JOHN BARILLA

Designing a World-Class Radio Station

WQXR in New York City is arguably the finest classical music station in the world. A pioneer in classical music programming for over 50 years; WQXR broadcasts an innovative blend of recorded music and live performance, interviews and special network feeds 24 hours a day.

In recent months, WQXR, AM & FM, (The Radio Stations of the New York Times) moved from its old facilities in the New York Times building to a new, more spacious location at 122 Fifth Avenue.

The new complex was designed and engineered under the hand of Northeastern Communications Concepts, Inc.(NCC)—a leader in the development of quality broadcast facilities.

NCC's president, Alfred W. D'Alessio recently spent the better part of a day with **db Magazine's** editors offering our readership a tremendous opportunity to glean some insights into the process of designing a world-class radio station.

ON THE MOVE

One of the first issues we wanted to explore was the reason behind WQXR's relocation. To the listener, WQXR had always pumped out what seemed like a quality signal, but recent advances in digital audio have essentially changed the level of expectation from broadcast audio. Since the advent of the compact disc with its superb noise specs, the lim-

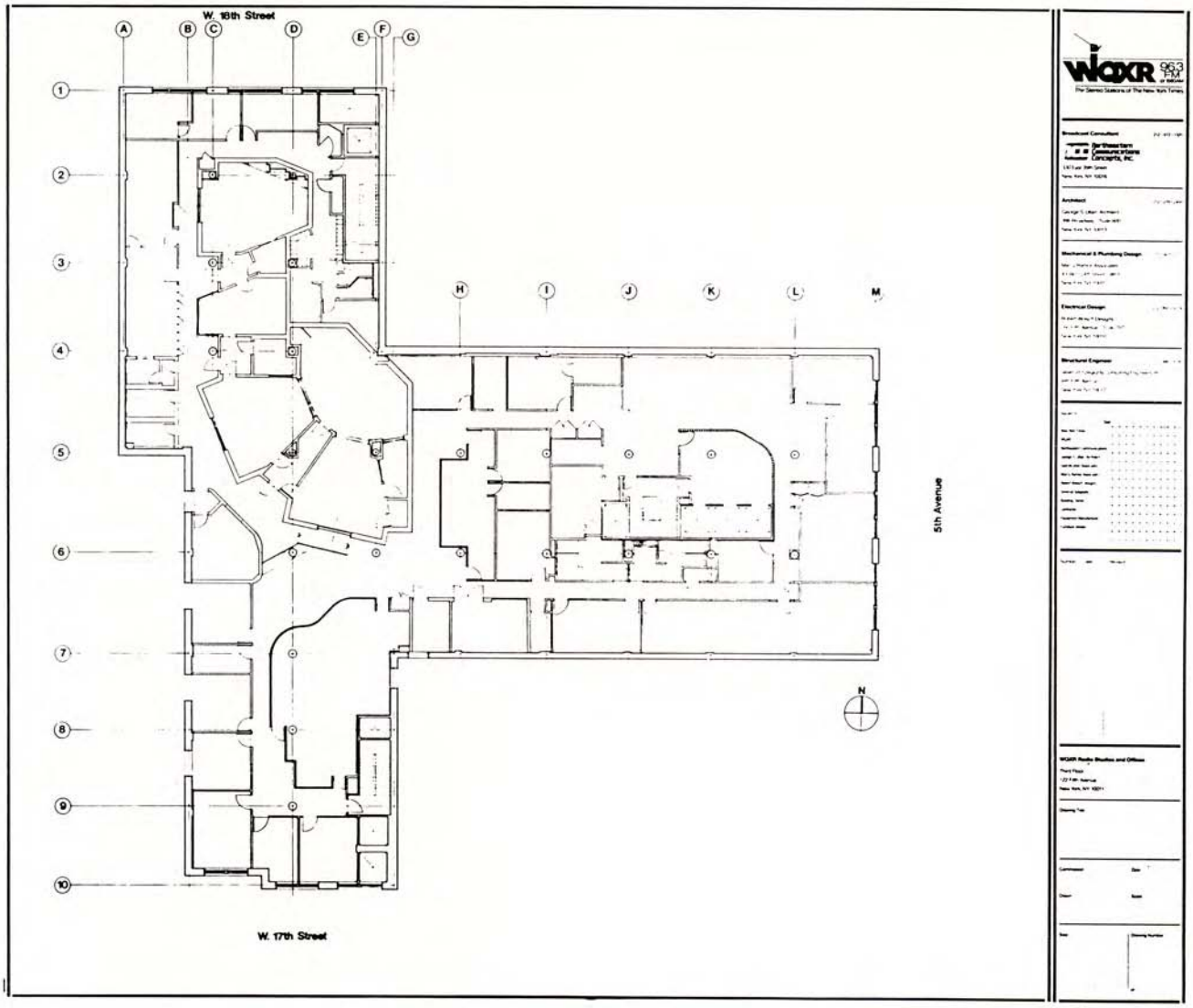

Figure 1. The "T" shaped layout of the WQXR offices. The studios are in the uppper left, entry from the elevators is at reception in the lower left.

iting factor has become the interaction between the other equipment in the broadcast chain. In order to bring noise factors to near theoretical limits requires an integrated acoustical/systems approach: piecemeal retrofittings are not sufficient.

A reshuffling of priorities at The New York Times Company (the parent company of WQXR) led to an unusual opportunity to redesign the facility completely from the ground up. The 43rd street location of the New York Times was simply getting too cramped, so a decision was made that the building should serve strictly the needs of the newspaper. Since the publication had offices scattered in various locations, they planned to consolidate the newspaper in one central location. The radio station however, could exist almost anywhere in the city. It did not need to be located near the editorial offices. So the decree went forth that WQXR was to seek a new location. While this decree could have been received with groanings in some quarters, it actually turned into a golden opportunity for WQXR to move up to a strategically-planned facility.

NCC was in on this move from the earliest stages, indeed, even from before the project was conceived. NCC was originally retained by Doc Masoomian (who was previously chief engineer at WQXR) to provide out-of-house engineering services to the station. At that time NCC was also re-designing WNYC—another of New York's classical and news stations. Herb Squire (now chief engineer at WQXR) was then the telephone-communications consultant to WNYC. So even before the design stages, working relationships between NCC and the in-house engineering staff were being forged. The excellence of communication between staff and design consultant has been cited as an important factor in the success of this ambitious venture.

NCC's Al D'Alessio notes that WQXR's management wanted to make two statements with the move: First, they wanted to make a

