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INNOVATIVE STRATEGIES FOR ADAPTIVE BUILDINGS IN LARGE CITIES

E. Pizzi, G. Iannaccone, P. Ruttico
Department of Building, Environment Science and Technology (BEST)
Politecnico Di Milano
Milan, Italy
e-mail: emilio.pizzi@polimi.it, pierpaolo.ruttico@mail.polimi.it

ABSTRACT

Changes characterizing our society include an ageing population, urban migration towards big cities, our lifestyle and work. These changes often make traditional building approaches obsolete. The existing building stock cannot totally satisfy the changed needs and new projects ask for careful valuations and new operating tools. In order to face the change, a feasible solution could be obtained by introducing the requisite of flexibility within both the design process and the construction technology of a building. By adopting a computational design methodology and an industrialized construction technology is possible to realize adaptive buildings, or buildings that can modify their characteristics according to the changing boundary conditions. The paper summarizes the management of adaptive/flexible buildings through the use of customized design tools, paying special attention to structural, energetic and technological issues. In order to design a building as an active, adjustable evolving system, is possible to develop a parametric program analysis visualization that allows to deeply understand complex architectural programs in four dimensions. The constantly evolving social mix is visualized with diagrams that automatically solve adjacency requirements and suggest planimetric and sectional relationships, enabling the user to explore different options and configurations. The algorithm can be implemented with arbitrary design choices and the programmatic use of collective spaces in order to reach the best feasible solution from the architectural and social standpoint. This raises questions as to how form emerges and how it continually differentiates, transforms and performs in relation to its specific environment.

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Several case studies show how it's possible to increase structural efficiency allowing a great flexibility in the interior transformation which could be obtained during the service life cycle of the building. Using internal lightweight walls, flexibility and transformation can be easily obtained without using too much energy for the necessary works. Prefabricated façade elements are designed and conceived with the same level of flexibility as the interior walls, by using innovative materials such as textiles. Outdoor spaces could be integrated in the interior spaces (e.g. balcony could change into loggia). A proper evaluation of changes in natural lighting, fire safety, noise reduction, solar gains, thermal insulation is needed in order to always guarantee high levels of comfort.

Key words: Flexibility, Adaptability, Adaptive Envelope, Computational Design, Parametric Design Tools.

Introduction

Contemporary architecture is bolstered by old principles based on immutability that have always constituted the essence and the objective of the design activity. The permanence and the resistance against transformation are at the base of a built environment that we would like to preserve for the future generations independently from the quality and the value of each single component.

The entire system of standards and regulations is aimed at facilitating the conservation of the architectural work making any change difficult and nourishing a principle of safeguard of construction even when this shows clearly to us its fragile soul and the limits of its concept. The value of the exterior image seems to prevail even when its utility decreases.

Is therefore a space in this context for a more ductile architecture that can be adapted to the continuous change of the requirements of the complex organization of the modern society? This is an interrogative that inevitably cross another question not always present in the de- sign brief of every new architectural work: for how long? How long must a building last and at which conditions has it to be maintained even when the functions and the related requirements radically change?

The temporal dimension makes us reflect in a concrete and pitiless way on the limit of the architectural intent and on its perfectibility but also on the live need of introducing corrections capable of encouraging the hope of a full compliance with the ever changing human conditions. More and more frequently we assist to the quick obsolescence of modern buildings when they are for public use but also for single residential units.

We realize, against our will, that the buildings created to respond to our needs actually constitute the stronger limitations to our every day life. There is no space that doesn't irremediably carry the idea of outgrowing of its use conditions. Spaces used for education purposes inevitably will change with the development of pedagogical and management teaching principles; spaces used for healthcare are continuously revised as a result of progress in medicine; working spaces live a continuous transformation due to the evolution of companies' organization; domestic space evolves with the mutation of the needs related to the dynamics of the family group.

