THE “ADDITION STRATEGY” IN BUILDING EXTENSION AND SUSTAINABLE TRANSFORMATION

Jacopo Gaspari
IUAV University of Venice, Faculty of Architecture, Dorsoduro 2206 Convento delle Terese, I- 30123 Venice, Italy, gaspari@iuav.it

Summary

Among the sustainable strategies for operating on the urban fabric, the transformation and requalification of existing buildings are often the most used ones in several cities all around Europe. The refurbishment of the existing building stock is usually aimed at increasing the technological quality in order to answer to a sustainable demand and to a reduction of energy consumption. The behaviour of the system as a whole can be modified in order to obtain a better energetic performance and to face the introduction of new requirements. The paper will analyze the opportunities of transformation, both technological and morphological, finalized to obtain a building extension with sustainable features (massive envelope, ventilated cladding, solar gain, solar shading, winter garden, etc.). The “strategy of addition” will be also analyzed from the durability point of view. As a refurbishment action can be considered an extension of the lifespan of the building, an energetic balance, including the embodied energy of materials and the energy spent on assembling the system, must be evaluated in the life cycle of the building. Examples of technological solutions and guidelines for refurbishment actions will be provided.

Keywords: requalification, building addition, durability, transformation, energy reduction

1 Transformation for requalification

1.1 Starting position

Several requalification processes are taking place all over Europe with the aim of increasing the quality of urban fabric in order to promote a sustainable development of the cities. Working on existing buildings is not only a way of saving resources and soil, but also a way to offer a new life (social and economic) to depressed or dismissed areas. In this strategy two main issues can be remarked: the one of improving the technological features of the existing buildings and the other of increasing the density to contrast the urban sprawl. As a consequence of the 2009 financial world crisis, the Italian Government has promoted some economic initiatives (not really belonging to the urban planning activity) that can have an important impact on the development or on the transformation of the cities. The idea is to support the local economy promoting the activity of the building sector and encouraging the private investment at the small-medium scale. The legislative tools allow owners, bypassing the general dispositions of the urban plan, to increase the volume and the surface of a building by means of additions according to specific parameters (like distance between volumes, typology of urban area, etc.) defined at
Regional scale. Furthermore, solutions for reducing energy demand and for introducing sustainable features are requested as well.

1.2 **Limits and goals of supporting initiatives to building sector**

Even if these rules (as any similar supporting initiatives in other countries) can be considered an extraordinary measure, they could have a deep impact on the transformation of the cities and for this reason the following limits have to be considered:

- There are no common defined standards for what concerns quality and energy performance;
- Quality and features of building materials and technological system are not addressed;
- There is a lack of control by the Institutions over the quality of the project.

As the initiative has an economic nature and not a planning one, the private action is controlled only by the responsibility of the designers.

So the problem is that the single project, even that one characterized by a good quality level, is not inserted into a strategic urban vision. In the same time the goals are:

- To support local economies;
- To improve the quality of the building stock;
- To ensure a sustainable approach to the energy demand.

To face these limits and to encourage the requalification process and the related goals two actions can be followed:

- To find out and to study well designed interventions proposing them as best practice;
- To extract design procedures and decisional tools in order to create guidelines to be added to the rules.

But how can we know (and possibly control) the effects of transformation processes?

2 **The “addition strategy”**

2.1 **Effects at the scale of urban fabric and at building scale**

Adding volumes to existing buildings brings different impacts in terms of image and density according to the typology of the areas (suburbs, expansion areas, first urban belt, central zone, historic areas, etc. – and some of these can be excluded by the action). In case of single house system (low density) there is a wide range of densification according to increasing parameters and to the owners’ intent. Otherwise, in case of multi-storey building system the expansion is conditioned by the boundary arrangement, the neighbouring volumes, etc. and by a possible multi-proprietary decisional process too.

