

# Creation of a New National Museum to Meet the Environmental Needs of the Twenty First Century : Kyushu National Museum

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## Creation of a New National Museum to Meet the Environmental Needs of the Twenty-First Century: Kyushu National Museum

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### 1. Introduction

From the perspective of one who worked in the field of conservation of cultural heritage for 14 years, I would like to discuss the theme of how museums meet the environmental needs of the times in conserving, utilizing, and inheriting cultural heritage. I was a manager in charge of the conservation and restoration of materials at the Kyushu National Museum (hereinafter “Kyhaku”) from April 2003, when it was still under construction, to March 2017.

From the outside, the Kyushu National Museum looks like a gigantic, strangely shaped dome (Photo 1). Since it opened in October 2005, almost 14 years ago, the Kyhaku has welcomed 15 million visitors.

Kyhaku’s preliminary design was developed in 1999. The goal was to design a



**Photo 1** Kyushu National Museum (Kyhaku) (Source: Kyushu National Museum, 2004)

building that would meet the environmental needs of the coming twenty-first century, conserve energy, and be in harmony with the surrounding natural environment. In the final design formulated the following year, revisions were made to the facilities for conserving cultural heritage such as the storage area and biological treatment system in accordance with climate change prevention measures. These changes arose from our desire to use as few ozone-depleting substances and chemicals as possible for sterilization and pest control in the museum.

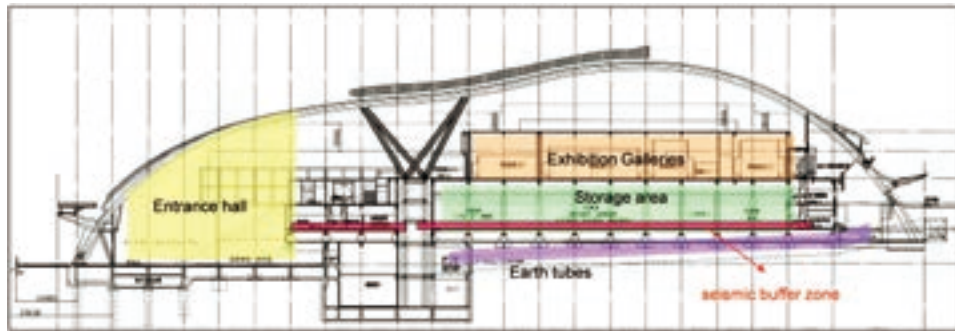
In the following paragraphs, I will introduce the issues that arose from the facilities in which cutting-edge technology was implemented to meet the environmental needs of the times and give examples of the efforts made by the museum in response to subsequent societal changes.

## 2. Concepts of the Museum

There were three national museums within the National Institutes for Cultural Heritage holding art collection of esthetic and historical values—in Tokyo, Kyoto, and Nara, respectively—all of which date back over 100 years.<sup>1)</sup> Focusing on art and history, Kyuhaku is the fourth national museum and the first to be built in 100 years. The museum interprets the formation of Japanese culture from the perspective of Asian history and collects, stores, exhibits, investigates, and researches cultural properties in order to inform and educate. Accordingly, it engages in activities under the following four concepts.

- (1) To be jointly and cooperatively managed by the Kyuhaku, an independent administrative institution of the National Institutes for Cultural Heritage, and the Fukuoka Prefectural Asian Cultural Exchange Center.
- (2) To have an environmentally friendly architectural design that considers energy conservation as well as the conservation of cultural properties.
- (3) To be an open and “living” museum that is in harmony with nature and the community.
- (4) To be a center for museum science, conservation, and restoration for Kyushu and all of Asia.

As indicated in (1), Kyuhaku was established and is managed jointly by national and local governments—the first of its kind in Japan. Concept (2) deals with societal needs, and (3) was the result of strong requests by the local community. To ensure the continuance of a lush, natural environment, we created a biotope using spring water on the premises, reduced the size of the parking lot, and planted plants that evoke each season. Once the museum opened, we planned to operate a “living” museum with the help of over 300 local volunteers. Concept (4) was in response to the needs of experts in Kyushu.



**Figure 1** Kyuhaku (cross-sectional drawing) (Source: Kyushu National Museum, 2003)

### 3. Overview of the Facilities

The museum is an immense titanium dome measuring 160 meters east to west and 80 meters north to south. The functions it houses are shown in Figure 1. The site is 170,000 square meters, and the building has a total floor area of 30,000 square meters, with two basement floors and five floors above ground.