The challenge of flexibility

It would be possible to attribute the limits of the resistance against transformation to the use of rigid construction technologies which are not modifiable or that can be modified only with the use of complex and ruinous demolition processes. In reality at the bottom of this there is a design conception that is very little keen to transformation and totally not interested in the evolution dynamics that affect our day-to-day life. We are therefore capable of prefiguring these changes and we can metabolize them within the design process envisaging a reasonable degree of transformability within time and contemporarily maintaining the everlasting values of architecture within the creation of landscapes and cities.

This is the challenge of flexibility but also the challenge of modern times. To accept it we need to put certain principles back into discussion. In the first instance we need to discuss the image of architecture itself in which we can envisage the transformations. Empty spaces that can be filled, heights that can be modified, and surfaces that can be modeled in accordance with new geometries.

This does not mean that we need to follow a route with no rules but, on the contrary, we need to be able to envisage within these rules legitimate alternatives that can be put into practice in different moments in time.

More adaptable design technologies are now available to us and they are capable of addressing these alternatives but considering the constraints of the location and, even if the development of the architectural concept becomes more complex, we can equally explore and develop in a complete manner the whole variety of variations assessing each of them in compliance with their impact on the local environment. At the basis of a flexible construction there is therefore a design that is capable of exploring the alternatives offered by flexibility and assessing their feasibility.

Space can be modeled and forged offering new arrangement and new opportunities for its use. This is the same lecture included in the transformations that time has layered over the architectures of the past and that makes us reflect on the possibility whereby today we can look at the future of the construction of contemporary architecture.

Flexibility imposes the need of being able to look carefully at the organizational and managerial reality of the functions to be included within each new construction. It encouraged to closely investigate the evolution mechanisms at the base of each activity and in particular it requires the knowledge of the potentials offered nowadays by technology. We are today in the happy situation of being able to build a different balance between the different constituting components of the construction: structure, services, finishes are more closely integrated. But we have also got the possibility of intervening independently on each of the above components also thanks to an easier access to these parts.

The use of layered dry systems, but also the improvements in the prefabrication techniques, certainly offers great opportunities for solutions that can be easily modified also in relation with the possibility of changing their performance through time.

Flexibility and sustainability issues

The topic of flexibility crosses the theme of sustainability because it can provide the base for a better resource investment.

A design based on the adaptability and flexibility concept makes it possible to continue using the building even if needs have changed: this is the “loose fit, long life” concept that aims at the maximum reuse of the structural components of the building.

For buildings to be adaptable they should be able to accommodate substantial changes. As most buildings are designed for a considerable lifespan it is inevitable that changes will be required. This is especially valid in relation to building materials and services which are constantly evolving. A building that is adaptable will be utilized more efficiently and may stay in service longer as it can respond to change at a lower cost. A longer service life may in turn translate to a better environmental performance over its lifecycle.

The predisposition of technological solutions which are suitable to be transformed can certainly reduce the costs of these transformations. They can also be quite rightly identified as a condition for a more efficient use of the space.

We must especially look at the dynamic conception of the space if we want to fully understand the opportunities of an architecture that is truly flexible.

The European Housing Contest competition

The concept of flexibility and adaptation in architecture reveals its potential in large cities where changes characterizing our society are more evident. They include ageing

population, urban migration, dynamic lifestyle and work, coexistence of different cultures. These often make traditional building approaches obsolete. Aiming at the identification of new concepts of contemporary living, the City of Milan promoted this year a European Competition to form a directory, over five years, of model designs for residential buildings with high quality technological and building type features that can be built at low cost. The project requirements included: optimal usability and design flexibility; aggregability and flexibility of the apartments' building solutions.

A case study: an adaptive building in Milan

Following the Competition requirements, some project proposals offer an example of application of new tools to the management of high-performance standards according the flexibility issues.

The building proposed by EPTA is a 5000 GSM 12-storey-high residential tower. With its innovative layout typology, the building becomes a spectrum of optimal conditions: from public programs to private residences, from open and flexible plans to tailor made layouts, from vibrant public space to peaceful green gardens.

