendrisio*, sought to strike a delicate balance between the need for functional restoration of the existing structure and its essence as a living space extensible and adaptable over time, while safeguarding its original characteristics as fully as possible, with a series of minimal interventions, also with a view to financial sustainability. In fact "preserving the materiality of an existing building and considering it a resource, apart from its cultural value, implies an economy of means and a return on investment in the short term"[9].

Conclusions

There are three general criteria for interventions to protect this building's architectural heritage: the preservation of the aesthetic qualities of the project and its characteristic extensibility to be achieved through the restoration of the system of sliding glass infill panels, retention of the original materials through the consolidation of the original elements, renewal of the metal frames of the new windows and the repainting of all the walls and windows, so as not to lose the historical value of the innovative technologies adopted, and finally the environmental sustainability of the actions to be taken through a careful choice of the materials so as to improve the energy performance of the unit as a whole. There are three specific actions necessary to reactivate this now abandoned structure. Firstly, the maintenance of the prefabricated elements and the related integrated insulation panels. In fact, the three-dimensional load-bearing and non-load-bearing elements still perform their function well while, in the light of recent Italian regulations, the anti-seismic resistance of the transversal median septum rising to double height needs to be adapted to the current standards. In this case, on a preliminary basis, it can be considered sufficient to strengthen the median element by applying collaborating carbon fibre fabric.[10]

Secondly, restoration of the functionality of the elements necessary to enable the large glazed panel on the north-east front to be slid along the rails in the wall. The recovery of this feature of the building, together with the restoration of the ability to assemble or dismantle rapidly and easily at least a portion of the floor that divides the double-height space facing the north-east front, could make the building's cultural and innovative value clear and enduring. The dynamic energy analysis made it clear that for improved comfort and energy saving, the standard hand-made float glass, will have to be replaced with low-emission double glazing.

Thirdly, the enhancement and restoration of all the technological systems originally envisaged in the project, which at that time corresponded to the most advanced forecasts of energy efficiency and environmental sustainability. In fact the "Report on the E.H. evolutionary project typology" contains interesting insights into the use of solar energy, and intended to achieve energy self-sufficiency for the whole unit by installing an array of photovoltaic panels on the roof. This was not done at the time and it was subsequently replaced by a gas boiler. Also with regard to the utilities, in line with the overall capacity of the system to "evolve", it was expected that these would be placed fully in view so as

10 Renzo Piano & P. Rice Engineers and Architects with Gruppo Isovibro Perugia "EH, Evolutionary Building", Solomeo, Italy, 1977. The house as a living and therefore evolutionary organism: two large sliding windows ensure plentiful light and inside residents are free to organize their apartments as they wish. © RPBW-Renzo Piano Building Workshop. Photo by. Ishida Shunji.

to be easily adapted to the various configurations and types of spaces. Only the sanitary fittings and their connections to the drainpipes were expected to be fixed and positioned in the central module adjacent to the transversal septum, which was also intended to have an anti-seismic function.

Finally, once the proposed interventions have been carried out, we will again be able to appreciate the potential of this building, designed to respond to the need for emergency housing and planned to be subsequently adapted by the user, with a few simple actions, to meet needs as they changed over time. For the maintenance of the building and its adjacent lot, it will be necessary to identify a suitable use for it, probably as a temporary residential or exhibition space. ▮

Notes

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