The entrance hall on the first floor is a vast, open area with a seating capacity of 1,000 and a height of 36 meters. Various barrier-free events have been held at the entrance hall, from the opening ceremony and concerts to parties after business hours.

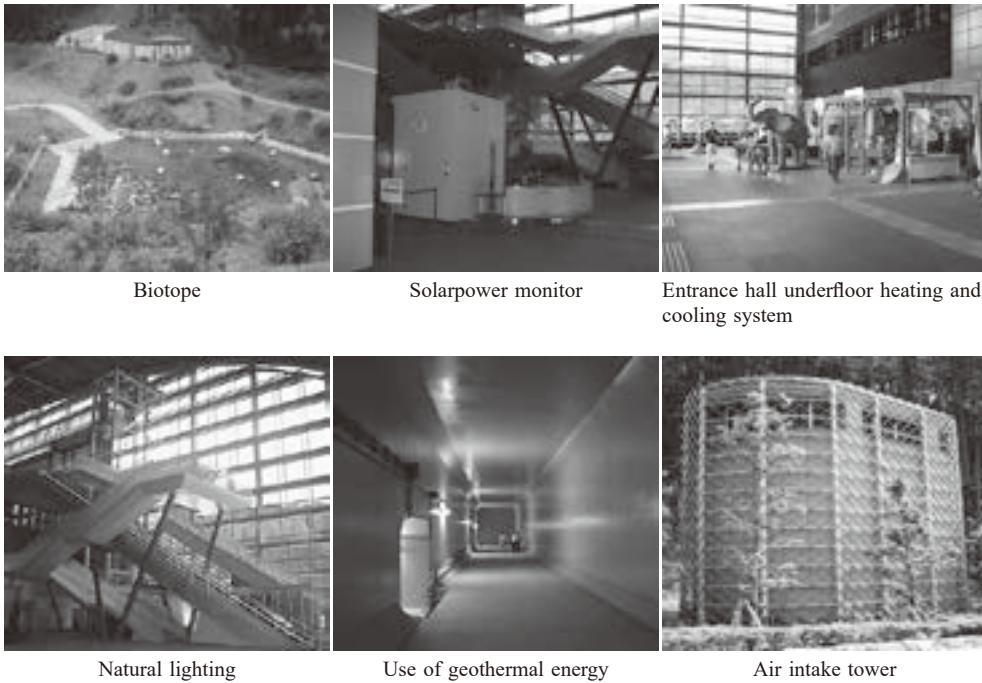
A seismic buffer zone (the red layer in Figure 1) was installed between the first and second floors to separate the storage area and exhibition galleries on second floor and above from the ground. In earthquake-prone Japan, there is a great need for seismic base isolation and earthquake-proofing for buildings. Every Sunday, we hold volunteer-guided tours of the base isolation system to deepen local residents' understanding of the museum's crisis management measures to protect the people and cultural heritage.

The storage and research office areas are located on the second floor. Facilities have been established to ensure that the conservation and restoration of cultural properties is carried out safely, and freelance restoration specialists are contracted to perform restoration work. Age-old traditional techniques for conserving and restoring Japanese works of art and crafts have been passed down from generation to generation, and museums carry on these traditions.

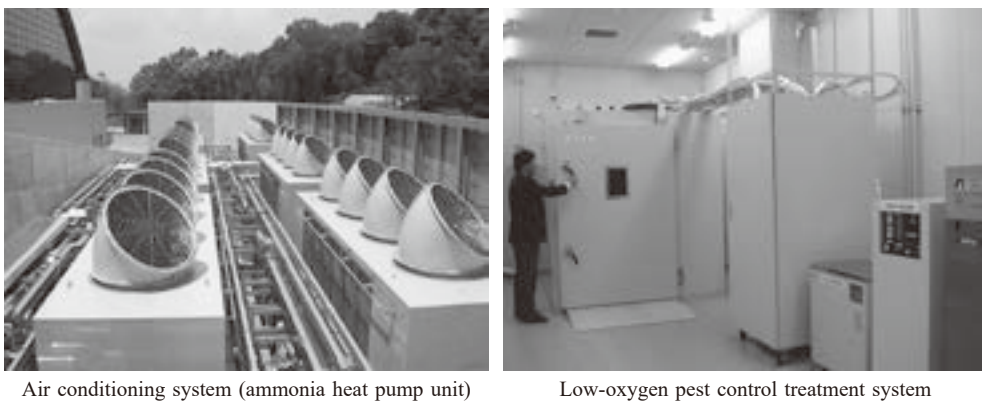
The third floor houses the 1,500-square-meter Special Exhibition Gallery, and on the fourth is the 4,500-square-meter Cultural Exchange Exhibition Gallery. On the first floor, there is also an exhibition room called the "Ajippa" that is used for educational dissemination. The temperature, humidity, and air quality in each of these areas are fully controlled to maintain an environment that is friendly and comfortable for both people and the exhibits.

