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Auditoria and public halls. The preserved architectonic heritage, in the perspective of sustainability.

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Abstract

Theatres and *auditoria* have only rarely been "virtuous" examples for energy use both for their peculiar space requirements and for the discontinuity of their use; such statement is even more true when such spaces are located and hosted within monumental buildings such as former churches or industrial areas; that is a quite frequent case in the Italian urban contest. To re-think critically the entire process - from political-planning decision-making to the managing phase – does represent a key step to prevent the decay and abandonment of works of great value and great architectonic and cultural significance. To that aim, three cases of architectonic and historic quality, located in Torino (Italy), are reviewed.

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1. Introduction: "Monument Restoration" vs. "Sustainable Historic Preservation"?

This study aims at discussing the cultural and procedural mechanisms which to-date, in Italy and Europe, have guided the concept of refunctionalization of heritage buildings. In particular, reference is made to the validation and classification of performance vis-à-vis historic buildings of remarkable heritage value – historic-artistic and architectonic-urban value – as to what is defined in English as *"Sustainable historic preservation"*. That means *"... a term often used by those who advocate historic preservation by promoting the position that preservation has tangible ecological benefits, on the basis that the most sustainable building is one that is already built, and that historic buildings have advantages*

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over new construction with their often central location, historic building materials, and unique characteristics of craftsmanship". (From: Wikipedia,"Sustainable preservation, s.v.).

In the consolidated tradition of preservative restoration - accepted and implemented in Italy- the global approach entailed in the principles of "*Sustainable preservation"* appears sporadically or, in the best of cases, is intended "*lato sensu*". The Ruskinian [1] approach of the discipline, taken over by Boito (1836-1914) and Giovannoni, (1873-1947) – and become the "Italian way to restoration" – is in fact based on the preservation of the original matter of the building and the careful study of the relations between the project itself and its related implementation: such approach however neglects the complex interaction exercised by the monument on the socio-cultural and environmental components within which it is inscribed. Given its idealistic profile, such an approach has only rarely paid attention to the above-mentioned values and only by defining, in generic and abstract terms, the relation between the *"object to preserve"* and the *"natural/built environment".* In that respect, also the economic (managing and financial) requirements are either missing or marginal.

Just the opposite, vis-à-vis the mainly philological concern reported by "*Stone of Venice*", is represented by the cultural approach of SPI (*Sustainable Preservation Initiative*): the work of overseas *Councils* responds to the equally categorical imperative of placing the anthropological needs before the aesthetic-material ones. The "ethical" restorers, mainly active in the archaeological sector, are inspired by the motto "*People, not stones*!". That is a perspective based on the recovery experiences of UNESCO heritage, mainly carried out in South-East Asia or Latin America. The first goal is "sustainability" *tout-court* and the "social" profile of the interventions made [2]. In that approach, the recovery initiatives are deemed "[…] *to preserve the world's cultural heritage by providing sustainable economic opportunities to poor communities where endangered archaeological sites are located. Sustainable Preservation Initiative (SPI) believes the best way to preserve cultural heritage is creating or supporting locally-owned businesses whose success is tied to that preservation*."

2. Building and "Heritage": The "Requirement /Performance" Relation

The "technological" approach of APTI (*Association for Preservation Technology International)*or of the *National Trust for Historic Preservation* appears less extreme from a cultural perspective although still far from the Italian way. Since 2006 it has joined the *LEED (Green Building Rating System)benchmark methodologies.* That represents a way of assessing the architectonic asset from a quantitative point of view, on top and beyond the purely qualitative one, by highlighting the construction, energy, management aspects that are key in the "economic sustainability" perspective. To-date there is no evidence that in Italy a similar assessment analysis has been performed on historic buildings or complexes to such an extent that can allow to draw related conclusions or appraisals. The theme of *"preservation vs. sustainability vs. installations"* is anyway on the agenda and could not be otherwise given the numerical and qualitative incidence represented by historic and preserved architectonic buildings within the overall framework of the Italian heritage being managed. It is therefore obvious how the missed consideration and management of such issue may affect the calculation of Co_2 emissions and economic burdens: from monuments to the variety of articles, even minor ones spread all over the country, to the ancient city centres, it is undeniable that the issue of potential and actual energy saving in the country heritage is of extraordinary relevance.