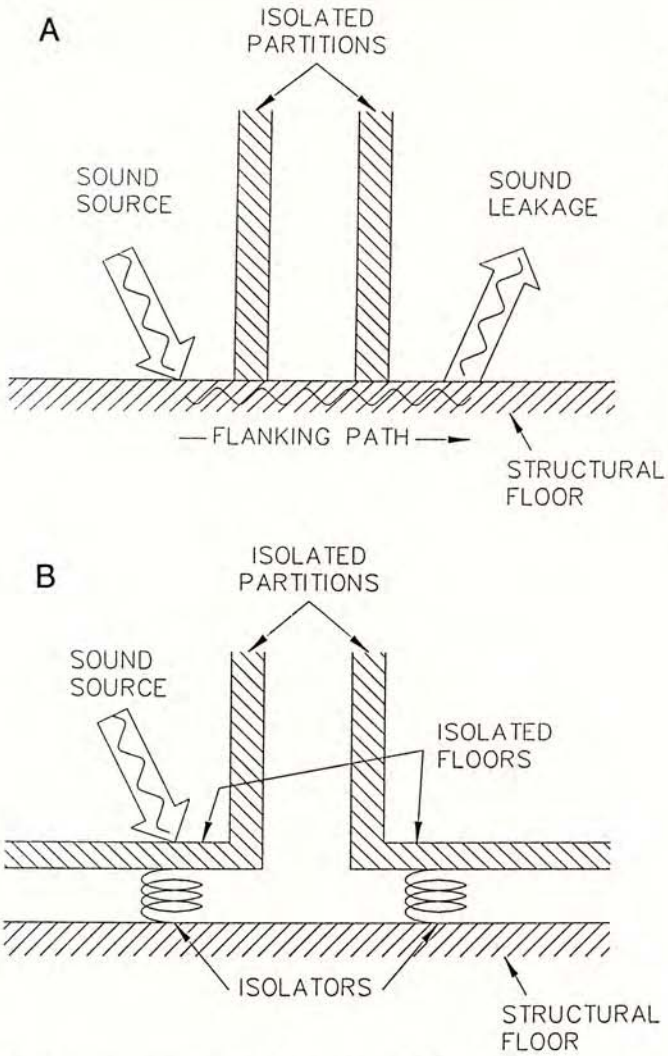

Figure 2. A (A) leakage can occur if partitions are fixed to the floor, but at (B) isolators between the partitions and the structural floor and the isolated floor do the full job. See Al D'Alessio's side bar at the end of this article for further information.

bold pronouncement that WQXR is the pre-eminent classical radio station in New York, and second, that the station was not at all content to sit on their laurels, but instead had their eyes fixed on increasing excellence. In order to achieve this, they required a facility that was technically without parallel, and aesthetically pleasing and user friendly as well.

As it turned out, WQXR's needs were almost a recitation of NCC's design philosophy. According to D'Alessio, NCC specializes in developing one-of-a-kind solutions to demanding design problems: "We put big systems together holistically, taking an 'operations-oriented' approach to designing a media facility. And we always try to have 'form follow function'." The advantage to the client is apparent. Rather than having to hire various individual specialists (designer, architect, acoustical and structural engineers) where the integrity of the functional theme can possibly get lost in a morass of communications: the client here deals with one central coordinator, in this case, D'Alessio—who is responsible for interpreting and clarifying the client's vision, as well as piloting the various specialists required for the project.

THE DESIGN PROCESS

The development of WQXR's new broadcast complex fell into some very definite phases. First, of course, was the choice of location, which is no mean task in New York City. As a whole, the city has a tremendous amount of microwave penetration, but some locations are better than others. The trick is to find a location with line of site to geo-stationary satellite orbits and WQXR's two transmitting sites. A structure capable of supporting massive acoustical construction and the world's largest (and therefore, the heaviest) private classical music library was also needed. While that immediately limits the number of possible locations, side-stepping major sources of RF is a helpful but less important consideration. With the world's most extensive underground transit system criss-crossing the city, putting distance between the facility and the nearest subway became another important factor. A building meeting these requirements was found in the downtown section on Fifth Avenue. It was considered a very fortuitous find since many media facilities and advertising agencies have recently relocated to that area.

The layout of the floor space that was available to WQXR is a "T" formation. This once again was seen as a stroke of good fortune. Since a radio station has three main operations, each operation was (more or less) allocated its own wing. The business office was to utilize the stem of the "T", whereas the horizontal wings were designated as a production area and a broadcast area (including both engineering and on-air personnel). The new location offered a substantial improvement over the old in terms of floor space as well: 18,000 square feet as opposed to 9,000.

But lack of space was not the only problem in the old facility. According to D'Alessio, the old WQXR was a poorly laid-out facility, "not intentionally—it just grew like topsy. When you entered the old 'QXR you went past a reception area for the auditorium (which was unattended), then down a very long "L"-shaped corridor. You ended up walking past all of the studios before you got to the receptionist." The result was a rather confused, inefficient mode of operation where personnel were walking large distances to interface with areas which should have been in immediate communication. Additionally, there was always the chance that unauthorized visitors might interfere with broadcast operations. The formula was not a happy one. It was simply a fact of existence that people learned to live with. Much money (salary) was wasted in what D'Alessio terms "walking wages." Thus, organization of space was one of the first design considerations for the new facility.

THE ARCHITECTURAL PROGRAM

The initial stage of NCC's involvement with the development of the new facility involved architectural planning. Before any electrical or acoustical considerations become possible, the available space must be divided. NCC sat down with

WQXR's management and engineering people and said basically, What do you need in the way of offices? What do you need in the way of studios? And if you're not sure about that, then just tell us what you want to do and we'll tell you what you need. And so began a dialogue that lasted nearly seven months. Every aspect of the design was planned and sometimes even tested before any construction took place.

Architectural considerations were of major importance. If you put an extra window in a studio or an extra desk or cabinets in a control room, the acoustics would need to be adjusted. So to the extent that these things could be foreseen, they were figured into the design as early as possible. In practice, things changed somewhat as the plans were developed and new needs were ascertained, but once the basic layout was decided, acoustical calculations could then be started in tandem with the architectural development.