### 4. Use of Natural Energy and Climate Change Prevention Measures

Kyuhaku is located in the sacred woods of the Dazaifu Tenmangu Shrine, nestled within



**Photo 2** Use of natural energy (Source: Kyushu National Museum taken between 2003 and 2007)



**Photo 3** Non-use of greenhouse gases (Source: Kyushu National Museum, left 2003, right 2006)

a lush, natural environment. Photos 2 and 3 show how natural energy is used and what climate change prevention measures have been implemented in the museum.

Rainwater that falls on the roof is collected and dispersed across the entire roof using the rooftop sprinkler, which helps to control the temperature inside the museum by keeping the temperature in the attic space from rising. Rainwater is also stored in underground pool and reused for toilets and watering plants after being filtered.

The glass walls in the spacious entrance hall bring in natural light, which allows us

to reduce the use of electrical lights. The underfloor heating and cooling system in the entrance hall is solar powered. The solar power system is capable of generating up to 40 kilowatts per hour. This energy is also used to power lights and other equipment inside the museum.

The museum conserves energy by using a geothermal energy system in which outside air is drawn in with an air supply tower. The air passes through “earth tubes” underground, where there is little temperature variation. This keeps the museum warm in the winter and cool in the summer and helps to reduce the amount of energy used for air conditioning.

The air conditioning system uses an ammonia heat pump instead of chlorofluorocarbons, which are ozone-depleting substances. In the same way, the museum’s fire extinguishers use nitrogen instead of halon, another ozone-depleting substance.

To protect cultural properties from pests, we have installed a low-oxygen pest control treatment system instead of using pesticides that contain methyl bromide—also an ozone-depleting substance. By taking nitrogen from the air, adjusting the temperature and humidity, and collecting it in chambers, we can maintain a constant oxygen concentration for about two weeks. After treatment, the nitrogen is returned to the air, so other than the electricity used, there is little environmental impact.

## **5. A Storage Area Design that Meets Environmental Needs**

As mentioned above, the Kyuhaku building makes use of various kinds of natural energy. At the same time, the museum works to minimize the environmental impact of its activities by avoiding the use of ozone-depleting substances. As an example, I will describe how the storage area—one of the most important facilities of the museum—was designed to meet the environmental needs at the time.

Museums serve two roles: to conserve and inherit cultural properties and to make them accessible to the public. In Japan, there are two types of traditional storerooms, wooden ones like those of the Shosoin Repository that make full use of the wood’s capabilities, and earthen ones, which use thick, earthen-mortar walls. These traditional methods have enabled fragile materials such as silk and paper from the time before there was electricity or machinery to have been passed down from generation to generation and still be handled today, even after 1,000 years.

Leveraging the experiences, wisdom, and techniques inherited from these traditional methods, we built the storage area mainly out of wood. The outer walls are double-concrete walls with 50 centimeters of space between them. The inner walls, pillars, flooring, and ceiling are made of wood (Photo 4), and wooden shelves and boxes are placed inside (Photo 5). Japanese cedar was used after having been thoroughly dried, and as is traditional with this wood in building storerooms, the lighter colored sapwood was used rather than the red heartwood of the center of the tree due to the fact that it has comparatively fewer volatile organic compounds.

Windows were installed on the corridor side of the storage area so visitors can view its structure during the volunteer-guided tour. By learning about the buffer effects of the



**Photo 4** Storage area (wooden walls, flooring, ceiling, and pillars)  
(Source: Kyushu National Museum, 2004)



**Photo 5** Storage area shelves (wooden boxes are placed on wooden shelves)  
(Source: Kyushu National Museum, left 2004, right 2005)

double walls and the wood's capabilities, visitors gain an understanding of the Japanese traditions to protect cultural properties based on the wisdom cultivated by the environment. The guides explain that wood helps keep the air humidity constant by absorbing moisture when the surrounding humidity is high and desorbing moisture when it is low and that friction created between the wooden shelves and wooden boxes prevents slippage, which helps mitigate earthquake damage.