Not differently, such considerations are even more valuable if referred to the clear reversed trend that is taking place within the urban context. By means of the strategic choice of "densifying" the existing urban fabric – mainly in the "historic" peripheries close to the city centre – it is now possible to re-use almost in toto the material substance of existing buildings instead of proceeding with new constructions or, to supplement potential unbalances, as per what envisaged by the new regional norms, with reductions, transfers or conveyance of so-called “building credits” (see: Law of Venetian Region, nu.14/04 on urban equalization).

In that respect, it is worth underlining that, in Italy, the initial procedures of the recovery process – from the identification to the use destination of the asset to preserve – generally started by private entities or by political-administrative bodies, have almost always lacked of in-depth assessment in terms of technical performance and, even more in terms of validation of the actual existence of energy performance requirements. Hence, already in this phase, the missing parametric analysis from the intervention planning, causes the absence or the insufficient validation of the financial-economic feasibility as to the implementation and post-intervention phase.

The case, still unresolved, of Palazzo del Lavoro, located in Torino, in the district “Italia ‘61”, may represent a good example. The large building, based on a plan by Pier Luigi Nervi and Gio’ Ponti, has been dismantled since 2008 and, while waiting for a use destination consistent with its value, its destiny seems to be that of hopeless decay [2].

Despite the statements of willingness made as to its preservation, it is evident how unbearable management costs for air-conditioning and heating may have played a key role on the status of its abandonment and missing new utilization.

3. Approach to Energy Efficiency in The Recovery Of Historic Buildings. “Methodological Notes”.

The energy assessment of recovered and refunctionalized historic buildings, if carried out by separating the energy analysis from the historic-organic assessment of the whole building, runs the risk to neglect the complexities of the assessment itself so obtaining parameters that can be easily compared but are little significant. Current energy/environmental classifications of buildings are in fact the result of the state-of-the-art and of the current technical vision as applied to products, which are by large standardized.

The significance itself of the assessment is higher as higher is the standardization of the assessed products, thanks to the possibility of assessing by comparing similar terms.

In dealing with the energy theme in the field of preservation, instead, the understanding of the variety of links between energy performance, the building’s roots and its new relation with society seems to play a key role. In that respect, it is almost desirable to suggest to take “a step back” from the indoor air engineering and thermo-technical perspective vis-à-vis consolidated reference parameters that regard mainly:

- Indoor requirements: they are specified by national and international standards related to the definition and measurement of indoor comfort. Such references range from systems born from in-lab observations, more constraining systems due to the fact that they do not consider the specific application context and the reaction of the user to it (as main example, the work done by professor Fanger, take over by ISO 7730) [3][4], to more flexible systems, allowing for a higher variability on the basis of some physical and psychological reactions of the user, the so-called *“adaptive models*” [5][6]
- Equipment implementation and performance standards: the current development status of environment air-conditioning technique envisages a high level of industrial pre-fabrication of standard parts (for example : boilers, pumps, valves, pipes, etc.) which, assembled by means of more handicraft-like abilities, shape installations. Such system is very flexible as it enables to adapt to different situations but its base structure and its compiling modules derive from or are mainly optimized for a kind of use that is more typical and appropriate for contemporary building.
- Calculation models and procedures: mathematical models largely applied in the calculations of thermal loads and energy needs are made on simplifications based on average buildings making the building park. Such simplifications do not model correctly the major part of historic buildings and are not

capable of analysing energy performance in detail.

Such elements are at a development stage which goes in parallel with that of buildings and only in part have been adapted for their application to historic buildings. The term "to adapt", moreover, is already indicating a pathway that usually does not start from the historic understanding of the original functioning scope of the building itself. Such understanding can certainly lead to exciting discoveries as in the case of certain traditional buildings taken as example in the literature on *bio-climatics*, or it can highlight how the original concept of *indoor climate* is far from what is expected today for its new destination of use. Commonly speaking, it may also lead to a sort of in-between result. In any case, however, it is highly relevant that such an analysis is included in the initial framework of each project of heritage valorization as it may generate a more harmonious upgrading of the building or a more aware transformation of it in all those elements hampering its correct and efficient (sustainable) functioning, once its use destination is identified.