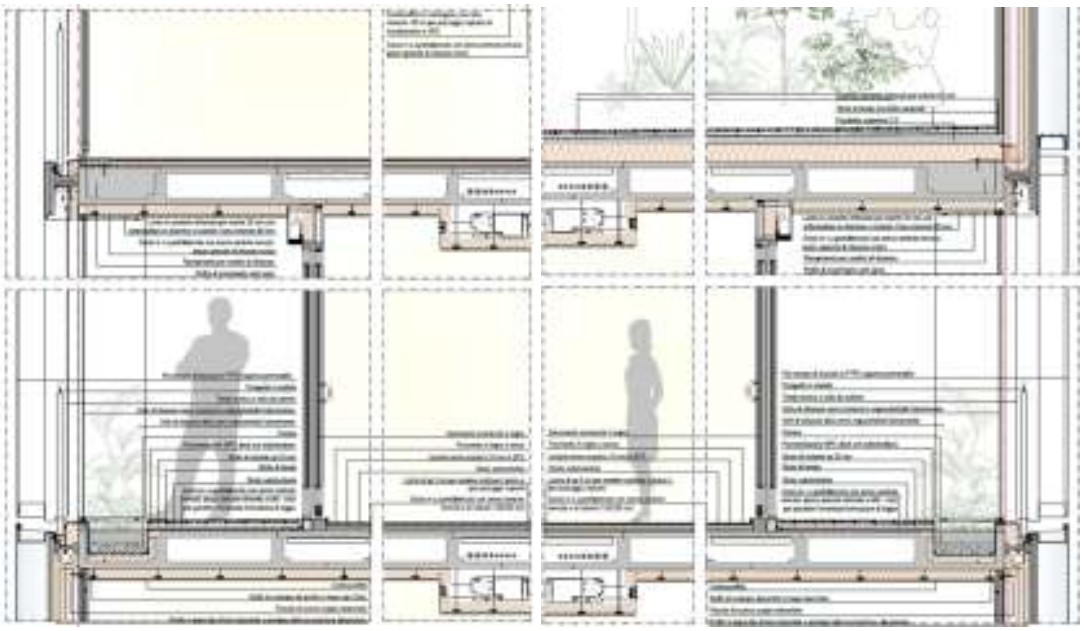

Figure 1 : Detailed cross section of an apartment. Lightweight internal walls and prefabricated cavity concrete slab allow for flexible internal layout. External loggias offer additional spaces for the extension of apartments (© EPTA srl)

The building volume provides optimal air, light and views to all flats and central corridors system. All apartments, 71 units ranging from 35 SM for a studio to 118 SM

for a 3 bedroom apt., have loggias, that extend the life inside the building to the outside in the warmer months.

The façade is designed in a barcode fashion in its alternation between void and solid. The wall strips span three floors, they are structured with cross Lam insulated timber panels wrapped in a flexible customizable fabric. A novel prefabricated concrete shear wall system is designed to better fulfill the layout flexibility. The building is designed to be entirely built of prefabricated parts assembled within a modular system.

The highly industrialized building techniques allow the building to be adaptive according to the changing needs of the residents.

Figure 2 : Housing contest competition – Milan: High performance, low cost residential buildings (© EPTA srl).

Parametric design for adaptive buildings

Parametric design tools and computational design processes allow to create a collaborative environment between architects, engineers, residents, builders and developers.

In order to design a building as an active and adjustable evolving system, it is possible to organize a modular environment which supports the decision-making process, allowing inputs from different actors at any stage of the process. A parametric program analysis visualization allows to deeply understand complex architectural programs in four dimensions. The constantly evolving social mix is visualized with diagrams that automatically solve adjacency requirements and suggest planimetric and sectional relationships, enabling the user to explore different options and configurations.

A generative process [Fig.3] generates the combinations of spaces and borders within a constraints list. The needed percentage of apartments [Fig.4] typologies is configured automatically according to future residents needs and construction constraints.