During this very critical planning stage, D'Alessio worked in close contact with architect George S. Ultan. Ultan generated a series of fifty-four drawings that covered every aspect of facility construction: from floor plans and wall sections to detailing, from structural changes to HVAC and electrical specifications. Ultan made many creative contributions to the project, but one is particularly worthy of note. Amongst the architectural considerations was the need to "humanize" this high-tech environment in such a way that it would become a low-key, nonthreatening work space. This design objective was made more difficult by several factors: The nature of the "T"-shaped space was that very few offices had windows with available sunlight. Many were in the shadow of another building, and even more had no windows at all. Ultan solved this problem by utilizing a concept known as "borrowed light." Conceptually, what this means is that where no natural source of light is available, you create an aura reminiscent of sunlight by causing a mix of natural and artificial light from a neighboring space to leak into the room. By calling for clear glass transom panels between adjacent rooms (extending down from the ceiling for about two feet), Ultan gave the work spaces a more open feeling. Another technique he used to "warm-up" the entire facility was to call for a bold theme of American cherry wood trim and wainscoting throughout the entire facility. The natural wood in juxtaposition with studio equipment or even office accoutrements gives WQXR a coziness not usually found in broadcast facilities.

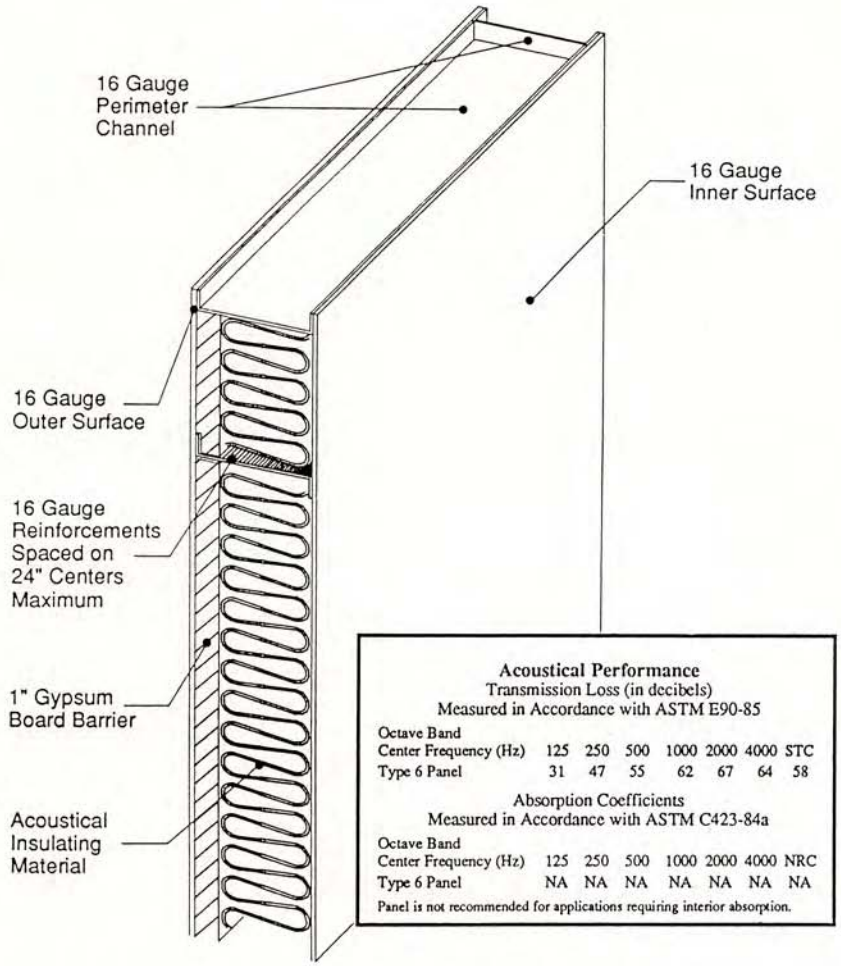

Figure 3. A cutaway view of one of the modular panels.