Such concept can be made more explicit by the following steps:

- "Historic-environmental analysis" – Analysis of the original functioning scope from energy/climate perspective of the architectonic asset being upgraded or retrofit.
- "Development of the requirements for the new functions" – Definition of comfort requirements identified for the new functions and elaboration of functioning and assessment principles vis-à-vis installation and building interventions made necessary to perform the new function/s while respecting contemporary efficiency and performance requirements and parameters.
- "Critical analysis" – Assessment of the constraints introduced into the original system by the new functions.

Such critical approach aims at underlining bigger or minor differences in each of the case studies presented as well as which elements of the "ASSET", i.e. the old building, are in contrast with the needs of the new functions. In this way, fundamental points are raised:

- AUT1: the newly-envisaged use is changed and a solution closer to the original energy/climate functioning scope is chosen,
- AUT2: comfort expectations are drastically reduced,
- AUT3: radical changes to original elements are accepted, which are in contrast with the new energy/environment functioning (that is the most frequent case which will be reviewed in the examples coming up in this paper).

As an alternative, the result could be a compromise of difficult balance and poor energy efficiency (and often of difficult and expensive maintenance).

4. Case-Studies: The Architectonic Recovery For The System of Theatres and Shows in Torino.

The experience of a success case of architectonic-urban recovery performed in the past decades in the city of Torino give us the opportunity to verify ex-post the propositions made in paragraph 2). Away from being a statistically significant sample, such experiences may release operational reflections potentially useful to start a planning process of higher awareness.

The case involves three buildings, intended to become auditoriums and theatres, obtained by means of recovering buildings of original religious [Chiesa and Coro di Santa Pelagia, 18th century], performance [Ex-movie theatre "Astra", now: Teatro Astra, 20th century], or industrial use [ex transformer room and now: "Casa del Teatro Ragazzi e Giovani"], either partially dismantled or in decay. All interventions submitted – as per plan by professor and architect A. Magnaghi et alii - were planned and carried out from 2000 to 2006.

Fig. 2. (a,b) Church and Choir of Santa Pelagia, Torino. Choir detail. [Pictures © Bruna Biamino]

5. Santa Pelagia

The factory of S. Pelagia, currently a Catholic Church – former Augustinian female monastery – opens up as a perspective wing on the narrow street of S. Croce, in the heart of Torino historic centre. The building of outstanding architectonic-artistic value, can be fully ascribed to the Piedmontese Baroque tradition [8]: the imposing factory in brick is characterized by its indoor central structure, dominated by a dome inserted in the high cross-shaped lantern. Although damaged in war events, it has kept almost intact its original decorative-architectonic structure. The central hall, along which there run the entrance and three chapels, is used, although rarely, for sacred functions. Through the same hall access is given to the remarkable semi-elliptical choir, the only architectonic work remained as proof of its ancient monastic destination. A double order of walnut balconied stalls is leaned against the hall walls which are lightened with high windows on the upper level. After the restoration interventions, mainly aimed at consolidating the wooden and wall structures and the cleansing of the painted surfaces, the most delicate and problematic operation was performed, which envisaged the positioning of the installations and the insertion of technological equipment into the ancient structure of the asset.

The hall is now used for concerts, drama, debates and conferences open to the general public. Its dimensional characteristics (choir surface: 140sqm for a height of about 15 meters) allow to host 98 seated spectators accommodated in the internal hall space and the wooden stalls. Excellent acoustic diffusion performances are very rarely improved by use of sound amplifying equipment. The wooden balcony over the stalls is supported by wooden corbels. The balcony cannot be accessed by the public but only and exclusively by operators and technicians for maintenance purpose.

