ECO

FOR SUSTAINABLE DESIGN

No 2 2009

SOUND HEALTHCARE

TAILORING ACOUSTICS TO SUIT ACTIVITIES

SAVING THE HEARING OF TEACHERS AND PUPILS

DON'T FORGET CORRIDORS!

Planning for a sustainable indoor environment

Do you feel, as we do, that people no longer need to spend time in a substandard indoor environment? If so then we are writing for you.

We know that it costs more to do things right from the start, but also that it is much more expensive to change your mind and put things right afterwards. Our aim is to give you the advice you need to make the right decisions, as well as the necessary know-how to influence the planning of offices, schools, care premises, restaurants and any other premises where people work and spend time. Greater well-being, less stress and better efficiency are among the fruits of success you can harvest by designing a better indoor environment.

The title of this magazine is ECO – For Sustainable Design, but sustainable design can be interpreted in different ways. For anyone who works with the indoor environment and building technology it means among other things:

1. Choosing building products that are not hazardous to work with and do not emit toxic substances into the indoor air. The materials used must be of high quality and it must be possible to show that products have minimal impact on the environment at every stage – from raw materials to manufacturing, transport, use and disposal – and in extraction, energy use, emissions and recycling.
2. Creating sustainable systems and products means choosing materials and technologies that are appropriate for the intended use of the premises. Systems must also be designed to last and to work efficiently for long periods without excessive maintenance.
3. Products and systems must be logical and easy to work with in order to eliminate mistakes and errors that can occur during building. Redoing a job or replacing products costs money and means more impact on the environment.
4. Flexible systems allow you to change the layout of premises without making major changes to the building structure and interior.
5. If you choose building solutions that provide a sustainable indoor environment and choose a supplier who can guarantee the required functionality, you eliminate the risk that premises could impair well-being and efficiency.
6. An attractive and carefully considered aesthetic solution will last a long time. Beautiful materials and smart systems that give the planner plenty of opportunities to be creative and freely combine products provide the foundation for good end results and overall success.

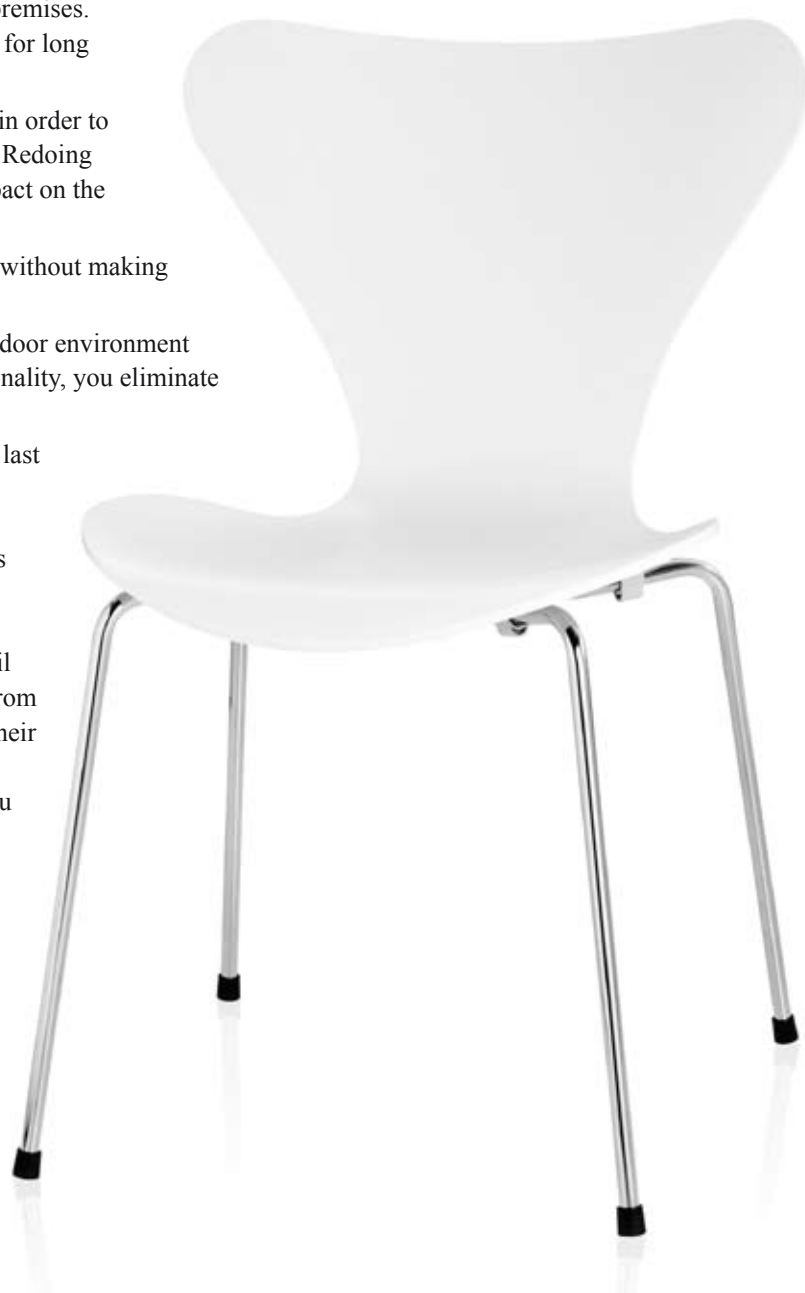
In coming issues of this magazine we will explain in more detail what is meant by Sustainable Design and describe the subject from the perspective of planners and others, as well as reporting on their importance and responsibility for social building in the future.

You can subscribe free of charge by registering with us. If you know anyone else who would be interested in the magazine please let them know about us too. See the back page.

Happy reading!

Staffan Nilsson
Chief editor

The Series 7 chair, created by the world famous designer Arne Jacobsen in 1955, has been the biggest success in Danish furniture history. This chair is a fine example of what sustainable design is all about, and has a look that is more popular today than ever.



ECO

FOR SUSTAINABLE DESIGN

ECO – For Sustainable Design is a magazine that focuses on the sustainable design of indoor environments. Our aim is to highlight the indoor environment, both from a functional and an aesthetic perspective, through a continual dialogue with the reader. Don't hesitate to contact any of our companies through the website, www.ecophon.com!

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"An attractive and carefully considered aesthetic solution will last a long time. Beautiful materials and smart systems that give the planner plenty of opportunities to be creative and freely combine products provide the foundation for good end results and overall success."

CREATING A HEALING ENVIRONMENT WITH ACOUSTICS

A healthy acoustic environment is conjusive to **efficient healthcare** and **the well-being of staff**. A modest investment in effective room acoustics leads to a **saving in healthcare costs** that is many times greater than the financial input.

Have you ever thought about the effect the acoustic environment has on the way we feel? Research shows a clear link between our well-being and a good acoustic environment. The correlation is clearest of all in the care sector, where a good acoustic environment contributes to:
– a reduction in the use of painkillers by patients and a lowering of blood pressure
– improved well-being among staff and the ability to cope better

Unfortunately noise has become more common and noise levels have become significantly higher in caring environments, in other words in hospitals and other types of care premises. Noise is generated by both modern technical equipment and by people moving around. The negative effects are accentuated by the many hard materials that are widely used in care premises. Hard surfaces and poor sound absorption mean that sounds simply bounce around the room, disturbing patients and staff.

A carefully planned acoustic environment is especially important in hospitals because it improves the well-being of staff. It also encourages sleep and reduces the stress levels of patients. A good acoustic environment can also contribute to improved safety and security.

Reduced costs

If improvements in the acoustic environment can improve the job satisfaction of staff and make patients feel better then they can ultimately reduce the costs of care and deliver better financial performance for hospitals. Research findings suggest that they can even shorten care times and reduce the need for future treatment.

There are excellent opportunities to create a healthy acoustic environment if plans are made early in the building process, but considerable improvements can also be made in existing buildings.

Room Acoustic Comfort™

The latest research has shown that it is possible to adapt the acoustics of a room to create an acoustic environment that suits the activity for which the premises are intended. *Room Acoustic Comfort* describes the various key parameters that are necessary to meet acoustic requirements. In care premises it is important to:
– improve short-range speech perception
– dampen noise from items such as medical equipment

By choosing a full acoustic ceiling of the highest absorption factor (class A) it is possible to achieve a good balance between early and late sound reflections, which improves speech clarity and hence perception. A ceiling with a high absorption factor also helps to reduce the sound level in rooms. It also softens sounds, helping to create a more relaxing and comfortable environment.

To find out more about *Room Acoustic Comfort* go to www.ecophon.com.

Operating theatres, intensive care rooms, nursing rooms and reception rooms, laboratories, receptions and corridors. A good acoustic environment is essential wherever people spend time.

Researcher assesses acoustic environment in hospitals

Dr. Michael Phiri is Senior Research Fellow in the School of Architecture at the University of Sheffield. He is interviewed here by Marc Janssen from Ecophon following his lecture at the acoustic conference in Paris in 2008. Dr. Phiri, who has been researching problems in the healthcare environment for several years, has developed tools for measuring the quality of the indoor environment in hospitals, with the aim of improving existing healthcare facilities and building correctly from the start. His insights into the importance of room acoustics came to good use at the international acoustics conference, at which he was one of the speakers. This is what he had to say during the subsequent interview:

"It seems as if the acoustic environment is just getting worse and worse in our hospitals. This is because they no longer operate in the same way, and sound has therefore become more important – for good and for bad. At the same time hospitals today are not built with sound reduction as a priority.

"I believe that more research and more studies are needed to find ways of controlling sound. You have to remember that the hospitals we build today will affect the quality of care for a long time to come – for 20, 30 maybe even 40 years! We have to find ways to make patients feel more comfortable during care and help them sleep better to reduce treatment times."

A HEALTHY INDOOR ENVIRONMENT IS KEY TO RECOVERY

University College London Hospital is one of the biggest hospitals in the UK. **Hygiene requirements** and the need for a **good acoustic environment dictated the choice** of suspended ceiling.

