NEW APPROACH FOR CLIMATE CONTROL IN MANAGING CULTURAL COLLECTIONS HOUSED IN HERITAGE BUILDINGS

Muhammad Ilmam Tharazi
Faculty of Creative Technology and Heritage
Universiti Malaysia Kelantan
ilmam@umk.edu.my

Abstract

Cultural objects in museum are usually kept in controlled environment which rely heavily on air-conditioning systems to ensure that a stable climate is maintained in order to prevent the objects from deterioration. But based on “content analysis” made on recent museum guidelines and new methods on climate control, the notion that museum needs to have tight control environment can be challenged. As many of heritage buildings were being converted into museums, heavy changes were made to those buildings in order to accommodate the air-conditioning systems. These lead to some of the architectural features and defining characters being removed or altered. However those same features which were built to response with the climatic conditions may help to contribute a better indoor environment for the collections. Several visual observations made on selected case studies showed that they were designed to deal with climate passively and able to regulate the temperature and relative humidity, which can be utilized by the museums. This paper hopes to provide answers and examples of how by incorporating passive design in converting heritage buildings into museums not only can preserve the authenticity of the buildings, but also for the benefits of preserving the cultural collections inside.

Keywords: passive design, heritage building, climate control, museum.

Introduction

The beauty of heritage buildings not solely lies on the decoration and ornamentation only, but also in terms of the relationship between the design and the surrounding environment. These buildings were designed as such to deal with the local climate passively, and its building materials were properly selected to attenuate exterior conditions. As results, the system provides comfort for its occupants without having to rely on heavily mechanical systems of modern buildings. These heritage masterpieces have stood the time and continued to serve its purpose.

Many argued the practicality of housing a museum in the heritage building. The issue highlighted is that museum needs specific requirements, layouts and other considerations which are vital to the stability and safety of the collections it trying to kept and protect. After all, the architecture of museum can be defined as “the art of designing and installing or building a space that will be used to house specific museum functions” (Desvallées & Mairesse, 2010, p. 23). So it would be better if purpose-built museums take the role of safeguarding the invaluable assets of artefacts and cultural objects. As the building was not originally built to accommodate a museum, there must be conflicts that would surface between to have the best practice in building conservation and the best practice in museum design. Certain compromises or even sacrifices have to be made in order to find the right balance between both needs.

However many overlooked the original design and architectural features of the building itself that may help the museum to fulfil its requirements and standards. Usually, buildings which acquire new uses are heavily modified to suit new needs thus hampering the climatic responsiveness of the building in its original state. Architects and conservators tend to adopt and rely entirely on the mechanical Heating, Ventilating and Air-Conditioning (HVAC) systems without paying attention to the building’s original design and its features as ideal climate tools, for both human comfort and the conservation of museum collections (Toledo, 2006). Therefore, this research tries to look at the state of the art of the close relationship between architectural features of heritage buildings and the practice of preventive conservation in museums. This research argued that for the sake of the building and the collection it housed, climate control can be achieved by simply enhancing the original architectural features without having to rely heavily on the controlled mechanical systems. As stated by Toledo (2006, p.4) that “it would be even more efficient if the original building designs and spaces could be reviewed and rejuvenated.”

Literature Reviews

The Practice of Conservation in Museum

The responsibilities of a museum to its collections include monitoring the condition of collections carefully and also deciding whether an object or specimen needs treatment or restoration that requires the services of a qualified professional. The principle goal of this intervention should be the stabilisation of the object or specimen. According to Boylan (2004), all conservation procedures should be documented and as reversible as possible, and all alterations should be clearly identifiable from the original object or specimen.

Michalski (2004) identified two types of conservation, the first being the treatments of objects called “remedial conservation” and the other is called “preventive conservation”. While remedial conservation is about ‘fixing’ the damage, preventive conservation is about “ensuring that the museum’s collections are displayed, handled, stored and maintained in ways that do not lead to damage or deterioration” (Ambrose & Paine, 2006, p. 167). The latter emerged as conservators acknowledged the need to prevent new damage, and the fact that the method is far safer and cheaper as compared to treating the objects, which are time consuming and if done wrong, can do more harm than good.

Overall, conservation should be the key component in the museum management. The first step towards caring for collections is ‘preventive conservation’, which is to protect the objects from damage. As Ambrose and Paine (2006) pointed out, that apart from regular conservation assessments of the museum’s collections, there is a need for buildings inspection and methods for stabilizing environmental conditions in the museum. Preventive conservation simply can be started by paying attention to the building design. By practicing preventive conservation method, it can minimize the need for remedial conservation.

