Armstrong
Your ideas become reality™

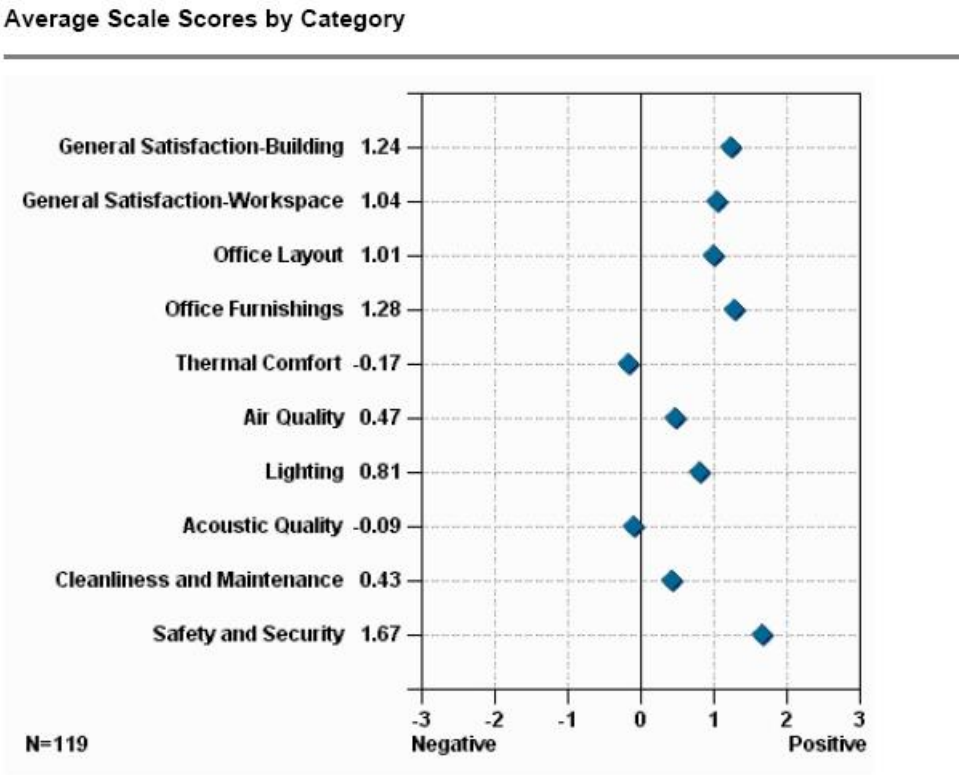
ARMSTRONG WORLD INDUSTRIES, INC.
2500 COLUMBIA AVE., LANCASTER, PA 17603
P.O. BOX 3001, LANCASTER, PA 17604
717 397 0611

www.armstrong.com

What we did?

1. In order to understand the degree of satisfaction expressed by occupants of 701, we conducted an occupant survey available from the Center for the Built Environment (CBE) at UC Berkeley. Below are the results, showing a need for improvement in acoustics. This is a common need for both green/LEED and non-green buildings.

From this survey, we searched by building areas to find the most critical area for acoustics and privacy, which was on the first floor in the Shared Services department. This department deals with all benefit matters for Armstrong employees and retirees. The department is set up in four pods with internal teams within the pods. Communication is needed among the team members, leading to increased noise levels in the entire department. Confidential information is discussed.



2. We took sound measurements for the existing architecture and masking sound systems as a base case. The existing architectural setup had at the time of 1st occupation been chosen by the occupants, many of whom still occupied these spaces. However, due either to personnel or functional changes, not all were still convinced that the current furniture system was capable of providing the desired acoustic results. Additionally, some occupants had experienced the new 'i_ceiling' sound masking system and preferred that to the existing system.