EQUIPMENT AND ACOUSTICS

NCC was given a large degree of latitude when it came to outfitting the studios. WQXR's chief engineer, Herb Squire, had only one requirement which was, as it were, laid in stone:

All broadcast consoles had to be from Pacific Recorders and Engineering. These units are reputed amongst broadcasters as possessing excellent specs and great simplicity of operation. But beyond this, Squire left it to NCC to suggest the majority of remaining peripherals. When several viable choices were available, NCC performed trial and evaluation on the pieces and made decisions with significant feedback from Squire. While T&E of the equipment was going on, NCC was also working out the acoustics of the rooms. Since NCC had control of the equipment and furniture selection as well as knowledge of virtually all other variables (like how many people are likely to be sitting in the room), they were able to consider these factors before making final acoustical calculations.

One of the most important design objectives was that adjacent studios and control rooms should have acoustical independence, in other words, work going on in one room should not have any interaction with the next room.

D'Alessio says he knew this goal was achievable, but as always, it took a bit of wrestling to make it a reality. He puts it like this:

"I would also have you appreciate the fact that when you're designing in New York City, most of the buildings limit your freedom in terms of

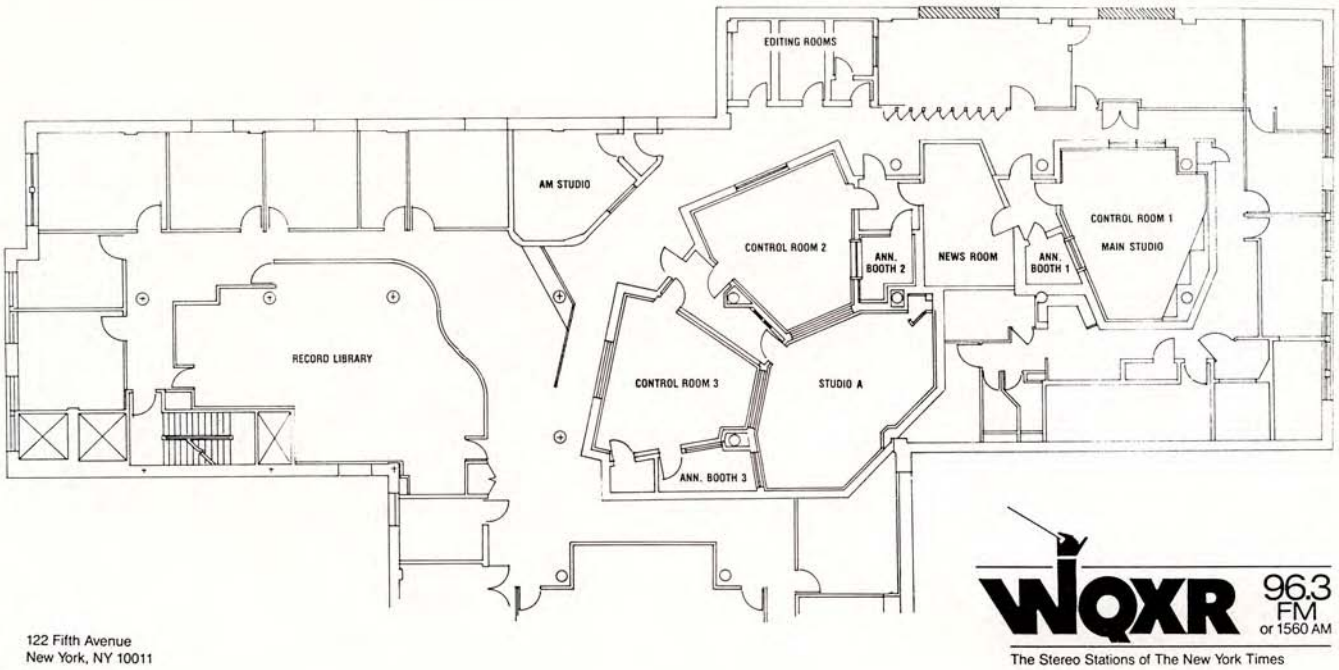

Figure 4. A detailing of the studio portion of the "T" as was seen in Figure 1.