During musical or theatre performances, usually held in the choir, the church hall is kept separated by heavy velvet curtains. Such device, requested by the Preservation Authority in order not to interfere visually with the order of the sacred place, guarantees only partial resistance to air and heat dispersion towards the worship hall.

Hence, there is a sort of "suction" effect of warm air towards the colder area with upward motions and streams noxious to the public and mainly to the actors, musicians or singers, who generally occupy the hall area closer to the Church.

The newly-installed equipment is an all air system. There are two different and independent installation sections : one for the main hall, the other for the concert/choir hall. The air handling unit (AHU) is placed under the organ, the second one is placed outside of the Church, on the roof of a small adjacent building.

Air diffusion varies in the two areas: in the main hall the air supply is performed via jet nozzle diffusers masked by the choir wooden gratings of the mezzanine floor; the return air is instead performed via the grill inlets obtained in some doors leading to ancillary areas under the choir/organ.

In the hall of the large semi-elliptical choir, the supply has been carried out in the floor and the return takes place through gratings masked in the choir itself. Floor diffusers are placed under the choir stalls, along the whole perimeter of the semi-ellipsis.

In the Choir, the duct pathway, serving all floor inlets, has been developed partly in the underground areas and partly in the technical inner courtyard dug in cutting at the basis of the external wall of the choir. From here, the network reaches the outside AHU by passing through the adjacent court.

5.1. Energy Analysis: a case where original characteristics of the building have been kept in place

The “energy functioning” of a building of this type is characterized by two main factors : the large surface of the cover bordering with the outside and the big volumes linked to the considerable heights of the different spaces. In environments of such a type, temperature gradients generate high thermal flows per unit of useful floor surface and start intense connective motions linked to floating forces, that, as known, develop into vertical motions as high as the available height. Such connective motions often generate also a strong thermal stratification according to which the difference between the temperature of the occupied space and that of the hall upper level can easily exceed ten degrees. The higher the temperature differences to be generated and kept between indoor and outdoor, the higher are such characteristic effects, which, for their very same nature, entail high dis-homogeneity of indoor thermal conditions.

The spaces allotted to host the new function for concerts would currently be, instead, conceived as areas where the control on the homogeneity of comfort conditions plays a key role. In that respect, it is clear that the comfort expected during a worshipping ceremony differs from that wished for an artistic or entertainment show.

To make that possible, modern *auditoria* (also obtained through restoration such as two of the cases presented), although characterized by elevated heights for the necessary inclination of the stalls and for acoustics, are mainly conceived as an isolated technological box interacting as little as possible with the outside environment and “surrounded” with installations which are pervasively distributed along all surfaces.

In the case of Santa Pelagia, taken as example of a building typology largely diffused within the Italian historic heritage, as to its envisaged refunctionalization, two main difficulties are observed as particularly relevant:

- The different spaces have characteristics that make the climate control very difficult
- To obtain the best climate control solution in such environment, it is necessary to have pervasive installations allowing to intervene in the most distributed and homogeneous way within the whole indoor volume. In that case, the need for high-level technical spaces and leads for equipment networks, not envisaged in the original building, do clash sharply with preservation instances.

The intermittent use adds a further element of unbalance in the new functional order. In such cases, the efficiency of any air-conditioning installation is only rarely at its best and problems become bigger if the installation serves a space such as that above where it is not possible to intervene even for a partial moderation of the thermal dynamics described above.

The theme of air-conditioning in historic churches is quite topical and difficult and, in the past, some effort were devoted to the topic [7]. Typically, such programmes highlight the internal issues already reported above, as well as evidence of the noxious effects on the artistic heritage generated by the implementation and use of “modern” air-conditioning installations. Such topic, although not directly linked to energy efficiency, affects the positive outcome of the management activities.

6. The "Casa del Teatro Ragazzi e Giovani" (House of Youth Theatre)

The *"Casa del Teatro Ragazzi e Giovani"* [*House of Youth Theatre*] is hosted within a building of industrial origin, utilized in the past as transformer room of the Torino-based energy company AEM, in Corso Galileo Ferraris 266/c, on the corner with Corso Sebastopoli. This intervention is part of the extensive activities of urban requalification implemented by the City of Torino, between 2003-2006, in view of the Winter Olympics. The original industrial complex, in full decay since the 90's, is located in the densely-populated district of Santa Rita, close to the Olympic Palasport, now called "Palaisozaki. The construction of the original structure, by engineer Clemente Bornati, dates back to 1927-'28 and represents a high-level example of the best technical-industrial culture of the first half of the 20^{th} century.

