Productivity: How Acoustics Affect Workers' Performance In Offices & Open Areas

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Productivity is a ratio of a measure of output to an index of input use.

{Palgrave Dictionary of Economics}

Acoustical conditions profoundly impact human performance in office settings as well as in factories and other work environments. These impacts are well-known in factories. For example, OSHA has very specific standards for noise levels and the EPA has recommended guidelines for noise levels in hospitals. But the fact is that the impact of noise has also been objectively measured in office settings where 70% of Americans are now employed as "knowledge workers." And these impacts yield what economists call gains or losses in "productivity."

In fact, numerous demonstrations of these impacts on office worker productivity have been published by a variety of independent research teams on two continents over several decades. And as long ago as 1972, one of the world's largest property owner-managers (the US General Services Administration) published reports on their attempts to measure and standardize acoustic conditions to improve working conditions for office workers.

Nevertheless, the literature on office worker productivity and its link to acoustic conditions remains little known among planners, architects and design professionals. However, two factors have made the subject of office-worker productivity a matter of intense scrutiny in recent years.

First, approximately 73% of the U.S.'s workforce (about 100 million people) are 'knowledge workers' who work primarily in open office environments.

Second, productivity growth is the principal determinant of overall economic growth in national, regional and local economies and is widely acknowledged to the USA's greatest strategic advantage.

So productivity is a matter of significant concern to governments and organizations in the private sector. Recently, seven leading technology companies--*Microsoft, Intel, Cisco, Hewlett Packard, Xerox, Accenture* and *SAP*--working together with economists at several leading research universities--formed a group called the Information Work Productivity Council (www.iwproductivity.org) with the specific goal of developing standard measures of human productivity as related to information workers. But early versions of some standard productivity measurement tools had already been used to measure the impact of acoustical conditions on office workers. For a short list of references, see the last section of this essay.

What Current Research Shows

Worker productivity is, simply, the relationship between "inputs" (information, materials, instructions, etc.) and "outputs" (tasks, decisions, etc.). And since the "production machinery" in offices consists primarily of people, anything, including noise, that materially affects their work conditions is likely to have some impact on their ability to work productively.

"Productivity" is a broad measure of a variety of aggregate behaviors. And despite interest in the subject there is not currently a standard methodology that is accepted by economists or finance and accounting professionals for measuring "total-factor productivity". Presently, the seven most frequently-studied productivity impacts are:

1 the speed with which tasks are performed;
2. the accuracy with which tasks are performed;
3. the level of stress encountered by workers;
4. the impact various stressors (such as noise and vibration) have on the competence and endurance of workers over time;
5. the amount of down-time and sick-time (particularly as a result of injuries, for example from hearing damage, back injury or or Carpal Tunnel Syndrome);
6. employee turnover rates;
7. various attitudinal measures (i.e., a high rate of satisfaction with workplace conditions usually correlates with increased productivity).

The Biggest Cause of Lost Productivity in Open Workplaces is ‘Conversational Distractions’

Apart from loud noise from machinery--which is not usually a factor in office environments--numerous surveys have identified *one particular factor* as having the most impact on office workers and their productivity. This factor is "conversational distractions." Because this finding has been consistent over so many studies, the effort to improve the acoustics of office environments is largely focused on understanding and removing these "conversational distractions."

One outcome from this research has been a suite of publicly available technical standards from ISO, ANSI and ASTM. The earliest of these standards was first published in 1969 and has been regularly updated and in continuous use since that time. It defines the metric by which "speech intelligibility" is measured called the Articulation Index. All of the other standards refer to this "root" standard and focus on various aspects of measurement using engineering instruments of "speech privacy" or "low intelligibility" conditions using the Articulation Index as the basis.

This work has recently acquired much broader relevance due to the passage of numerous privacy-protection laws by foreign countries (EU Directive 95.46) at the federal level in the U.S. (HIPAA and GLBA), and at the state level (California, alone, has passed 50 privacy protection statutes since 1999 in an effort to lead the U.S. in privacy protection).

