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Requirements and solutions for universal design

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Norway's new Planning & Building Act states that universal design and accessibility for all people must be a critical focus. The detailed acoustic requirements for buildings, given in the existing Norwegian standard NS 8175, will generally provide satisfactory acoustic conditions in schools and several other buildings, and the forthcoming new revision of this Norwegian standard will encompass many more building categories and room types than before – thereby giving better acoustic conditions for the visually and hearing impaired.

Still, following the new Norwegian standard will not be enough to ensure satisfactory acoustic conditions in all situations. They will be a good basis to achieve good acoustic conditions, but they will not necessarily guarantee satisfactory acoustic conditions that prevent discrimination of different groups of people. Case studies and images that focus on the typical problem areas and their relevant measures will be presented.

1 Introduction

There is an increased focus on universal design in new building projects.

The notation universal design was first used by Norwegian authorities in 1997 in a publication for functionally disabled, and in 2007 Norwegian authorities signed the FN Convention on the Rights of Persons with Disabilities, article 2.

The new Norwegian Planning and Building Act, from 2008/2010, states that universal design and accessibility for all people is a main subject, and must be a critical focus for both new and existing buildings.

The first paragraph in the first chapter in the new Act quotes that the principle of universal design is to be ensured in the planning and the requirements to each individual building project. By stating this in the first paragraph in the new Act the authorities shows how much universal design are emphasized.

Building acoustics is one of the important fields that need detailed focus to achieve universal accessibility for all people, and the new Act underscores this by stating that:

- Warning signals must be understood clearly and the ease for orientation and navigation must be assured.
- New buildings must incorporate acoustics in accordance with universal design requirements.
- Buildings must have geometry and sound absorption characteristics that ensure satisfactory acoustics.

The increased focus on universal design in the new Planning and Building Act have involved a initialization of a revision of the Norwegian standard for detailed acoustic requirements for buildings, NS 8175. The existing standard is not adequate to ensure the new requirements for speech intelligibility, the sense of direction/locality, and the communication for people with hearing disabilities and people with visual disabilities.

Based on an inquiry amongst visually and hearing impaired people, the new Norwegian standard will probably include more building categories and room types than before, and will most surely incorporate reverberation time requirements as a function of room height in public buildings.

In universal design in buildings in Norway there has been a natural focus on functionally disabled people, like wheelchair users. There is an increased demand for information about the needs for the other groups that are discriminated in new and existing buildings, like people with hearing disabilities and people with visual disabilities. Information about practical solutions to ensure satisfactory acoustics for the visually and hearing impaired people are also demanded.

By presenting case studies and images that focus on visually and hearing impaired and their typical universal design problem areas and their relevant measures, some of the increased demands will be answered and hopefully the focus on acoustics and universal design will enhance.

2 Model – acoustics in rooms

It is useful to look at acoustics in rooms as a model with three main parameters. These parameters could be the sound source, the channel of communication, and the receiver.

The figure under illustrates one alternative for this model, where the teacher is the sound source, the classroom is the channel of communication, and the pupils are the receivers.

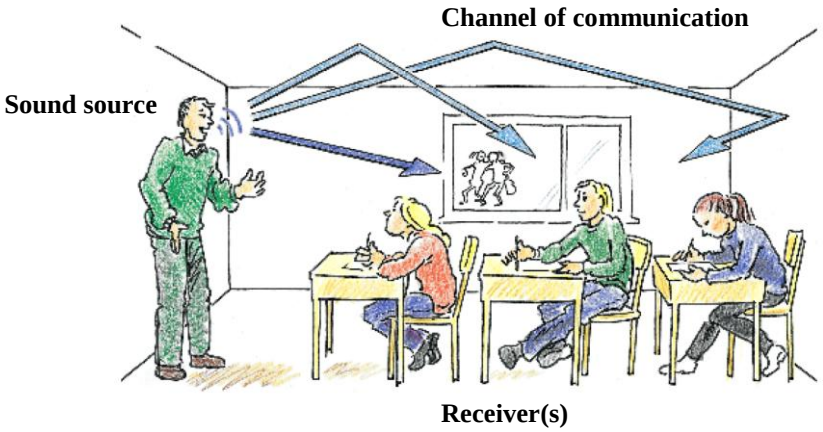

Figure 1: Example of model – acoustics in rooms [1]

The figure illustrates this model in an educational establishment, but it could as well be in a public building like a library, or a reception area. In a reception area the sound source could be sounds from the reception, the channel of communication would be the whole room, and the receiver could be a hearing impaired.

The sound source – what is important

The sound source(s), are an important parameter for visually and hearing impaired. In a classroom the teacher will be the typical sound source. The sources loudness level, intelligibility, and level of recognisibility are important for both the visually and hearing impaired, while the possibility to lip-read is also important for people with hearing disabilities.