Although we designed the storage area based on the sustainable “wooden culture” that was cultivated in Japan’s environment, conventionally, when a wooden storeroom like this is built in this country, it is fumigated when completed to eliminate pests and sterilize the wood. However, the final design was formulated based on the assumption that we would not use methyl bromide, an ozone-depleting substance used in fumigation. Conventional storeroom doors have hatches to allow fumigation gas to be supplied and discharged, while the doors of the Kyuhaku storage area were designed to have no hatches, making it difficult and dangerous to supply and discharge gas. Even if we were to fumigate, the gas could affect nearby homes. For this reason, we decided to avoid

fumigation.

The wood we used had already undergone electrical seasoning during the sawmilling process to completely eliminate pests, eggs, and microorganisms, so we decided to solve this issue by ensuring management and cleanliness during construction. In reality, however, always using clean gloves and carrying out inspections and meticulous cleaning at each stage of construction requires significant labor resources (Photo 6). This would not have been possible without the contractor's understanding and cooperation. The fact that we were able to implement these climate change prevention measures and not use chemicals, thanks to the efforts of so many people, is profoundly meaningful.



Inspecting wood at the lumber mill



Inspecting before construction



Inspecting during construction



Cleaning after each construction stage

**Photo 6** Inspection and cleaning during construction of the storage area  
(Source: Kyushu National Museum, 2003)

## 6. In Harmony with Nature and the Community

The Kyuhaku building was built to meet environmental needs from the late twentieth to the early twenty-first century. Thanks to the cooperation of all the people representing various fields who helped to create the museum, we were able to start operations in line with the needs of the times. We continue to carry out activities that meet the current



environmental needs—from energy conservation, the use of natural energy, and climate change prevention measures to efforts to maintain biodiversity and minimize the impact of chemicals.

As mentioned in the beginning, ever since Kyuhaku was first established, we have identified such environmental needs and have striven to attain harmony with nature and community participation.

Kyuhaku's building is easily affected by the surrounding natural environment, especially birds and insects. Museum operations are based on the concept of IPM (Integrated Pest Management), and we pay attention to use preventive measures rather than curative methods based using of chemicals. First, we had to learn about the natural environment where Kyuhaku is located. The first step toward our goal to be in harmony with nature was to have experts conduct a study to ascertain the relationship between museum activities and the surrounding natural environment. They collected cultural property pests representing 3 orders, 9 families, and 18 species. In particular, varied carpet beetles (*Anthrenus verbasci*) were found on various species of white flowers. Over 150 species of insects were found to live in the area, including a rare species of damselfly, *Ceriagrion nipponicum*, which was found near a spring and had been discovered before construction started. Photo 7 shows a training session for the local volunteer environmental division. These volunteers walk around the biotope and walking paths to monitor the conditions of the plants and identify the birds, insects, and other animals that are there and where they live on the site. Environmental division volunteers actively participate in IPM activities inside the museum and learn about the natural environment around Kyuhaku to make it a museum that is in harmony with nature.

Local volunteers go on inspection patrols inside the museum (referred to as “IPM Watch”) and report on the relationship between the number of visitors and the amount of garbage. Based on their reports, we have increased the frequency of general cleaning and begun routine maintenance operations of exhibited items. Specialized technicians perform IPM services that consist of checking the conditions of items, removing dust by circulating air around the items, and carrying out a regular cleaning of hands-on materials.



**Photo 7** Environmental training session for local volunteers (Source: Kyushu National Museum, 2006)

Kyuhaku monitors pests by setting around 300 adhesive traps per year. The volunteers prepare the traps every two weeks and set and replace them in visitors' areas such as the exhibition galleries and museum hall. Volunteers also replace chart paper for the hygrothermographs and organize the data. An NPO formed by volunteers performs IPM services in the rooms and the passageway in front of the storage area where cultural properties are not stored. These volunteers also inspect the dust that is collected during IPM operations and the traps collected by other volunteers. Cultural properties on display in the exhibition galleries and hands-on materials are maintained daily by specialized IPM technicians. Technicians are required to have curator certification, and they carry out maintenance operations in the storage area where cultural properties are stored in accordance with the rule that items are not to be touched (Photo 8).



