Today, well-trained acoustical consultants play an important and well-compensated role in many major architectural projects. People recognize that a building should not only be pleasing to the eye, but also to the ear. But long before there were textbooks and teachers of architectural acoustics, the ancient Greeks somehow managed to get on the right track. After all, they somehow managed to develop theaters whose acoustics were superb. What lessons can we learn from those theaters? And what acoustical properties accounted for their renown?

Robert Shankman gave an excellent introduction to the history of architectural acoustics, including Greek theaters, in "The development of architectural acoustics," American Scientist, 1972, 60, 201-209. Shankman argued that the success of ancient Greek theaters depended upon

- extremely low background noise (nowhere near superhighways)
- acoustical aids used by the actors (actors wore masks with built-in mouthpieces (funnels); also actors often stood on resonating sound boxes while they declaimed)
- during key moments the audience was very quiet (they appreciated the religious or political significance of the action)
- sound-reflecting surfaces, usually a stone floor, were placed very near performers (reflections from the stone kept actors' voices from being lost as soon as the lines had been spoken)
- the stage was elevated (this caused the actors' voices to radiate well over the entire audience; if the stage had been low, say below the first row of the audience, voices would have tended to be absorbed by the bodies in those first rows, making it hard to people toward the rear to hear).

Shankman also describes how the acoustics of early churches influenced the development of the religious services held therein. Because the first Christian churches were made of stone, their hard surfaces created echoes and reverberations. As a result, any church music had to be played or sung very slowly in order to be understood. Ultimately, according to Shankman, speaking gave way to chanting --Gregorian chants and slow choral works. The poor acoustics of those churches may well have made the visual spectacle of the service more important than its sound dimension (what the congregation saw was more important than what words they heard).

Boston's Symphony Hall celebrated its centenary just a few years ago. The hall is renowned all over the world for the superb quality of its acoustics. An article by Joseph Horowitz (New York Times, Sunday October 8, 2000) explains how this architecturally-simple hall with its spare decoration got to be so acoustically spectacular.

The hall was paid for by Henry Higginson, who had also founded and funded the Boston Symphony Orchestra in 1881. Higginson wanted a hall that would be simpler and a bit smaller than New York's Carnegie Hall. "For an architect, Higginson chose Charles Follen Kim, of the celebrated New York firm McKim, Mead & White... Higginson wrote McKim: 'As I must bear the burden of the new hall, perhaps quite alone, and as I keep my purse fairly depleted all the time, I must not --cannot-- spend too much money.' I always like the severe in architecture, music, men and women, books."

McKim chose to create a stripped-down version of a famous European hall, the Leipzig Gewandhaus, which was built on a simple, rectangular plan. Because the Gewandhaus held an audience of just 1,560, the Boston-version would have to be enlarged --so it would accommodate 2,500, as Henry Higginson wanted. McKim's plan was straightforward; he would simply scale up the Gewandhaus layout by 30% in each of its linear dimensions. But Higginson had the wisdom and good fortune to hire a young Harvard acoustics expert to consult on the project. This expert was Wallace Sabine, the person who single-handedly invented the discipline --and methods-- of acoustical architecture. Sabine warned against making the hall's stage too high or too deep, because that large space would swallow up a lot of the sound. Most importantly, he argued that scaling up the Gewandhaus' linear dimensions by 30% would create a space whose acoustical properties would be subpar. As a result of Sabine's advise, Boston's Symphony Hall became the first such structure ever to be planned in accord with the laws of acoustical science. Incidentally, there was one cost to Sabine's otherwise superb advice. Because the stage of Symphony Hall is so shallow, when a concert piece calls for a very large chorus, the stage gets a temporary, forward extension.

Speaking of concert halls, the New York Philharmonic Orchestra got a new permanent home in Avery Fisher Hall when Lincoln Center for the Performing Arts was constructed in the 1960's. Lincoln Center, which is one of the world's premier cultural centers, was designed by Max Abramowitz. The Lincoln Center buildings are stunning --a far cry from the buildings that Abramowitz designed for Brandeis University, including some of its first dormitories.

But concert halls have to do more than merely look good; they have to accommodate a certain quality of sound. Unfortunately, despite the efforts of some of the world's foremost authorities, the orchestra, its conductor, as well as audiences found Avery Fisher Hall's acoustics unsatisfactory, to put it gently. The orchestra sounded dry and lifeless, its bass sounds were weak, and echoes at some seat locations caused a single note to sound like two notes. Worst of all, musicians in the orchestra could not hear what they themselves were playing --or what their neighbors were playing.

Between the hall's opening in the early 1960's and the end of 1974, there were five separate attempts to solve these problems. Finally, Columbia University's Cyril Harris, an acoustics expert, ordered that the hall be gutted and rebuilt, virtually from...
scratch. It took tens of millions of dollars to redo the concert hall.

The original design for Avery Fisher Hall was flawed, flawed, flawed. Despite the efforts of the world’s pre-eminent architects, the hall was an unmitigated disaster. One problem was that the original architect had not raked, or tilted, the floor sufficiently. Because the stage was not terribly high and because the audience seating was relatively flat, sounds created on the stage tended to be absorbed by the bodies and clothing of people in the first few rows, leaving little residual sound for the ears of people who sat further back (in the cheaper --and quieter-- seats). This error is astonishing; after all, this maneuver was something the ancient Greeks had worked out long before.

Here's one straightforward, but difficult solution for concert halls that tend to absorb too much sound: keep them as empty as possible. I guess you have to let an audience in, but try to let in as little else as possible. Incidentally, one problem with the original design of the hall was the failure to include enough, convenient coat rooms. As a result of this omission, during cool or inclement weather nearly every concert goer carried his or her coat into the hall, instead of checking the coat outside the hall. Can you figure out what impact these coats would have on the acoustical properties of the hall?