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Designing of Kioi Hall — Aiming at Music Hall with a Tradition —

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Abstract:

The Kioi Hall opened in the spring of 1995. It was planned as part of Nippon Steel's program to commemorate the 20th anniversary of its foundation by returning some of the its profits to society. Composed of an 800-seat hall for Western classical music and a 250-seat hall for traditional Japanese music (the first of its kind in Japan), the Kioi Hall is the first concert hall designed by Nippon Steel. The concept and outline of its design, centering on the classic Western music hall, are described. The design of the Western music hall is characterized by its integration of "software" and "hardware" and by its philosophy of respect for the European tradition and the intention to transfer it to the present day. The results of acoustic experiments conducted for the acoustic design of the hall are also presented.

1. Introduction

The Kioi Hall opened in April 1995. Nippon Steel took charge of all phases of its construction from planning, management, and architectural design to actual construction. The reputation of the Kioi Hall has exceeded even the expectations of its architects. This is an exceptional phenomenon when one considers that buildings of this type often receive severe criticism when they open. The Kioi Hall has an 800-seat Western classical music hall and a 250-seat traditional Japanese music hall. The design of the Kioi Hall, centering on the Western classical music hall, is introduced here.

2. Achievement an Enduring Music Hall — Software and Hardware —

The Kioi Sinfonietta Tokyo is the name of the resident orchestra formed for the Kioi Hall. Thus the orchestra has started its activities at the same time as the Kioi Hall, and will carve a history together with the building.

The first design consideration was the enduring nature of the Kioi Hall as a building. As can be seen from music halls in Europe and the Kabukiza in Japan, tradition-shrouded buildings assume an increasing presence over time. Such a building is a desirable hall. To build such a music hall, it is essential to first decide on the purpose, or software, of the hall and reflect it in the design of the building. What should be emphasized most about the design of the Kioi Hall is that this has been achieved to a high degree. The formation of the resident orchestra is a symbol of this achievement.

A concert hall and an orchestra are inseparably connected. The orchestra builds its base and grows through the process of cultivating and confirming its own sound in its own hall. With such a base, the orchestra can display its ability to the fullest possible extent even when its surroundings change. The orchestra can know how a given hall differs from its home hall and how it should play to accomodate the differences.

*1 Building Construction Division

The Vienna Philharmonic Orchestra makes its home in the Musikvereinsaal, said to be the archetype of today's music halls. The Berlin Philharmonie is famous as the Karajan Circus. The world's oldest orchestra, the Leipzig Gewandhaus Orchestra, performs in its home, the Gewandhaus, as does the Concertgebouw Orchestra — most of the world's renowned orchestras have their own home halls. In Japan, the importance of this has been recognized only recently. In the initial design stage of the Kioi Hall, the opinion of many experts was sought regarding its design. The most significant outcome of this endeavor has been the concept of the resident orchestra.

At about the same time the policy for organizing the resident orchestra was determined, a software study team of music experts was also formed. Hardware was designed in an ideal process involving detailed discussions with members of the resident orchestra and the software study team. The discussions of the software and hardware people covered every possible aspect, including the music halls themselves, the foyers, the lobbies, the backyard, floor planning, architectural design, material selection, and equipment planning. As a result, the long-praised ideal of integrating both hardware and software of music halls has been brilliantly accomplished in the Kioi Hall.

Since its opening, the Kioi Hall has been managed by the software study team. The place of the Kioi Hall over time, whose endurance is the basic philosophy of its design, will be assured by the team.

3. Interpretation of Tradition

In regards to the relationship between the music hall and the orchestra, Japan still has much to learn from foreign countries, and in particular from European ones, even though Japan has produced many world-class musicians. To think about this fact with modesty, and thereby to design the Kioi Hall from a global point of view — this was our determination from the outset of the design phase. In other words, the second design consideration was "to inherit from good tradition, to render a modern interpretation of that tradition, and thereby to create a new tradition".