The sound sources loudness level is important to ensure that the information delivered by the sound source through the communication channel is loud enough for all the receivers, independent of where they are. Both the distance between the source and the receiver, and the background noise must be considered to achieve satisfactory acoustics.

Good intelligibility for the source involves that a teacher articulate clearly, he do not speak to fast, and he do not use contractions and too much smart acronyms.

If the source is well known, if the pupils have heard the teacher before, then effect of recognition will give increased individual speech intelligibility.

The sound source, is often the parameter that is most difficult to achieve improvement with. Personal training in the use of the voice, and sound reinforcement (microphones and loudspeakers) are often the actions taken when the source is the focus.

The receivers – what is important

The receivers, or the general public in rooms, are the reason to make improvements to the sound source and the communication channel. All room acoustics are based on people that are supposed to receive some form for audible communication.

The acoustical needs will vary between different groups of people. Under are some groups and their particular acoustical needs listed:

Hearing impaired people need low background noise and a signal source that is sufficiently powerful and clear. In schools it is also important to take special care to minimise low frequency indoor ambient noise levels, as many hearing impaired pupils make use of low frequencies below 500 Hz to obtain information from speech [2].

For human sound sources hearing impaired will also be dependent of good visibility, meaning good lighting and avoiding lighting reflections from i.a. windows, to be able to lip-read.

Visually impaired people will request both low background noise and low reverberation time to achieve the best listening opportunities.

A recent survey [3] indicates that reverberation time might be more important than background noise for visually impaired. This could be because the sense of direction and locality for visually impaired are based on sound reflections, and high reverberation time will give false reflections and thus give the impression that the sound source is located somewhere else than it really is. It is also possible that high background noise from speech sources are perceived as positive information because this information gives an indication on where the different sound sources are placed.

Elderly people will typically suffer from hearing loss associated with aging. Their acoustical needs will be both low background noise and general conditions that facilitate clear communication.

Children and non-native speakers need good speech intelligibility, which means good audibility and clarity. Children do not have the same ability to guess words they do not hear, as opposed to adults, because they do not have the same experience. It is often easy for adults to guess missing words because they have heard similar sentences many times before.

People with mental disorders like concentration difficulties, people with special social needs, people with ADHD, people with central auditory processing difficulties etc will have a lot of the same acoustic needs as children and non-native speakers.

People in need of hearing aids will in general need a low background noise and much like the other groups listed above, a controlled acoustic environment.

For all these groups a poor acoustic environment can be a significant barrier to inclusion.

The channel of communication– what is important

The channel of communication, or the room, is the parameter that have to be improved to allow different groups of receivers to achieve good acoustic audibility and clarity from different transponders, or signal sources. This means that acoustic treatments of the room must be done to include groups that are often discriminated because of poor signal sources and acoustical poor rooms.

The detailed acoustic requirements for buildings, given in the Norwegian standard NS 8175, will generally provide satisfactory acoustic conditions in schools and a lot of other buildings. The new revision of the Norwegian standard will probarly encompass many more building categories and room types than before, but the acoustic topics will be the same, apart from speech transmission index, STI, that might be a new topic.

The standard topics in NS 8175 are airborne sound insulation, impact sound insulation, reverberation time, sound absorption, and ambient noise.

Still these standard topics, even when including STI, will not be enough to ensure satisfactory acoustic condition in all situations. They will be a good basis to achieve good acoustic condition, but they will not necessarily guarantee satisfactory acoustic condition and prevent discrimination of different groups of people.

The figure under, a floor plan, illustrates an example from a school project, where the standard acoustic requirements do not give satisfactory acoustic condition for all groups of people, or pupils.

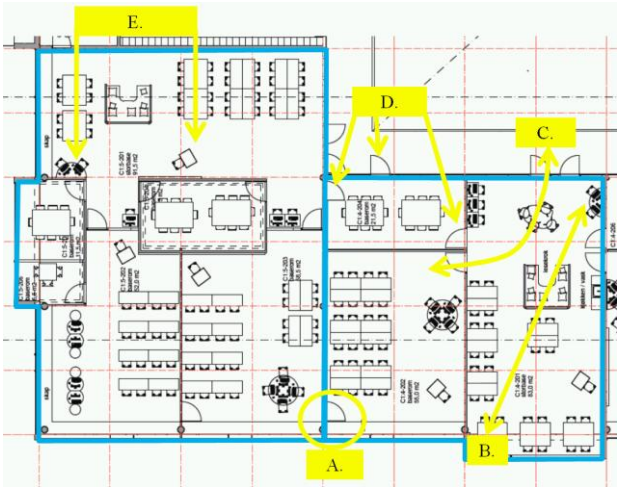

Figure 2: Floor plan, example from a school project

It is important to define the different situations in this exampel, to show how discrimination can occur in a project where the basic acoustic requirements are fullfilled.

