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Human Factors in Design
Midterm Paper
10/24/2011

Resurrecting Noise in the Modern Building

Have you ever sat in a restaurant and been able to hear the conversations at the tables next to you unintentionally? Despite your best efforts, sometimes you can't help but to overhear private conversations in public areas. While overhearing conversations in a public environment is usually harmless and not very distracting, this can be an entirely different matter in the workplace. As buildings become more efficient and technology improves, quieter mechanical systems and building materials have reduced the amount of white noise in the work environment. Combining quiet systems with an increase in the number of workers that are crammed into the same space has led to elevated verbal or other distracting noises.

Figure 1 - (Cracks in the Cubicle)

The unintended consequences of these changing noise levels and types is that the amount of distracting noises, which can have adverse effects on worker productivity, have become more noticeable while white noise traditionally provided by mechanical building systems has decreased. As a result of newer and on-going research in the field of building acoustics and psychology, designers are starting to include and specify "white noise" or "noise masking" systems that are intended to boost efficiency levels in the workplace by replacing some of that lost white noise or finding a way to conceal negative or distracting noises.

Prior to the industrial revolution, people rarely found themselves working in a large room with many other people. Business was conducted on a smaller scale and workers had much more personal space to carry out their individual tasks. The industrial revolution changed the utilization and efficiency of space as workers were crammed into the smallest areas possible and often given one type of task to complete. One of the intentions of this was to create the most productive working environment possible where workers could be easily supervised and distractions would be limited, but as the size of these buildings increased, the building systems supplying them became ever noisier. These noisy systems were eventually thought to decrease worker productivity and engineers sought a solution to the building noise problem. As Lewis Goodfriend, an acoustical engineer predicted around 1975, "There are solutions for quieting machines that are feasible and economically viable right now that should be commonplace in the next ten years" (Kavaler 111). The advances in machinery that have occurred since this statement have reduced vibrations, presumably increased the life cycle of equipment, and consequentially reduced the amount of noise that travels through mechanical systems into occupied areas. The following graph shows the noise reduction of a unit that I personally experienced during a product demonstration a number of years ago:

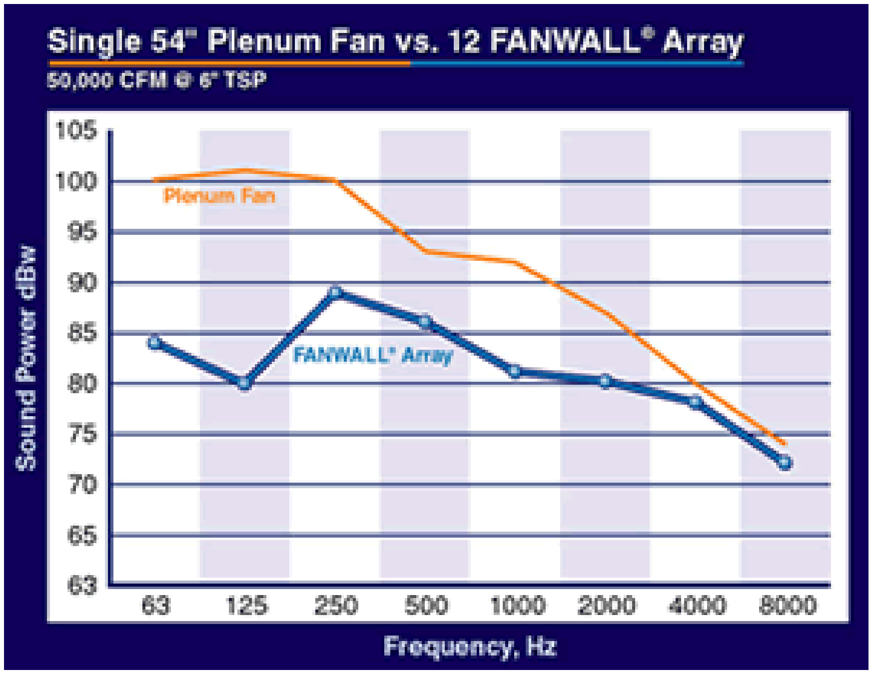

Figure 2 – (CES Group)

The manufacturer claims that "conversational speech is possible in the airstream while the unit is in operation." True to what the manufacturer had claimed, I was able to carry on a conversation with someone standing next to me while both of us stood next to the running units. By contrast, I have also worked inside of traditional air handling units where the equipment is so loud that special sound attenuation devices have been installed in the ductwork to limit the amount of noise that reaches occupied spaces. The question at play here is whether or not the unintended consequence of these quieter machines is that the workplace has now become so quiet that it has reduced privacy (which comes at a premium in an open plan workplace arrayed with cubicles) as well as increased the distractibility of workers who previously could not hear each other over the "loud" mechanical systems.

When it comes to workers being distracted by noise, the amount of noise does not seem to matter as much as a perceptible change in noise. Research outlined and analyzed in the Handbook of

Acoustical Measurements and Noise Control shows that "the loss of [worker] efficiency is proportional to the size of the change in sound level… If, after the subjects are exposed to white noise at a sound level of approximately 80dB(C), the noise level is either increased or reduced by 12 or 24 dB, performance is impaired" (Harris 24.3). When you consider that the average human conversation is somewhere between 40 and 70 dB (Harris 1.9), it is easy to see how simply overhearing your coworker take a phone call can reduce concentration through the abrupt change in decibel level. This is where white noise comes into play.