Beyond the creation of theatre halls and multi-functional labs available for the city and requested by the Authority for Heritage Preservation, there was the request, among all recovery goals, to keep the pre-existing building without upturning interventions on the essential formal and partitioning features. According to that principle, it was possible to guarantee a balanced relation between preservation needs of the pre-existing building and the creation of theatre areas while preserving the supporting structure, horizontal and vertical pathways and façade sections.

The most interesting elements of the interventions, awarded with prizes and public acknowledgements [9], are represented by the quality of modern architectonic inserts within the rigid industrial structure.

Flexible theatre spaces enable maximum changeability of the scene within the planimetry of the former AEM transformer room.

Spaces so obtained can be briefly classified as follows:

- *"Sala grande"* (Large Hall): i.e. a surface of 406sqm. for a total of 298 seats. The stage is 16-meter deep by a 10-meter wide scene. The hall is 11.20-meter high and planned to stage different types of shows by changing its configuration thanks to its telescopic stairs and a mobile platform.
- *"Sala Piccola"* (Small Hall): i.e. a surface of 132sqm., allocating 132 seats. The multi-purpose hall is aimed at hosting small-size shows, exhibitions, meetings, conferences, etc.
- Rehearsal rooms, laboratories, conferences : there are 4 units in the complex, for a total of 350sqm.;
- Areas for the public including *foyer*, ticket office, wardrobe, coffee-shop, bookshop: an overall surface of 700sqm. that, in the summer, integrates with an outdoor arena, with tier of seats, of about 200sqm. hosting about 120 seats.

From the energy point of view, it is evident how the large halls and the large foyer are more critical as regards the control on winter and summer environmental parameters. In the volume close to via Ferraris, already equipped with large glass windows, the Planner wanted to integrate additional existing uncovered surfaces into the heated volume. Hence, the new vertical closings have been made with fully glass windows that influence significantly the micro-climate of the triple-height foyer.

The different spaces are endowed with complete installations, typical of modern theatres. The halls and the spaces for the public are served with all-air conditioning systems: it is for sure a choice that fits such environments densely crowded and intensely intermittent.

The main hall is equipped with two independent sections of 21.000m3/h, one for the stage area and one for the audience area; they have variable capacity as per occupation level. The foyer area is equipped with an additional section of the same capacity. Air is supplied via slot and jet nozzle diffusers in the halls and the return is made via ceiling gratings.

Fig. 3. (a,b), "Casa del teatro Giovani e Ragazzi", Torino. Hall detail, reverse angle of the hall towards the stage. [Pictures © Bruna Biamino]

6.1. Energy Analysis: a case of "decoupling" of the new function from the historic envelope

The planning of show halls obtained as "technological boxes" – i.e. spaces which are architectonically and functionally independent – not interacting directly with outside areas, is a solution that enables to by-pass the original thermal function of the building. It is a kind of solution that brings about positive results as far as the interface spaces between the box and the original case/envelope allow for the positioning of the necessary installations on top of the functions which are related to the hall itself.

From the thermal perspective, the new intervention is almost completely decoupled from the original structure. That is a responsible choice as the new function would not adapt well with the original envelope. The "technological box", i.e. the energy decoupling of the original with the new functions, cannot be easily adopted in contexts where the internal decoration represents a valuable element. In such cases, the constraint of the original order prevails.

