ARCHITECTURE, ACOUSTICS, AND PROJECT COORDINATION FOR SALA SÃO PAULO, BRAZIL

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1 INTRODUCTION

Sala São Paulo is an adaptive conversion of a portion of the Júlio Prestes railway terminal in São Paulo, Brazil into a traditional "shoe-box" concert hall of 1509 seats, and is an important element of the ambitious re-organization program of OSESP – Orquestra Sinfônica do Estado de São Paulo (State of São Paulo Symphony Orchestra).

Estação Júlio Prestes dates from 1938, and the new concert hall occupies the space of the Grand Hall that was originally designed to serve as a reception area for the Sorocabana railway company's first class passengers. Because of its location within an existing structure close to heavily used railway tracks, and its protected historical and architectural significance, the construction of the new concert hall and supporting facilities within it was an enormous challenge to the Brazilian team engaged in the coordination, architecture, and acoustics. Artec Consultants from USA joined the team to develop and oversee the basic design concepts.

Sala São Paulo opened in July 1999, and since then the room has become a city, state, and national landmark. Citizens, visitors, and local concert-goers are justifiably proud of this new hall, the first single-purpose concert hall in South America. Situated in the City's central downtown district, which had suffered serious social and urban problems, Sala São Paulo has become a catalyst for positive urban renewal throughout the area.

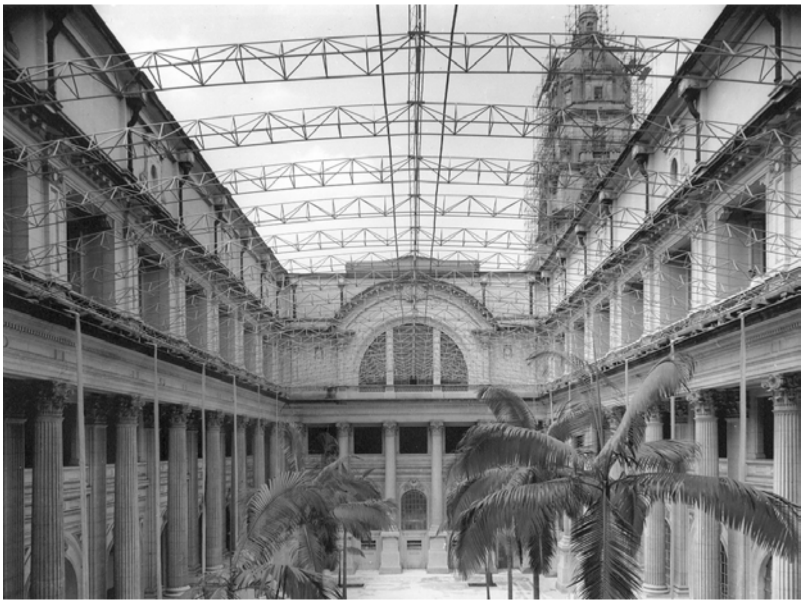
This paper presents the main steps and details of the acoustics, architecture and design coordination for Sala São Paulo, from the preliminary design stages through construction and opening. The 15-segment moveable ceiling, the 1100 m^2 floating floor, the balcony design alternatives (and how they could be best inserted in a protected building), the accelerated time schedule, and other design, construction, and coordination issues are described.

2 THE HALL

Sala São Paulo project is directly associated with the OSESP artistic and organizational restructuring process lead by maestro John Neschling. Among Neschling's plans was to build an Orchestra capable to reflect the importance and tradition of the city of São Paulo. Created in 1953 OSESP had no hall of its own, had rehearsed and performed in several spaces, none of them with qualities and amenities required by a first class orchestra.

In December of 1996 São Paulo 's Secretary of State for Culture invited Artec's Chris Blair to visit and comment on several existing spaces in São Paulo that might accommodate the orchestra's program. Not surprinsingly one by one was rejected due to inadequate physical accommodations and acoustics. The last site to be visited was the Julio Prestes railway station. Walking through the garden he recognized there a "shoebox" geometry with proportions reminiscent of Boston's Symphony Hall and Vienna's Musikvereinssaal. Blair's recommendation was promptly accepted by those engaged in the project's early days.