Many cultural objects are sensitive to environmental conditions with temperature and relative humidity (RH) being the key agents of deterioration in museum collections (Ambrose & Paine, 2006). Controls of these two agents are essential to ensure the long-term safekeeping of collections. The collections must be protected in a controlled environment where such variables are maintained within a range of damage-limiting levels. Museum collections are often made up of not only a mix of cultures and origins, but also a variety of materials too and those two agents mentioned affect different categories of material in different ways. The fluctuations in temperature and RH are the biggest conservation issue for museum collections and the museum management must ensure that appropriate conditions for collections on display or in storage are maintained (Toledo, 2006; Ambrose & Paine, 2006).

Museum Indoor Environment

There are various standards for museums to follow in terms of range of RH and temperature. Ambrose and Paine (2006) noted that museum should have a constant RH all year round and that RH should not rise above 60% or fall below 40% while temperature of 18°C is an acceptable for the museum. Ambrose and Paine (2006) also pointed out that for museum in older building, 45% to 50% RH is an effective compromise. Grattan and Michalski (2010) on the other hand noted that 50% RH with the temperature between 15 and 25°C often defined by museums as the set point to maintain although practically, other factors

such as the performance of the building, the needs of the collections and the availability of HVAC system can also determined the museum climate.

However, Toledo (2006) argued that a climatic stability is more important than the internationally known and recommended standard climatic values, which museum objects acclimatize to their immediate surrounding environment, as long as it is stable. Museum management should aim for a steady indoor climate when converting a historic building into a museum, as the perception of an 'ideal museum environment' is very relative (Toledo, 2006). This new thinking is further stressed by Grattan and Michalski (2010) arguing that it is not necessary to have very tight controlled conditions because it is not acceptable in terms of economically and environmentally. Museums should strive for fluctuation control that pose the main threat to most collections rather than the traditional thinking about museum environments, which called for stringent control of RH and temperature (Grattan & Michalski, 2010).

Michalski (2004) pointed out, preventive conservation formed part of basic strategies that can address all or many deterioration agents at once and it started with the museum building that provides the first layer of protection between the outside environment and the collections. Having preventive conservation measure can reduce many different risks at once and they are often cost efficient. Museum building with a reliable roof and walls can block all agents of deterioration although not always perfectly, but to a large extent (Michalski, 2004).

Heritage Buildings and the Concept of Passive Design

The concept of passive design in climate control is basically to provide a comfortable and healthy environment for the occupants. Other than that, the approach of passive controls can be associated for three main reasons:

1. For economic reason as it reduce the needs of heavy mechanical systems. Less energy consumed translates to less cost for operating the building.
2. For environmental reason as less energy consumed translates to less amount of waste, thus less impact on the ecosystem.
3. For aesthetic reason as design of the building is more likely to be based on local climate thus creating distinctive look of the area.

The concept of passive design in climate control is always associated with traditional and vernacular architecture. Due to this, Toledo (2006) noted that buildings in warm and humid regions always have physical similarities which contribute to the climate control. The similarities include ventilated pitched roofs, openings on all facades, long eaves, above-

grade basements and stilts that separate the building from humid ground (Toledo, 2006). In Malaysia, those features can be found in its traditional built forms, especially the traditional house. Later, buildings during colonial period too were built to be climate responsive. All of these architectural features can be highlighted to reduce the temperature and humidity of indoor climate.

There are also other factors that can contribute to the system as Weeks & Grimmer (1995), Esmawee (1995), Smith (2005), Park (2004), Randl (2004) and Toledo (2006) summarized the approach that can be taken to achieve energy efficiency:

1. Encourage natural ventilation in the building with open plan concept and high ceilings.
2. Building orientation towards north and south. Avoid openings on the east and west façade. The importance of the building's placement which taking considerations the sun orientation, prevailing winds and rains, along with careful location of openings help creating a comfortable indoor living.
3. Tiered roof with high level of openings can be used for ventilation as tiered roof can facilitate the exhaustion of hot air.
4. Huge space and the use of courtyards to encourage the process of natural ventilation.
5. Exposed roof structure and the use of roof tiles, especially the traditional ceramic roof tiles can help to dissipate hot air as their juxtaposition is normally air-leaky.
6. The use of shading devices "Fig. 1" on building surface exposed directly to the sun and deep overhangs can also reduce heat gains to the building. They were remarkably efficient and cost effective as mechanisms to block out the sun's rays while admitting daylight and allowing air to circulate between interior and exterior.
7. Single room thickness and in-between space. The principle of layered control to temper exterior conditions whereby the use of transitional spaces as buffer zones "Fig. 2" are always useful in dealing with climate passively. This is evident with the use of verandahs, corridors, atriums, ventilated attics and above-grade basements, etc in warm humid buildings.
8. The use of building materials with good thermal insulation can greatly reduce heat gains and losses thus minimizing the daily climate fluctuations. The use of porous materials in interior finishes too can help controlling air humidity and buffering climate variations.

Fig. 1: Shading device.

Fig. 2: Corridor.

The use of shading device and corridor can provide shades and help filter direct sunlight from penetrating the external walls which could largely reduce cooling loads and improve indoor thermal comfort and day lighting quality.

It is important to note that many heritage buildings in some ways have a natural capability to moderate external conditions on interior climates in order to ensure human comfort. These buildings were designed and constructed to rely on certain materials, an overall form, and horizontal and vertical communication between interior spaces. A key element in conditioning the indoor climate of heritage buildings was the active participation of its inhabitants, which operate the building features such as doors, windows, shutters or shading devices to capitalize on favourable external aspects, such as breezes, for ventilation and comfort (Henry, 2007).

Therefore, the architectural features of heritage buildings should always be revisited and evaluated at first, in order to utilise their existing energy-conserving potential before converting them into museums. Any changes or refurbishment works to heritage buildings needs to be carried out with particular care to ensure that the building's authentic character is retained (Weeks & Grimmer, 1995).

Mechanical Systems for Heritage Buildings

Due to the preferred choice to have centralized air-conditioning systems, many of these heritage buildings lost its passive climate features as installing the new systems mean that they will be tightly sealed and heavily modified. The decision to mechanically control museum’s indoor climate for collections care often reflect the ignorance for the needs to preserve the authenticity of heritage buildings (Henry, 2007). As mentioned by Park (2004), adapting new mechanical systems to heritage buildings are not an easy task as there is a need for careful planning to be conducted during the early stages of designing new mechanical systems so that only suitable and appropriate systems are installed. Park (2004) further stressed that introducing unsuitable systems to heritage buildings can lead to these following damages, which are:

1. Parts of historic and defining characters of the building being removed in order to accommodate the systems.
2. The systems may increase the load more than the building can carry. The vibrations they generate too can lead to stress.
3. Building fabric may absorbed moisture generated from the systems thus causing damage such as biodegradation, freeze/thaw action, and surface staining.
4. In order to install the systems, exterior cladding or interior finishes are stripped in order to put the new vapour barriers and insulation.
5. Historic finishes, features, and spaces are altered by dropped ceilings and boxed chases or by poorly located grilles, registers, and equipment.
6. Changes in proportion of spaces and characters due to lowered ceilings.
7. Equipments, registers and grilles are poorly installed.
8. Systems that incompatible with the new use whether they were too large or too small due to improper planning.

It is important to first understand the historic parts of the building, and to identify the defining characters on the building such as what are the features, spaces and finishes that made of the building unique on the first place. The building's new needs should be evaluated too, in order to draw the realistic cooling and ventilating for human comfort and its contents. There is a need for a systematic approach to ensure that the mechanical systems are successfully installed or better still, the existing systems to be upgraded first. Proper planning, design and subsequent follow-up program of monitoring and maintenance can ensure the integrity of the heritage building.

Methodologies

Methods of this research were focused on the physical condition assessment, architectural evaluation and types of enhancement made to the building design of museum. Visual method was used to analyze building's features that can contribute to the passive ways of controlling climates. Photographs of the building and its component and elements were taken. These provide an accurate record of the setting and how it was utilized. This method also was used to discover and to record the changes on the buildings as well as to justify the importance of the changes in adaptation to museum.

For this research, unscheduled observation was implied. Observation was carried out during weekdays to avoid crowd visitors during weekend. Direct observation was made to identify the following:

1. The architectural features that contribute to control climate passively.

2. The changes made to building to stabilize the museum environment.
3. Overall layout and design of the museum building.