3. An upgraded architectural and sound masking strategy was developed based on the design guideline matrix below.

Architectural Design Guidelines for Open Plan Offices – Levels of Acoustic Performance

Space: Open Plan Offices

	Absorb	**Block**	**Cover**	**Privacy**
Office Design Objective	**Ceiling Acoustical Properties**	**Furniture System Height & STC**	**Background Noise**	**Speech Privacy Index**
Superior	Articulation Class ≥180	≥ 66" STC = 25	Use of electronic masking system delivering 48 dBA ±2 dB spatial variation	80-95% Non-intrusivel
Better	Articulation Class <180 .60-.70 NRC	≤ 60" STC = ≤ 15	Basic electronic masking system **OR** HVAC system, reference ASHRAE RC 30-40	60-80% poor
Typical	Articulation Class - not rated .50 - .60 NRC	≤ 54" STC = ≤ 15	HVAC system, reference ASHRAE RC 30-40	0-60% none

Armstrong 701 Building – after improvements

Armstrong 701 Building Open Plan Areas	Optima 1" foil AC 200	72" max furniture panels STC =25	i-ceilings sound masking system delivering 48 dBA ±2 dB spatial variation	90% open areas 65% in team areas with lower panel height

4. Both architectural upgrades and a new masking sound system were installed, and the performance measurements where repeated. Review the attached documents for improvements made.

Evaluation of Speech Privacy – Bldg 701

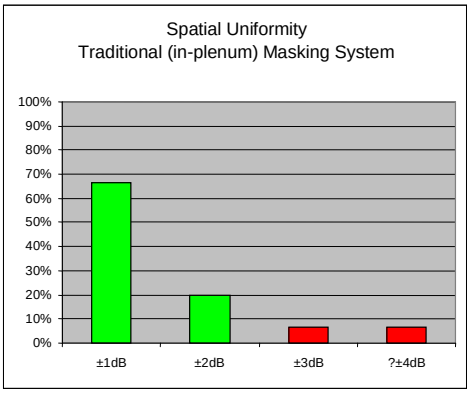
Including open plan measurements:

- of sound masking before/after upgrade
- of speech privacy before/after upgrade

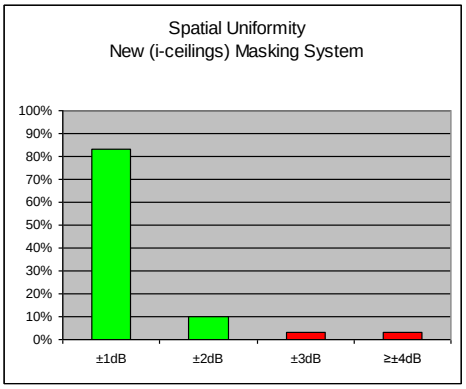
The first step was to upgrade the sound masking system from the traditional in-plenum system to our new i-ceilings masking sound system. The new i_ceiling system is a 'direct radiator' technology which tends to provide improved spatial uniformity over the office area. This relative difference is shown in the following chart. In summary, the existing masking sound system provided an acceptable spatial uniformity over 87% of the occupied space, whereas the new masking sound system provides an acceptable uniformity over 93% of the space.

Measured Sound Masking Level Uniformity over Space

(industry standard is max. ±2 dBA)



The previously installed traditional system met the uniformity requirement for 87% of the open office occupants.

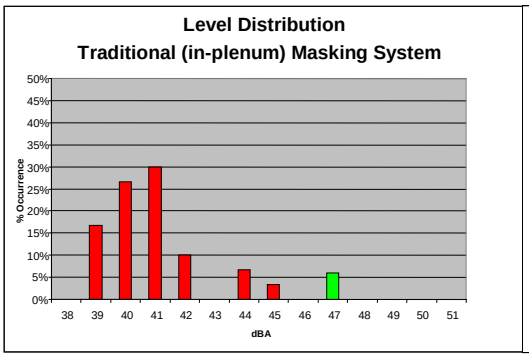


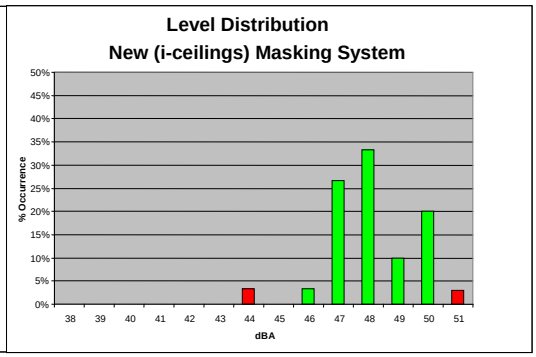
The newly installed i_ceilings system met the uniformity requirement for 93% of the open office occupants.