This prestigious hospital project in central London was built by a consortium of contractors in collaboration with the Llewelyn Davies architectural practice. The project is a private finance initiative, with the state acting as tenant. A hundred hospitals of the same type are already under construction or at the planning stage in the UK.

High standards of functionality and the need for effective sound absorption influenced the choice of acoustic ceiling at University College London Hospital.

The reason why sound absorbers from Ecophon were chosen was because they met the strict requirements for a hospital environment, according to Roger Coleman, an architect with the Llewelyn Davies architectural practice in London.

Properties such as fire safety, low particle emissions, surfaces that can be cleaned with disinfectants and freedom from carcinogens were also instrumental in the decision. These factors, combined with the excellent acoustic characteristics, led to the installation of over 40,000 square metres of acoustic ceiling in the 75,000-square-metre hospital complex. Acoustic ceiling panels from Ecophon were installed in patient rooms, examination rooms and in laboratories where high standards of hygiene are essential.

Acoustic ceiling from Ecophon
Ecophon Hygiene™ Meditec A

Noise in intensive care exceeds WHO guidelines

Patients who are seriously ill and in intensive care require plenty of peace and quiet. But is this what they actually get?

This is a reasonable question following a noise study carried out in an intensive care unit at Sahlgrenska University Hospital in Gothenburg.

The unit in question is probably representative of its type with regard to the work carried out and the layout of the premises. The floors are covered with linoleum, the walls are constructed from plasterboard and there is a suspended acoustic ceiling (in this case of unknown absorption class). The noise study was conducted over a total of five days.

It revealed that the average noise level was 20 decibels above the guidelines set by the World Health Organization (WHO)[1].

In terms of the perceived noise level, this is equivalent to a sound pressure level that is just over four times higher than it should be.

Kerstin Persson Waye, project manager.

Sophisticated medical equipment produces many audible alarms that contribute to increased sound level and stress.

Insufficient rest time

Even more significantly, the study reveals how the average duration of periods of recovery (lower noise levels)[2] was only nine minutes during the day and 13 minutes at night.

By comparison, the corresponding average duration of periods free from maximum noise levels (L_{pAmax} below 55 dB for five minutes) was 10 minutes during the day and eight minutes at night.

The number of such periods varied between one and four during the day, and between eight and 10 at night.

WHO recommends a maximum sound level of 40 dB(A), and previous studies of healthy individuals have shown that sleep can be disturbed when maximum sound levels exceed 45 dB(A).

"We know relatively little about how patients who have received sedation are affected," says Kerstin Persson Waye, project manager and associate professor in occupational and environmental medicine at Sahlgrenska Academy, University of Gothenburg.

"Previous studies have shown that sleep is fragmented during stays in intensive care, but many factors come into play. We are conducting an ongoing study to improve our understanding of how different physiological factors, such as heart rate and blood pressure, are affected by noise in intensive care."

Staff under stress

All the staff questioned during the study reported that they found the acoustic environment stressful. Causes include frequent random alarm signals from medical equipment.

"We intend to take a closer look at the health of staff and how this is affected by noise," says Kerstin.

She believes there is something to be learned by showing just how short the average quiet time or recovery periods are, rather than talking about average sound level.

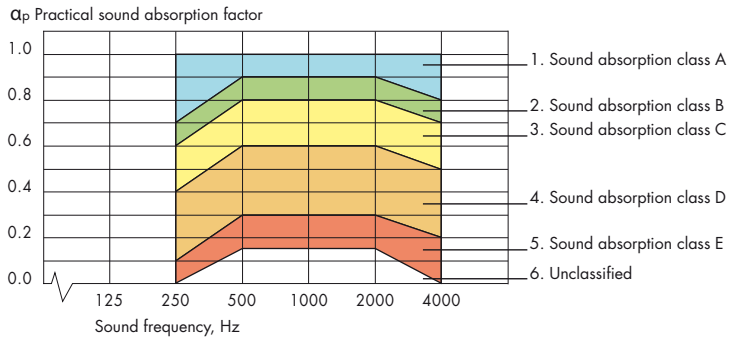
To create a better acoustic environment and reduce stress, staff should consider using supplementary technology to alert them to alarms, such as visual or vibrating signals.

"I'm convinced that as people become more aware of how patients and staff are affected, the acoustic environment will also become an important factor in care," says Kerstin Persson Waye.

1. The study showed that the average sound level was between 53 and 58 dB (L_{pAeq}), depending on the time of day. The World Health Organization, WHO, recommends an average level of 35–40 dB, depending on the type of care room.

2. L_{pAeq} below 50 dB for more than five minutes.

Class A sound absorption is always a good choice for ceilings



The effectiveness of an acoustic ceiling is closely linked to its sound absorption class. Choose a ceiling in class A, the best absorption class, to reduce reverberation time, lower sound levels and minimise sound propagation.

The goals of the noise study in the intensive care unit described in the article alongside did not include examining factors that influence room acoustics, such as the ceiling and the rest of the physical environment.

Russian hospitals put hygiene first

In recent years major initiatives have been taken in Russia to expand and improve healthcare. To reduce the risk of infection, hospitals insist on using surface materials that can be washed with chlorinated detergents.

Following countless tests, suitable materials were eventually found – sound absorbers and acoustic ceiling panels that meet the grade! News about these chlorine-resistant products is now spreading among Russian hospitals like ripples on a pond.

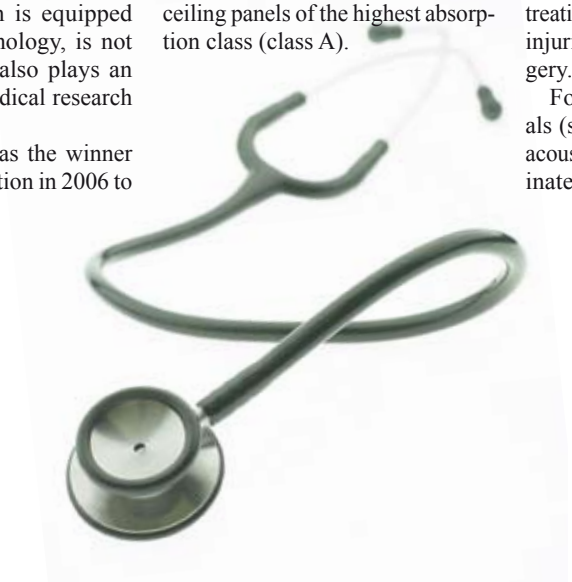
Botkin Municipal Clinical Hospital in Moscow is one of the leading medical centres in Russia and Europe.

The new clinic building, which was opened in March 2007 by Jurij Luzhkov, Mayor of Moscow, has a total area of 90,000 square metres and can accommodate 800 patients.

The clinic, which is equipped with the latest technology, is not just a hospital, but also plays an important part in medical research and development.

The new clinic was the winner of a Russian competition in 2006 to find the "Best project for investment and construction".

A series of trials led to the selection of Ecophon Hygiene™ Meditec, an acoustic ceiling panel with surface properties that meet the strict demands regarding cleanability with chlorinated detergents in medical departments.The reception and corridors are also finished with acoustic ceiling panels of the highest absorption class (class A).



The Emergency Children's Surgery and Traumatology, was built in 2003 when Paediatric Hospital no. 20 was renovated and extended to provide new premises. The hospital can trace its history back to 19th century Moscow.

The hospital has a unique combination of scientific focus and practical application. It specialises in treating children who have traumatic injuries and require emergency surgery.

Following good results in trials (see the article to the left) with acoustic panels that withstood chlorinated detergent cleaning, it was decided that only the best was good enough. Ecophon Hygiene Meditec acoustic ceiling panels were therefore chosen to meet hygiene requirements in the medical departments. Ecophon ceiling panels have also been installed in the corridors and halls, providing a superb solution for enhancing the acoustic environment in noisy premises.

Architect

Leonova Marina Mikhailovna

Acoustic ceiling from Ecophon

Ecophon Hygiene™ Meditec A
Ecophon Gedina™ A
Ecophon Focus™ D

The old suspended ceiling in room 5 was removed and replaced ...

... with a class A acoustic ceiling that reduced the sound level by 3 dB(A) and considerably reduced sound propagation.

New ceiling cuts noise level in intensive care unit

Noise had been a long-standing problem for the hard-pressed staff of the intensive care unit at Karolinska University Hospital.

In just a few hours one afternoon the old suspended ceiling was replaced with a genuine acoustic ceiling. The noise level was markedly lower and sound propagation was reduced – even though the reverberation time remained roughly the same.

Making life or death decisions is part of the routine for staff of the intensive care unit (ICU) in the Thoracic Clinic at Karolinska University Hospital in Solna. Their work situation was hardly helped by the fact that the acoustic environment in one of the rooms, room 5, made it far from the most desirable place to work. The noise from equipment as well as people rushing about in the room and in the corridor outside all contributed to a stressful noise level.

Technology saves lives – and causes irritation

The room has four care stations, where patients and staff jostle for space with complex equipment such as pumps, carbon dioxide meters and respirators. Every single piece of equipment has a vital role in caring for and rehabilitating sick patients, most of whom have undergone open heart surgery. The shortest stay is 24 hours, while some patients stay for up to a month, constantly monitored by sophisticated medical technology, which in turn is operated by specially trained staff. Doctors and nurses listen out for alarm signals from the equipment around the clock.

"There can be around thirty different signals from a single care station, so we have to be observant and ready to respond," explains a member of staff.

The noise in the room made it difficult to communicate, so people had to raise their voices, which contributed to the feeling of tension and an increase in headaches.

Replacement had immediate effect

During an inspection by the Swedish Work Environment Authority it emerged that there was a deep and widespread feeling of dissatisfaction with the acoustic environment in room 5.

In an attempt to tackle the problem, consultation between the intensive care unit, the Work Environment Authority and the property company Locum led to replacement of the existing rigid suspended ceiling with an acoustic ceiling meeting sound absorption class A. In just a few hours the old ceiling panels had gone and the new acoustic ceiling had been installed on the existing framing.