Several conditions favor this design concept. The Kioi Hall was designed to make the most of such conditions.

3.1 Location

The first condition favoring this concept is location. Music halls have traditionally been situated at the center of cities. The Kioi Hall is located in Kioi-cho, Chiyoda Ward, in the heart of Tokyo, and one of Tokyo's most prestigious districts.

Conversely, music halls are important facilities that can help to establish an area as a city center. When one looks back on existing music halls in Tokyo, one notices that they have not always been built at ideal locations. Kioi-cho, though, has an atmosphere befitting the lively sense of a big city. It has rich greenery, parks, a university, a church, high-class hotels, and historical spots.

The authors undertook the design of the Kioi Hall with the intention of making the most of these favorable site conditions. For instance, take a basic approach to hall planning. The first step in planning a music hall in the past has been creating this lively environment. Rich greenery is planned, sufficient space is provided between the entrance and the building, and an external environment is produced. Not satisfied with this, a sumptuous lobby and foyer are constructed in the building, and seats in the hall are generously dimensioned (when clients do not demand maximization of the number of seats available). The final outcome of all these is an amply appointed music hall. Is this the ideal picture we should aim at?

While such spaciousness is the declared goal of many music halls, the design of the Kioi Hall aimed at the contradicting theme of "density". The goal was the creation of an optimum layout to realize a closeness and an enthusiasm between the musicians and audience, and between the members of the audience themselves. It is no exaggeration to say that this thinking would not have been possible without ideal site conditions, similar to those of the best traditional concert halls of Europe.

3.2 Private ownership

The second condition favoring this design concept is that the client of the Kioi Hall is a private organization. The architects aimed to design a music hall different from public music halls, they would use the freedom resulting from private ownership clarify definitely the purpose of the music hall, and take bold decisions where required. There are now many multipurpose public music halls, which from a generation ago became the typical model of a public hall. The architects of Kioi Hall aimed at something different.

The design of the Kioi Hall was modeled on traditional music halls in Europe, with top priority given to the creation of a space with superb acoustics, where the audience could enjoy music in a comfortable safe setting. All other objectives were considered secondary to this. Therfore (as is often the case with music halls in Europe), it was inevitable that some seats provide a restricted view of the stage. Such are the types of bold decisions which were taken, and which are not readily possible for public halls.

Another bold decision taken was the wooden flooring-on-joint framing construction, adopted to enhance acoustics, especially in the low-pitched sound region. Footsteps sound clearly loud as compared with a wooden floor installed direct on a concrete slab. The adoption of this flooring construction is a bold choice for music halls that must meet the severe noise level requirement of NC-20 or less. As a result of such decisions, the Kioi Hall is rated extremely high acoustically.

3.3 Designing in a new field

The third condition favoring this design concept was that the designers were new to the design of a full-fledged music hall. This is commonly a negative condition, but has been put to good effect in this case. More specifically, the architects could tackle the theme of European tradition unencumbered by the customary design methods of public halls in Japan.

In fact, those concerned with the design of music halls in Japan have often gone overseas to inspect music halls there. But these trips appear to have been overshadowed by a strong awareness of prevailing conditions in Japan. The Musikvereinsaal is talked about as a legend, and false reports of the Berlin Philharmonic are exchanged. Foreign countries seem still to be far from Japan.

The architects of the Kioi Hall acquired a considerable amount of knowledge about the actual state of famous music halls abroad in a single tour while also securing an information pipeline that they would use throghout the design process. For example, detailed drawings of the floor and ceiling of the Concertgebouw were obtained by one telephone call.

Familiarity with historical music halls overseas proved extremely valuable in designing the Kioi Hall. The fine points of

European music halls with long traditions could be evaluated with more impartial eyes and incorporated into the design of the Kioi Hall. In reality, however, it cannot be denied that Nippon Steel's architects were not sufficiently familiar with the design practices for music halls. To compensate for this shortcoming, Nippon Steel formed a joint design team with Yamashita Sekkei Inc. The new ideas of Nippon Steel and the skilled know-how of Yamashita Sekkei combined to produce synergistic effects and to enhance the high-level design of the Kioi Hall.