On the specific subject of "conversational distractions" and "speech privacy", three recent independent studies using large and statistically-valid sample sizes (see the references below to studies by Lewis, Lemieux & Sykes and Evans & Johnson) produced interesting results. Two of these studies were conducted under laboratory conditions and the other was conducted in a field setting (an actual work site).

These studies, all of which have been published in peer-reviewed professional journals, showed the following improvements that resulted from making specific adjustments to the acoustical conditions in open office environments with the goal of improving speech privacy by removing "conversational distractions":

1. Focus: the ability of office workers to focus on their tasks improved by 48%;
2. Distractions: "conversational distractions" decreased by 51%;
3. Error-rates: performance of standard "information-worker" tasks (measured in terms of accuracy [error-rates] and short-term memory) improved by 10%;
4. Stress: when measured in terms of the actual physical symptoms of stress, stress was reduced by 27%.

What Improvements Should Planners, Architects, Designers and Specifiers Make to Increase the Productivity of Office Workers?

Among professional researchers who study the productivity of office-based information workers, it it now universally accepted that "conversational distractions" are the most important factors to limit and control. Ironically, it is often assumed by planners, architects and designers that reducing "conversational distractions" means requires developing and specifying "quiet," workspaces, i.e., library-like, working environments. However, this assumption has been proven to be wrong.

A recent survey of workers and occupants in seventeen libraries at Princeton University (see Markham in the references below) showed that people who work in libraries define "quiet" as meaning "freedom from distractions," in particular, "freedom from conversational distractions."

And it turns out that workspaces that are designed to be "quiet" result in conditions where "conversational distractions" are increased, not decreased--because, in an absolutely quiet space, occupants can literally hear a pin drop hundreds of feet away. In fact, in quiet, open workplace conditions, "freedom from conversational distractions" may only be achievable by increasing the levels of background sound, not be decreasing them.

To achieve "speech privacy" in office environments--whether to comply with the new privacy laws or simply to improve worker productivity--acoustical engineers and consultants traditionally use a method called "the A, B, C's."

This convenient acronym literally describes the three factors that need to be controlled to achieve "speech privacy," i.e., Absorption of sound waves (such as by using a high-NRC-rated ceiling tile, Blocking (such as by using high-STC-rated panels, partitions, walls, windows, etc.) and Covering (such as adding a source of amorphous (i.e., not music which is "information" and is therefore distracting), low-level background sound (i.e., 48 dB or less with 48 dB being regarded as a threshold of occupant comfort, that is, above that level, sound becomes noisome, distracting or uncomfortable).

Systems that produce this type of background sound (which typically sound like HVAC noise) have been in wide use since the 1970's and are generically described as "speech privacy systems" or "white noise systems" or "pink-noise systems" ("white" and "pink" are oft-used but highly inaccurate terms), or "sound masking systems."

"A, B, C's" is a convenient and memorable acronym of three components that must usually be combined in some form to achieve an acceptable level of "speech privacy" in order to improve workplace productivity.

But in terms of the relative effectiveness of these three components (Absorption, Blocking and Covering) the acronym should be spelled "C.A.B's." This is because the ***most gain can be achieved least expensively, most quickly and with the least disruption by starting with "C"--i.e., employing a low-voltage electro-acoustic background sound system of proven quality*** *that has been designed and installed by qualified professionals to improve "speech privacy."*

These systems are available in two types: older-style "plenum systems" (i.e., they are installed above ceiling tiles and radiate sound upward into the plenum), and "direct-field systems" (these are installed in the ceiling plane and radiate sound downward into the occupied space). Recent research reported at the 2003 annual meeting of the Acoustical Society of America, indicates that significantly better privacy can be achieved at lower decibel levels using "direct field" systems.

Regardless of what mitigation methods are employed, in conditions where true and repeatably measureable "speech privacy" is required--whether for regulatory compliance purposes or to increase workplace productivity--a simple, acoustical performance specification should be added to the planning, design, engineering and construction process.

This specification should state that a "speech privacy" level is required in the finished space of AI = 0.2 or less at 48 dB or less. This simple specification allows all participants in the development process to consider a wide range of methods for achieving an office workplace that is optimized in a way that will materially impact the productivity of the workers who inhabit it.

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