Room Acoustic Designs for the Tokyo International Forum

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Abstract: One of the most expensive buildings of our time, the $1.6 Billion Tokyo International Forum, set a new standard for the acoustics of multipurpose urban performing arts centers.

Hall A

This hall has a capacity of 5,012 and can be used for a wide variety of programs from classical symphony concerts to popular amplified events to conferences. In order to meet the wide range of the programs, the Hall was designed to be acoustically neutral with a reverberation time of 2.0 seconds empty and 1.8 seconds full. This might seem long for amplified productions, but experience has shown that for this hall's large volume (54,978 cubic meters or 1.94 million cubic feet) these times are optimum. Sound absorption materials were carefully located on the rear walls, doors and within the wooden proscenium arch to control long delayed reflections which would be perceived as ethos.

The large side walls were made of laminated glass which was carefully constructed to avoid sympathetic resonances. For classical concerts, a wood and steel concert enclosure moves into position entirely on motorized lines. The shell incorporates automated tunable ceiling elements that assist in blending and balancing the orchestra. For symphony concerts, electronic enhancement (AFC) was the only possible way to achieve the proper reverberation time and level, as well as proper envelopment and surround. This is discussed in other papers at this session.

Hall A Data:
Volume = 5497.1m^3 Surface Area S = 14,873m^2
Hall unoccupied – Rt. mid. freq. ave. 2.01, average alpha 0.26
Hall occupied – Rt. mid. freq. ave. 1.81, average alpha 0.28

Hall C

This 1500-seat theatre and concert hall has a stagehouse and proscenium that would typically have a demountable acoustical shell for symphony performances. Rather than a typical shell which may provide insufficient air volume to the orchestra making it hard to balance high-energy brass and percussion at the back of the shell with the strings in the front, we designed a “Concert Hall Shaper” that responds to these problems and improves on-stage hearing. The Concert Hall Shaper consists of a wood and steel reinforced ceiling that slides over the stage area before a symphonic concerts closing off the fly space. Reflectors which hang from this “shaper ceiling” improve on-stage hearing, sectional balance while also allowing some sound to couple into the volume below the movable wood ceiling, increasing reverberance.

The Hall chamber is essentially a shoebox with a shaped throat area to project sound out into the hall. The side walls are a wood veneer over multiple layers of plasterboard, instead of masonery due to the requirements of “Box-in-Box” constructions. The side walls cant into the hall and terminate with an acoustic shelf that provides lateral side wall reflections. The upper side walls are visually blacked out and hide a series of sound diffusive chevrons, randomly oriented within a hierarchical grid. These elements can be covered with automated sound absorption shutters that store in the attic over the Hall and drop down the sidewalls and rear walls in front of the diffusion elements to control
reverberation time. Constructed of two-inch (5 cm.) thick fiberglass panels, these shutters reduce the reverberation time at mid frequencies from 2.05 seconds to 1.2 seconds, unoccupied.

Hall C Data:
- Volume = 20,499.1 m³
- Surface Area S = 6724.5 M²
- Hall width (ave.) = 85 feet; height = 65 feet; length = 118 feet
With Concert Hall Shaper in position:
- Hall unoccupied – Rt. mid. freq. ave. = 2.05, average alpha 0.22
- Hall occupied – Rt. mid. freq. ave. = 1.86 ave. alpha 0.23
- LE = 19.3%, Lf = 25.6%, C80 = 1.7dB, ST₁ = -9.1dB, ST₂ = -8.5dB

Hall B

This 1400m² foot flat floored space is divisible into two rooms and seats a total of 1200 people. Acoustical absorption is placed in an even pattern behind perforated metal wall panels. In the ceiling, a checkerboard pattern was implemented. The reverberation time in the divided spaces are 1.27 seconds and 1.68 seconds in the full open configuration supporting a program of fashion shows, summit meetings and receptions. Extensive A.V. Systems are discussed in subsequent papers.

Hall B Data:
- Unoccupied Rt. mid. freq. ave. (divided) 1.27 sec. ave. alpha 0.29
- Unoccupied Rt. mid. freq. ave. (full open) 1.68 sec. ave. alpha 0.32

Hall D

This versatile space serves as an experimental theatre, recital Hall and live television studio. Seating 300 in theatrical seats, the 340m² space has adjustable acoustic draperies that ride behind a skin of perforated metal panels, and in front of shaped acoustic diffusion surfaces. Acoustic drapes on upper wall surfaces allow for further acoustic adjustment of the acoustic environment along with an AFC system described in other papers. The natural reverberation time can range from 1.4 seconds to 0.90 seconds. Extensive motorized ceiling elements called technocubes, drop to the floor to allow almost infinite ceiling configurations for theatre, recitals and video productions.

Hall D Data:
- Volume 4578.70 m³
- Surface Area S = 1920.95 m²
- Unoccupied Rt. mid. freq. without acoustic drapes 1.4 sec.
- Unoccupied Rt. mid. freq. with acoustic drapes 0.98 sec.