The design of the Kioi Hall was carried out under the basic concept "adopt tradition to the present age" by making the best use of the three favorable conditions described above. Of course, this basic concept also applies to the architectural design of the Kioi Hall. The most typical example is in the interior finish of the Western classical music hall.

4. Outline of Building

The basic design ideas of the Kioi Hall have been described above. The outline of the Kioi Hall building, and the acoustic experiments conducted for the acoustical design that determines the life of music halls will now be introduced.

4.1 Outline of plan

4.1.1 Outline of construction work

Project: Nippon Steel Kioi Building
Location: Kioi-cho 6-5, Chiyoda Ward, Tokyo
Owner: Nippon Steel
Architect: Joint design office of Nippon Steel and Yamashita Sekkei
Construction: Joint venture of Nippon Steel, Kajima, Taisei, and Takenaka Komuten
Term of work: January 1993 to January 1995

4.1.2 Outline of building (See **Fig.1** and **2**)

Main applications: Music hall
Number of stories: 2 stories underground, 7 stories above-ground, and 1 penthouse
Height: Maximum height of 43.68 m and eaves height of 36.18 m
Site area: 3,120.21 m²
Building area: 2,233,73 m²

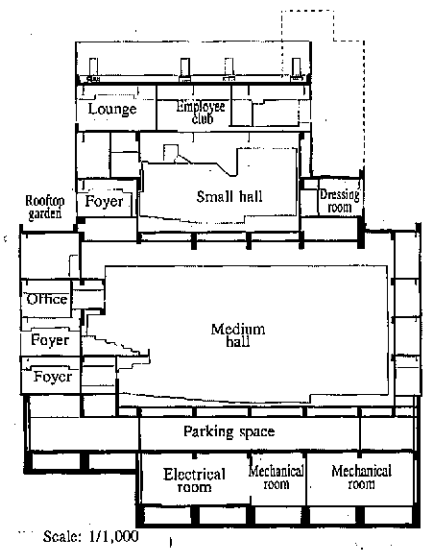
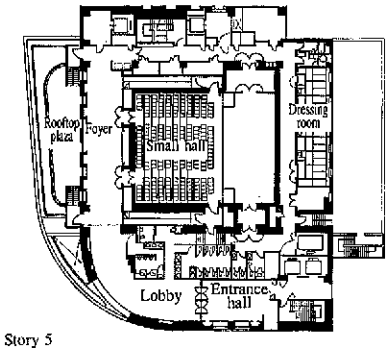
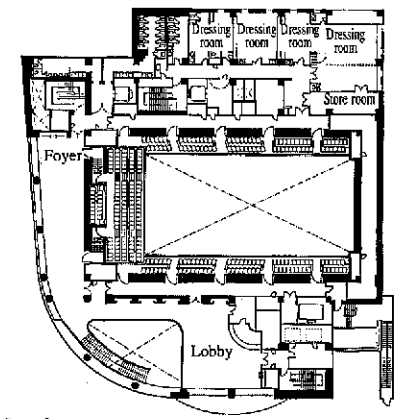