where columns are located, what the floor bearing capacity for heavy acoustical construction is. All of that gets thrown into the same 'design soup' out of which we have to create an environment that's going to be productive for our client. Productivity is a good key here, because a lot of production-oriented enterprises (not just radio stations, but recording studios and production houses), a lot of them can't use two adjacent rooms because they interfere acoustically with each other. That doesn't exist here." Even at the outset, NCC was so convinced that they could deliver an attenuation of 60 dB between adjacent rooms that they issued an "acoustical guarantee" which specifies a substantial price penalty if they didn't meet the criteria. In other words they were promising WQXR that no more than 1/1,000,000 of the acoustical energy (at the human ear's most sensitive mid-range and high frequencies) would be allowed to enter any adjacent room. Music can therefore be played at some rather ear-splitting levels in a control room, yet be barely audible in the adjacent studio.

FLOATING INTO SILENCE

How was this 60 dB figure achieved with all the factors that were aimed against it? Floating construction, of course. (*See sidebar.*) While there is nothing revolutionary about floating construction, NCC did develop an interesting new wrinkle on an old scheme. All of the control rooms and studios at WQXR (with the exception of the AM control room) are floating. But where is the typical isolated concrete slab? There is absolutely no concrete slab to be found. The rooms are not floating on concrete or even on wood. Al D'Alessio explains: "All of the rooms are their own separate modules, which were actually built in a factory, made out of four basic ingredients: steel, gypsum, fiberglass and (where required) laminated acoustical glass." The result is the acoustical equivalent of 12 inches of solid concrete in only 4 inches of space, and a fraction of the weight!

The factory-built modules are in several ways superior to any similar kind of site-built construction. One very obvious advantage can be immediately seen by looking at a sectional drawing (*See Figure 3).* Notice that the modules are a sandwich of gypsum and fiber-glass, in varying layers and thicknesses, bounded by an exterior of rigid steel. The units are bounded on all sides by steel, and are precision built units, easily fitted together. This, of course, makes acoustical sealing a rather easy job. One interesting side effect of the metal-bounded modules is that as large ferric surfaces, they

Figure 5. Studio A. This is also seen in color at the beginning of this article. Both the ceiling and the walls have adjustable acoustical panels.

Figure 6. NCC's Al D'Alessio at the piano in studio A. This served as an excellent sonic example of the fine acoustics of the studio.

offer a certain amount of Faraday shielding against stray RF, and as Al D'Alessio pointed out, "if the windows and doors had been outfitted with RF screws, the whole studio structure could then be earth-grounded offering even further protection. However, in the case of WQXR, which was already in a relatively quiet RF location, the process would have been engineering overkill."

The typical size of the modular panels was about four feet by eleven and-a-half feet. Panels were used not just for walls, but because of their structural integrity, they were used also for floors (sitting on neoprene isolators) and ceilings as well. In this case, the entire room floats—not just floors and walls as in most conventional applications. D'Alessio explains:

"One of the problems with floating rooms conventionally (where you pour a concrete floor on top of an isolated plywood form) is what do you do with the ceiling? Traditionally, ceilings have been hung by neoprene and spring isolators, which gives you a firm attachment to the floor above. If the floor above is noisy, or has mechanical equipment on it, noise and vibration will be transmitted through the isolator because there is never enough mass in the ceiling that the isolators support, for the isolators to really do their work properly.

"The modular ceilings that form the roofs of the studios and control rooms at WQXR have no mechanical connections whatsoever to the floor above. They are supported entirely by the walls and floors of that unit, which sit on a floor that WQXR has total control of."

While the modular construction forms the "inner-box" (rigid, acoustically sealed, and supported entirely by a floating floor), the addition of an independent "outer-box" with a dampened air space in-between is what enabled NCC to deliver the 60 dB attenuation between acoustical spaces and the outside world. While the critical acoustical interface between studio and control room involved two spaced modular walls, the less critical boundary between control room or studio and hallway utilized a site-built secondary wall. To increase attenuation, the adjacent walls were constructed with different interior thicknesses, and even the air space between them was damped with fiber-glass. The same concept of damping through use of different materials and thicknesses was also carried through on the control room windows. The glass chosen was a laminate of varying thicknesses of glass and plexiglass. Two such glass panels were installed for each window with a damped air space in-between.