The Júlio Prestes railway station was designed by the Brazilian architect Christiano Stockler das Neves at beginning of Twentieth Century. The space where Sala São Paulo was ultimately constructed was originally intended to be the first class passenger's reception area. The construction of the building began in 1926 and finished in 1938. The original design was altered during the construction process and the reception area was left open to the sky and was designated as a garden in the final construction plans. In the last recent years sometimes the garden was used for social parties, reception and events. The space before the renovation can be seen in the photograph below.



Júlio Prestes Hall – before Sala São Paulo construction.

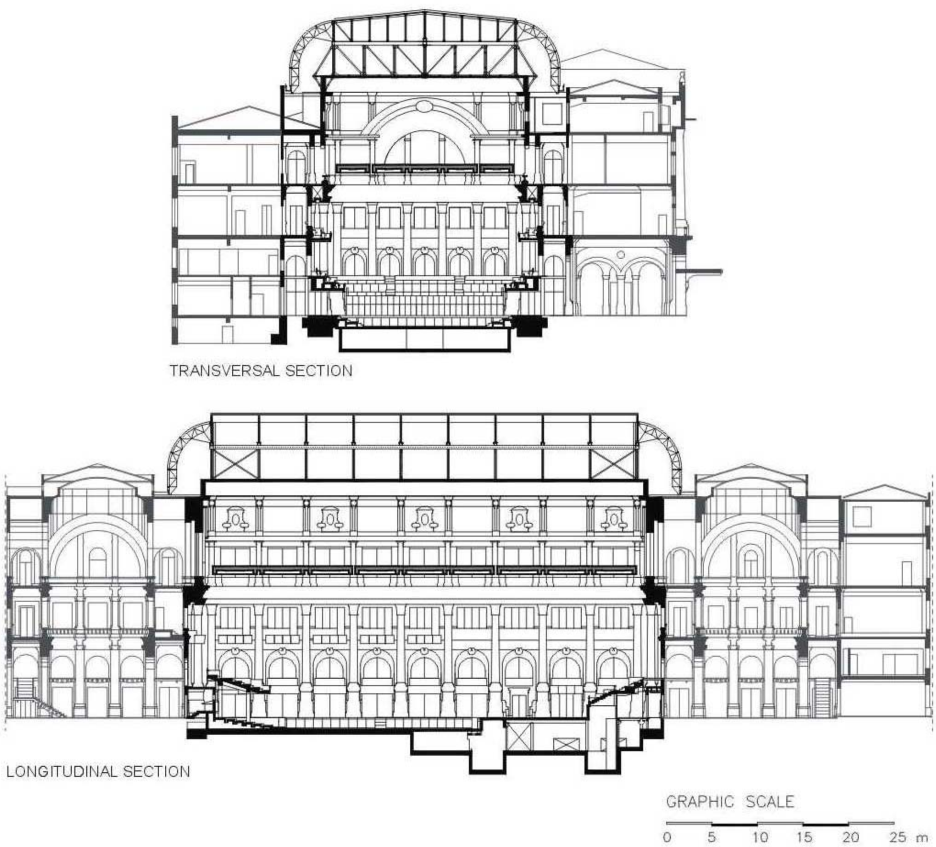
As can be seen the garden was open to the sky and a temporary canvas was used as weather protection. The Sala São Paulo was built in this space and the ground level was excavated to accommodate the audience area and technical zones below the stage platform. The balconies were installed between the columns. The Technical Floor was built just on the top of sidewalls, and the moveable ceiling, in 15 pieces of equal area and weight, was suspended in the void. The space renamed as Sala São Paulo can be seen in the next photo.

