

## **Noise control in after-school centres – methods and results**

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Child and youth workers are among the professional groups with the highest rate of work related noise exposure in Denmark, and noise has been shown to be a significant cause for child and youth workers leaving the profession. Recently the Municipality of Copenhagen initiated a project to show the potential benefits of noise reduction in three after-school centres. The objectives were: (a) to gain experience with different noise abatement processes, (b) to integrate organizational, pedagogical and building noise abatement methods, (c) to test different types of noise abatements, and finally (d) to document the effects through acoustic measurements, anthropological studies, questionnaires, and records of sick leave. For the purposes of noise reduction, the project implemented pedagogical, organizational and building changes. Both the increases in the sound absorption on the premises, and sound insulation between noisy and quiet activities, led to significantly reduced reverberation times and noise levels. Noise annoyance decreased from 63% to 16%, and self-reported stress decreased from 52% to 25%. Furthermore, the child and youth workers judged the quality of their work place higher, the short-term sick leave fell significantly, and fewer employees reported that they wanted to leave the profession.

## **1 Introduction**

Returning national surveys on work environment conditions in Denmark have shown that child and youth workers are among the professional groups with the highest self-reported noise exposure. In the surveys of the occupational environment, which is carried out each year in the Municipality of Copenhagen, child and youth workers have reported that noise is a serious nuisance in their daily work. An internal study in the Municipality of Copenhagen found that noise is the single most contributing factor to sick leave. For these reasons the Municipality of Copenhagen decided to launch a larger noise reduction project.

The primary subject group of the project has been the child and youth workers. The children's well-being is also an important issue but has been left out to be studied in other projects.

The project's duration was two years with a cost of approximately 600.000 €.

## 2 Objectives and basic philosophy

The aim of the project was to find useful and practical methods to reduce noise in existing facilities, as well as to strengthen the knowledge base for the establishment of future after-school facilities with fewer noise problems.

The project focused on the following objectives:

- A holistic approach, including pedagogical, organizational and building related activities
- Reduce the noise without limiting the pedagogical possibilities or the children's natural activities.  
There should continue to be "room for all".
- Commitment of child and youth workers and high involvement of building controllers in the Municipality of Copenhagen.
- Documentation of the final results of the project.
- Communication of the results to the Municipality and institutions in the whole country.

## 3 Implementation

The project was carried out in three institutions with different, but significant noise problems. One was a fairly newly constructed institution with a good opportunity to deal with the pedagogical and organisational activities. The second institution was established in former classrooms of an older school, which necessitated employment of acoustical control measures. The third institution was an open-plan building in a closed production facility, where there was a need to reduce the sound propagation.

As a precursor to the project, a questionnaire study was carried out among the personnel, anthropological studies among children and adults were conducted, and acoustical measurements were performed.

In each institution, introductory meetings were held with all employees to prioritize the noise issues to be included in the project.

Following the introduction, most of the organizational and educational activities were implemented, i.e. rearrangements and relocation of activities as well as changes within the groups of children. Also education and increased focus on noise were implemented.

Simultaneously, the construction process started, which was based on the same methods, principles, norms and standards as other building processes in the Municipality of Copenhagen.

At the end of the project, the questionnaire survey, anthropological studies and acoustical measurements that began the project were repeated in order to monitor the changes.

## 4 Technical Building Solutions

The technical reconstruction of building can be split up into three categories.

### 4.1 Layout and noise reduction furniture

In order to implement the organizational and pedagogical changes, it was necessary to carry out certain reconstruction of the building. e.g. movement of walls and wardrobes, add separation of the rooms, and instalment of doors.

The largest rooms had serious noise issues, and tests showed that simply dividing the room could substantially reduce the noise level, and consequently the rooms were divided by book shelves, screening walls and other kinds of furniture.

As a part of the project, very effective absorbing mobile screen walls were developed and used to divide up large rooms.



Figure 1. Mobile screen walls developed under the project

## 4.2 Reduction of Noise Propagation

Various forms of acoustic separation between noisy and quiet activities were set up. Especially in the institution, which has been established in a former factory as an open plan institution, there were huge problems with noise propagation throughout the whole facility. Therefore the entire area was acoustically divided into four sections, and acoustic shielding was added around different areas of activity.

In order to avoid obstructions for the transparency and the free passage in the main walkways, effective sound absorbing tunnels were established in several of the acoustic shielding walls.



Figure 2. Sound absorbing tunnel

## 4.3 Acoustic Absorption

In all living spaces less than  $250 \text{ m}^3$  with reverberation time  $> 0.4$  seconds, Class A glass wool absorbers were added. All wall surfaces over  $2.1 \text{ m}^2$  were covered with 40 mm Class A glass wool absorbers.

In one institution there were four acoustically identical rooms with acoustic ceiling panels of perforated gypsum and a reverberation time of approx. 0.4 seconds. In these rooms an experiment where the reverberation time was reduced

through different methods was performed. In one room the gypsum acoustic ceiling panels were substituted with Class A glass wool absorption, in another room supplemental wall absorbers were added, and in a third room both the gypsum ceiling panels were substituted and the wall absorbers were added. The effect of the different solutions was evaluated with acoustical measurements and interviews of the employees. After the experiment Class A glass wool absorbers were mounted on ceilings and wall absorption added in all the rooms, so that the reverberation time was reduced to approximately 0.3 seconds.