Fig. 1 Section





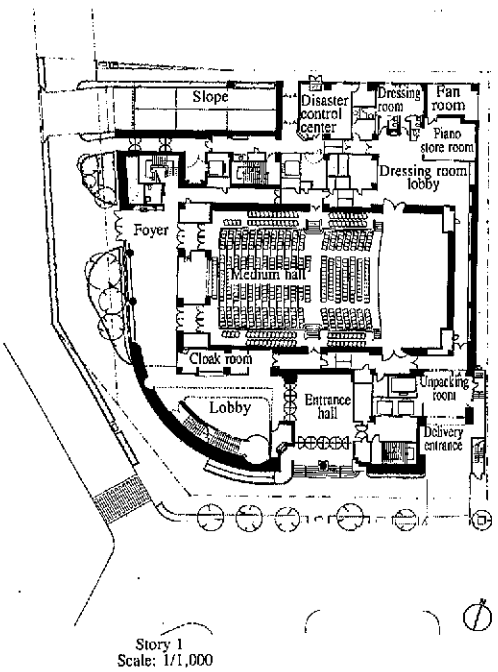


Fig. 2 Floor plans

Total floor area: 12,625.73 m²
Construction: Underground: Reinforced concrete
Aboveground: Steel frame construction, partly steel frame and reinforced concrete composite construction

4.1.3 Overall composition

To best utilize the site area, one small hall and one medium hall are constructed one above the other.

(1) Kioi Main Hall: Stories 1 to 4
(2) Kioi Small Hall: Stories 5 and 6

There also are a restaurant for Nippon Steel employees, parking spaces, and a machinery room.

4.2 Kioi Hall (for Western classical music)

4.2.1 Concept

Target: Realization of music hall of the highest class, suitable to commemorate the 20th anniversary of the founding of Nippon Steel
Basic policy: To contribute to society by providing a venue for cultural exchange
Theme: "Place for discovery, creation, cultivation, presentation, and exchange"
"Place for exchange between musicians and those who appreciate music"

4.2.2 Outline of facilities

- Number of seats: 800 seats (522 seats in Level 1 and 278 seats on Level 2)
- Overall style: "Shoe box" style
- Stage: Open type

4.2.3 Design goals

- To create an acoustical space ideal for performances of Western classical music by a chamber orchestra
- To create a music hall styled on the traditional European "shoe box" form: a space with opposing walls parallel, a flat floor, and a flat ceiling, with the floor mildly stepped to preserve clear lines of sight to the stage.
- To provide for an open stage, so that musicians and audiences can share a common ambience.
- To provide for balcony seats on both sides of Level 1 and on three sides of Level 2, to create an intimacy between musicians and audience.

4.2.4 Interior design

(1) Design with emphasis placed on "comfortable space"

- Design to evoke feeling of newness while retaining traditional composition
  Opulent columns and gently curving beams
  Continuous cylindrical columns to accentuate spaciousness
  Symbolic front wall composed of a colonnade in a mild curve
  Three-dimensional ceiling with beam shape continuous with column shape
- Selection of softly textured materials and restful color plan
  Wall finish: Imported cherry wood with bright finish
  Ceiling finish: White paint to emphasize lightness and an enlivened atomosphere
  Brass moldings to evoke a lively image
  Seating in green
- Lighting plan to produce the refined atmosphere of an artistic space
  Soft illumination provided mainly by indirect lighting and brackets
  Chandeliers (designed by Minami Tada) to accentuate high ceiling

(2) Design to reproduce the traditional acoustics of Europe

- Design composition to make good use of "shoe box" style
  Basic shape of parallel walls and parallel floor and ceiling
  Details designed with surface irregularities for sound diffusion

4.2.5 Acoustic plan

(1) Selection and consideration of interior materials

- Ceiling: Fiberglass-reinforced concrete panels - Sound reflection over entire sound band
- Front and side walls: Laminated board - Sound reflection over entire sound band
- Floor: Wooden floor-on-joint frame construction - Slight sound absorption in low-pitched sound region
- Seating: Wooden (covered with cloth) - Sound absorption in medium- and high-pitched sound regions

(2) Reverberation time

- 2.05 s for empty hall; 1.75 s for full hall

4.3 Kioi Small Hall (for traditional Japanese music)

4.3.1 Concept

Target: Creation of ideal space for traditional Japanese music
Basic policy: To provide a place to support music culture
Theme: Realization of Japan's first traditional Japanese music hall

4.3.2 Outline

- Number of seats: 250
- Audiotrium: One-slope type with mild slope
- Stage: Open type

4.3.3 Design goals

- To create space with acoustics ideal for performances of traditional Japanese music
- To provide an open stage after the Noh stage, and a one-slope seat area to create a new hall space for traditional Japanese music
- To realize a close intimacy by placement of the 250 seats
- To provide easy to use stage equipment appropriate for a traditional Japanese music hall, while also allowing for traditional Japanese dancing.