The potential morphological and technological effect of transformation has to be evaluated including the impacts on surroundings. In this field, the multi-storey building sector is the one that attracts several attentions both for what concerns experimental design and for its social-urban importance as well. Following the idea that a great part of requalification process will involve this typology, it is useful to analyze the possible addition solutions and to deepen some related meaningful aspects.
2.2 Addition solution models

In the first step of the analysis the addition is evaluated with relation to geometrical parameters (addition+existing volumes) leading to define three main solution models. Each of them offers specific expansion opportunities and involves different technological implications in order to reach the quality and the sustainable goals. So it is necessary to compare the different approaches.

The three main models can be summarized as follows in Tab.1.

**Tab. 1** Scheme of addition models.

<table>
<thead>
<tr>
<th>Addition model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basement Addition</strong> – this solution is based on the extension of the volume connected to the public space. The structural scheme is simplified by the direct link to the ground but, at the same time, this option increases the use of the soil and in case of dense urban fabric it is not suitable.</td>
<td></td>
</tr>
<tr>
<td><strong>Façade Addition</strong> – this solution works on the building boundary and it is one of the most used strategy because it can provide homogeneous advantages in every floor introducing technological features, new spaces, thermal buffer zones, etc. The structure can be developed from the ground (using a small or a large surface). The principal limit is the respect of the distance from the neighbouring volumes.</td>
<td></td>
</tr>
<tr>
<td><strong>Roof Addition</strong> – the most evident advantage of this solution is that it makes possible a densification without using any soil quotas. The main problem is the evaluation of the residual structural capacity of the existing building in order to bear the new volumes. In this case the technological choice is a basilar element to assess the feasibility of the project.</td>
<td></td>
</tr>
</tbody>
</table>

Here are some examples of different addition models:
Fig. 1 A basement addition built in Paris, Saint Denis. (credits: J. Gaspari)

Fig. 2 Detail of addition: the structure is a steel frame with a corten cladding over an insulating layer (credits: J. Gaspari).

Fig. 3 A facade addition built in Chur. (credits: N. Bianchi)

Fig. 4 Detail of addition: the structure is a steel/timber frame with glass sliding elements (credits: Jügling & Hagmann Architekten).
The chance of improving the performance of the existing building has to be related to a morphological evaluation of the image transformation in order to avoid a loss of the original identity of it. This could not be a problem in case of low-quality building but it can become a great one in case of historic or traditional urban fabric like in the following example.
Even if morphological implications can be very important (especially for what concerns public opinion), the fallout on the surrounding buildings could be more meaningful. In fact the configuration of the addition can influence the use of soil, and other important parameters (as ventilation, insulation, etc.). All these factors must be evaluated.

**Fig. 8** In case of a basement addition there is an important reduction of public space in the surroundings and the intervention is strictly limited by the distance among the buildings allowed by rules. The road conditions are involved too. (credits: L. Abbascià)

**Fig. 9** In case of a facade addition the distance among the neighbouring buildings is the greatest limit to the geometrical configuration of the extension in order to preserve a good solar exposure. (credits: L. Abbascià)

**Fig. 10** The roof addition seems to offer good chances of densification without modifying the neighbouring conditions. In the meanwhile, the residual carrying capacity has to be assessed in order to develop the intervention. (credits: L. Abbascià)
Among the different solutions available, the roof addition is the one that allows the greatest opportunities to work in dense areas even in historic centres. If the image of the existing building has to be preserved, the addition can operate in setback position using a different and recognizable language. In the meantime the same strategy can be followed to transform low quality buildings to improve the net rentable area with speculative intent (in contrast to the original aim of requalification). The risk of wrong effects on the urban fabric depends on the carefulness regarding the application of the rules.

But how can we develop good policies and efficient evaluation procedures without defining a design strategy?

3 Roof addition design strategy: opportunities and limits

3.1 Methodological outlines

Once the roof addition model has been chosen with relation to urban condition, it is important to define some strategical aspects of the design process. First of all the residual carrying capacity of the existing building must be investigated.

- Step 01 – to perform a structural analysis of the existing building
  - Positive result – the addition can be realized
  - Negative result – a consolidation action must be provided

This step seems to be very simple but it depends on the technical rules adopted (in Italy NTC-2008) that often lead to ambiguous results. For example there is residual carrying capacity but it is not enough if it is compared to the new requirements. This condition would bring to a negative result with the consequence of consolidation intervention, with an increment of costs and, of course, complexity of works.