With studio isolation well in hand, the room interiors were tuned to control the absorption and dissipation of sound in accordance with the population and use of each space. Here, the American Cherry hardwoods were fashioned into Helmholtz resonators to control low-frequency absorption and to complement the absorbent acoustical properties of the fabric-wrapped wall panels and splayed ceilings.

D'Alessio is resolute about not applying live/dead end acoustics to radio station control rooms. In radio, the control room is also a studio and must be treated with mic'ing as well as monitoring in mind. Since the largest radio control rooms feature less than 3000 cubic feet of volume, control of early reflections by attempting to create a reverberant field confined to a contiguous volume of less than 1500 cubic feet is suicidal. Ironically, the WQXR live performance studio is marked by one of the most popular acoustical materials among LEDE designers. The ceiling features a 200 square foot field of acoustic diffusers, custom built by RPG to NCC specifications. The RPG's, complemented by adjustable room acoustics, permit the studio to be used simultaneously for voice and live music broadcasts and recordings.

QUIETING THE AIR

Air conditioning isolation was accomplished quite easily, says D'Alessio, by doing the following things:

First, "placing the (ducts) entry points where the acoustical flanking (leakage) path would be the least from any adjacent room—as far away as you can get it from any potential noise source."

And second, "use acoustically-lined duct which will attenuate any noise that can seep into the duct itself—including it's own noise."

Third, keep air velocities low with ducts having a large cross-sectional area. Beyond that, he specified using a duct two gauges thicker than that used in normal commercial installa-

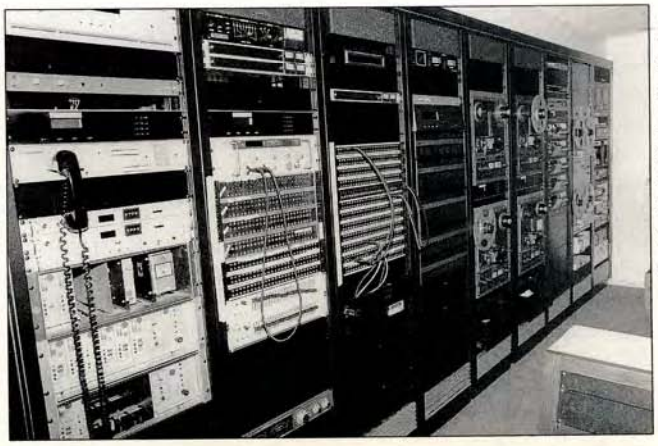

Figure 7. The equipment bays in the Terminal Room. All the gear is fully accessible from the rear via semi-concealed doors (not seen here).

Figure 8. Control Room 1. Announcer Matt Edwards can reach everything that he needs on-air from his seat. Note the cart storage racks on the wall.

tions. Duct attenuators (which are somewhat analogous to a car muffler) were also implemented. When done just right, the result is air conditioning you simply cannot hear. As he graphically puts it: "It's just like somebody is taking a bucket of cold air, gently tipping it over and dumping it into the room."

MIC LINES AND TIE LINES

Any attempt for an acoustical isolation is limited by the weakest link in the chain. If you have achieved an STC of 60 dB between rooms, and then poke a hole between the rooms and create a mechanical attachment by running wires between them, the isolation could suffer by as much as 30 dB. NCC took no chances in this matter. In fact, "there is no firm connection between any of the walls of the inner control rooms and studios to the outside," says D'Alessio. Wires were generally suspended over ceilings or under floors and dropped straight into the room without piercing the wall. "If it was necessary to traverse the gap between inner and outer walls, there would always be a "compliant component," that is, a flexible conduit. Use of such a flexible conduit where cabling exits or enters a room serves to de-couple it and hence preserve the isolation.

Since stray capacitance can be a problem in running long lengths of cabling, NCC specified 26 gauge wire instead of the normal audio 22 gauge. Since long parallel runs of wire can be begin to react much like a capacitor (oppositely charged plates separated by an insulator), a decrease in wire gauge effectively reduced the surface area of the (inadvertently formed) capacitor "plates."