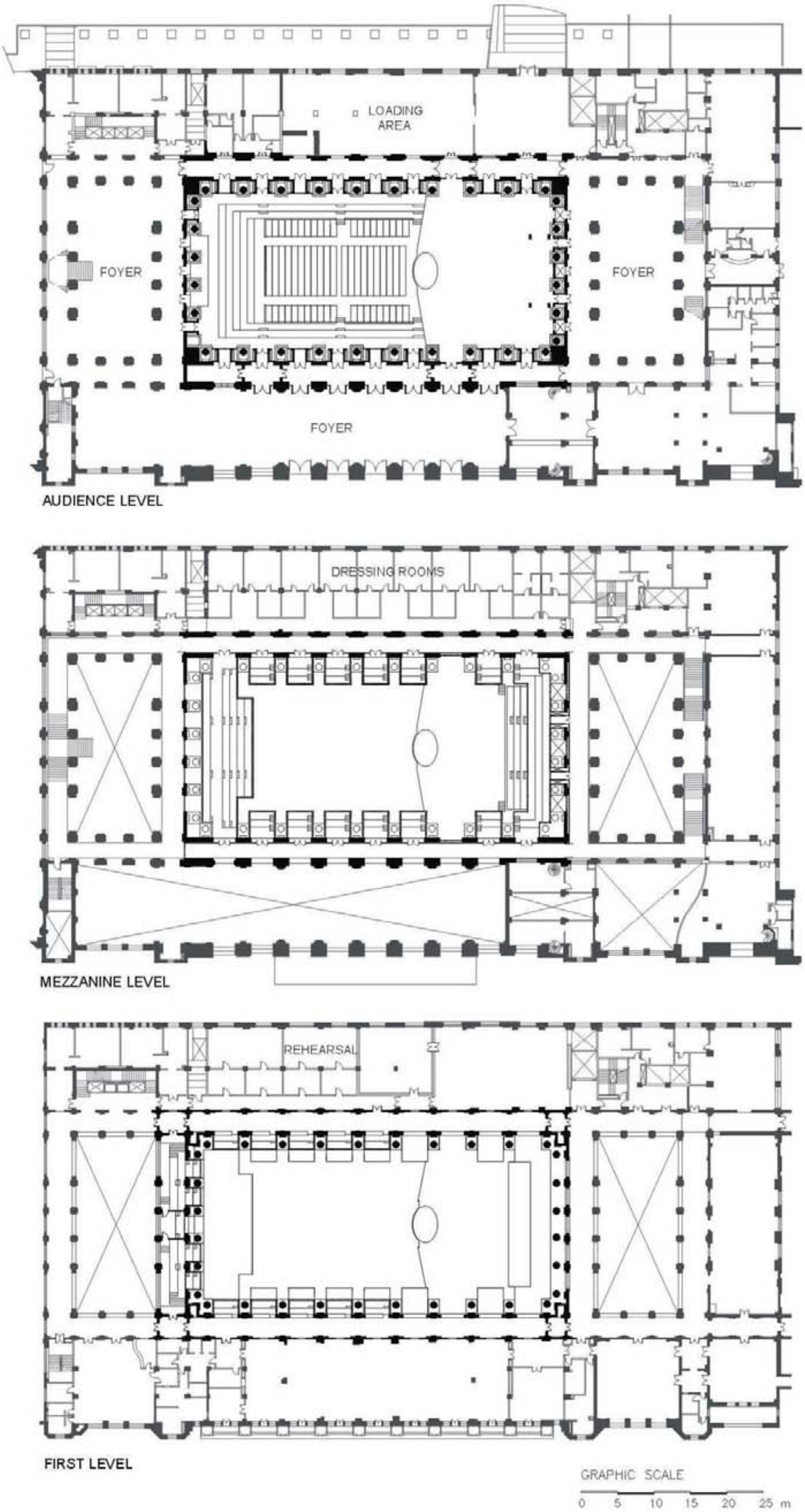
Sala São Paulo looking to the stage

The Sala São Paulo complex is about 26.263 m^2 including the concert hall, rehearsal rooms, dressing rooms, administration, musician lounge, and areas for recording studio, small auditorium, etc. Add to this 20.870 m^2 for the garage and 10.634 m^2 for plazas.