7. Astra Theatre

The rough building events of Teatro Astra are integral part of Torino residential fabric. The building is located in via Rosolino Pilo, in the Campidoglio district. Inaugurated as theatre in 1930, as per the plan by engineer Contardo Bonicelli, it could host 1,250 spectators and was sided, in the adjacent garden, with a building hosting a beer-house. In the war and after-war years, the structure got transformed into the *"Teatro-Cinema Astra",* undergoing further changes and modifications. In the 70s, the Astra suffered from the general decline of movie theatres and was finally shut down in 1978. Purchased by the City of Torino, it rapidly decayed due to its abandonment that led the building to the threshold of destruction. The restoration assigned to professor Agostino Magnaghi in 2001, on behalf of Teatro Stabile di Torino, has allowed to return it fully to its original function. The recovery works and the installations made were finalized in 2006.

The intervention is quite unusual and complex both in formal and functional terms : the façade and the foyer have been restored according to strictly philological criteria and the spaces for the dressing-rooms and theatre labs have been built ex novo on pre-existing volumes. The theatre hall is surprising for its unusual feature of "consolidated ruin"; its walls have in fact undergone maintenance interventions, without operating recoveries or reconstructions of the original matter and thus keeping in situ the remains of the original cement structures partially destroyed by vandalic acts.

As regards the indoor order, the choice opted for was that of a fully reversible technology containing in the same area tiers of seats, stalls and co-planar scenic space, so satisfying the needs of both avant-garde and traditional theatre events. The hall extends on a surface of 556sqm. and is 15.50-meter high. Current capacity, drastically reduced vs. the original one, is of 300 seats. The scene framework is fully in view; that choice, due to the requests of the artistic direction, has caused a considerable increase in the hall volume to be heated.

8. Conclusions

In the Torino case – mainly in reference to theatres and monumental buildings – particular value has been given to the formal re-qualification and to the improvement and optimization of spaces open to the wider public and available for staff and artists; the need to reduce energy costs paid by management bodies – either private or public – sets as a priority replacement interventions, implementation of building shells architectonic installations aimed at controlling and guaranteeing comfort and sustainability. In the cases reported the winter season has proved to be particularly expensive in term of managing costs. Energy *retrofitting*, with the choice of improving the building energy class, would imply the need to improve the performance of envelopes, installations and new enlargements. As for new buildings, also in the case of recoveries, the better the envelope performance, the better the performance supplied by the plants in terms of environmental comfort and energy efficiency. Whereas re-functionalization envisages to keep the original shell, the coupling between the historic building and the modern plants will have to be made on the basis of a compromise between preservation requirements and energy performance needs. The original building represents almost always a good compromise between functional and comfort needs, on one side, and structural requirements, on the other side, providing examples of a specific historic context.

Its re-use should match with the identification of a new and positive solution deriving from the integration of the original matrix and the new technological possibilities. In all cases reviewed, the planning interventions – characterized by high autonomy and architectonic quality – have aimed at increasing indoor and outdoor comfort parameters, at improving emission levels but they are not yet sufficient to guarantee a more accurate and careful use of energy for air-conditioning.

It is likely that technological evolution and recovery experiences of historic buildings may allow to solve in a more satisfactory way also cases in which then original shell is to be preserved.

However, the paradoxical situation, by which the assessment of the building artistic value affects the clear assessment of its use, seems very close to the limit of technological possibilities (and of economic investment). In such cases the straining of an intervention is paid with a sort of violence (the installation of equipment necessary to correct indoor climate in non-suitable places) on an asset that is deemed to be better valorized or preserved (see the example case of *Palazzo Madama*, in Torino) [10]

A further possibility of re-using a historic building for a new function is that of energy un-coupling of the new function from the original which becomes in this way a container of a new self-sufficient building (see the concept of technological box for halls). The scientific efficacy and philological accuracy of a fully reversible intervention shows however intrinsic weakness: i.e. its being strongly influenced by the figurative quality of the intervention and by the technological emphasis which it is fatally called to take on.

The final conclusion of these reflections is that, today more than ever, disciplinary specialization and separation of operational practices show our inability to provide convincing answers for complex cases. For such reason, an effective and timely assessment of use destinations, carried out in the greenfield phase of the project – i.e. during the definition of the "design brief"- and reported in a protocol or a dedicated checklist – can represent a valid discriminant for the destiny of the Asset, accompanied with a responsible and correct use of Community economic resources.

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