4.3.4 Interior design

The interior design was made simple to enhance the stage effect.

4.3.5 Acoustical plan

(1) Sound insulation structure

The Kioi Small Hall is located above the Kioi Hall. To allow for the simultaneous use of the two halls, double slabs were installed between the halls, and the ceiling, walls, and floor of the Small Hall were constructed to form a floating sound insulation structure, as described below.

Ceiling: A vibration-isolating and sound-insulating ceiling with vibration-isolating hangers, plaster boards and rock wool above the finished ceiling.
Wall: A vibration-isolating and sound-insulating wall with rubber isolators, plaster boards, and rock wool.
Floor: A floating floor with rubber isolators on concrete.

(2) Acoustical design

No technical information or data were previously available for acoustical design for traditional Japanese music.

Therefore, to prepare for the acoustical design of the Kioi Small Hall, performers of traditional Japanese music were interviewed, and existing halls where traditional Japanese music is often played were thoroughly investigated.

- Reverberation time: 0.93 s for empty hall; 0.83 s for full hall

4.4 Building structure

The building of the Kioi Hall was required to insulate sound to a high degree and to be completed in a short time. The aboveground portion was built in a combination of steel frame construction and steel frame and reinforced concrete composite construction. Each hall was enclosed within earthquake-resistant walls to carry 40% to 60% of earthquake force. The twist of the building resulting from its setback was balanced by adjusting the earthquake-resistant wall thickness between 15 and 30 cm. The foundation was built as a 1.2-m thick mat slab to reduce the amount of excavation required.

4.5 Electrical equipment

The main features of the electric equipment are described below.

- 5-kW amorphous solar cell power generation equipment
- Building electric equipment with high safety and maintainability, including oil-less power receiving and transforming equipment
- Stage lighting equipment with PTFC (pan, tilt, focus, and color) lighting fixtures (Kioi Hall)
- Stage acoustic equipment, including high quality sound recording equipment (Kioi Hall)
- Lighting experiment with 1/50-scale model (Kioi Hall)

4.6 Air-conditioning and plumbing equipment

The main features of the air-conditioning and plumbing equipment are described below.

- Heat source
  Gas-fired chilled/hot water generator, 180 USRT × 2 units
  Dynamic ice thermal storage system (made by Nippon Steel)
  Thermal storage capacity 300 USRT × 2 units
  Ice-making water-cooled screw chiller, 40 USRT × 2 units
- Air-conditioning equipment
  Single-duct, constant-air flow volume system (for halls)
  Air-conditioning noise
  Kioi Hall: NC-15
  Kioi Small Hall: NC-20
- Automatic control
  Autonomous distributed system (made by Nippon Steel)
  Heat source: Ice-thawing trend control according to radiation schedule data base
- Water supply equipment
  Wooden received water tank and elevated water tank

5. Outline of Acoustic Experiments with Model

5.1 Purposes of experiments

The Kioi Hall is designed mainly for a chamber orchestra, and so naturally it attaches importance to acoustical performance. Its overall shape is a shoe box erected at end. Shoe box-shaped halls have their optimum acoustic conditions established by computer simulation. The acoustic study of the Kioi Hall was completed before the acoustic experiments, and basic chamber geometry and the like were considered to be at acoustically high levels. An additional acoustic condition for concert halls is that initial reflected sound should be as consistently high as possible.

Given the above considerations, the acoustical experiments were conducted with a 1/10-scale model to allow a more detailed acoustical study and to confirm initial reflected sound (See **Photo 1**). In particular, because the walls around the stage are the primary reflection walls for the musicians on the stage and the audience in the first-floor seats, these walls were carefully investigated to determine their most desirable shape.