The sound level and sound propagation were measured for the original suspended ceiling and the new acoustic ceiling. The various reverberation times were also recorded carefully.

Reverberation time is often used a means of measuring the acoustic environment. Reduced reverberation time is regarded as being a good indication of lower sound levels, and vice versa.

In the case of room 5 in the Thoracic ICU, however, it's clear that this is not the case: the reverberation time was roughly the same after the ceiling replacement – although the sound level was reduced by 3 dB(A)! Sound propagation was also tangibly reduced at the same time. At a distance of 3.8 metres from a continuous sound source (an audio generator) used in the test, the sound level had fallen by 3–4 dB(A) after the switch to a class A acoustic ceiling – a very clear improvement!

In a room that has several care stations, both sound propagation and sound level can thus be reduced by using the right sound absorbers, which should help to create a better acoustic environment for patients and for staff.

Reverberation time inadequate

As for the truth regarding noise levels versus reverberation time, the level of sound is also linked to what's known as the diffuse sound field. This is the propagation of sound that occurs when furniture and other interior objects reflect sound energy in a thousand and one different directions. When reverberation time alone is measured it gives no indication of the diffuse sound field. Analysing these sounds as well gives a more complete picture of the acoustic environment.
In order to manage the level of diffuse sound – and this is a critical point when considering the choice of acoustic ceiling – the absorption class of the sound absorbers plays a vital role. When diffuse sound reaches the suspended ceiling it is important that the sound absorbers used are of the highest absorption class (class A) in order to reduce the sound level. This is clearly shown by the measurements made.

What did the staff think of their "new" working environment?

Cautious optimism could be detected after consulting around ten doctors and nurses. One person commented that the sound seemed more muted, while another felt that they didn't have to raise their voices as much as before. Another person, who wore a hearing aid, described a clear difference: "Before it was just chaos when I was in room 5, now it's better and quieter."

ING DIRECT CALL CENTRE IN MILAN

A decrease from 78 dB to 69 dB – almost **half the perceived sound level** – was the impressive result of installing an acoustic ceiling.

Metroqubo project. Photo: Marco Banfi

The staff had great difficulty concentrating whilst having conversations with customers, due to speech from collegues at the call centre in Milan operated by the international banking group ING Direct.

The cause was high sound pressure levels and the long reverberation time. Up to 100 operators worked alongside each other in an open-plan office measuring just over 2,300 square metres, constantly answering telephones and taking enquiries from the bank's customers.

No interruption

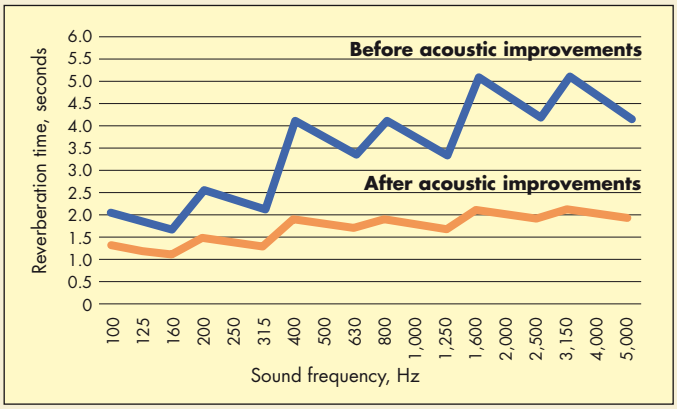
Following preliminary sound measurements it was decided that something had to be done about the acoustic environment, but not at any cost. It would have to be done quickly, as it was important not to disturb the business of the office unnecessarily. The answer was suspended acoustic units that were hung from the existing louvered ceiling, above the work stations. This ensures an effective solution at low cost without any intervention that would have led to loss of productivity.

Impressive acoustics

Gianpiero Majandi, an acoustician from Studio Majandi, who carried out the acoustic measurements, was himself surprised by the results:

"It's an impressive achievement to reduce the reverberation time by more than half using suspended sound absorbers – and avoid major disruption to the premises."

Reverberation times before and after acoustic improvements.



Before the acoustic changes a reverberation time of 3.48 seconds was measured in the premises, which is regarded as very disruptive to communication. The high sound pressure level that was measured, 78 dB(A), is not only stressful and makes speech difficult to perceive, it can also increase the risk of temporary hearing impairment.

After the acoustic ceiling was installed the reverberation time dropped to 1.64 seconds and the noise pressure level fell by a full 9 dB to 69 dB(A), which is perceived as almost a halving in the sound level! The measurements were carried out with the same number of operators, 50 people, in the premises on both occasions.

Reverberation time is a measure of the time it takes for a sound created in a room to fall by 60 dB once the source of the sound has stopped. In other words it is the length of time it takes for the echo to fade away.

The reverberation time is determined by:
- The amount of sound absorption and where it is placed
- The amount and placement of sound-propagating objects such as furniture, shelving and the like
- The shape and size of the room

The sound level is essentially determined by the amount of sound absorption.

Speech clarity is mainly determined by:
- The difference between early sound reflections and late reflections
- Background sound level

The sound-absorbing units were installed quickly and easily over the work stations at the ING Direct call centre. The staff are now much happier and have a reasonable chance of carrying out their duties without excessive background noise.

Acoustic ceiling from Ecophon
Ecophon Master™ Solo S

NEW ACOUSTIC ROOM DESIGN MAKES OPEN-PLAN OFFICES A BETTER PLACE TO WORK

Many people dislike working in open-plan offices. Noise is one reason. **"Acoustic parameters for open-plan solutions"** is one current project that aims to change this situation.

There is a clear need for free communication in open-plan offices, but each employee also needs to be able to work without distraction.

This is an elusive goal that has time after time proven difficult to achieve. The sound of other people talking is what disturbs most people and prompts most complaints.

One reason why the acoustic environment is often poor is that inadequate measurement methods have been used in the past to check the acoustics of rooms.

These methods are based on traditional methods that assume a cubic room geometry in which sound energy diffuses uniformly.

In open-plan offices, however, the real situation is quite different: the geometry is complex, as is the sound propagation. The sound field is not diffuse and there are many different sound sources in this type of environment.

Despite this, traditional measurement methods are still used most of the time.

Pioneering work

"Acoustic room measurements for open-plan solutions" is a project that has been supported by NICe, the Nordic Innovation Centre, a body set up by the Nordic Council of Ministers to support innovative, knowledge-based companies.

The project was run by Ecophon in collaboration with ÅF-Ingemansson, an expert in sound and vibration, and Mats Nilsson, an associate professor who specialises in the fields of sound and psychology at Stockholm University.

The project was unusual in that it had to break new ground to determine the most accurate way of assessing the acoustics of open-plan offices.

It was also much needed, because of the negative impact on health of the often noisy acoustic environment in open-plan offices (see article on Australian study, page 15).

Finding concrete ways to tackle the two biggest challenges of the open-plan office – reducing noise levels and ensuring that the sound pressure level subsides quickly – is one of the most important results of the project (see table 1).

Put simply, people can sit closer together if you use the right aborbers in the right place.

From a purely financial viewpoint this means that office space could be used more efficiently.

However the real goal is to create a working environment with better room acoustics that makes the work place more comfortable.

Another aspect that makes the NICe project unique is that it is based on extensive studies of five open-plan offices and their acoustics, and that employees' perceptions of the acoustic environment were surveyed by means of detailed questionnaires.

The offices that were studied were at Dicentia, in Copenhagen, Denmark (a distributor of digital media); two departments of the power company Vattenfall, in Stockholm, Sweden; the oil company Statoil, in Stavanger, Norway; and the Finnish Association of Civil Engineers, in Helsinki, Finland.

Two offices get acoustic makeover

In two of the offices – Dicentia and one of the departments at Vattenfall – it turned out that the acoustic environments were very important.

They were both given an acoustic makeover, including acoustic ceilings, suspended units and wall absorbers. The project managers were then able to compare the results of measurements and replies to questionnaires before and after the acoustic treatment.

Some results of measurements and surveys are shown in tables 1 and 2.

The acoustic environment in areas where people gather is improved significantly with the aid of wall absorbers.

Foto: Björn Sunde

Suspended sound-absorbing units reduce distractions from surroundings and lower sound pressure level.

Table 1.
Room acoustic measures

Before refurbishment		
Office	DL_2 (dB)	DL_f (dB)
Vattenfall Help Desk	3,3	6,7
Dicentia	4,5	7,5

Efter akustisk design		
Office	DL_2 (dB)	DL_f (dB)
Vattenfall Help Desk	5,0	0,6
Dicentia	7,0	2,6

DL_2 describes how the sound pressure level falls off with distance, while DL_f indicates the reduction in sound level. It can be seen from the table that good acoustic design ensures that sounds subside faster, as well as reducing the sound level. These are both factors that play a critical role in the acoustics of a room and employee satisfaction in an open-plan office.

Table 2.
Example of replies to questionnaire at Vattenfall

	Before acoustic makeover	After acoustic makeover
Proportion who felt the acoustic environment was generally poor	40%	10%
Proportion who felt the acoustic environment was generally very poor	20%	0%
Proportion who felt the acoustic environment was poor because of disturbance by others' conversations	36%	30%
Proportion who felt the acoustic environment was very poor because of disturbance by others' conversations	43%	0%

Continued on next page

Continued from previous page

Photo: Björn Sunde

Improved sound absorption in corridor ceiling and office partitions limits sound propagation between work stations at Vattenfall.

Brief facts about the NICe project and acoustic parameters for offices:

The project comprised the following stages:

1. Measurement of acoustic parameters for offices questionnaire regarding before and after changes.
2. Analysis.
3. Proposal of suitable parameters and measurement methods to assess the acoustic environment in open-plan offices.

