2aAAa2. Sound system in a small college auditorium

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A new two hundred and twenty seats college auditorium needed an electroacoustics system in order to adequately perform all its normal activities which included live voices for lectures and conferences, a sound reproduction system working alone or together with the projection equipment, sometimes background music, and eventually some small groups with live music presentations as requested in the specs of the auditorium usage, it also needed recording capabilities for the most important lectures and presentations. A twelve/eight channel with stereo output system with peripherals was chosen for the installation, where three microphones were reserved for the front table, six distributed in fixed stands located in the aisles of the audience area for questions and dialog, and the other three were movable. Background noise was not an issue because the auditorium is located in a tree full area within the university campus, away from busy streets. Budget for the acoustical conditioning and the electronic equipment was very limited.

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INTRODUCTION

Although this auditorium was newly built at the time when the audio system installation request was placed directly to the department staff, no particular noise isolation design or acoustical conditioning was considered before, during or after its construction. The required sound system had to be installed inside the room, without modifications, as delivered by the building company, as there was no budget for any acoustical improvement that might be needed, and after the first audio equipment recommendation was presented, the teamwork was informed that the budget for the audio equipment and installation was extremely limited. For this reason, the people from that department searched for technical support in other areas of the university.

With regard to background noise, it is not a significant problem due to the fact that the auditorium is in the middle of the campus, no less than eighty meters from a secondary street holding fairly low traffic, and the whole area where the building housing the auditorium is located, is surrounded by a parking lot and a low profile area with plenty of trees and grass. The nearest building is located over twenty meters away from this one, in the opposite side of the auditorium, across the related office areas, and belongs to the same university department. This means that the most significant background noise inside the room is the one produced within the premises of the academic department that holds it, and therefore easy to control in case of special needs.

The front wall of the auditorium, backing the stage area, and where a large projection screen will be installed, is facing through a corridor part of the office area of the same building in the complex, and is made out of masonry and a small aluminum and glass door, which is the only entrance to the auditorium. This wall provides an STC value in excess of 40 dB. The back wall, which includes the control room, was build using the same sort of materials. Both side walls are masonry and include large aluminum framed glassed windows, with ventilating louvers on top of them, which provide little acoustic insulation. Floor is a 15 cm. layer of concrete over an office area with plafond, and an empty space below the sitting area, providing very good sound isolation, and the ceiling is a thin concrete layer, with a plafond some 40 cm. bellow it, with nothing on top of it. As a result of this construction, the average background noise level within the room was measured in the vicinity of 40 dB (A), which is only slightly above the relevant recommendations, but perfectly adequate for the proposed use with either plain voices or amplified voice or music presentations.

Figure 1 below depicts the plan and side views of this building. The Auditorium is located in the second floor with a total height equivalent to two stories of the same building, due to the slant sitting area providing good viewing and listening possibilities to the audience; part of the area underneath the audience is now used only for storage purposes; and the audio and video control room is in the rear with a small observation window. The ground floor and the other areas of the same building, and located adjacent to the auditorium, are open plan area offices, which generate moderate noise levels.

The general inner dimensions of the auditorium room are 10.4 m., wide; 19.5 m., long; and the height fluctuates from 5 m., at the front and 3 m., at the rear. From these dimensions it is simple to determine the relevant surfaces and room volume, showing that the total floor and ceiling surfaces are 202.8 m² each; each side wall measures 83.2 m², while the front wall is 52 m² and the rear wall is 31.2 m². Adding up to a total inner surface of 655.2 m², and the room volume, without the control room, amounts for 851.8 m³. This means that the free volume per person inside the auditorium is 3.85 m³, which can be considered adequate. There is no air conditioning system, and ventilation is carried out by the glass louvers only.

![Auditorium Office](image1)

**FIGURE 1.** a) Floor plan and b) side view, of the office building including the auditorium.

The finishing materials employed inside the auditorium by the construction company are for economic motives simple and resistant: White painted plaster gypsum covered masonry walls; common glass supported in aluminum frames for all the doors, windows and louvers; vinyl tiles directly over the entire concrete floor; 216 fully
upholstered seats distributed in eighteen rows with twelve seats each; and a light plafond in the ceiling, located 40 cm. from the concrete cover layer.

**DEVELOPMENT**

Among the objectives settled since the planning of this room, they included its application as an Aula Magna for speech presentations, and eventually like a small Theatre for different kinds of speech and small groups’ musical performances.

From the physical dimensions and actual materials present in the auditorium, the acoustical conditions of the room were determined by calculus, and found that at least the axial standing waves have no coincidences at all. The reverberation times obtained for the empty room fall around 1 sec. in the six frequency bands, while the recommended reverberation time for the room due to its size and application is about 0.8 sec., although some extra sound absorption is required, when the room is occupied by the audience the reverberation time will decrease. No further study or modification was attempted for acoustical conditioning.