A possible solution is to reduce the general weight of the new volumes.

- Step 02 – to design a structural scheme to reduce general weight
- Step 03 – to make a choice of materials useful to reduce the weight

The idea is to limit the intervention on the existing building and to increase the quality through addition. Among the goals there is certainly the reduction of energy demand too, not only in terms of environmental control devices, or in terms of thermal buffer solutions, but also in terms of embodied energy [EE] of materials and systems [1].

- Step 04 – to select sustainable solutions considering the EE

The final result will be a design process in which the different solutions are assessed in order to choose the technological solutions that have to be translated in technical drawings.

3.2 Examples of good practice

In many cases a timber based strategy has been chosen in order to decrease the EE value and the general weight of the addition. A first structural solution that is often adopted is a timber or steel frame completed by sandwich panels composed of wood and insulation. A second structural solution is based on cross laminated timber panels especially when a high carrying capacity is necessary [see the case studies in the digital version of the paper].

Both of these systems allow a great variety of cladding whose design has to tackle the waterproofing problem. This is a critical choice because it can deeply influence the efficiency and the durability of the system. The insulation stability is important to offer good thermal performances (and an energy reduction demand as a consequence), but durability of materials and components is essential to get a longer life cycle. In fact the
addition has to last the time necessary to reach the break even point for what concerns the initial investment of energy. This time must be evaluated with relation to the existing building which can be assumed as the permanent layer [2] in the ELCA.

An interesting example of requalification process is offered by an experimental project run on an 80s building in the hinterland of Milan. The roof was affected by some technological problems concerning the thermal insulation and the waterproofing solutions. The extraordinary maintenance activity became the opportunity to transform this space into a new floor with green roofing. The image of the existing building has been maintained (as the very low quality of the building itself) and the extension is clearly recognizable thanks to the material used. The main structure is a steel/timber frame with stratified insulation layers and an external timber cladding.

**Fig. 11** The building before the refurbishment.  
(credits: Studio Albori)

**Fig. 12** The building after the refurbishment.  
(credits: Studio Albori)

**Fig. 13** A front view of the addition.  
(credits: Studio Albori)

**Fig. 14** A cross section of the addition.  
(credits: Studio Albori)

Project: studio Albori (E. Almagioni, G. Borella, F. Riva)  
Design team: M. Alberti, S. Bodria  
Structure: F. Valaperta, G. Sordi / FVprogetti  
Services: C. Barrese, StudioBarrese
One of the most interesting aspects of this kind of solution is represented by the chance to develop a transformation action without operating on the other levels of the existing building (which can be maintained in use during the intervention). In the meanwhile the use of an assembled frame structure allows to reduce the building time and especially the whole weight of the extension. The relationship between the general weight and the statical behaviour of the building has been considered as a strategic factor in the most recent refurbishment actions in which the use of Cross Laminated Timber panels has been explored.

The use of timber panels allows to reduce also the embodied energy of the intervention and the energy used for construction phases. The negative aspect could be the durability of the timber components, but this factor strictly depends on the technological details adopted by the project in terms of waterproofing and insulating solutions. During the ELCA of the building it is important to consider the EE value of the system and the expected lifespan as well.

4 Conclusions

Initiatives to promote investments in the building sector finalized to requalification have to be supported by adequate guidelines to develop the design activity in order to prevent speculations and to reach an increasing of the general sustainable quality of the urban fabric. Among the main issues that have to be achieved in the guidelines there are:

- Introduction of quality parameters to choose the addition model
- Introduction of EE value as an assessment tool
- Definition of a durability range parameters for expected life cycle of building additions

Fig. 15  Example of cross laminated timber panels assembled on a waterproofing layer. (credits: J. Gaspari)  
Fig. 16  The use of timber panels offers high structural performances with a limited weight and with a limited EE value. (credits: J. Gaspari)
References