The following acoustic parameters were examined during the study:

- Reverberation time T20, T30 and EDT (ISO 3382-2)
- Speech perception STI (EN 60268-16:2003)
- Privacy index PI according to ASTM E 1130-02e1
- Rate of special decay DL_2 (ISO 14257:2001)
- Sound level from radiating speakers with constant output.

The department at Vattenfall is a help desk that employees call to get support when they have IT problems. New office partitions were also installed here. The percentage of department employees who were dissatisfied with the general sound level fell from 60 to 10 per cent after the office received an acoustic makeover.

"You should also remember that the acoustic environment is normally approved if no more than 20 per cent of staff are dissatisfied with it," says Erling Nilsson, a doctor of technology and acoustics specialist who was involved in the NICe project.

Influence on new standard

Erling Nilsson reports that the project has led to a change in name of a forthcoming ISO standard, from "open-plan spaces" to "open-plan offices".

"The goal of the NICe project is to create environments that permit work and communication, without different groups of workers disturbing each other. We call it *Room Acoustic Comfort*™," says Erling Nilsson.

Strategies for a better acoustic environment

Many companies are now building open-plan offices in an effort to maximise efficiency. The benefits are quick and easy communication between people, and the flexibility to adapt the office layout to suit the working methods of the company.

An open-plan office also reflects the company's philosophy and the values it stands for. The office building is a means of projecting the corporate image, so the quality of acoustics is also very important.

Creating a good acoustic environment is not just about eliminating sound. Sound is of course made up of both information – which is positive – and noise – which is undesirable. It is always the listener who decides which category a sound belongs in. The more complex the task you need to do, the greater the effect a distracting acoustic environment has on the results.

When you ask people in open-plan offices what they regard as the most distracting aspect, you usually get the answer "people talking". At the same time this is exactly what people also like most about an office environment – being able to communicate with their workmates.

Room Acoustic Comfort™

Ecophon, which is a leading company in room acoustics, contributes to international research and the development of new sound standards. There are three main factors that are important to consider in order to create a good acoustic environment: the people, the room and the activity in that room. At Ecophon we call this approach to creating a comfortable acoustic environment *Room Acoustic Comfort*. It involves reinforcing positive sounds and minimising negative sounds, so that people can work well and feel good in their work place.

Organising seminars

To create a good acoustic environment in open-plan offices you should furnish acoustically, reduce sound propagation in the room and provide rooms where people can concentrate.

Last but not least – we need to learn to observe good sound discipline in open-plan offices.

Ecophon organises seminars and courses, and can also help you plan and specify a healthy acoustic environment. Contact Ecophon to find out more and take part when the opportunity arises.

Research shock – open-plan offices make people sick

Photo: Sharon Thompson

Dr Vinesh Oommen was shocked by the results and believes that employers need to make a major commitment to tackle noise problems in open-plan offices.

The move to open-plan offices is a worldwide trend. But one side-effect is that people are feeling unwell. This is the finding of a unique research report from Australia.

It points out that there is a desperate need for measures that can improve the acoustic environment – and there is no shortage of those.

"How are employers going to deal with it?" asks Dr Vinesh Oommen, who compiled the report.

The evidence is overwhelming that working in open-plan offices often has a negative effect on people's health. This was the clear conclusion after scientists in Australia decided to review studies from all over the world. They found that the transition to open-plan offices led to a fall in productivity and a rise in stress levels. Ninety per cent of the studies show negative consequences of choosing an open-plan solution over closed offices.

Irritation and high turnover

Dr Vinesh Oommen, researcher at the Institute of Health and Biomedical Innovation at Queensland University of Technology, was the author of the report.

"The results were shocking!"

The report revealed high stress levels, personal conflicts, high blood pressure and increased staff turnover. Privacy was compromised and employees felt a loss of identity. Concentration deteriorated and productivity fell. Personnel turnover also rose, according to the Australian scientists' review of global research.

Vinesh Oommen is pessimistic when he considers what employers are likely to do about the problem.

"Are they going to recreate the whole office design or re-locate the office workers to closed offices or sound-proof the whole office, or do something else?"

"Keeping in mind that all of these carry cost in dollars and from a business perspective I don't think employers will take a quick decision on this. With the current financial crisis, employers will be very hesitant to do something."

Acoustic ceilings often overlooked

According to Vinesh Oommen acoustic ceilings were not fitted in roughly 70 per cent of offices.

"Even in the other 30 per cent, staff complained of phone conversations, phones ringing, people talking, noise from photocopiers and other noises."

Good room acoustics are clearly important, he explained to ECO, but added that he doubted whether the noise problems can be solved entirely.

Demand for noise-reducing measures has grown as more and more open-plan offices are built. The first priority is to install a full acoustic ceiling.

Here are some of the most important and most effective measures.

Advice for making the work place healthier and more efficient.

- Restrict the propagation of sound over large areas.
- Install an effective (class A) acoustic ceiling and if possible supplement it with sound-absorbing, freely suspended units.
- Use glass screens to create partitions between project teams and work units, for example.
- Place people who have similar duties close to each other.
- Invest in sound-absorbing furniture and partitions.
- Check that floor and wall coverings help to dampen sound.
- Place noisy office equipment in a separate room.
- Applying good sound discipline can improve matters significantly, such as holding longer conversations in "free zones" such as quiet rooms and coffee areas. People should naturally not yell across a room, but walk over to the person they want to talk to. Cordless telephones, preferably set to vibrate, are guaranteed to be welcomed by everyone!

HIDDEN HEARING PROBLEMS THREATEN SCHOOLWORK

A major Polish screening programme has revealed that **many parents do not realise** that their children have serious hearing problems. The use of sound absorbers in school premises is important to reduce harmful noise.

A hearing impairment is in many ways an unseen problem.

Alarming evidence of this has been found in Poland, where over 80,000 seven-year-olds have recently undergone hearing tests. A further 12,000 schoolchildren between the ages of eight and twelve have also had their hearing checked.

The results revealed that one in five children has a problem with hearing.

In the group with the most severe hearing problems, 7,710 children, it turned out that 60 per cent of parents were unaware of the problem. Naturally if parents do not know that their child has hearing difficulties, the teaching staff at the school do not know either.

"The screenings were carried out to detect hearing problems. They were also of an informative nature and their objective was to raise the public awareness of the medical and social consequences of long lasting hearing disorders," comments professor Henryk Skarżyński, general manager of IPPH, the Institute of Physiology and Pathology of Hearing (Instytucie Fizjologii i Patologii Słuchu), in Warsaw.

The IPPH was responsible for the screening programme, which was carried out over the period March–June 2008 in seven eastern provinces that are home to 40 per cent of the Polish population.

The massive screening programme took in almost 90 per cent of all primary schools in the provinces, totalling 5,701 schools.

Hearing tests were also carried out on 20,000 twelve-year-olds in the capital, Warsaw.

Breaks lead to tinnitus

One in three children in both groups reported that they had problems with tinnitus – ringing, squeaking or other noises in their ears.

In a pilot study conducted in 2006, sound levels in excess of 100 dB were measured at break times in some Warsaw schools.

"This is the most probable cause of recurring and chronic tinnitus," according to Henryk Skarżyński.

Professor Henryk Skarżyński, general manager of IPPH.

Professor Andrzej Czyżewski from the scientific board of IPPH.

The IPPH study was carried out in collaboration with: The Multimedia Systems Department, Gdansk University of Technology (Politechnika Gdańska), The Hearing Impaired and Deaf Persons' Friends Association, Poland, The Board of Hearing Pathophysiology, Speech and Communication Disorders at the Polish Academy of Sciences (Polska Akademia Nauk)

The screening programme involved checking the hearing threshold in the range 250–8,000 Hz, assessing the brain's ability to process heard sounds and recording the speech of children who were assessed.

In addition to investigating the prevalence of hearing problems and spreading knowledge about these problems and loud noises, one of the aims was to offer treatment to those with problems.

It is hoped that the study will help to open up opportunities to offer early and regular medical checks for the entire population.

It was also noted that the ability to perceive sounds was reduced after breaks – a 30-minute break could reduce perception ability for up to a couple of hours.

This phenomenon is known as Temporary Threshold Shift (TTS), and means that the threshold of hearing is raised for a short period. Listening to portable CD and MP3 players can cause similar effects. It turns out that listening to personal music players can also contribute to permanent hearing problems, sometimes called iPod ear.

TTS is also mentioned in the pilot study.

"The TTS effect was present from first to last break and also during lessons," points out professor Andrzej Czyżewski from the Multimedia Systems Department at Gdansk University of Technology (Politechnika Gdańska), which supplied the technology for the hearing tests, among other things.

"The authors strongly emphasise that the high TTS values were observed for frequency ranges essential for speech perception, in other words from 1,600 to 3,400 Hz."

He agrees with professor Skarżyński that there is a big need for education on the threat to children's hearing.

"Children must know that they are responsible for their health, including hearing," he says, adding when asked about the challenges of tackling the acoustic environment in schools:

"Effective acoustic adaptation of classrooms and corridors is the main factor that should be always considered."

Absorbers needed in schools

Acoustic ceilings, possibly combined with wall absorbents, reduce background noise and increase the ability to perceive speech.

Children with impaired hearing also suffer other problems, according to professor Skarżyński.

"Hearing disorders influence their emotional and intellectual development, their progress at school and interpersonal relations."

"The decrease in hearing perception after so-called 'relaxing long breaks' at school, is as we see it one of the most significant problems."

Photo: Mikko Pekki/Studio Sempr

High noise levels during breaks make speech perception more difficult during subsequent classes.

"Effective acoustic adaptation of classrooms and corridors is the main factor that should always be considered," stresses professor Andrzej Czyżewski.

The photo shows a school corridor with an acoustic ceiling that dampens the sound pressure level and reduces sound propagation.

"Acoustics in sports halls – from problem to solution"

Photo: Richard Brokels

"The absorbing wall panels reduced the reverberation time by over a second, so that we were able to meet Dutch national guidelines!"

The attractive sound absorbing wall panels that reduced the reverberation time in the sports hall by a full 1.1 seconds – an impressive achievement.