5.2 Outline of experiments

5.2.1 Experimental items

(1) Optical experiment: Confirmation by laser beam of effective sound reflection surface

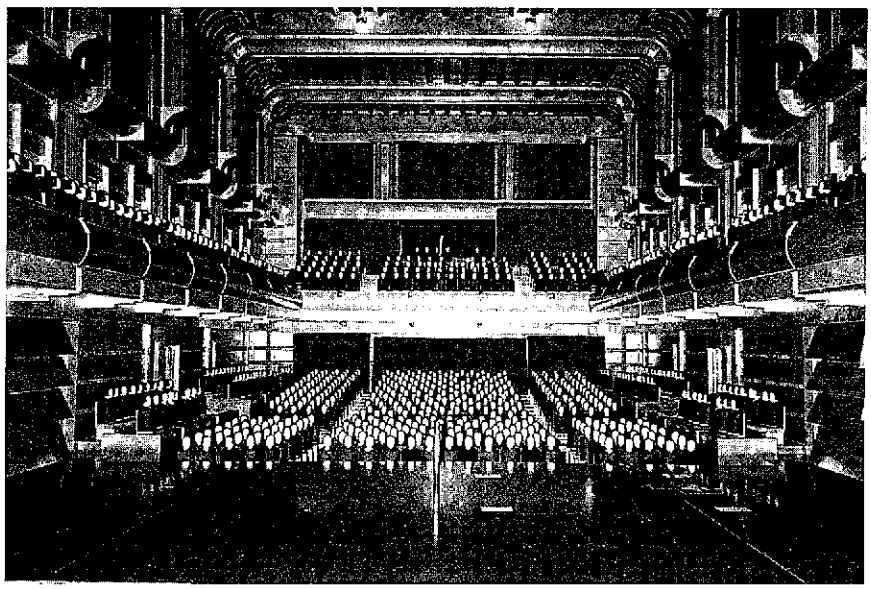


Photo 1 Inside view of model

(2) Acoustical experiment: Measurement of impulse response (measurement of reverberation time, measurement of REC curve*1, and observation of echo pattern)
(3) Detection and correction of long-path echo

5.2.2 Experiment goals
- Confirmation of basic room shape
- Study of detailed shape with attention focused on shape of walls around stage
- Detection of long-path echo that serves as acoustical disturbance

5.2.3 Outline of model
(1) Scale: 1/10
(2) Interior finish: Simulation of the sound absorption characteristics of interior finish materials is important in acoustical model experiments. Materials or structures were selected to be capable of simulating to some degree the sound absorption characteristics of actual interior finish materials.

5.3 Outline of experimental methods

5.3.1 Optical experiment (confirmation of effective sound reflection surface by laser beam)

The direction of sound reflected at the ceiling and wall surfaces and the arrival of direct sound at the audiences in their seats were visually confirmed. Mirror finish films were applied to the ceiling and the wall surfaces, and laser beams were projected on the mirror finish films to trace the trajectories of sound waves.

5.3.2 Acoustical experiment

(1) Quantitative determination of initial reflection sound and study of detailed shapes of parts

From the various physical quantities proposed for quantitatively determining the initial reflection sound, which is highly related to the acoustical quality of concert halls, the REC curve was selected and studied for its effect on the shape of walls around the stage.

One of the purposes of the acoustical experiment was to search for a shape for the walls around the stage better than that confirmed in the design stage. The wall shape of the original design, the front wall of the stage, the side walls of the stage, and large sound diffusion surfaces were studied comparatively.

(2) Detection of long-path echo

A nondirectional sound source and a directional sound source were set on the stage, dummy head microphones were placed at measuring points on the stage and on front seats, and harmful echoes such as flutter echo and long-path echo were detected.

5.4 Summary of experimental results

The optical and acoustical experiments were conducted as described above, and their results were reflected in the acoustical design of the Kioi Hall. Main experimental results are summarized below.