The complex occupies five levels: Understage; Audience and Foyer Level; Mezzanine Level for the first tier and dressing rooms (This level was specially constructed for Sala São Paulo); First Level accommodating the second tier, rehearsal rooms and reception hall; Second Level with rehearsal rooms, musical archive, and administration; and finally the Technical Floor where rigging systems for the moveable ceiling and acoustic banners are installed.

In the drawings below can be seen the sections for the whole building and the plan views for Audience, Mezzanine and First Level.




LOADING
AREA
FOYER
FOYER
FOYER
AUDIENCE LEVEL
DRESSING ROOMS
MEZZANINE LEVEL
REHEARSAL
FIRST LEVEL
GRAPHIC SCALE
0 5 10 15 20 25 m

3 PROJECT COORDINATION

The project operations started in January of 1997 with a clear target: a Hall complying with international quality standards should be opened in July 1999. The time schedule was divided into phases:

- Concept phase: January 1997 to April 1997
- Basic design phase: May 1997 to December 1997 (bid documentation by July 1997)
- Construction: January 1998 to July 1999

3.1 Concept Phase

At this phase the design team was Solé (coordination), José Nepomuceno (acoustics) working in close collaboration with Artec's consultants, Chris Blair (acoustics) and Michael Mell (theater and lightning design).

Acoustical criteria, floor vibration measurements, the moveable ceiling issue and mechanical system criteria were discussed. The objective was to establish solid design guidance to be followed in the architecture and installation design development. Building space program, seating lay-out, technical and public circulation, room shaping and stage height were also discussed.

One of the first issues committed in this phase was the noise criteria. Different theaters in São Paulo have high noise levels and this would not be accepted in Sala São Paulo. PNC < 15 was decided as design noise criteria.

A first budget estimation was set. An estimated figure of US$ 35,000,000.00 was established and pursued. The official number for the construction is around this value including the garage area.

3.2 Basic Design Phase

In the basic design phase architect Nelson Dupré was selected. The guidance and recommendations prepared in the concept phase were then developed and the first architecture drawings born. Structure, mechanical and installation teams came aboard. Dupré as the architect and Nepomuceno as the acoustician start to work in the site in weekly design collaborative meetings. A team of more than 12 architects was hired.

In this phase the Authors had several technical meetings with conductors John Neschling and Roberto Miczunk to discuss different design aspects to ensure compliance with Orchestra requirements.

The basic bid documentation sufficient for contractor selection was closed by July 1997 and from that month to December 1997 architecture, acoustics, structure and other teams revised their data, drawings and basic details, to provide a consolidated basic design to the selected contractor. A time schedule for detailing design phase, to proceed in parallel with demolition and foundation work, was prepared to efficiently coordinate the efforts of the design teams.

3.3 Construction Phase

The detailing design phase was simultaneous with the beginning of construction and the design team had to be very well coordinated to work under this complex operation. For example the structure design ran ahead of other efforts, allowing time for other teams prepare their fine details.

Roof, technical floor, acoustic insulation, mezzanine, mechanical systems, added an extra weight of 60 t per structural column. This required the use of extra and huge reinforcement at the column foundations. The modifications in the existing structure and the problems that arrived when the excavations started – that can not be found in the 1900s drawings – were a serious risk for the project. While foundations problems were discussed, the other design teams developed their details with holds. Due to coordination and cooperative relationship of architecture, structure and acoustics teams the problems were overcome in time.

Quality assurance was another issue. Under crossfire of time, budget, and quality, the Authors needed to oversee each progress step on the site development, and at the same time prepare the details to be followed by the contractor.