De Wijde Wereld sports hall in Vleuterweide, Holland.

"Hearing damage is much more common among sports teachers who work in premises with a poor acoustic environment than in a good environment."
Len van Rijn, representative of KVLO (the Royal Association for Physical Education Teachers) in Holland.

"The best way to get people to really understand the importance of acoustics in a room is to experience the results for themselves," says Guus Klamerek, Concept Developer Education at Ecophon's training premises in Benelux.

Almost 100 people took part in a national seminar on the acoustic environment in sports halls on 15 December last year.

The speakers were Jeroen Neggers of ISA sport, Institute for Sports Accommodations (linked to the Dutch Olympic Committee) and Theo Appeldoorn, Acour Lawaaibestrijding (a noise prevention company) as well as Len van Rijn, representing KVLO (the Royal Association for Physical Education Teachers) and Guus Klamerek from Ecophon.

Wall absorbers reduce reverberation time

During the meeting the delegates visited De Wijde Wereld sports hall in Vleuterweide, Holland, where the reverberation time was reduced by over a second by installing effective sound-absorbing panels on the walls! Despite previous attempts at fitting "sound-absorbing" wood wool slabs around the edge of the ceiling, the reverberation time remained far too long – a full 2.9 seconds.

After the new absorbing wall panels were installed the time was reduced to 1.8 seconds. According to ISA Sport, which ensures that premises are suitable for sportspeople, the reverberation time in this type of premises should not exceed two seconds.

Remedy for flutter echoes

During their visits the delegates listened to a talk entitled "Acoustics in the working experience of a teacher in physical education", given by Len van Rijn, a sports teacher and representative of KVLO who himself has a hearing impairment due to bad acoustic environment. He explained that hearing damage is much more common among members of his organisation who work in premises with a poor acoustic environment than in a good environment. KVLO is convinced that a poor acoustic environment also contributes to symptoms such as fatigue, headaches, voice problems and stress.

Flutter echoes are a phenomenon that raises the sound level due to echoing between two parallel walls. This greatly reduces the quality of the acoustic environment, especially in premises with long, high walls, such as sports halls and gyms. The best way to combat flutter echoes is by installing absorbing wall panels in the premises, which was also discussed during the seminar. It was also pointed out that the absorbing panels must be resilient, yet at the same time resistant to knocks and impacts.

Sports teachers sue schools for hearing damage

Dutch sports teachers have sued their employers after suffering serious hearing impairment due to poor acoustic environments in their work places. The schools (i.e. the local municipality responsible for the sports premises) are having to pay financial compensation to the teachers.

The teachers were supported in this action by the Royal Association for Physical Education Teachers (KVLO), a Dutch organisation that looks after the interests of sports teachers as employees.

Poor room acoustics are not a new problem, however! KVLO had previously published a report on hearing problems, voice problems, fatigue and stress suffered by teachers. This was one of the main reasons why a stricter Dutch standard was introduced in 2005 – which clearly had not helped in this case.

Sports premises and gyms generally have hard flooring, walls and ceilings. This, combined with the large volume of such spaces, leads to high noise levels and troublesome reverberation.

When a teacher speaks it can be very difficult for pupils to hear what they are saying, especially if the environment is noisy and the teacher has to project his or her voice across a big room. This can result in teachers over-exerting their vocal chords and suffering voice fatigue.

A poor acoustic environment can also be a hazard to safety. Teachers must be able to react quickly and make themselves heard in an emergency in order to get attention.

In premises with long, parallel walls, such as sports halls, special attention must be given to the acoustics of the space, as troublesome flutter echoes can otherwise occur.

Unfortunately it is quite common to find that sports halls have a reverberation time of over 3.0 seconds and sound levels above 80 dB(A). Remember that lasting hearing damage can occur at sound levels of just 85 dB(A), depending on the duration of exposure to the sound!

Best sound absorption!

When choosing sound absorbers for walls and ceilings it is very important that the products offer the best possible sound absorption, even at lower frequencies. This is essential in order to fulfil the requirements of standards and meet guidelines. The sound absorbers must also be able to withstand the knocks and impacts of exercising pupils and their bats and balls.

The sound of a teacher's whistle, which is in fact designed to be used outdoors, can reach 105 dB(A) at a distance of one metre, in other words above the threshold for harmful noise.

AN ACOUSTIC CEILING THAT'S TOUGHER THAN MOST

Jumping, running, bouncing balls, whistle-blowing and yells of encouragement or calls to pass. The high noise level and the large volume of sports halls and gyms make it **difficult to hear and communicate**. Premises of this type can also contribute to **hearing damage**, which makes **effective sound absorption essential**.

Sports halls or gyms have an inherent acoustic problem that needs to be solved. The large volumes of these spaces, with their long, high walls, make sports activities a potential hazard to health. High sound pressure levels, echo effects and unrestricted sound propagation make the background noise level unbearable at times for teachers and pupils.

It's sometimes said that noise breeds noise, a phenomenon that is known as the Lombard effect. The higher the background noise, the more we raise our voices to be heard. This process then builds into a crescendo of sound that makes it difficult to communicate, raises stress levels and could result in hearing damage. The more people there are in the premises, the worse the situation becomes.

Better acoustics make premises more versatile

If premises are used for a variety of sports and other purposes, the acoustics of the space should be tailored to the noisiest activity. Are the premises also likely to be used for music, lectures and other events that require sound systems? Thanks to sound absorbers, the acoustic environment is being improved and easier to control.

Thankfully the problem is easy to solve – at a reasonable cost – with the aid of effective sound absorption. That is, if you get things right from the start…

Sports halls and gyms – a little more to think about

1. In a teaching environment, such as a sports hall, speech perception has to be good if pupils are to hear instructions, calls and warnings. This means that sound propagation in the premises must be restricted.

2. The sound pressure level must be lowered to avoid stress and hearing injury.

3. Reverberation time must be short enough to meet requirements for generally good room acoustics. We recommend that the reverberation time does not exceed 1.2 seconds, which is difficult to achieve unless you plan to take the right steps at an early stage of the building process.

Existing buildings are often poorly prepared for installation of an acoustic ceiling, and the rigid walls are not designed to meet sound absorption requirements. However there is always a way to at least improve room acoustics – by utilising every available surface for sound absorbers!

4. Sound absorbers, of the best absorption class (class A), have to be able to withstand rough treatment.

Photo: Jeff Faraday

European standard impact resistance

Suspended ceilings and wall absorbers are tested and assessed for impact resistance in three classes for different applications, according to European Standard EN 13964:

- Ceiling systems and wall absorbers in class 1A must be used in multipurpose halls or sports halls where high-energy ball games are played, such as handball and tennis.
  Sound absorbers for ceilings and walls that meet the requirements of class 1A can be found in the **Ecophon Super G™ Plus** product range.

- Ceiling systems in class 2A are recommended for gyms and other premises where low-energy ball games are played, such as volleyball and floor ball.
  Sound absorbers for ceilings and walls that meet the requirements of class 2A can be found in the **Ecophon Super G™** product range.

- Ceiling systems in classes 2A and 3A are suitable for all situations and premises where an impact-resistant ceiling is required, such as school corridors and preschools.
  Sound absorbers for ceilings and walls that meet the requirements of class 2A and 3A can be found in the **Ecophon Super G™** and **Super G™ Dp XL** (for "vulnerable" ceilings in school corridors) product range.

You can search the product pages for Ecophon Super G™ at www.ecophon.com

How to improve room acoustics

To reduce reverberation time, sound propagation and the sound pressure level, sound absorbers of the highest absorption class (class A) were installed over the entire ceiling. Combined with the installation of effective wall absorbers on two adjoining walls, this solution also eliminates flutter echoes, when sound tends to bounce between two walls. It was essential that the absorbers were installed flat on the substrate and that they have a surface that is resistant to knocks and impacts.

Photo: Kees Rutten

The De Matrix school won the "2009 School Building Prize" – a major Dutch architectural competition that focuses on sustainability. The gym is lined with sound absorbers to ensure a safe and comfortable acoustic environment.

Ecophon Super G™ is a range of Impact resistant sound absorbers for ceilings and walls in active environments such as sports halls, gyms and school corridors. The tough Super G surface enables absorbers to withstand with everyday knocks and impacts without damage.

FIRST PRESCHOOL IN EUROPE TO USE PASSIVE HOUSE TECHNOLOGY

When the first preschool to use **passive house technology** was built in Europe, the acoustic environment was a high priority. This guided the choice of everything from **acoustic ceilings** to sound-deadening material for the tables. The preschool has even had a **royal visit**. Come on in!

Illustration: Glantz Arkitektstudio

The extra-thick walls are the only indication that the preschool, which is less than a year old, is different from other preschools.

It was in the autumn term of 2008 that the preschool moved into the newly built premises, having previously been based in converted apartments on the ground floor of an apartment block.

The preschool, known as Stadsskogen, was constructed using passive house technology and is a pioneering project. It is the only preschool in Sweden – and probably the whole of Europe – to be built using the same energy-saving technology.

The staff took part

One of the main concerns was how to create a good acoustic environment and avoid irritating noise. When lots of lively children are gathered under the same roof the noise level can easily become loud and tiring.

"There's a big difference compared to the level of noise in our previous premises," explains Agneta Augustsson. "We don't get as tired at the end of a day's work as we used to."

She explains that the staff were involved throughout the planning stage and had the opportunity to give their views on aspects such as the acoustic environment.

Acoustic ceilings have been combined with sound-absorbing wall coverings, and deliberate steps have been taken to reduce the background noise.

For example, there is only one dishwasher, and office equipment such as the computers and fax

Photo: Sara Bengtsson

Deep window recess that children can huddle in. Ebba Brunegård and Emmy Antmarker are two of nearly a hundred children at this unique preschool.

machine have been moved from communal areas and placed in a small, separate office. The tables are also covered with sound-deadening material to reduce the clatter of glasses, cutlery and other hard objects.