GETTING GROUNDED

Probably the most troublesome threats to a studio's signal-to-noise ratio come from grounding problems. Many studios still endure the illegal and potentially dangerous practice of lifting all electrical grounds. This is mainly a stopgap measure, because the grounding system was never properly designed. In

order to achieve hum-free operation properly, NCC worked out a carefully executed integrated ground scheme where both audio and electrical grounds were referenced to the same ground point.

As D'Alessio points out: "Ground problems exist if either electrical or audio ground is seen by the equipment as being at a different potential due to different resistances to ground. If however, the ground path resistance is made to be less than 1 ohm, there will be no problem."

This was achieved by implementing a classic "star-grounding" configuration for all audio grounds and tying it in at the origination point for the electrical ground. A pleasant side effect of a properly grounded studio is that it does offer some additional RF protection.

FINAL APPOINTMENTS

It's the final touches that really show off a good design. The WQXR installation has its share of them. For example, there is automatic logic switching built into all recording consoles in all control rooms. Anytime a microphone is opened up, "QUIET PLEASE" signs are lit all along the path to the designated area.

There are no "ON THE AIR" signs at WQXR. NCC advised against it, because there are more far more times a studio is used for production then for being literally on-the-air. It was reasoned that it's better to inculcate considerate behavior amongst personnel and visitors than blatantly lie and say you are on the air when you are not. It's perhaps a small point, but it fits well the low-key ambience of the facility. Another small but noteworthy appointment is the use of acoustical analog clocks. Their oil-damped mechanisms are smooth and totally noiseless and of course, all tied together by house sync.

Another consideration is that all floors (being metal clad) are grounded and carpets are computer-grade, which are designed to dissipate static charge. Along with this, humidity is strictly controlled so that nothing will interfere with microprocessor controlled equipment.

Monitoring the various systems that are incorporated in the broadcast chain is humanly speaking, an impossible job. With signal routing chores inside the studio, network feeds from the outside world, and links to transmitter sites for simultaneous FM and AM broadcasts, there are over 120 potential trouble spots. Many of these systems could be down for hours before any human operator was aware of a malfunction.

To avert this kind of broadcast horror story, NCC designed and built a "custom annunciator system" comprised of electronic bulletin boards which keep the engineering staff constantly apprised of the status of each potential trouble spot. If a malfunction should occur, it will specify the location, the nature of the problem, and offer an appropriate course of action to remedy the situation.

NCC's comprehensive set of electronic design documentation paid off by shaving five-and-a-half weeks off the completion date. Without a hitch, Spectrum Broadcast Inc. was able to install and test the equipment

required to get the station cut-over from their old studios in three-and-a-half weeks instead of the originally scheduled eight weeks.

Together with the architectural plans, the documentation will facilitate the maintenance and future growth of the facility well into the future.

All things considered, NCC has created a virtual dream-machine for WQXR. The station is user friendly, easy on the eyes and very, very quiet.

With this sort of edge, WQXR will undoubtedly remain the pre-eminent classical music station for quite some time.

Why Float Acoustical Studios?

Alfred W. D'Alessio, NCC Inc.

Most radio and recording engineers have long realized the value of floating construction. By suspending the walls, floor, and ceiling of a studio or control room resiliently, vibrations in the host building structure set up by mechanical equipment, air conditioners, foot falls, door slams, etc., can be isolated from that room.

However, an often overlooked requirement for floating construction concerns the limitation of sound transmission properties of the partitions separating adjacent studios caused by the building itself. As can be seen in *Figure 2(A),* even if double wall partitions are used between rooms, some of the sound energy originating in one room can be transmitted through the host building itself, and reappear as sound leakage in another area. The floors and ceilings common to each room are excited by sound waves setting up vibrations in the structure. Because sound or vibration travels over ten times faster and more efficiently in wood, steel, and concrete than in free air; any structural element common to two adjacent rooms becomes an efficient pipeline (flanking path) for transmitting sound around intervening partitions of any design.

When the same two rooms are floated, they have no firm mechanical contact with each other, or with the building structure. As a result, they will be isolated not only from building vibrations, but also from themselves as depicted in *Figure 2(B),* with the isolators serving as attenuators in the flanking path. Regardless of the materials and cost of the intervening partitions, it is difficult to achieve more than 50 dB of isolation between rooms at 500 Hz without employing a floating constuction. db