Figure 2 is a layout of the floor plan of the auditorium, where the front flat area for the presentation table or small groups are to be installed, the audience area divided in eighteen rows with twelve seats each, the stair and the control room can be seen.

![Figure 2. Floor plan of the auditorium, showing seats rows, control room and stairway.](image)

**Audio Equipment**

From the very beginning the selected audio equipment was basic and economic in consideration to normal applicable budgets within this university, and only included a stereo console with twelve inputs and eight outputs in order to be able to connect up to eight microphones plus a couple of stereo audio reproducers at the same time, or a computer or other audio devices; the output stage, apart from the eight individual outputs, provisions specified stereo and monophonic outputs in order to be able to feed the power amplifiers for stereo or mono addressing inside the auditorium, and to record any single channel or the stereo or mono mixture; and two audio signal level measuring devices. This console was complemented with eight dynamic microphones; three one hundred Watts power amplifiers, three baffles of the same power capacity, two CD players, one turntable, one DAT recorder, one eight channel audio recorder, microphone stands, peripherals, cables and accessories.

When notice was received by the people in charge of the auditorium that the complete budget for the equipment and installation was inexistent, although there was a deadline for getting the system ready under working conditions, a search was done in order to find out wherever possible the equipment required could be obtained, and a student’s teamwork from another department was set in place to take charge of the complete installation. Several departments graciously provided used equipment as those specified in the project list or similar, including professional and domestic appliances, and inevitably some limitations aroused.

Among the constrains found were: a) some of the electro-acoustic apparatus were non-consistent with regard to operating audio levels, impedance, polarity, physical sizes, cable and connector types; b) there was also a complete lack of instruction and operational manuals for every piece of equipment supplied. For the students teamwork it was
a rewarding experience to find out all those limitations, learning on the fly, and get the system working in time, as needed.

For instance, most of the microphones came from a debating chamber that recently installed a brand new system, and had in storage part of the old one, i.e. miniature condenser microphones with goose neck, long cable and without connectors, usually mounted over a table in a fix permanent position, and in the auditorium they had to be fully movable for hand held or in different height stands (for the table, shows or audience area), because those planned for the front table could not be permanently mounted because the table size could change in presentations, and the use of no table at all was also an option. Those planned for fixed positions at both sides of the audience area, could not be mounted permanently either, because of microphone safety reasons. And for the speakers or singers frequently are used to hold a microphone in their hands while performing, so the diminutive cabled microphone with goose neck is rather strange.

Although there are established operating levels for audio equipment, a careful commercial literature reading of technical specifications shows that instead of the frequently recommended 0 VU as the normal operating level (which by the way, in the professional arena, could be equal to + 4 dBm, + 8 dBm or even + 12 dBm), some professional audio devices are build to operate at only one level in the range from -10 dBm to + 10 VU, either at the input or at the output of the given device, forcing to adjust levels in order to preserve the signal to noise ratio of the system. This sole condition has proved to be a puzzle even for experienced people relaying in their operation manuals, so at the beginning it was a challenge for blindfolded students.

At least a couple of the equipment pieces had high output impedance, commonplace in domestic applications, but because of this, delivering a very low voltage to the entrance of the next stage, the console, so that the microphone input had to be used in order to be able to raise the level of the audio signal.

With regard to Phase, pin 1 is reserved for ground connection, which is all right, but pins 2 and 3 sometimes are exchanged with each other to establish the normal +/- polarity of the audio signal, and this parameter is fundamental for stereo signals and for monophonic mixtures.

Adaptations had to be made at the Connectors stage, because there were XRL, telephonic, mini-plugs, loose terminals, etc., and connectors usually take a great deal of the budget.

TESTS

Due to the fact that the actual equipment came from different installations, and their operating conditions were not consistent, plenty of audio measurements were performed in order to find out the proper levels, phases and impedance matches for this ‘new’ system, and to make sure the system could work nearly under optimal response, or at least fulfill the required needs. Here was where the students felt as working in the real world as compared with the average laboratory practices.

RESULTS

All the audio signals were set with the correct level, polarity and impedance, so the system completely fulfilled the expectations, including the sound level within the room, and it is simple to operate, being the most strange condition on the user side, the type, size and shape of microphones. A general description of the general installation was prepared for future users.

The whole installation took less than two weeks, with the most time wasted on the search for the equipment and understanding on the donors’ side. In any case, the installation was finished within the available time frame with the full complacence of the department authorities and a bitter-sweet flavor on the working team.

CONCLUSIONS

Team work is always rewarding and leads to good problem solutions. Learning by fact about the large differences commonly found in real world audio equipment is a far better experience than just reading it in books and manuals.

REFERENCES