Change in policy for municipality

Plans had already been drawn up for the preschool when the politicians who govern Alingsås decided to adopt a proactive policy on energy-efficient building.

They made a dramatic turnaround and chose to build the preschool using passive house technology instead of traditional building methods.

"It meant that the building ended up a little bigger than the planning permission had been granted for," comments Maria Hallberg, the architect in charge.

In other respects, the change in building method did not entail any notable architectural differences, reports Maria Hallberg, who works for Glantz Arkitektstudio, which has experience from several previous designs that have used passive house technology.

She points out that passive houses do not use plasterboard panels in the ceiling, but that the half-metre thick thermal insulation above the acoustic ceiling serves as a sound-absorbing backing.

Really low frequencies can be absorbed more effectively this way, which among other things can reduce the level of some background noise, from ventilation equipment for example.

As well as requiring a good acoustic environment, good air quality was also an important consideration.

In a passive house, no additional heating is provided, except when temperatures are extremely low. Heat is instead extracted from the indoor air and transferred to the incoming air as it passes through a heat exchanger.

Everyone learns sound discipline

It's sometimes said that noise generates more noise. In premises with poor acoustics and a long reverberation time, people have to raise their voices to be heard. The result is that they end up shouting over each other.

The use of effective sound-absorbing materials and good acoustics instead creates an environment where people do not need to shout

Continued on next page

Head teacher Agneta Augustsson speaks for all the staff when she says that the acoustic environment in the new premises is excellent. Note the acoustic ceiling, which is of the highest absorption class.

Architects
Glantz Arkitektstudio

Acoustic ceiling from Ecophon
Ecophon Gedina™ A
Ecophon Hygiene™ Perfomance A
Ecophon Wall Panel™ Super G

Continued from previous page

Photo: Sara Bengtsson

Cold outside, warm inside. The indoor temperature at the preschool is kept at a comfortable level.

Sound-absorbing materials on the ceilings and walls reduce problems with flutter echoes, for example.

in order for others to hear what they are saying.

It is only then that children can be taught sound discipline. The preschool provides special training for both staff and children, to teach them how to create a quieter and calmer environment in which everyone feels happier and more comfortable.

"I feel we've come a long way and achieved what we wanted," says Agneta Augustsson, head teacher at the preschool.

Royal visit

The Swedish royal couple, King Carl XVI Gustaf and Queen Silvia, have visited the preschool. Carl XIV Gustaf is known for his strong commitment to environmental issues.

The royal couple are said to have asked a lot of questions about passive house technology, which they felt could also be useful at Drottningholm, the castle that is the official residence of the family.

Drottningholm Palace estate is a well-preserved estate dating from the 17th and 18th centuries and modelled after the French style.

In 1991 Drottningholm was included on UNESCO's World Heritage list as a site of outstanding value to humanity.

A light well penetrates the full acoustic ceiling. Cleverly placed windows admit as much light as possible without excessive direct sunlight.

Germany and Austria lead the way – but the EU hesitates

Germany and Austria have been the quickest to adopt passive house technology. However, the term "passive house" will be eliminated from the final EU draft of the energy performance of buildings directive.

In autumn it is likely that the EU will adopt a directive that imposes stiffer requirements with the aim of reducing energy use. The term passive house was included in the early drafts of the directive, but was subsequently removed because it was not felt to be technology-neutral.

Only seven of the 27 EU Member States have formulated a national definition for houses with exceptionally low energy use.

Austria is the only country to include the term passive house in its national definition: "Klima: aktiv passivhaus standard". Around ten per cent of new builds in Austria are passive houses. Germany also has a strong lead and the current housing stock includes around 8,000 passive houses. Denmark has set a target that all new builds should be passive houses by 2020. In Sweden, barely 20 houses have been built or renovated using this energy-saving approach.

In Austria an exemplary apartment block was built using passive house technology in the town of Wolfurt in 1999. The building comprises a steel skeleton with exterior walls of timber and up to 350 millimetres of insulation.

In 2016 the EU intends to launch a completely new building standard, based on the same standard that is used in Austria today. However, it appears that the EU will again eliminate the term "passive house" to avoid restricting the use of technology.

According to the EU, the means

does not matter as long as the goal is achieved – that the buildings of the future save energy and reduce emissions.

Under the skin of a passive house

It is the total energy consumption for heating that determines whether a house can be classed as passive. In Sweden and Austria, for example, the energy consumption must not exceed 15 kilowatt hours per square metre per year.

In a passive house all the major components are optimised: the walls, windows, floors, roof and ventilation system. Energy losses are minimised at the same time. In practice this means creating a building with a well insulated and airtight "climate shell" equipped with mechanical ventilation and efficient heat recovery.

No advanced technical solutions are needed.

The heat comes from people, appliances and lighting, for example. One person gives off roughly as much heat as a 100-watt incandescent bulb.

Avoiding cold bridges is one of the most important details. There have been cases where houses have been built according to the detailed rulebook for passive house construction, but where a builder has drilled holes in the wrong places in the walls and unwittingly ruined the insulating climate shell.

To take full advantage of solar energy it is important to orientate the house correctly on the plot.

It only costs a few per cent more to build a passive house than a conventional house. But in the long term the overall cost is lower, thanks to the reduction in energy use.

It has become possible to use increasingly large windows in buildings, as the insulation performance, or U-value, of windows has improved.

Passive houses can be provided with back-up heating that can be switched on if temperatures get really low. The preschool in Alingsås is able to use the district heating system in exceptionally cold weather.

Passive house technology works well in countries that have hot and cold climates.

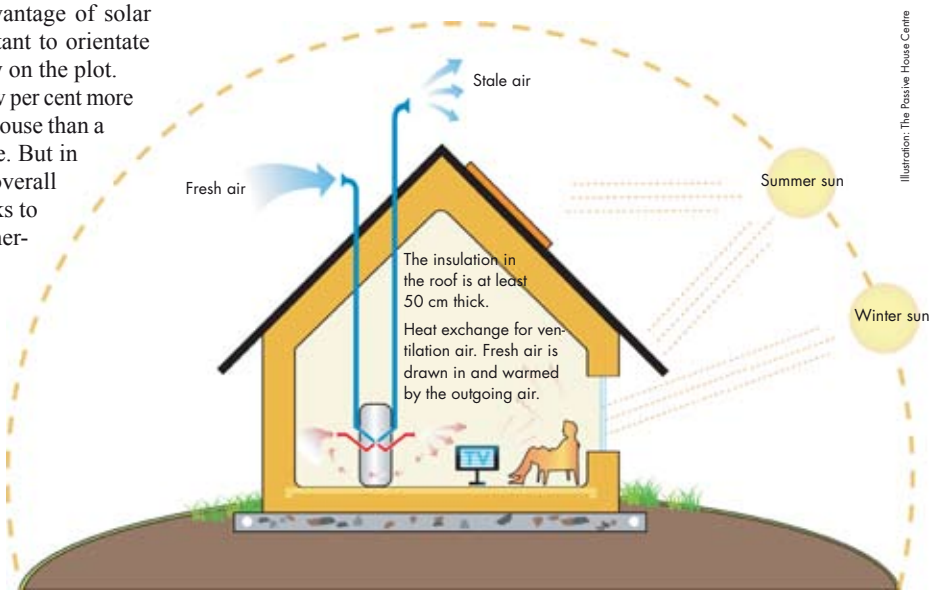


Illustration: The Passive House Centre

The sketch shows the principles behind insulation and heating – the two factors that can make a house passive – in other words not needing additional energy for heating.

School kids break industrial noise barrier

Noise levels in a number of schools, preschools and after-school centres have been studied by Robert Wålinder, a consultant in occupational and environmental medicine at Uppsala University Hospital in Sweden, in collaboration with research colleagues.

The researchers found that noise levels sometimes exceeded 80 dB(A), which is the threshold value (or action value) in Swedish industry and requires that the employer informs employees about hearing protection and the risk of hearing damage.

In some cases the level topped 85 dB(A), the upper limit at which employers are obliged to ensure that hearing protection is worn.

Noise measurements revealed that the average noise level was 70 decibels, which is equivalent to the noise level from city traffic.

"Sudden yells do most damage"

Robert Wålinder believes that the standard for measuring noise in industry is not appropriate for these settings, however. The Leq value, which is the equivalent noise level or mean noise level, is based on the average over eight hours.

"But teachers don't spend eight hours in the classroom. Acute hearing damage caused by sudden yelling in the ear can also be more harmful than the constant noise of machinery close to the action threshold. Acute hearing damage due to sudden yells and other impulse noise is not reflected in an average value taken over eight hours. This means that the measurement method and the results are not fully indicative of the medical risk," says Robert Wålinder.

The study included a survey sent out to 4,600 employees, to which eight out of ten responded.

The acoustic environment in schools would not be accepted in other work places, according to consultant Robert Wålinder.

Don’t let lighting ruin the ceiling

Photo: Åke E:son Lindman

The ceiling, normally the largest free surface in a room, plays an important role in the overall impression a room conveys. It turns out that it is possible to achieve a surface that radically reduces the negative impact of sound. This is your chance to find out how retro-reflection affects your perception of a room!

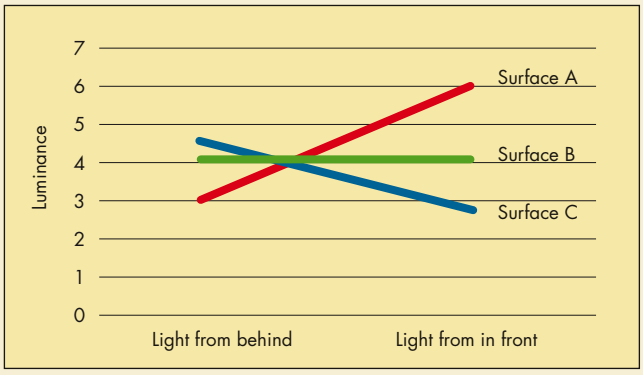
The ability to create a room in the way it was originally conceived is a natural expectation of architects or others who work with buildings and design. Unfortunately things don’t always turn out as expected. The ceiling reflects light differently depending on the surface texture, and undesirable reflections from windows and artificial lighting can often make the ceiling appear unevenly lit.