Construction phase included also acoustical tests. We carried out reverberation time tests without the seats, ½ seats, with all seats; background noise levels; sound isolation tests in the rehearsal rooms. Although some of this data lacks precision, the measurements gave us clear indications that we were going in the right direction and allow us to adjust systems before the opening.

4 ACOUSTICS

4.1 Physical Data

Volume	Seats (S)	V/S	Width (W)
12000 m^3 to 29000 m^3	1509	7,95 m^3 to 19,21 m^3	21 m

Length (L)	Height (H)	Stage area	Stage height
28 m	12,2 m to 23,7 m (max)	230 m^2	1,20 m

Length is from the edge of the stage for the most distant seat in the audience level. The hall length is 49 m. The stage area can count an extra area of 59,5 m^2 of the chorus lift. The stage has a piano lift.

4.2 Moveable Ceiling

The moveable ceiling is composed by 15 panels, nine of them are central with 11,60 m x 4,96 m and six are lateral with 15,38 m x 3,7 m. The panels are made by special plywood sheets covered with finishing wood in irregular steps providing diffusing surface. Each panel weights 7,5 t. The moveable ceiling can be adjusted in several different sets to accommodate different musical compositions. The panels can be moved down and up by a rigging system installed in the Technical Floor.

The space above the moveable ceiling and under the slab of Technical Floor is an acoustically coupled space to the main Hall by the space existing in the panels. The coupled response is further tunable by provision of absorptive banners that can be deployed in the space. The acoustic impact of various ceiling adjustments can be see in the paper presented by Nepomuceno, Doria, and Blair in the Auditorium Acoustic 2002 program.

4.3 Floating Floor and Vibration Isolation

Sala São Paulo is situated close to a heavily used railway track. Structure-borne noise due to the railway operations could interfere in the Sala's acoustical climate quality and would not be accepted. The vibration measurement in the floor over 1 hour period when converted to octave bands is below:

16 Hz	31,5 Hz	63 Hz	125 Hz	250 Hz
-54 dB (ref 1 g)	- 59 dB(ref. 1 g)	- 62 dB (ref. 1g)	- 65 dB (ref. 1g)	- 69 dB (ref. 1g)

To minimize the floor structure-borne noise a concrete floating floor with a slab of 15 cm thickness and neoprene pads was designed in collaborative effort with Bernard Baudouin from the Brazilian company Vibtech. Almost 2000 isolators were used in the main floor.

Isolators were tested according to ASTM D-2001 series. The stiffness and natural frequency were tested in a number of isolators according to statistical parameters. The isolators are cylinders with 90 mm diameter, durometer 50 ± 5 shore A, vertical stiffness 24 kgf/mm ± 15% under nominal load of 180 kgf for 7,5 mm deflection.

The vibration in the balconies could also be a source of structure-borne noise or comfort for the users. To avoid this, precompressed neoprene isolators were designed and installed in steel frame as a part of the balcony structures. Stage structure is also supported on vibration isolators.

4.3 Balconies Design

Artec first suggestion included among other features a single wrap-around hanging balcony. The proposal was evidently based on the tradition applicable to the case, a re-interpretation of Grosser Musikverseinsaal and not an architectural solution applicable to an existing and protected building. That balcony approach was a great interference in the architectonic value of the building. It would devalue the building's original design and destroy the elegant proportions of the 32 Corinthian columns.

The Authors discussed several options all of them inserting the balconies inside the column space. In the last and approved option the lateral balcony was fragmented in several small pieces, occupying the central spans of the lateral intercolumnar spaces. To acoustically compensate for the loss of down-kicking area in front of the columns, a second level of side tiers was introduced as shown in the photograph and drawings.

4.4 Mechanical Equipment and Air Conditioning System

To achieve noise criteria no mechanical equipment could be installed in the building structure and had to be installed in other parts of the building. Duct runs above the Technical Floor supplies air to the Hall at low speed (2,5 m/s) through direct open duct termination without grilles or diffusers. The distance from the duct opening to the closest seat in the First Level is about 18 m and the air stream passes by the ceiling panel spaces.