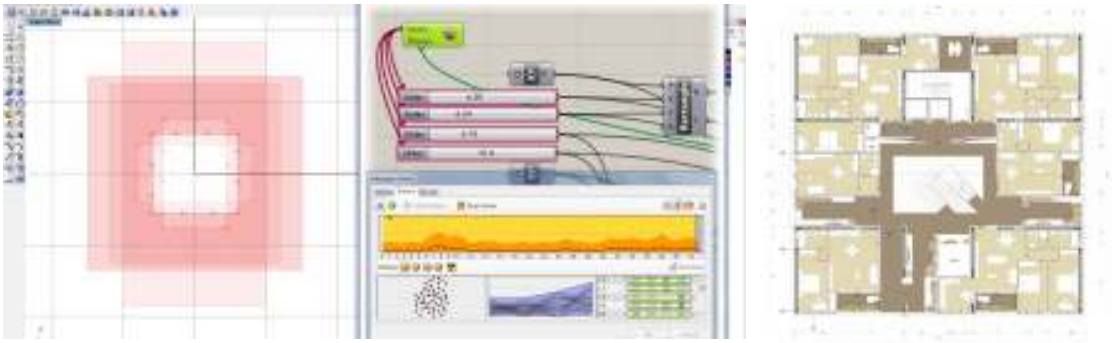

Figure 3 : Housing layouts are drawn on a parametric grid where blocks stand for a space typology (kitchen, living room, bathroom, bedroom, master bedroom) (© P. Ruttico).

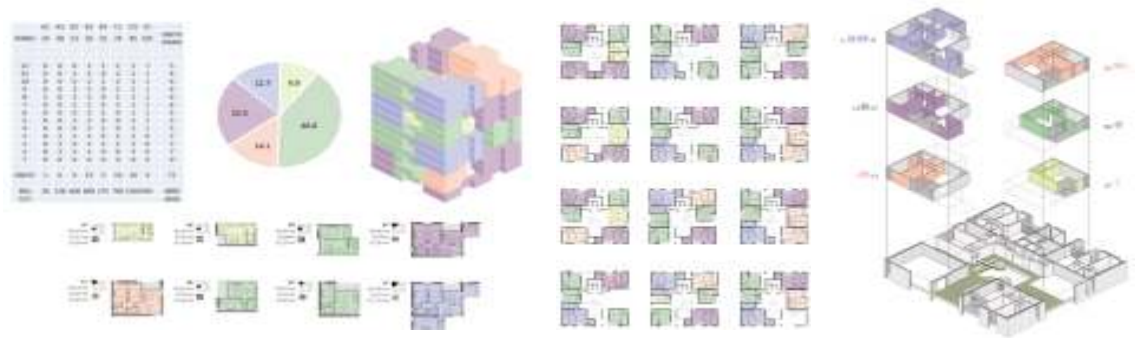

Figure 4 : A multiple choice control panel enables the system to generate a model that suits to the client's request. The design process tends to be interdependent, each layout option depends on the partial layout already developed (© P. Ruttico).

The algorithm can be implemented with arbitrary design choices and the programmatic use of collective spaces in order to reach the best feasible solution from

the architectural and social standpoint. This raises questions as to how form emerges and how it continually differentiates, transforms and performs in relation to its specific environment [Fig.5].