(1) From the results of the optical experiment, it was confirmed that the sound reflection finish of the upper rear wall of the second floor increased the arrival of the initial reflection sound to the balcony seats of the second floor.
(2) It was confirmed that increasing the lower ceiling area above the sidewall cylindrical columns of the second floor increased the arrival of the initial reflection sound to the rear seats of the first floor.
(3) On the stage, long-path echoes were detected from the sound reflected twice from the walls located at either side of the doors in the rear wall of the first floor. Therefore, these sidewall portions were finished for sound absorption.
(4) Slight flutter echoes were detected from the flat surfaces of the upper sidewalls of the second floor. Therefore, these areas were shaped for sound diffusion.
(5) It was confirmed that providing downward sloping surfaces in the sidewalls of the stage increased the arrival of the initial reflection energy to the seats on the first floor and the side balcony seats on the second floor.

The optical and acoustical experiments were conducted jointly with Nagata Acoustics Inc. at Nippon Steel's Building Research & Development Center from November 1993 to February 1994.

6. Conclusions

When completed, the Kioi Hall was covered by many mass media. The articles that impressed its architects most are introduced below.

Mr. Naoki Watanabe*2 said: "This is the birth of a post-bubble economy concert hall. The Kioi Hall is different from halls built in many parts of Japan during the bubble economy in that it exhibits high-minded aspirations in many respects. Among the features of the concert halls built during the bubble economy period are: (1) design by a famous architect; (2) planning by a famous producer; and (3) performance by famous foreign musicians.... The new Kioi Hall, which is managed by the Nippon Steel Arts Foundation, is poles apart from the halls built during the bubble economy period; it is a concert hall long wished for by Japan's music lovers".

When the present authors visited the Berlin Philharmonic, its large hall happened to be under total reconstruction. At the suggestion of a guide there, the authors went to the architectural design office in charge of the reconstruction project. What we heard there while looking at drawings was that the major premise of the remodeling was the faithful reproduction of the original design of Scharoun*3. It was a very interesting story.

About 30 years after its construction, the Berlin Philharmonic is already a legendary hall. Although it is only in the realm of imagination whether Scharoun or Karajan was responsible for the legend, the Berlin Philharmonic was a truly ideal concert hall. Back in Japan, Yokohama was embroiled in a controversy about whether to demolish or preserve the Kanagawa Prefectural Music Hall. The Kanagawa Prefectural Music Hall is a similar example. The authors hope that the Kioi Hall will become such a legendary music hall.

We later heard that the Berlin Philharmonic Hall, rebuilt faithfully according to the original design of Scharoun, is not popular due to the acoustic changes it has undergone. This episode keenly convinces us of the difficulty of designing music halls.

*1 Cumulative curve of initial reflection energy in impulse response excluding direct sound. For seats in which spectators can receive a good acoustical impression in a concert hall, the REC curve smoothly rises, and the cumulative level of initial reflection sound energy reaching with a time delay of 80 to 100 ms is high.