Mechanical equipment was installed on high deflection spring isolators; ducts were installed using neoprene double deflection hangers; attenuators were installed at supply and return and ductwork were lined with 25 mm of glass-fiber.

The Leq measured at the Sala São Paulo opening tests with air system in normal load and empty Hall complies with noise criteria adopted by the project.

31,5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
45,3 dB	40,9 dB	33 dB	22,4 dB	15,2 dB	12,1 dB	11 dB	< 9 dB	< 9 dB

5. ARCHITECTURE DESIGN

The heart of the new Júlio Prestes railway station is the concert hall, where a large part of efforts to transform the existing building was concentrated. This transformation was due much more to adding new attributes than by altering the existing ones, and these changes occurred to a minimal but inevitable degree.

The changes in the patio, which had been originally designed as a monumental waiting room but was left unfinished and remained empty and unused for years, were neither innocuous, nor naive.

From the beginning was made the decision: any new built element should clearly show the moment and the place of this physical intervention. When one looks in the Hall , what is the “old” building and what is a “new” element is easily identified.

To develop the architectural design we needed to perform a complete documentation of the building. We needed to check all and every space in the building. With help of old drawings from the beginning of 1900s and some additionaldrawings showing modifications carried-out in time, a team of 12 architects started to measure and draw all part of the building in section and plan views. Together with this site service, the entire building was photographed.

Restoration of the entire building was other important part of the Sala São Paulo complex. The main façade, originally almost entirely in stucco, now had some parts in mortar. A cleaning was done with pressurized jets of warm water and alkaline detergent. Some parts were recomposed with stucco. The original mosaic floors (Foyer, galleries, corridors) was quite damaged, probably due to the routine use of chemical products in its cleaning. Without a chance to return to their original condition it was decided to conserve the floors as found protecting them with a resistant acrylic resin. Doors, plaster elements, stained glass windows and sky-lights, internal masonry, window frames, are other elements included in the restoration service.

6. SALA SÃO PAULO EXPERIENCE

The development of Sala São Paulo was an unforgettable experience for all who participated in the conception and project process. The design has won different international awards among them the USITT 2000 Award of Merit. Certainly this project has changed in different ways how future theater and special rooms will be designed in Brasil. The project is well described in the fully illustrated book written by architects Anita di Marco and Ruth Zein “*São Paulo Concert Hall – The making of the Júlio Prestes Central Station rehabilition*”.

Is not only the city of São Paulo that is proud about the Orchestra, but the entire country. The entire OSESP restructuring process includes not only the Hall, but musician qualification auditions, musical archives, training, exchange of experience with overseas ensembles, and workshops. Various homeless orchestras around the country look to the OSESP as the paradigm for successful development. The success is evidenced in full houses in regular concerts; records released; an international tour to various cities in the USA ; and many visitors to Sala São Paulo from all parts of Brasil and abroad.

Prior to this project, a collaborative effort among acousticians, theater designers and architects in the very beginning phase of design was a “fantasy” in Brasil. By tradition the architect designs the room – including shape and geometry – and theater designers and acousticians are called in the basic design to “help” with some “magic” bandage. Frequently the design is so advanced and the size and proportions committed at a point that a good acoustics response is a matter of “luck” and not a result from specific and proper design.

Sala São Paulo was a real example to us that the collaborative exercise in the concept design results in excellence. The first obvious result of this is the present development of the 2000 seat Teatro Alberto Nepomuceno in the Convention Center of Fortaleza, Ceará. One year and half after Sala São Paulo opening, the acoustics and theater design team joined the master plan architects to discuss the size, shape and program of that theater in the very first days of the project. They established all guidelines for the internal design of the theater to be followed by the design architects and project teams hired one year later.

Among other results we can quote the materials developed for the project. A new seat was specially designed to Sala São Paulo and now it is available to the market and is now used in other halls. The vibration isolator system developed for Sala São Paulo was subsequently used in a huge broadcasting complex with great success.