Recent research makes it possible to calculate what type of surface is ideal, providing the right balance between gloss and retro-reflection, a parameter that is linked to the smoothness or irregularity of the surface.

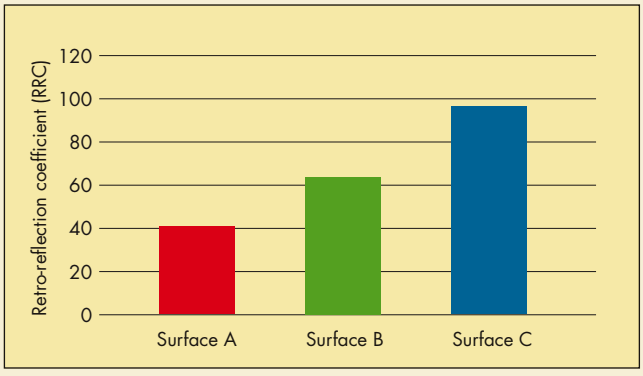
“Snow is a good example of how retro-reflection works,” says Johanna Friman, project manager at Ecophon.

“Powder snow has a high coefficient of reflection and is perceived as blindingly white, thanks to the newly fallen snow crystals that lie loose on the ground, while ‘old’ snow is more compact and has a denser surface that does not reflect light as efficiently.”

Danish Delta has developed the retro-reflection approach and measured how different ceiling surfaces react to daylight and artificial lighting. If there is too little retro-reflection the ceiling appears much lighter and produces more glare when you look towards a light source than when you have a light source behind you. The opposite applies when there is too much retro-reflection. When the retro-reflection coefficient has a value of around 60, the luminance (brightness) of the ceiling surface is roughly the same regardless of where you stand in the room, as shown in the example below.



The diagram shows how different ceiling surfaces are affected by lighting depending on where you stand in the room, and hence which direction the light is coming from. The most uniform lighting is obtained by choosing a ceiling with surface B.

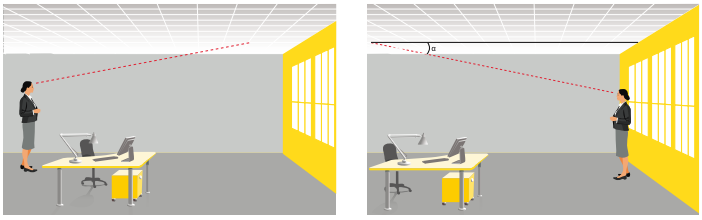


Different ceiling surfaces reflect different amounts of light. A retro-reflection coefficient of around 60 gives the best value (ceiling with surface B).

Fact

Coefficient of retro-reflection $= \frac{mcd}{m^2lx}$

where cd = candela, the unit of luminous intensity (how much light radiates from a light source in a given direction) and lx = lux , the unit of illuminance (a measure of the apparent intensity of light striking a surface). The coefficient of retro-reflection has a minimum value of 0 and a maximum value of 120. The value for the surface of a ceiling should be around 60.



One of the most important characteristics of a ceiling is that the surface should appear illuminated in the same way no matter where you are in the room. Reflections, glare, colour shifts and coloured lighting effects can be eliminated. The room should appear as it was originally intended.

"It's all a question of balance," says Kai Sørensen, a lighting expert with Delta, a Danish consultancy in electronics, lighting and acoustics, who is researching the phenomenon of retro-reflection. A ceiling reflects both daylight and lighting in different ways depending on the properties of the surface. Ideally, we want to avoid distracting reflections wherever possible, which is related to gloss, an effect that arises depending on how shiny a surface is. The more matt a ceiling is, the less it appears to gleam or create reflections."

Since the ceiling is usually viewed from a fairly shallow angle, as you look at it with the surface stretched out before you, the surface texture has a big effect on the way that light is reflected. The coarser the texture, the more reflection there is from surface irregularities. In order to get the right balance this requires the optimum texture. This gives the surface a consistent luminance over the entire ceiling area regardless of where you stand in the room, while the ceiling appears a light, neutral white. We describe this in the form of a retro-reflection coefficient, which should ideally have a value of 60.

How does an acoustic panel coated with Akutex™ create a **better acoustic environment than a panel with no coating at all**?

Ecophon sound absorbers and acoustic ceiling panels consist of a glass wool core with an Akutex surface treatment developed by Ecophon that creates a protective and aesthetically attractive surface. The porous core efficiently absorbs distracting noises in premises.

The result is an all-round improvement in room acoustics. Reverberation time and sound propagation are reduced, the sound level is lower and speech perception is much better.

More effective sound absorption

The sound waves that penetrate into the glass wool are absorbed as sound energy which is converted into other forms of energy, according to the first law of thermodynamics. The resulting friction converts sound energy into thermal energy. A temperature rise of fractions of a degree can be measured in an acoustic panel even when the sound level in a room is "normal".

The amount of sound energy that is absorbed depends mainly on the thickness, density, porosity and texture of the panel. Glass wool in particular has exceptionally good absorption characteristics.

However, the surface of the panel also plays an important role in determining how much sound energy is not reflected, but penetrates into the core. Akutex is a surface coating that has countless small pores of carefully chosen size (fractions of a millimetre in diameter), which exert the appropriate "flow resistance" on sound waves as they penetrate into the panel. The pores are just large enough to prevent the penetration of dirt, dust and water during cleaning.

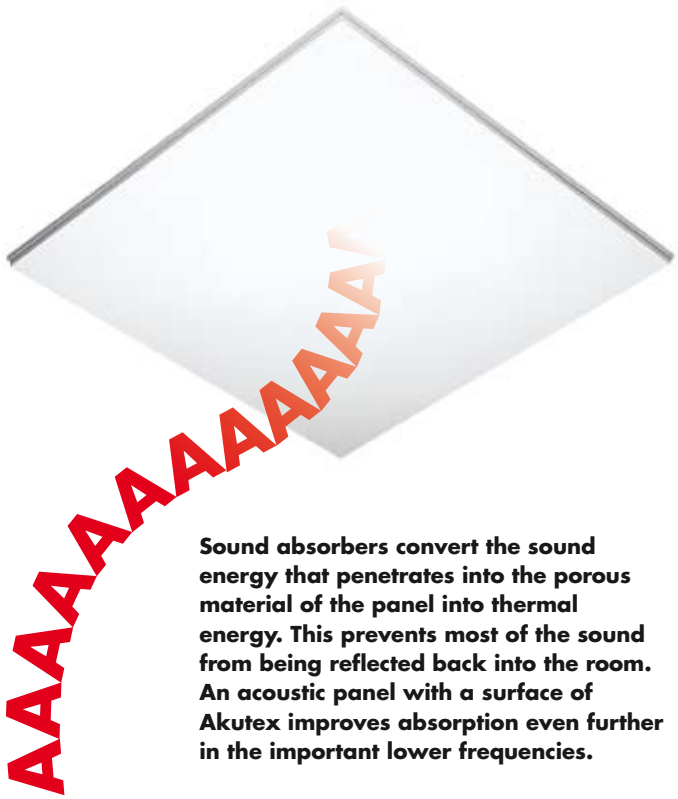
Sound waves with a short wavelength, in other words high-frequency sounds, have the lowest energy content and are therefore less likely to penetrate the surface. The secret behind the unique acoustic properties lies in the choice of pore size and density. This makes it possible to create "flow resistance" that is perfectly acceptable for high-frequency sounds, but at the same time has a much greater effect on the lower frequency sounds that it is so important to absorb.

The inertial mass of the Akutex surface also means that the panel oscillates against the volume of air behind it, which results in further damping of sound energy as a result of the resonant absorption that occurs in a suspended acoustic ceiling.

This means that an acoustic panel with a surface of Akutex has better sound-absorbing characteristics than a panel of glass wool alone.

Better acoustic environment for everyone

Good sound absorption in the lower frequencies is the key to improving speech perception for individuals with any form of hearing impairment. This means that Akutex provides more effective sound absorption that benefits everyone, throughout the spoken frequency range.



Sound absorbers convert the sound energy that penetrates into the porous material of the panel into thermal energy. This prevents most of the sound from being reflected back into the room. An acoustic panel with a surface of Akutex improves absorption even further in the important lower frequencies.

Akutex™
Surface Technology
by Ecophon®

www.ecophon.com

An acoustic ceiling
is never better than its surface

Technology and aesthetics in perfect balance
As the leading acoustic ceiling company, Ecophon has for thirty years been at the forefront in developing new properties for acoustic ceiling surfaces. Our painted surface Akutex™ has set standards that many have tried to emulate. Architects all over the world value the Akutex™ Surface Technology, seeing it as an important element in room design, resulting in functional as well as emotional comfort for end users.

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A CRYING NEED FOR BETTER ACOUSTICS

Many announcements that may be vitally important to travellers are often drowned out in the relentless din of an airport. A quieter acoustic environment **improves speech perception**, makes airports **more enjoyable places** and **calms the nerves** in what is generally a stressful situation.

What was your impression last time you were at a major airport? Could you hear the constant barrage of announcements from speakers yet were still unable to work out what was being said? Was that your plane that had been given an early departure slot, or your departure gate that had been changed?

Being able to hear announcements can be critical to your whole journey. A poor acoustic environment can also compromise safety, which at an airport is naturally very important.

Retrofitted acoustic ceiling

Traffic through Dubai airport is growing steadily, largely thanks to rising tourism. When plans were drawn up for Emirates Terminal 3 at Dubai international airport a suspended ceiling of sheet metal was originally specified for the terminal, but this was then changed to a ceiling of plasterboard.

During the course of building it was quickly realised that the acoustic environment would not be good enough to allow all passengers to hear the information and announcements that are so vital at an airport. An acoustic ceiling of the highest absorption class (class A) was sealed to the underside of the existing ceiling to meet sound level requirements. In addition to lowering the sound level, speech perception has improved considerably and all announcements from speakers can be heard clearly and distinctly.