As for the selection of the case studies, the types of museum with specific material collections were chosen because it is easier to regulate the museum indoor climate when most of the objects are of the same materials as they require more or less similar indoor climatic conditions. This means they require less complicated systems so that the use of passive building features can be fully utilized. Two museums are chosen as case studies with each museum dedicated to each type of materials. The collections of objects of the first case study, the Army Museum “Fig. 3” consists of mainly inorganic materials (metals) while the second case study, the National Textile Museum “Fig. 4” is of organic materials (textile).

Fig. 3: Army Museum

Fig. 4: National Textile Museum

Analysis and Results

From the analysis, it was clear that both buildings were designed and constructed to suit the local climatic conditions. Some of the buildings’ components and elements were meant in such ways to be climate responsive. These features were used in the past to regulate the climate and create a stable environment inside the buildings. As results, these features can be used to contribute to the preventive conservation measure for the museums, particularly the temperature and Relative Humidity. As mentioned earlier, preventive conservation is about taking care of museum collections as a whole by providing a stable indoor climate that is very important to prevent museum collections from deterioration. Temperature and RH, which have greater effect on the collections, need to be controlled and fluctuation of those two should be minimized. Incorrect temperature and RH would lead to other problems such as fungi growth and microbial attacks, corrosion, and damages resulted from fluctuation of the materials.

In caring for collections, the museum management prefers to have a tight-controlled indoor environment by concealing the exhibition areas and relying heavily on the HVAC mechanical systems, especially the air-conditioning systems as demonstrated by the case

studies. While basically the systems can protect the collections, it does consume a lot of energy and cost to operate those systems. In some cases, the systems that supposedly protect the collections, become sources for deterioration as showed in the case studies, whereby damp and humidity can be traced back to the air-conditioning systems. The doors that were left open can result to condensation in the exhibition areas.

Rejuvenating the passive building features of those buildings can somehow provide as an alternative to the air-conditioning systems in taking care of museum collections. It showed that the architectural components, elements, and the use of building materials can act as mechanisms to regulate the indoors by allowing cross ventilation and buffering the heat and solar penetration which are important in controlling the temperature and RH of museum environment. Coupled with careful display placements of collections and pro-active museum staffs in monitoring the exhibition areas and the weather conditions, these passive designs of the heritage buildings can be used as the preventive conservation measure in those museums.

According to Maekawa, Carvalho, Toledo and Beltran (2009), there are other ways to control the indoor museum environment apart from using the air-conditioning (HVAC) systems. Preventive conservation in a museum can be done simply by using the building itself as a system to help regulate the indoor climate. The building envelope should be repaired and the passive climate designs restored. Coupled with the use of mechanical climate control systems consisted of a ventilator/dehumidifier, a stable environment for the museum can be achieved without having to seal the building in order to accommodate the air-conditioning (HVAC) systems (Maekawa et al, 2009). This system is not only very sustainable and highly efficient in terms of economic wise, but also helped to highlight the architectural features of the building, thus reducing the stress that the building has to endure if air-conditioning (HVAC) systems was in place. The potential application of a ventilation-dehumidification based climate control system as opposed to the conventional HVAC systems could be widely expanded to safeguard and maintain stable environments for collections particularly in heritage buildings converted into museums in hot and humid climates. Not only that, the system is also technically simple and has been confirmed through field trials (Maekawa et al, 2009).

But it should be noted that this research is only focusing on the preventive conservation pertaining to the temperature and RH only. It does not take considerations on other factors and issues related to preventive conservation. For example, while the use of passive features may help to achieve stable indoor climates of the museums, but it also could contribute to the pollution and dusts that can be brought in during cross ventilation

process. Direct sunlight, is also an agent of deterioration that if exposed on the collections, especially organic objects, can result in fading pigments and aging. Other issue that needs to be addressed is about safety of the collections, with openings such as doors and windows, while good for ventilation, it also may result in thefts and security concerns.

Conclusions

The management of both museums have done a good job converting those heritage buildings into museums which in line with ICOM Code of Ethics (2006) that stated “the governing body should ensure adequate premises with a suitable environment for the museum to fulfill the basic functions defined in its mission”. However the practice of adapting the museums has basically taken an aggressive approach rather than a passive one. The architectural evaluation of those heritage buildings have been disregarded in the planning process although there is a possibility of rescuing or rejuvenating passive building features that could enhance their climate performance. They should have taken advantage of the buildings that can lead to energy savings and sustainability. It would be better if they can utilize the architectural features of the buildings in providing the stable indoor environment for the museums. If those features were taken to considerations when designing the climate control systems for the museums, it might help to minimize the intervention and changes that need to be done to the heritage buildings. But due to changes done to the buildings and the surrounding areas, those features may not have the same effects like they used to perform during the times when the buildings were first built.

