Mechanical Breadth

Overview:

The original air distribution system for the lecture hall had diffusers mounted in the vertical sections of a cove system that also served as a lighting element. As part of my redesign of the lecture hall, these coves were removed; therefore, it became necessary to create a new layout for these diffusers. In keeping with the lighting design and new ceiling for the room, I would like to analyze using linear diffusers throughout. This will allow me to use a slimmer, more minimally invasive diffuser width. Care also needs to be taken to make sure the acoustics of the space aren't negatively impacted by the re-design.

Details of Existing Air Distribution to Be Retained:

There are four VAV boxes with reheat capabilities servicing the lecture hall. Two on the northern portion of the room are served by one air-handling unit, the southern two VAV boxes by another. Each VAV handles a minimum of 500 cfm of air and a maximum of 1000 cfm, for a total maximum of 4000 cfm for the room. I am assuming that the original space was properly designed for ventilation in line with ASHRAE 62.1-2007. The VAV boxes and all duct work (with the exception of those leading directly to the diffusers) are well above the new ceiling, and thus have not been affected by the new ceiling. Therefore, I am proposing no changes to the bulk of the existing air distribution system.

Standards to Adhere to For New Diffuser Layout:

One of my goals is to make the diffusers layout as slender as possible. However, as the area of the diffuser goes down, the velocity of the air goes up, and a concern is that if the diffuser area is too small, there could be too much draft in the space. The threshold for acceptable air velocity out of the diffusers to avoid this draft is 500 ft/min, and my goal is to be well under that. In addition, the diffuser system as a whole must be able to handle at least 4000 cfm of air.

Description of New Layout:

In most of the lecture hall, it's not going to be possible to do vertically oriented diffusers, as they are in the original design. However, in the very front and very back of the room, there is enough vertical distance to comfortably lay in diffusers, and this will allow good ventilation throw in the front speaker area as well as all three exit areas. There will be one row of linear diffusers over the center of the seating area. These diffusers will be aligned with the new ceilings. Since the pitch is only slightly off from horizontal, I don't anticipate any greatly uneven conditions parts of the lecture hall as a result of the ceiling design.

New Layout Drawings:

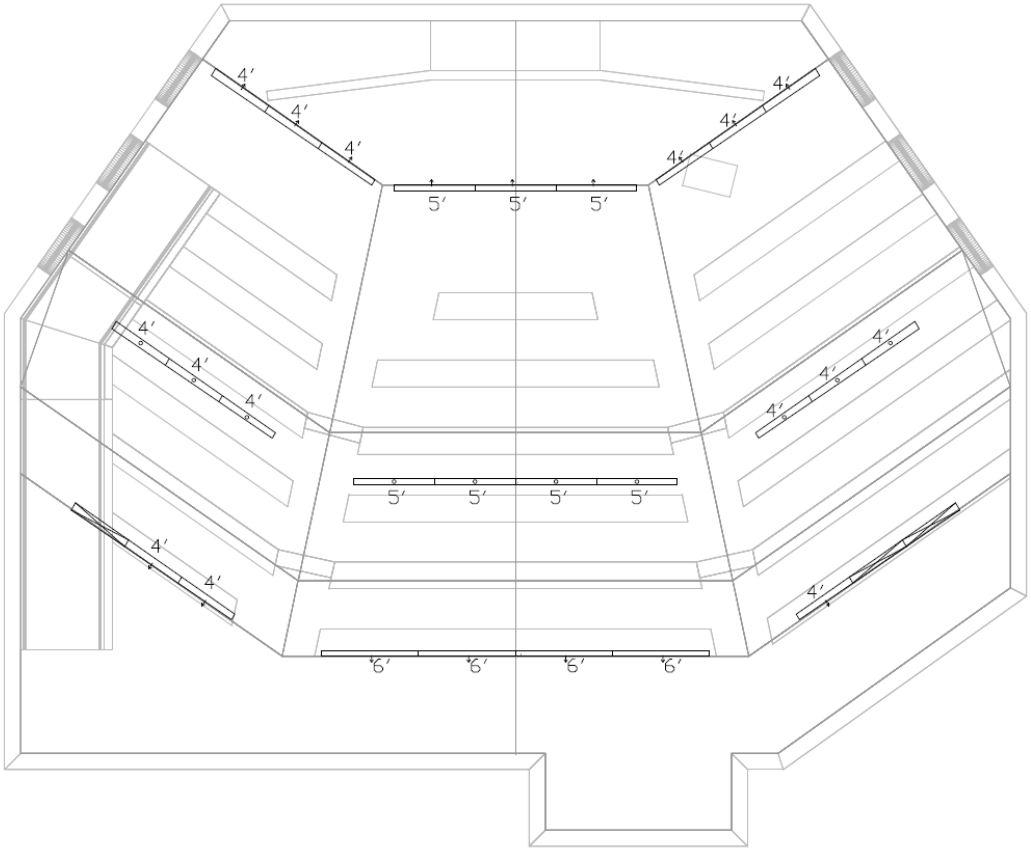

Figure 11.01 *Lecture Hall Reflected Ceiling Plan – Diffusers Only*

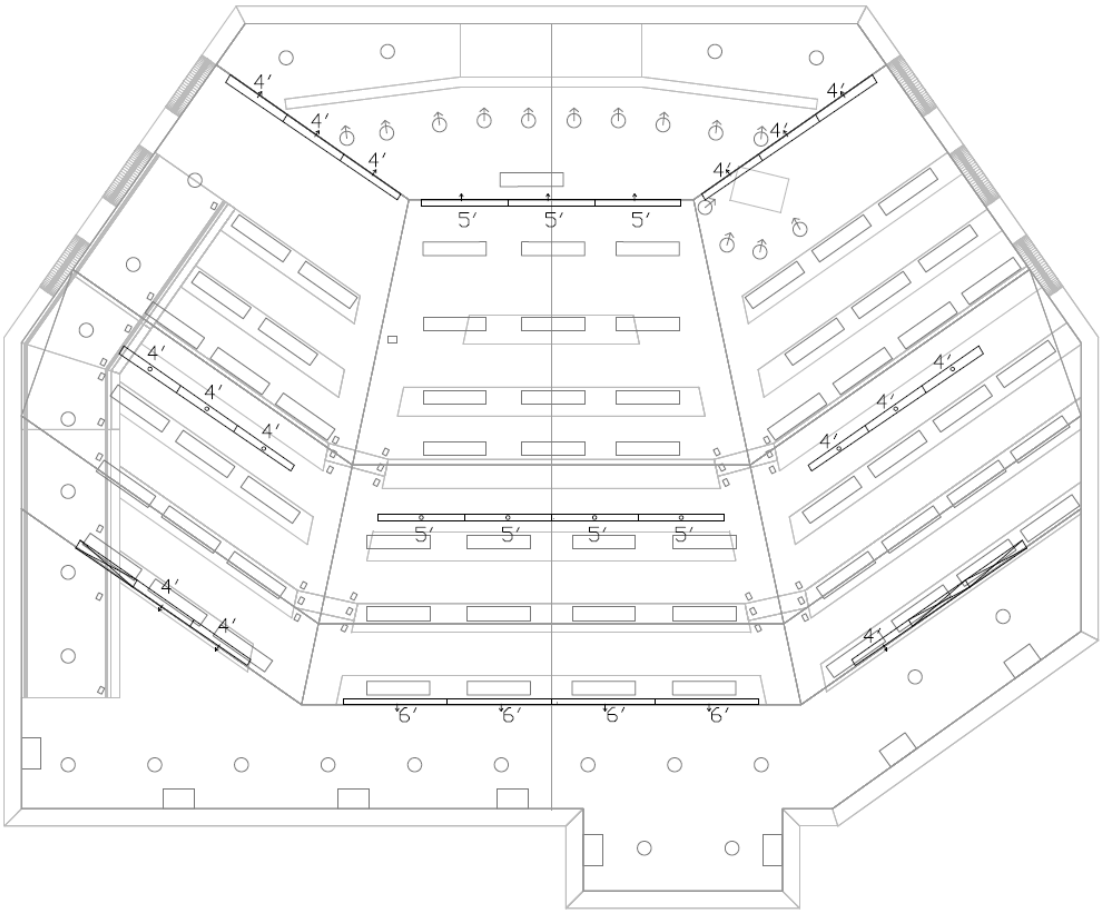

Figure 11.02 *Lecture Hall Reflected Ceiling Plan – Diffusers and Lighting*

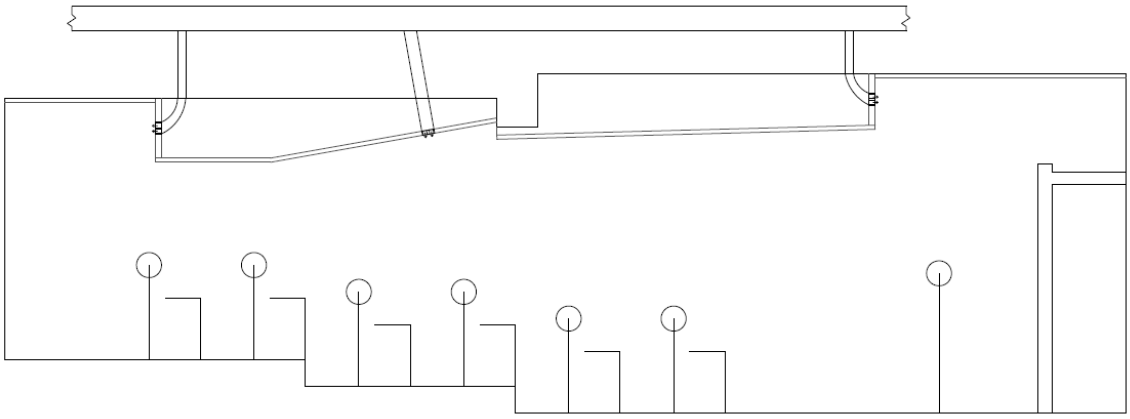

Figure 11.03 *Lecture Hall Section – Diffusers and Schematic of Air Distribution System*

Calculations:

Row	Left			Center			Right		
	Quantity	Length	Total	Quantity	Length	Total	Quantity	Length	Total
1	2	4	8	3	5	15	1	4	4
2	3	4	12	4	5	20	3	4	12
3	3	4	12	4	6	24	3	4	12

Total Length of Diffusers:	119 feet

Additional Length of Grill:	12 feet

Table 11.01 *Take-Off of Diffusers – Total Length Used in Lecture Hall*

Calculation	Quantity
Length of Diffusers	119'
Slot Diffuser Width	1"
Number of Slots	2
Maximum Air Flow	4000 cfm
Minimum Air Flow Required	33.61 cfm/ft
Air Flow Selected	40 cfm/ft
Air Flow Area	19.83 ft^2
Velocity of Air	201.68 ft/min
Minimum Air Flow	2000 cfm
Velocity of Air	100.84 ft/min

Table 11.02 *Air Velocity Calculations – Lecture Hall Diffusers*

Based on the above calculations, a diffuser with 2” of usable air flow width will have no problems limiting the air velocity to well under 500 ft/min, thus avoiding a draft issue. The diffusers must be able to handle around 34 cfm of air per foot of diffuser, and since they have been sized at 40 cfm, that is also not an issue. A cutsheet for the diffusers selected is included in Appendix C.

Acoustical Considerations:

A couple of locations will have the grill face of the diffuser, but no air flow connected to it. This is because of their proximity to the return air ducts. Because they are so close, most of the supply air here would simply flow into the return air, which is not only wasteful, but could cause some distracting noise in the space. With select diffusing sections removed, this becomes much less of an issue. The supply air system already has some acoustical duct silencers on it, so nothing else needs to be added. Overall, the layout as designed should not be detrimental to the acoustical quality of the space.

Conclusions:

The linear diffuser system seems to be a good choice for this new ceiling. Since the equipment used is comparable to the equipment used in the original layout, the cost of the air distribution system has not been greatly increased as a result of the new ceiling system. The layout works well with the lighting and the architectural design of the space. So long as there is proper coordination between the mechanical, electrical, and ceiling contractors, I feel this new ceiling will have a positive impact on the lecture hall.