Situation A: Single door between independent open plan spaces

In situation A two independent open plan spaces are connected through a single door. In this way the airborne sound insulation for the wall between the two independent rooms will be reduced because of the door. A single door will not give high enough airborne sound insulation to achieve two independent open plan spaces.

This means that the flexibility is greatly reduced, because you have to be aware of the activities in one of the rooms to plan the activities in the other room.

Situation B: Visual obstacle between people, but not a physical obstacle

In situation B the open plan space are divided by a small study place, that appears as a visual obstacle, but it is a obstacle that do not attenuate airborne sound transmitted between the two partly independed spaces. Consequently, there is a visual obstacle but not a physical sound reducing obstacle.

When people do not see the other people that they might disturb, then they often tend to disturb more than if they saw the other persons. This type of situation should therefore be avoided.

Situation C. People have to cross one open plan space to get to a study room.

The situation C demonstrate how pupils in the open plan space will be disturbed by other pupils that pass through to get to the classroom.

The group of individuals that pass though will be experienced as a major disturbance for pupils that are in a mode of concentration.

Situation D. Study room with three doors

Situation D is quite similar to situation A, where single doors will greatly reduce the airborne sound insulation between the study room and the three adjacent rooms.

The use of the study room will thus be depended on the use of the adjacent rooms, and flexibility in the use of the rooms are greatly reduced.

Situation E. Two teaching areas in one open plan space

In siutation D there are two teaching areas in one open plan space.

In this situation the chances for distraction and disturbance between class groups, from oral presentation from a teacher or other noise generated activities, are quite high.

The figure below illustrates the challenges for oral presentation in open plan spaces.

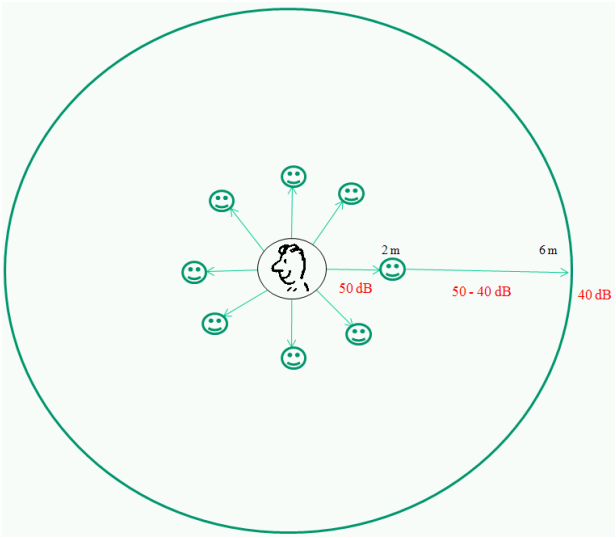

Figure 3. Inverse square law and occupying area

A teacher speaks to a group of pupils in 2 m distance. The sound level is 50 dB at 2 m distance from the teacher, which enables sufficiently audible and intelligible speech communication for the group.

To achieve 10 dB signal to noise ratio, other groups or teaching areas must be at 6 m distance from the teacher, because of the inverse square law – the weakening of sound with distance.

In this way the teacher and his group in 2 m distance will occupy 9 times the actual area with his pupils.

This leaves the teacher in a lot of open plan spaces three choices regarding oral communication:

1. Small distance between the speaker and the listener, one-to-one conversations
2. Conversations in small circles
3. Speak to the whole open plan space, i.e. speak to all the people in the open plan space.

3 Conclusions

The increased focus on universal design necessitates good acoustic solutions in new building projects.
A lot of different groups of people are discriminated because of the quality of the signal source, and a poor acoustic environment.

The standard topics in the detailed acoustic requirements for buildings are no guarantee to ensure satisfactory acoustic conditions in all situations, and for all the different groups of people, or sound receivers.

In addition to the standard topics in the detailed acoustic requirements, planning and design of rooms where the acoustics are critical, is vital.

Official principles for planning and designing rooms to achieve favourable acoustic environments are requested and demanded.

Good acoustic environments for hearing impaired people will favour all groups of people.

Acknowledgement

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References

[1] Figure from ”Att se, höra och andas i skolan”, Arbetarskyddsstyrelsen, 1996, ISBN 91-7464-963-9

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[3] L. Knudtzon: Syns- og hørselshemmedes opplevelse av lydforhold i rom og arealer. NIBR 2011, ISBN 978-82-7071-868-9