Due to the lack of scientific study in this research, it remains to be seen whether all the passive building features that were meant to control indoor climatic conditions can be applied to the preventive conservation method for museums. Another gap was about the lack of research and case studies on historic museum buildings in hot and humid climates. In Malaysia especially, while there are a lot of studies concerning the architectural features of heritage buildings, consistent references cannot be found on the practice of preventive conservation in museum. Hopefully, results from this research will serve as a guide for future research. Further studies that can test the connection between passive building design and museum indoor climates in the forms of scientific experiment can also be explored.

Preventive conservation should be the forefront in safeguarding the collections in museums. The museum management in Malaysia should undertake this new approach to collection management. It is important that museum professionals to be informed and educated on how the best ways to protect the collections and the buildings in sustainable and cost effective ways. Not only the use of passive building features in controlling indoor climate as preventive conservation approach can be used for museums housed in the

heritage buildings, but also it can be applied to the construction of new purposely-built museums too. Following the guidelines on collections conservation should not sacrificing the principles of building conservation. While there will be challenging needs between both sides, stakeholders involved should find the delicate balance by combining the expertise from each other. Hopefully, the partnership will produce new knowledge on conservation that can benefit not only museums but also heritage buildings.

References

Toledo, F. (2006). *The Role of Architecture in Preventive Conservation*. Retrieved May 27, 2010 from ICCROM Archives.

Boylan, P. (Ed.) (2004). *Running a Museum: A Practical Handbook*. Paris: ICOM.

Michalski, S. (2004). Care and Preservation of Collections. In P. J. Boylan (Ed.), *Running a Museum: A Practical Handbook*. Paris: ICOM.

Ambrose, T. & Paine, C. (2006). *Museum Basics* (2nd Ed.). London: Routledge.

Desvallées, A. & Mairesse, F. (Eds.). (2010). *Key Concepts of Museology*. Paris: Armand Colin.

Grattan, D., & Michalski, S. (2010). *Environmental Guidelines for Museums – Temperature and Relative Humidity (RH)*. Retrieved February 15, 2011 from http://www.cci icc.gc.ca/crc/articles/enviro/index-eng.aspx.

Weeks, K. D., & Grimmer, A. E. (1995). *The Secretary of the Interior's Standards for the Treatment of Historic Properties: with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings*. Retrieved February 13, 2011 from http://www.nps.gov/hps/tps/download/standards_guidelines.pdf.

Randl (2004). *The Use of Awnings on Historic Buildings: Repair, Replacement & New Design*. Retrieved February 13, 2011 from http://www.nps.gov/hps/tps/briefs/brief44.htm.

Smith, P. F. (2005). *Architecture in a Climate of Change*. Oxford: Architectural Press.

Park, S. C. (2004). *Holding the Line: Controlling Unwanted Moisture in Historic Buildings*. Retrieved February 13, 2011 from http://www.nps.gov/hps/tps/briefs/brief39.htm.

Esmawee Hj. Endut. (1995). *Design with Climate: Recommendations for Building in the Tropics. In Design Coursebook*. Shah Alam: UiTM.

Henry, M. C. (2007). From the Outside In: Preventive Conservation, Sustainability, and Environmental Management. *GCI Newsletter, 22.1* (Spring, 2007). Retrieved February 18, 2011 from http://www.getty.edu/conservation/publications/newsletters/22_1/feature.html.

Park, S. C. (2004). *Heating, Ventilating and Cooling Historic Building: Problems and Recommended Approaches*. Retrieved February 13, 2011 from http://www.nps.gov/hps/tps/briefs/brief24.htm

Maekawa, S., Carvalho, C., Toledo, F., and Beltran, V. (2009). *Climate Controls in a Historic House Museum in the Tropics: A Case Study of Collection Care and Human Comfort.* Paper presented at PLEA2009 - 26th Conference on Passive and Low Energy Architecture, Quebec City, Canada. *R*etrieved February 18, 2011 from http://www.getty.edu/conservation/science/climate/barbosa_plea.pdf.

International Council of Museums [ICOM] (2006*). ICOM Code of Professional Ethics*. Retrieved September 26, 2010 from http://icom.museum/what-we-do/professional-standards/standards-guidelines.html.