TABLE 1.1 The Average Sound Power Level of Various Acoustic Sources*

Power, watts (W)	Sound power level, dB re 1 pW	Source
100,000,000	200	Large rocket engine
10,000	160	Aircraft turbojet engine
1,000	150	
100	140	Light airplane, cruising
10	130	
1	120	
0.1	110	Crawler tractor, 150 hp
0.01	100	100-hp electric motor, 2600 r/min
0.001	90	
0.0001	80	Vacuum cleaner
0.00001	70	Highland bagpipe
0.000001	60	
0.0000001	50	
0.00000001	40	Whispered speech
0.000000001	30	
0.0000000001	20	Air outlet (0.1 m^2), air velocity 1 m/s; open damper, parallel louvers

*1 microwatt = 1 millionth of a watt; 1 picowatt (1 pW) = 1 millionth of a microwatt.

Figure 3 - (Harris 1.9)

White noise can create a phenomenon known as "sound masking." Masking occurs when the detrimental sound (to be masked) is surrounded by a range of frequencies that have lots of energy in the same frequencies as that sound (May 9). For example, if a conversation is occurring that falls into the frequency range of 2,000 Hz to 4,000 Hz (typical human speech range), then a masking device would emit randomized noise in that same frequency range, making the conversation indecipherable and hopefully unnoticeable. To be effective, the masking level should be 3 to 5 decibels louder than incoming speech from the source of the possible distractions (Lencore).

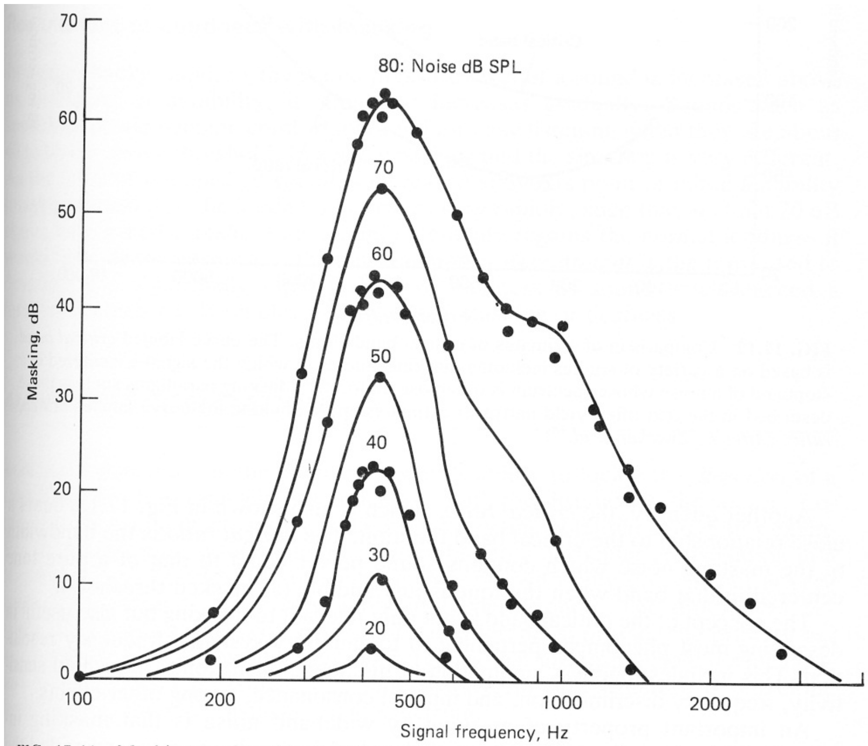

FIG. 17.11 Masking produced by a narrow band of noise on a pure tone signal. The threshold shift produced by the noise which was 90 Hz wide and centered at 410 Hz is plotted for different signal frequencies and noise levels. *(After J. P. Egan and H. W. Hake.[14])*

Figure 4 - (Harris 17.17)

A number of strategies may be employed to add beneficial noise back into the working environment. Ideally, every worker would have their own, private, office space which could be sealed off for noise control, but most offices utilize an open plan. In order to combat distracting noises in these open plan situations, companies such as Lencore Acoustic Corp are producing masking devices which consist of a programmable speaker set which installs either in the floor or the ceiling plenum and emits steady white noise at levels that mask conversation or other distracting sounds. Individual noise machines such as fountains or recordings of natural sounds may also help, but (contrary to what you are likely to hear from workers) listening to a radio or your MP3 player while at work may increase distraction by substituting one discernable conversation for another which is why the responsibility for noise control should be entrusted to an acoustic designer.

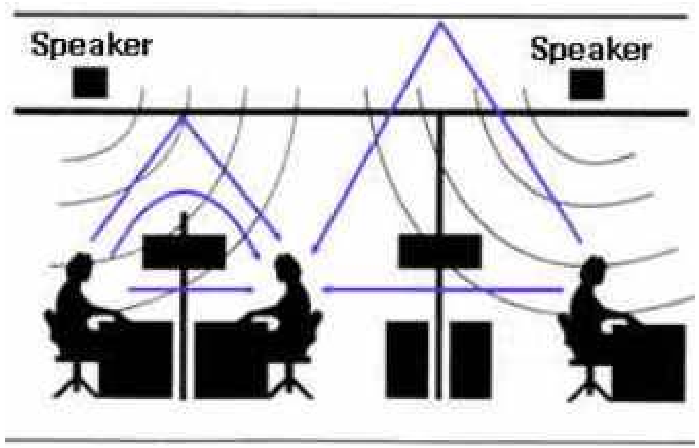

Figure 5 - (Turn-Key)

Ultimately, continued research will likely confirm the negative correlation between personal concentration and distracting noises. Architects and designers will increasingly be required to anticipate noise levels in their designs and find ways to compensate for those levels to minimize worker distractions whether that is realized through the use of a noise masking machine or a change in building form and plan layout.

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