Good experience with similar acoustic ceilings in the two other airport terminals had demonstrated their benefits, and this example clearly shows that only the best is good enough in such applications. Over 200,000 square metres of acoustic ceiling panels have now been installed at the three terminals.

However, hundreds of airports around the world still have a crying need to improve their acoustic environment – the question is simply how long can they hold out…

Burj Al Arab, the second tallest hotel in the world, after the Rose Tower, which is also in Dubai. The most expensive suite costs up to EUR 10,000 per night, and the cheapest room around EUR 700. Visitors who do not wish to pay for a room can use the lobby for EUR 50. The sail-like hotel, which is regarded as the first seven-star hotel in the world, stands on an artificial island. Areas such as the hotel's restaurant kitchen are fitted with acoustic ceilings which meet the high standards of hygiene that are demanded.

Foto: Göran Jacobsson

Lighting that shapes a space. Terminal 3 at Dubai has fascinating lighting provided by indirect ceiling lighting, reflections from the floor and the translucent columns. The ceiling is lined with sound absorbers of the highest absorption class. The terminal building also houses two hotels with a gym and spa.

Facts about Dubai
The emirate and city of Dubai is one of seven emirates that form the United Arab Emirates, located on the Arabian Gulf. Dubai is currently one of the fastest growing cities in the world. By 2012 it is estimated that Dubai will have over 30 skyscrapers taller than 300 metres. The latest is the Burj Dubai, which will be the tallest in the world at 800 metres, but there are already plans for a new tower that will break the kilometre barrier. The United Arab Emirates aims to accommodate 11 million people by the year 2015, and much of the infrastructure will be provided by Dubai. Oil is of dwindling importance in Dubai nowadays, as it is clear that it will eventually run out, and the city is instead investing in trade, financial services and tourism.

Acoustic ceiling from Ecophon

Dubai International Airport:
Ecophon Master™ F
Burj Al Arab Hotel:
Ecophon Hygiene™ Protec A

THE MOST-VISITED ROOM

Corridors are designed to enable people to get from one part of a building to another. But they are also used for transporting materials and essentials, and as a place where people meet. You could say that the corridor is the most-visited room in a building – a room where the **acoustic environment is really put to the test**.

This is where people get their first impression of a building and what goes on in it – from the entrance all the way to the conference room, classroom or hospital treatment room. Corridors and other communication areas are the nerve centre of the building, places where practicality and appearance take highest priority.

The corridor – some facts to consider

Corridors may require special technical solutions, since the void above the ceiling is often used for piping and cable runs for electricity, electronics, ventilation, heating, water and cooling.

Sometimes corridors have low ceilings, and practical and aesthetic solutions have to be found at junctions with connecting spaces. A common practical requirement is to provide access to the area above the ceiling. Attractive and reliable acoustic ceiling solutions are now specially available for corridors.

Where good acoustics mean everything

With better room acoustics, corridors and other communication areas can be used more effectively and for other purposes. According to the latest research, the simplest and most effective approach is to use the whole ceiling area to maximise sound absorption. *Room Acoustic Comfort*™ shows that several different acoustic benefits can be achieved using sound absorbers of absorption class A.

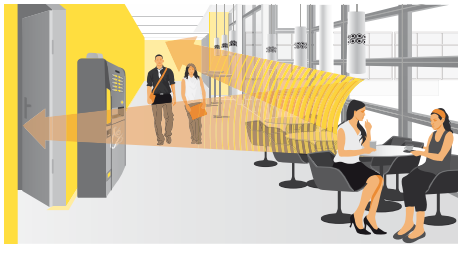
Both sound level and sound propagation are reduced, and this is especially important in corridors, which tend to carry sound along their length and into connecting rooms. Reverberation is also reduced, improving speech perception.

New acoustic parameters help enhance acoustic environment

The new parameters, DL_2, which describes how sound diminishes with distance from its source, and DL_f, which describes how a room contributes to the sound level in different parts of the premises, are used to assess the level of acoustic comfort in a room. These parameters make it possible to determine what acoustic measures are required in a room to create the desired acoustic environment.

In a narrow corridor where sound absorbers of absorption class A have been installed, it is estimated that the sound level (DL_2) will decrease by 3–4 dB(A) as distance from the source is doubled. Under the same acoustic conditions the sound level (DL_f) inside a room will be 7–8 dB(A) higher than if it were measured outdoors in the absence of reflecting surfaces. This indicates a good indoor acoustic environment, as this value represents a considerable reduction in sound level compared with a room with bare walls without any sound absorption.

Would you like to learn more about the various aspects of creating a good acoustic environment using *Room Acoustic Comfort*™? Go to www.ecophon.com.



In a hospital it is often desirable to keep doors open, so that staff can hear patients and signals from monitoring equipment. In many cases corridors are used as waiting rooms, and occasionally patients are temporarily placed in corridors. Spoken communication with patients has to be as effective as possible, even though many are elderly and may have impaired hearing. A poor acoustic environment can increase insecurity and stress in what is already a distressing situation. The best conceivable room acoustics are essential if corridors and adjacent areas are to be used effectively.

School corridors are used as a place to rest and relax, as well as for meeting and studying, as there is often no space set aside for group work. Students and staff constantly pass through the corridors, creating noise that can disturb adjacent classes. If it is noisy in the corridors then students tend to maintain the same noise level in the classroom, which can make teaching extremely difficult. The room acoustics in a school corridor should therefore be of the same quality as the classrooms if corridor spaces and adjacent areas are to be fully exploited.

The corridor is the most important place in an office for spontaneous meetings, so it should not feel like hard work to hold a conversation there. At the same time the sound from corridors should not disturb activities in adjacent work spaces. Multipurpose use of corridors places additional requirements on the acoustic environment. Areas may be set aside as meeting spaces or coffee corners. Some corridors may be used to house printers, photocopiers and servers that are noisy and distracting. The requirements for a good acoustic environment in corridors and other communication routes are therefore just as high as in the rest of an office.

For tough corridors

Ecophon Super G™ Dp XL is a new acoustic ceiling panel available in lengths of up to 2,400 mm and is designed specifically for corridors and installation runs. Spring-loaded mountings between the ceiling panels and the framing make it highly resistant to movement or damage as a result of balls, bags and other items being thrown in the air. The panels are securely held in the correct position.

The smart mounting system makes it possible to create a rugged ceiling that still allows easy removal and fitting of ceiling panels when work needs to be carried out above the acoustic ceiling.

This solution has proved very popular with school administrators and maintenance staff.

Ecophon Super G™ Dp XL resists rough treatment in areas such as school corridors.

During fitting, the ceiling panel is pressed against the spring inside the profile and is held in place by the channel.

Making access easy!

A true acoustic ceiling is attractive and contributes to good acoustic comfort. If you need complete access to installations above a suspended ceiling this is no reason to accept a sub-standard solution.

Utility installations such as ventilation ducts, heating and cooling systems, sprinklers and water piping, electricity and network cables are essential requirements in most buildings. Such installations can be even more complex in hospitals and care premises. The best place to conceal these installations is normally above the suspended ceiling, but eventually they all need to be maintained, replaced, extended or renewed.

This task is considerably easier if the installations can be easily exposed. Opening ceiling panels therefore offer the best solution in the long term, where there is a need for regular access to installations for a variety of reasons.

With Ecophon Access™, entire modules can easily be swung open to expose complete installation runs above the ceiling, without the obstruction of transverse profiles. Units can open in either direction, to avoid the nuisance of blocking doors or obstructing passages. When the work is complete the modules are swung back into their correct position. Ceiling panels are available in lengths of up to two metres.

Looking to design the **busiest** room in the building?

visit www.ecophon.com for **smart solutions for corridors**

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Welcome to a more pleasant, healthier and more effective indoor environment

Eco – For sustainable design is a magazine with the indoor environment in focus. Our aim is to deal with this subject from the aesthetic as well as the practical angle – concentrating on function, people and their well being.

We want to give you the necessary information and advice for making or influencing decisions when planning offices, schools, healthcare premises and other environments where people spend time, work and communicate. The magazine pays particular attention to room acoustics – significant for how people function, both on their own and together.

You can subscribe free of charge to Eco – For sustainable design, by visiting www.ecophon.com/eco and filling in your details.

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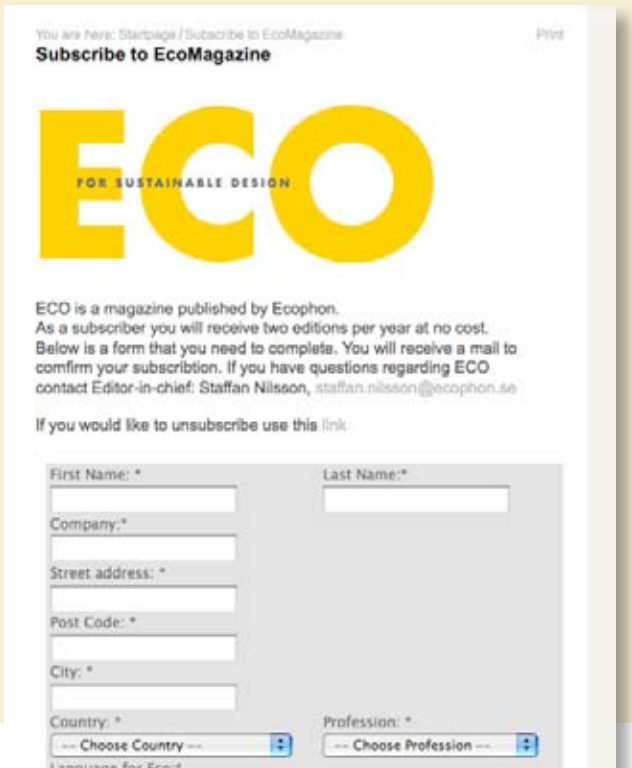

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