ENERGY EFFICIENT RETROFITTING OF MUSEUMS

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ABSTRACT: Rehabilitation of historic settlements should be a main architectural field for the 21st century. In order to promote that issue, we need to asset evaluations of the energy performance of the towns and buildings of the past and especially of museums where the same antiquities are exposed.

In this respect both quality and quantity of environmental improvements are crucial. As we say, historic buildings used to be sustainable but this feature is often neglected when conventional techniques for retrofit are employed. For example inadequate lighting, air-conditioning or acoustics abound in modern restorations[1].

But it is also important to question the efficacy of non-passive systems in the sense that the original atmosphere of the exhibits might be disturbed or even completely destroyed for the sake of commodity and ignorance of modern technicians and narrow-minded conservers. We could then arrive for instance to the absurd that, today, it may well be impossible to see an “inca” or “maya” statuette by the light of day, as if the “mayan” people had fluorescent lighting! We would present in this paper some European projects in which museums of painting and archaeology have been retrofitted according to an environmental point of view. The results are cost-effective but not only economically speaking because the climatic originality of the enclaves as been enhanced in the first place as a way to preserve and in the second place as a means to add value to the findings and exhibits that users and an increasingly tourism-based society expect to see.

Conference Topic: 4.4 Building ecology, biodiversity and resource conservation

1. THE MUSEMS OF ARCHAEOLOGY

Figure 1: The Museum of Seville. Spain

1.1 Building Description. The case of Seville

The archaeological museum of Seville was designed for exhibition purposes (World Fair) in 1929. It is representative of the regionalism style and has suffered several refurbishments in he past.

It shows an example of how history buildings are able to house modern functions if they incorporate environmental features.

In this case, a variety of clerestories and skylights are located in the upper areas of the building and great thermal mass was employed in the construction, the use of natural light was a decision of the architect who had previously disposed artificial lighting in sundry projects.

In the course of time however, the museum has undergone a process of various modernisations, in which many mismatches and inconsistencies occurred as a result of the lack of understanding of the quality and performance of historic structures. This mainly refers to artificial lighting, acoustics and air-conditioning strategies.

Some of the constructions systems became obsolete and thus, many of the original design features were omitted or contradicted for reasons of imperviousness of the roof, accessibility and gains of useful floor area. So far, no definite control strategy that takes account of the natural building performance has been proposed while later additions of electrical appliances and furniture demanded by modern techniques, play an unfortunate role in he facility.

Figure 2: Simulation of the existing main hall at the museum of archaeology.

1.1 Interventions

The main intervention that was developed is the retrofit of the light courts and skylights that were neglected because of the lack of imperviousness of old glazing systems. In the main hall this was done through two conoidal monitors facing South. Improvements of the skylights' design are necessary in order to control sunlight and daylight and allow for stack effect ventilation. The shading/light distribution system consists of a series of reflective baffles, positioned at increasing distances from the glazing so as to maximise daylight levels in response to solar geometry [2]. The obsolete acoustic conditions with average reverberation times of over 6 seconds were improved through the application of basalt-wool based acoustic absorbers to the light baffles and acoustic plaster to the elliptic walls while leaving 2/3 of the thermal inertia uncovered. The insulation level of the roof was increased for better thermal performance while the exterior walls remained in their original appearance in order to reduce visual impacts.

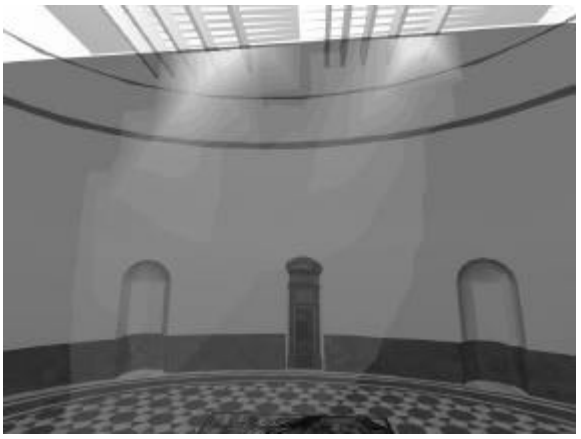

Figure 3: Sectional view of the simulation of the retrofitted main hall.

Other interventions included are:

- Intelligent control of windows and outlets to enhance the use of stack-effect due to the large heights of the main chambers.
- Integration with artificial lights and acoustics.
- New interior finishes for acoustic and visual comfort.
- Control techniques through PID algorithms and intelligent instrumentation.

Figure 4: Summer view of the retrofitted main hall.

1.3 Simulations Results

Acoustics, thermal and especially lighting simulations were conducted, which are depicted in physical and planar units as well as in virtual images. Considering the sunny climate of Seville the role of solar radiation was taken into account for the daylighting model [3]. The results show a good performance of the new systems especially as compared to the old features. A small fraction of those simulations is presented here as an illustration.

Simulated energy savings are 95% for lighting, 49% for HVAC (Cooling 47%, Heating 2%) and 59% in total.

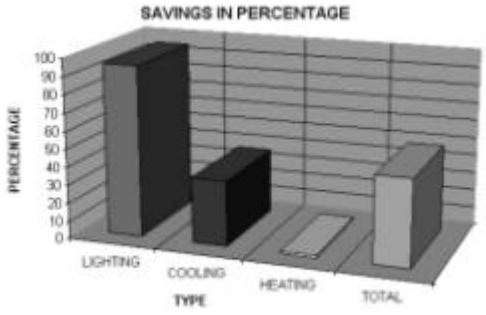

Figure 5: Expected Savings in the museum of Seville

1.4 Cost Benefit

When considering costs analysis, it has to be considered that the existing situation is not acceptable. However, it can be said that, only in terms of energy-use for lighting, savings can produce a pay-back period of the interventions of about 15 years. Under consideration of full air-conditioning demand of the spaces in general however, the pay-back period is reduced to 8 years.

Figure 6: The museum of Roman Art in Merida by R. Moneo. A typical case of visual aspect-only imitation.

1.5 The case of Seville as a "model" for other interventions

After the design experience in this and other museums throughout southern Europe, we became more aware of the necessity of retrofit for the "space" and the "environment" themselves instead of dealing only with walls and "solids" as is the conventional trend. If environmental space is not considered a historical value then the world will be deprived of one of its paramount features [4] but also the tourism market will resent this artificial standardization of monuments. This also implies that mindless architectural imitation is no longer a solution for rehabilitation politics. Cases like the museum of roman art in Merida by R. Moneo, clearly illustrate the point, that if environment is missing from architectural concerns, overtones of façade-mimesis are to a great extent irrelevant.

2. CONCLUSIONS

We have proposed innovative design solution to the historically sensitive situations in museums. This attitude is expected to solve the problems posed by the existing structures with fairly low investments while providing good comfort conditions at low energy consumption.

Lighting, acoustic and thermal solutions accrue to a sophisticated, contemporary and scientifically founded architectural design. On the other hand we achieve and recommend that the interventions have very limited visual impact on the surroundings, which is a crucial factor in historical enclaves.

2.2 Acknowledgments

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