The average masking sound level (dBA) for the existing in-plenum system was significantly lower than what was used with the i-ceilings system, due in part to the higher level of acceptance of the improved masking signal with the new system. The i-ceilings system is perceived as more comfortable due to both its spatial uniformity and signal content. With the new system, it was possible to tune the masking signal closer to the optimal level of 48 dBA +2 dB compared to the old masking system (the green values shown in the following chart).

Measured Sound Masking Level Distribution

(industry standard is 48 dBA ±2 dB)





The previously installed traditional system has only 6% of levels within the target range @ 48 dBA, and an 8dB range.

The newly installed i_ceilings system has 93% of levels within the target masking @ 48 dBA, and a 7dB range.

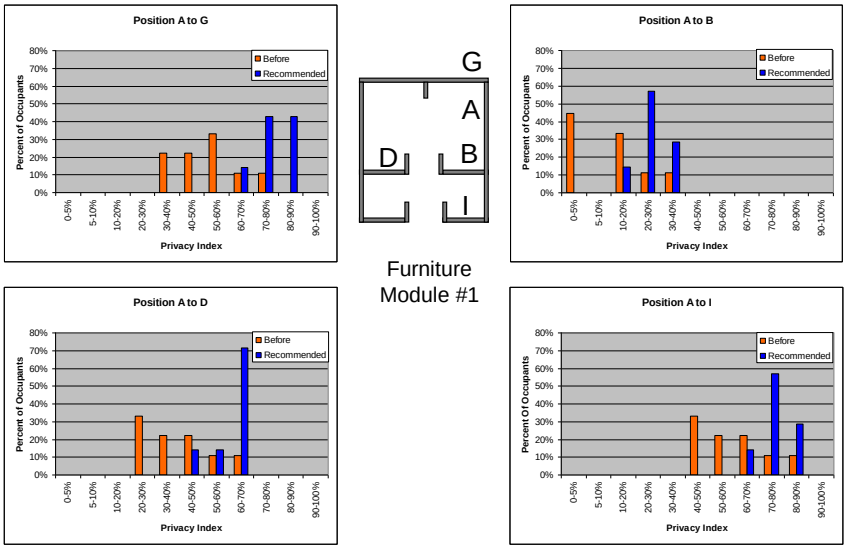
`

The second step was to devise an improved architectural system. From the sound measurements in the existing building, we were able to determine the appropriate acoustical treatments needed to achieve the desired privacy level. Since the existing ceilings were already a high performance choice (AC 200), and the floor was carpeted we moved next to the furniture panels. Since this building uses a modular furniture panel system, so it was simple enough to specify upgrades to push the panel height up to 72". Additionally, the occupants were given a choice of either adding a sound absorptive panel extension, or a clear glass extension (either choice works equally well for sound transmission loss). furniture panels where appropriate (see floor plan included), while maintaining daylighting. This increased the privacy in these key areas.

The speech privacy achieved in the upgraded space was significantly better than what had previously been experienced due to both contributions from the architecture and the masking sound. In the chart below are the improvements for the furniture module #1, as seen from various talker-listener paths from point A to [B, D, G, I].

Measured Speech Privacy for Furniture Module #1

(before and after installation of recommended upgrades)

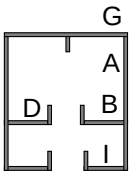


These privacy improvements are summarized in the following chart.

Measured Speech Privacy for Furniture Module #1

(before and after installation of recommended upgrades)

Average measured Privacy Index for Furniture Module #1 taken in various occupant directions as shown on plan



From Position..	Ave. Privacy Index Before	Ave. Privacy Index for Upgrades
A to B	6	27
A to D	33	61
A to G	45	80
A to I	52	77

How it was done?

1. All of our testing and methodology is based on these standards: (copies of standard abstracts are available in Appendix)

a. ASTM Standard C423 for Noise Reduction Coefficient (NRC)
b. ASTM Standard E1110, 1111 for Articulation Class (AC)
c. ASTM Standard E90 for Sound Attenuation Class (STC)
d. ASTM Standard E1130 for Speech Privacy
e. ASTM Standard E1374 Office Acoustics
f. ASTM Standard 1573 Sound Masking in Open Plan Offices
g. ASHRAE Guideline HVAC Related Background Sound in Rooms Table 34

Further Background

Appendix contains:

1. Acoustical concept definition and explanation
2. ASA presentation on LEED and Acoustics at December 2006 meeting
3. Slides from webinar from Square Footage.net recognizing the need for acoustics.