*2 Yukan Fuji, a Japanese evening tabloid

*3 Hans Scharoun, a German architect

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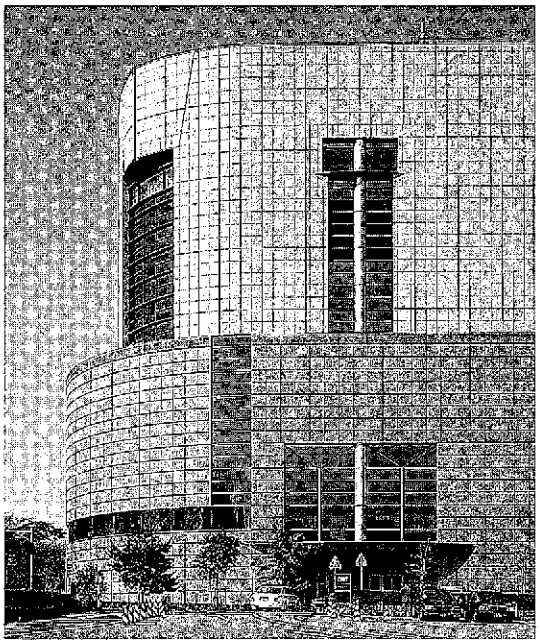
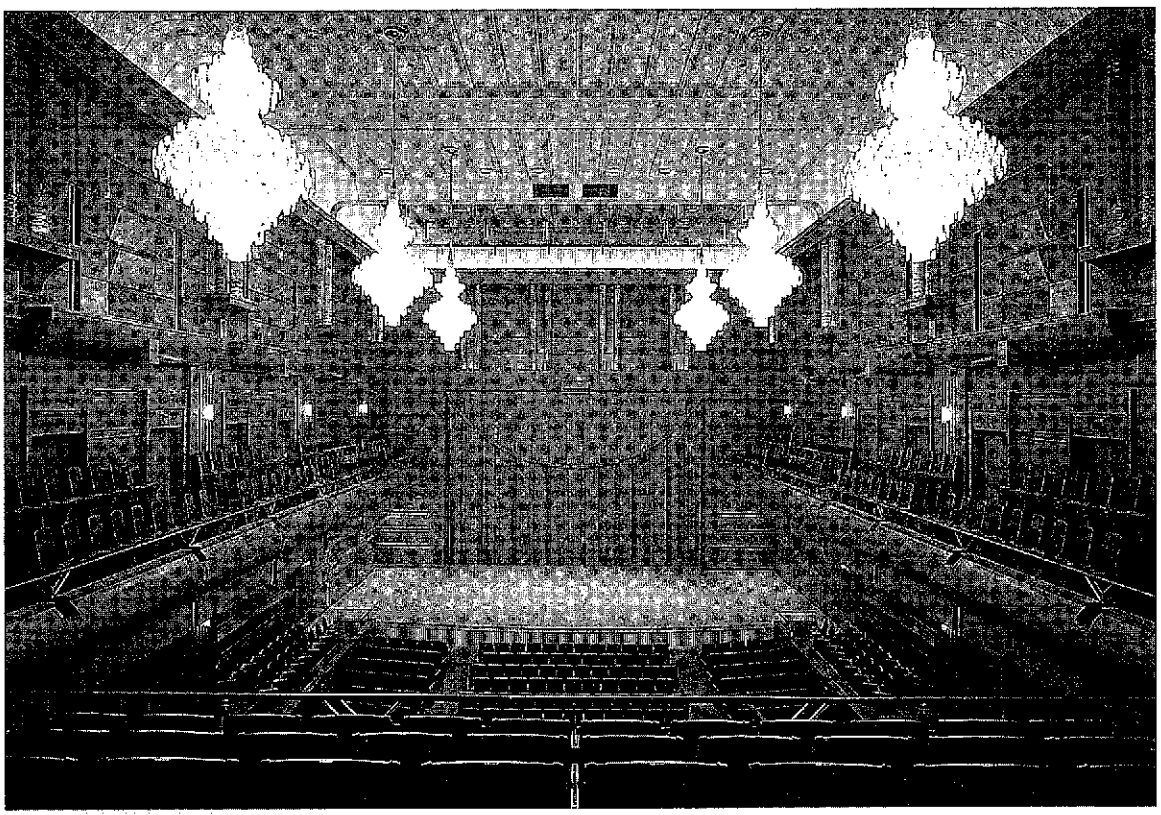
Small hall. Curtain was designed by Setsu Asakura (photo by courtesy of Shin Kenchiku Sha)



South side of Kioi Hall. The outside wall is constructed of granite-covered precast concrete panels (photo by courtesy of Shin Kenchiku Sha)



Western classical music hall with 800 seats (photo by courtesy of Shin Kenchiku Sha)