Local volunteers (replacing chart paper)



Local NPO staff (replacing pest traps)



Specialized IPM technician carrying out IPM operation in the storage area: cleaning with a vacuum cleaner

**Photo 8** Supporters of Kyuhaku's IPM operations (Source: Kyushu National Museum, between 2005 and 2011)

## 7. IPM Practices and Challenges

We have divided the museum into three areas based on their relationship with the cultural properties and have defined the roles and authority of the people who operate in each area. Specialists handle the cultural property area, which includes the storage area where

there are always cultural properties. The NPO handles the surrounding area, which includes the research rooms where cultural properties are not usually kept. Local volunteers handle the visitors' area, which includes the exhibition galleries. There were no specialized IPM technicians at the beginning, so the cultivation of such technicians was required. Fortunately, as their activities progressed, the local volunteers formed an NPO, and some local women who started at the NPO then launched a company specializing in IPM. Around that time, PCO (Pest Control Operator) companies also began to provide IPM services, thus widening the scope of companies that could be contracted. However, several issues have also emerged, two examples of which are described below.

### **7.1 Dust from the Large Number of Visitors**

We are grateful that so many people visit the museum, but there are problems that come with this as well. A considerable amount of dust is produced, especially from autumn to early spring, due to garment materials. The museum is cleaned several times per day during times when there are over a few thousand visitors in a single day, but in the evening, after the museum closes, large amounts of dust can clearly be seen on the floor in front of the barrier lines separating the exhibits from the visitors. With this much dust on the floor, we must consider its effect on the exhibited items. This has been a concern since Kyuhaku first opened, which is why we started the special maintenance system mentioned above (Photo 9).

### **7.2 Bird Collisions**

One of Kyuhaku's distinctive features is the immense glass walls. The glass reflects the surrounding forest, giving it the impression that the building is part of the forest, shining a beautiful, brilliant blue without being overwhelming. The sunlight passing through the glass helps to conserve energy used for lighting. However, every year, dozens of birds mistake the trees reflected in the glass for the real thing and collide into the glass. A number of measures have been taken to prevent collisions, such as placing birds of prey decoys and lights. We have accumulated 14 years of data in terms of estimated collision time, location, species, sex, and age, and collected stuffed birds for every species. However, while this has contributed to our understanding of the surrounding natural environment, it has not led to a solution, and neither can we change the glass walls to concrete. We will continue to research and try new creative solutions.

## **8. Conclusion**

To conclude, I would like to give an overview of the IPM-related expenses invested over six years, from the time preparations to open the museum began until the IPM system got underway, and then sum up this discussion.

The circle on the left in Figure 2 represents the estimated ¥100 million in expenses required if Kyuhaku had been fumigated when construction was completed. Since we decided to avoid fumigation, the expenses that all six years have in common are research



Local volunteers on inspection patrol



Dust on floor in exhibition gallery after closing



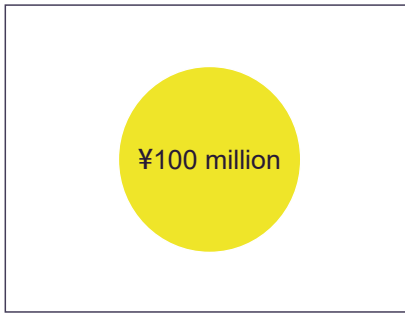
Specialized IPM technician maintaining exhibited items