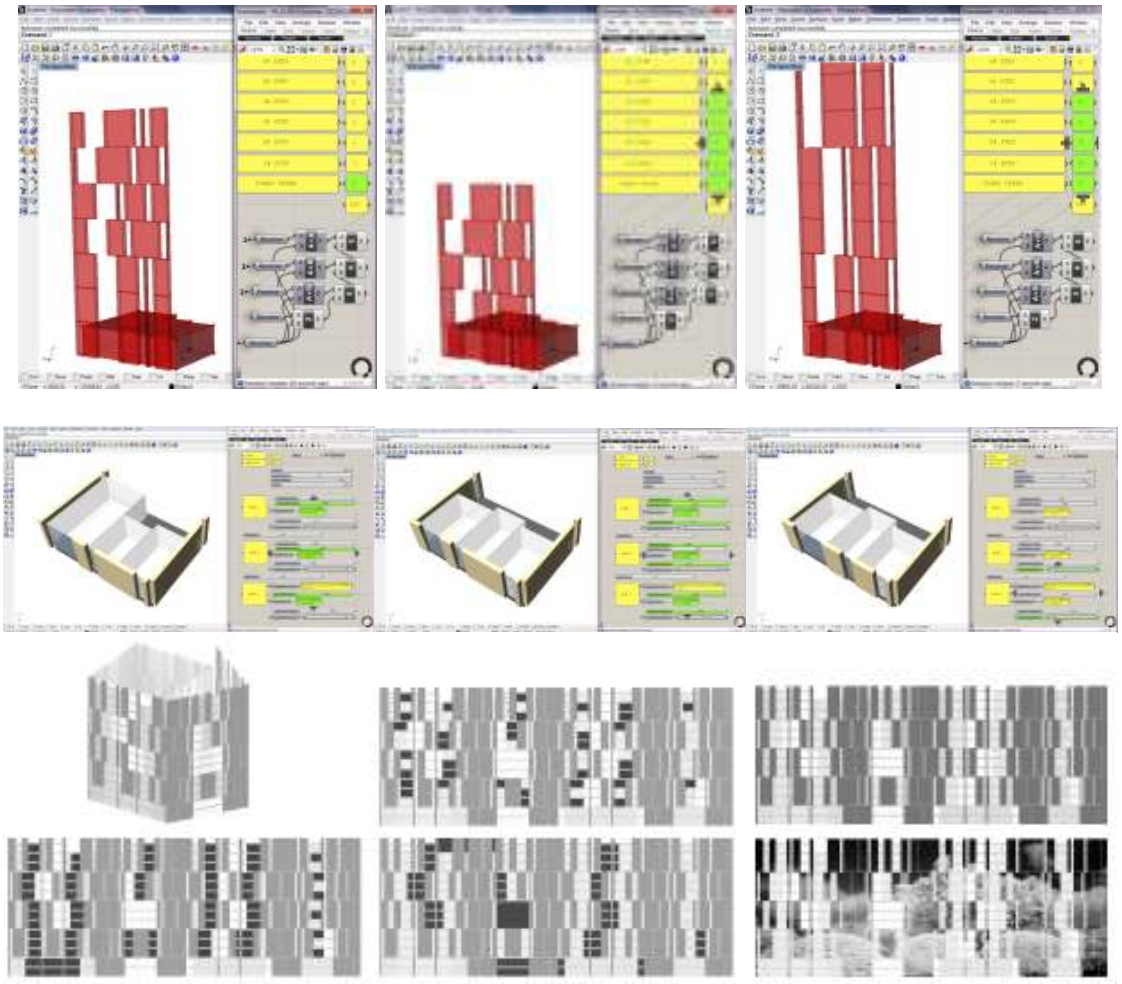

Figure 5 : The default configuration – square footage of rooms, windows size and placement, presence of "logge", green houses, public spaces - can be interactively modified by means of several sliders. The range of values of the sliders is related to the surface square footage and the number of inhabitants previously chosen (© P. Ruttico).

The parametric approach experimented within the Housing Contest competition in Milan is part of a prototype system which would need further development in order to best perform within given constraints and conditions. Specifically it is necessary to improve the interface design between user and system, including the ability to deal with arbitrary choices, site constraints and cost analysis.

Conclusions

The example of today's domestic space is quite emblematic in the reflection of the entire incapacity of being able to look carefully at the needs required by a family in having a space that can be adapted to them. In reality today's homes, also with the complicity of the diffusion of IT systems, are getting more and more complex and requiring more functions that span from the need to work from home to the requirement of cultural development of our children, to the care of the elderly to the space for spare time etc. These are activities that must find adequate responses in the definition of the spaces, in the service provision, in the possibilities of putting the right furniture and all of these opportunities have been so far neglected.

What we need is an architecture that in synthesis can live with us following our inclinations, even our moods and our emotions as it happens when we wear a dress or a suit. An architecture that we can wear in every moment of our life without finding it too small or too cold but actually like a inseparable part of our existence. This is the great opportunity that the next future architecture is reserving for us if we will be able to catch the opportunity and it extraordinary potential.

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