

# HEARING ACCESSIBILITY

## HOW ACOUSTICAL ENVIRONMENTS AFFECT PEOPLE

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### 1. ACOUSTICAL ENVIRONMENTS

The acoustical environment can be defined as the totality of sound to which an individual is exposed. Several generic points regarding the effect of acoustical environments on people are:

- the acoustical environment has a direct impact on normal-hearing and hard-of-hearing people;
- a non-optimum acoustical environment makes the world less accessible. This results in disability which, in turn, leads to handicap, especially for the hard of hearing;
- the magnitude of the impact / handicap depends on the exact characteristics of the environment, and on the individual impacted;
- this is an ergonomic/ecological issue - the environment must be adapted to the situation, taking into account human capabilities and the demands placed on people. There must be a good match between capabilities and demands.

What are the characteristics of acoustical environments that concern us? The main ones are:

- energy (loudness) - how much energy is contained in the sound (how loud is it)?;
- frequency (pitch) content - what frequencies (pitches) does the sound contain?;
- temporal variation (eg reverberation or echo) - how does the sound vary with time? How long does it take for the sound to die away?;
- direction - from what directions is the sound arriving?;

and, for a person with two ears:

- inter-aural differences - what is the difference between the sounds arriving at the two ears?;

and, in the case of a 'signal' (useful sound) in the presence of 'noise' (interfering sound):

- signal to noise ratio - what is the level of the 'signal' to that of the 'noise'.

### 2. AUDITORY FUNCTIONS

The act of hearing involves the following auditory functions, among others:

- detection - can the sound be heard?;
- discrimination - can the 'signal' be distinguished from the 'noise'?;
- recognition - can the signal be identified?; can the signal's meaning be understood?;

- localization - can the direction of the sound be perceived?

Here are some of the many complex acoustical activities that involve these functions:

- auditory scene analysis - the ability to construct an image of a situation from auditory information;
- speech perception - the ability to understand speech;
- warning signal recognition - the ability to recognize warning signals;
- cocktail-party effect - the ability to 'pick out' one meaningful signal from a lot of noise.

### 3. CONSEQUENCES OF A NON-OPTIMUM ACOUSTICAL ENVIRONMENT

A non-optimum acoustical environment results in a mismatch between human capabilities and the demands placed on people. It may be detrimental to exposed individuals with respect to the following aspects of life:

- health
- safety
- communication
- social
- intellectual
- economic
- enjoyment

The effect may be significant for normal-hearing people, but is worse for the hard of hearing.

Let's look at this in more detail:

- **Health** - fatigue, stress, anxiety  
- hearing loss
- **Safety** - reduced ability to identify and respond to warning signals
- **Communication** - compromised verbal communication  
- reduction of privacy
- **Social** - compromised social development  
- compromised social interactions  
- isolation  
- reduced quality of life
- **Intellectual** - compromised intellectual development  
- compromised learning in education
- **Economic** - compromised (motor and intellectual) task performance  
- increased absenteeism at work
- **Enjoyment** - annoyance, frustration  
- discomfort, dissatisfaction

Here are some examples:

- Industrial workshops
  - fatigue, stress
  - hearing loss
  - danger, accidents
  - compromised verbal communication
  - reduced productivity
  - annoyance, frustration
- Classrooms (students and instructors)
  - fatigue, effort
  - compromised verbal communication
  - compromised learning
  - annoyance, frustration
- Seniors' residences (staff and residents)
  - health decline
  - fatigue, stress, anxiety
  - compromised verbal communication
  - compromised social interaction, isolation
  - annoyance, frustration
- Movie theatres
  - compromised verbal communication
  - reduced revenue
  - annoyance, frustration

#### 4. EFFECT OF HEARING LOSS

A hearing loss affects the auditory functions discussed above in the following ways:

- reduced sensitivity;
- reduced frequency resolution;
- reduced temporal resolution;
- reduced spatial resolution;

and, in the case of a unilateral hearing loss:

- reduced ability to separate signal from noise.

A hearing loss amplifies the impact of a non-optimum acoustical environment and the associated impairment / handicap. It amplifies the mismatch between capabilities and demands.

#### 5. OPTIMIZING THE ACOUSTICAL ENVIRONMENT

The aim is to optimize the environment so that it is best adapted to the situation. The characteristics of acoustical environments must be matched to the human activity and auditory functions involved. The requirements are generally more stringent for hard-of-hearing than for normal-hearing people.

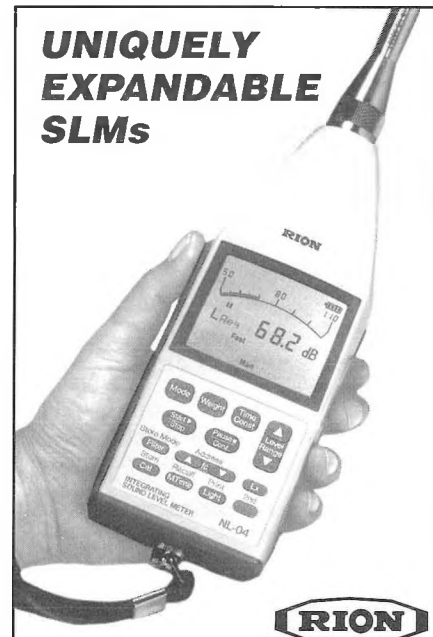
How to optimize acoustical environments is either quite well known (especially for normal-hearing people) or is the subject of research (especially for hard-of-hearing people).

The acoustical environment is optimized by administrative and engineering control measures.

Models exist for predicting acoustical environments. These can be used to optimize them.

A final practical point: it is crucial that we demonstrate that improving the acoustical environment is cost effective.

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