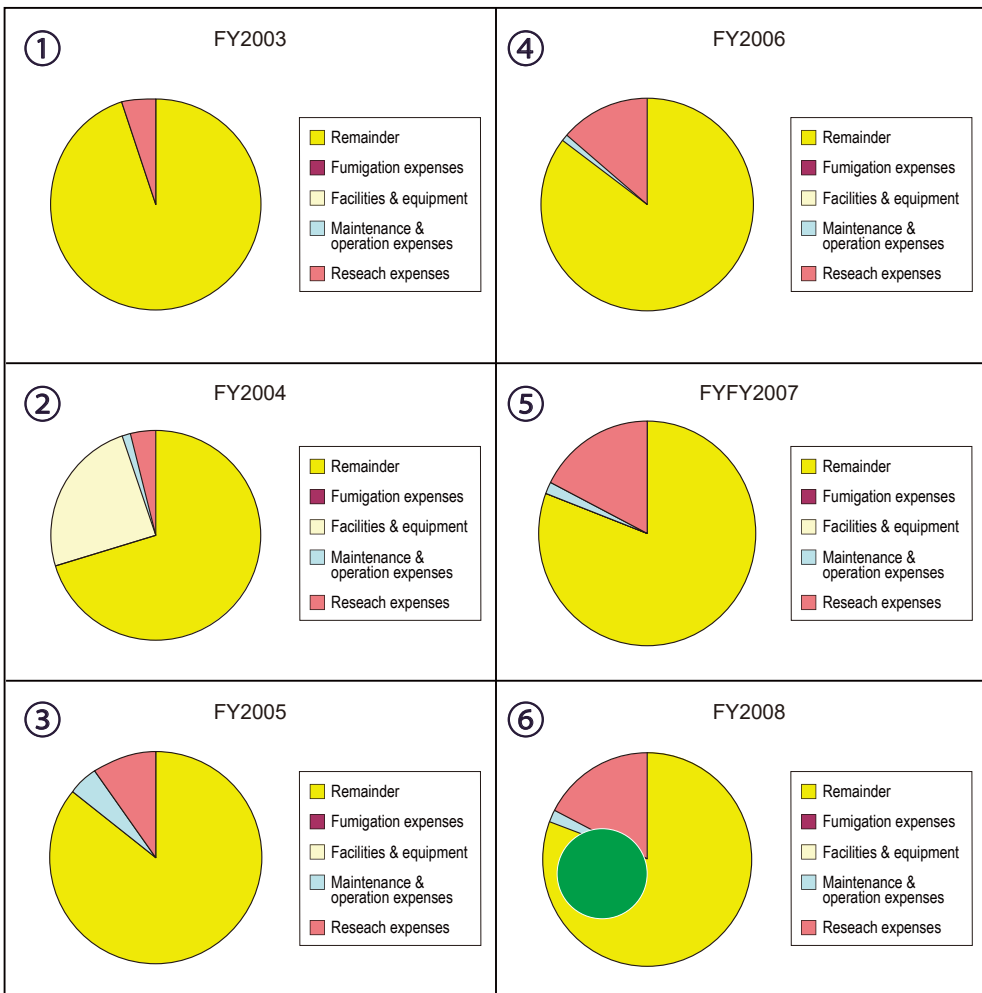
**Photo 9** Countermeasures against dust resulting from the large number of visitors  
(Source: Kyushu National Museum, between 2005 and 2011)

expenses. Research expenses for the first year in FY2003 (①) were for business trips to inspect the timber to be used for the storage area. After that, research expenses have been for the annual investigation of the air quality and organisms living in the museum. In FY2004, (②) expenses were incurred for purchasing a low-oxygen biological treatment system. The green circle that appears for the first time in FY2008 (⑥) represents expenses incurred in contracting full-scale IPM services for the storage area and exhibition galleries. Since then, the pattern has been basically the same. Responding to the needs of the times has resulted in dramatically reducing expenses, and choosing to not fumigate has created new maintenance work, which, in turn, has created local jobs and contributed to lifelong activities such as local volunteer and NPO activities.

There is no doubt that building and operating an environment to preserve cultural properties with the use of natural energy, climate change prevention measures, environmental friendliness, and traditional methods is contingent on the structure and materials of the facility. While building deterioration over time is inevitable, updating the building from time to time in line with technological innovations is, for the most part, beyond the scope of the budget. To continuously meet society's environmental needs, we



Actual expenses are shown as percentage, with yellow circle representing ¥100 million (100%)



**Figure 2** Changes in pest and fungus control expenses at Kyushu National Museum from the time preparations to open the museum began to the fourth year after opening (FY2003–FY2008)

will need to find creative solutions to many problems, and on top of that, problems will increase as the building deteriorates over time and dust accumulates in places we cannot see.

Creating a museum that meets the environmental needs of the times and ensuring its continuation requires an accurate understanding of the state of the building's facilities as they change from day to day, efforts to ensure their proper function, and flexibility such as actively gaining the understanding and support of local residents.

## Note

- 1) There are in total 10 national museums under the Agency for Cultural Affairs, Ministry of Education, Culture, Sports, Science and Technology in Japan.
  - Four national museums (Tokyo National Museum, Kyoto National Museum, Nara National Museum, and Kyoto National Museum) are organized under the umbrella of the Independent Administrative Institution, National Institutes for Cultural Heritage.
  - Five national art museums (The National Museum of Modern Art, Tokyo; The National Museum of Modern Art, Kyoto; The National Museum of Western Art; and The National Museum of Art, Osaka; The National Art Center, Tokyo) are organized under the umbrella of the Independent Administrative Institution, National Museum of Art.
  - National Museum of Nature and Science

In addition, there are two institutions (National Museum of Ethnology and National Museum of Japanese History) under the Inter-University Research Institute Corporation, National Institutes for the Humanities.