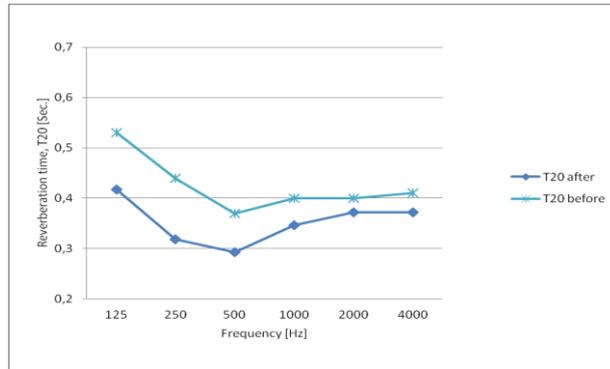


Figure 4. Gypsum acoustic ceiling panels substituted with Class A glass wool absorption

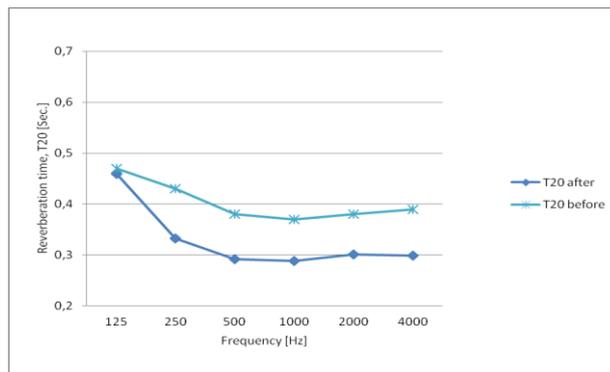


Figure 4. Supplemental glass-wool wall absorbers added and gypsum acoustic ceiling panels maintained.

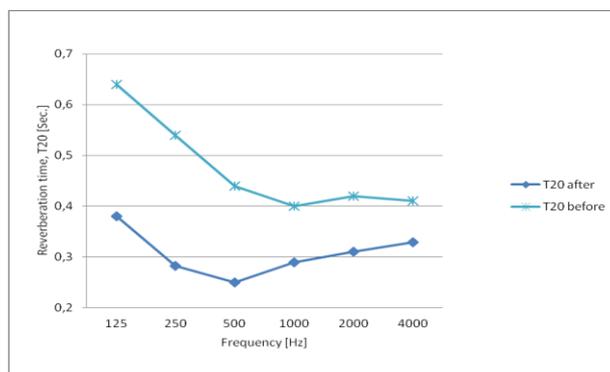


Figure 5. Gypsum acoustic ceiling panels substituted with Class A glass wool absorption and supplemental glass-wool wall absorbers added

## 5 Results

The reverberation time was reduced in all rooms where building related changes were performed. Also in the institution, where a test was carried out with different absorption solutions, the reverberation times in all rooms were at the end reduced to approx. 0.3 seconds. This reduction can be regarded as a significant improvement of the well being of both the employees and the children.

In the open plan institution the distance attenuation was increased by 8 dB, measured directly through the sound absorbing tunnels. Noise level measurements of the different rooms at various positions showed that the background noise level fell by 2 – 6 dB.

The anthropological studies showed that both children and adults experienced notable improvements of their well-being.

Questionnaire studies showed that the number of employees feeling annoyed by noise every day was reduced from 67% at the project start till 16% after the project's completion.

Consideration of changing employment is an important indicator for both well-being and health. At the beginning of the project, 42% of the child and youth workers answered that they considered changing employment. At the end of the project 26% considered change of employment.

The following questions with answers were among others used to evaluate the noise environment (on a scale between 0 and 6):

“I can perform my job without being exposed to annoying noise”: Increased from 2.5 to 4.1

“My work place is appropriately arranged”: Increased from 3.3 to 4.6

“The general atmosphere is characterized by job satisfaction:” Increased from 4.2 to 4.8

“I can perform my work with a satisfying quality”: Increased from 4.5 to 5.0

Short time sick leave – measured as days per employee per year – fell in the two years of the project's duration in all three institutions: 1) from 2.5 to 0.4; 2) 2.7 to 1.4; 3) 3.1 to 1.5. However, this reduction cannot be attributed to the achievements of the noise project alone.

## 6 Conclusion and Comments

The project's aim to reduce noise was achieved in full. The sound levels were reduced and the room acoustical conditions were significantly improved. The employees reported a notable reduction of noise, their sick leave fell, fewer considered leaving their profession and the general evaluation of the working conditions was highly improved.

However, of course all of the beneficial effects observed in the project cannot confidently be ascribed to the project, since it was not possible within this project to include a control institution. There are other mechanisms that may have contributed to the observed effects, for example, the Hawthorne effect, which is the tendency of subjects to react or modify their behaviour simply in response to being studied. Since the project was characterized by a large degree of involvement of the employees, who suggested solutions and gave feedback, a Hawthorne effect is not unlikely. Moreover, since the project took place over more than 1 year some of the effects can also be due to general changes in the working environment. Nevertheless, it is notable that in the same period other work environment factors were studied and only the observed effects related to noise are all in the positive direction.

The personnel's knowledge of and commitment to noise abatement has been a significant factor for solving the problems of noise. Spaces for both noisy and calm activity have to be created for the daily life of employees and children in the after school-care institutions in order to function well.

The project has demonstrated the importance of both working with organizational, educational and building related activities, whenever noise problems have to be reduced. The specific conditions within the individual institutions determine those solutions that should be prioritized.

The improvement of the acoustical conditions has played a significant role in the implemented solutions of the project. Short reverberation time seems to be a prerequisite for solving noise problems in after-school centres.

In Denmark it is required by law that new after-school centres have a maximum reverberation time of 0.4 seconds. The project has demonstrated that a significantly positive reaction can be achieved by reducing the reverberation time from 0.4 seconds to 0.3 seconds.

The results and the experiences from the project have been implemented in the procedures for construction and renovation of institutions in the Municipality of Copenhagen.

## **Acknowledgement**

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