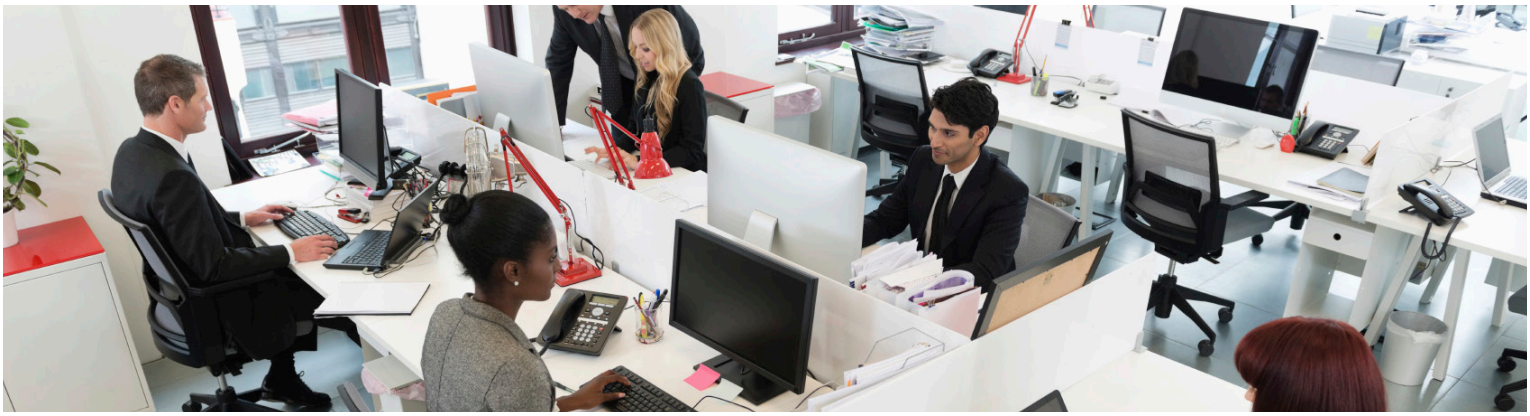

Visualisation of noise in office environments affects employee behaviour and reduces noise nuisance

A new concept developed by Jabra, SoundEar and DELTA breaks away from single-point sound measurements by visualising noise in open office environments in real time using sensors. By continuously measuring, analysing and visualising noise where it actually occurs and showing this to employees, they become more aware of noisy activity and change their behaviour. This means the future looks quieter for open office environments.

More and more companies allow their employees to work in open office environments despite their employees being exposed to noise nuisance. A number of studies show that the employees in large offices have difficulty concentrating on work when telephones ring, colleagues chat loudly and people move around behind them. The frequent work interruptions result in more mistakes, reduced productivity and a poor working environment.

Even though companies try to set up office noise barriers, sound-absorbing wall cladding or emit 'artificial noise' to mask the noise, noise nuisance is difficult to minimise. Perhaps because these solutions are passive and do not focus on the other employees' behaviour, which is the source of the noise.

Visualisation of noise

To help eradicate noise nuisance, SoundEar, Jabra and DELTA collaborated in 2013 to develop a completely new system that visualises the noise in an office for the purposes of helping the employees to change their behaviour. The three partners each brought specialist expertise and competencies in acoustics, noise measuring and wireless sensors. The project focused specifically on a system that can be used in large offices and call centres where employees frequently create noise nuisance during telephone conversations or discussions and when talking with colleagues.

The visualisation system focuses on remedying noise problems by measuring the noise simultaneously in several points over a large area and visualising the noise in real time on large screens. This creates an overview of the noise pattern in the office and identifies the noise sources.

"People's ears quickly get used to the actual level of noise, and the level at which noise becomes a nuisance depends a lot on the individual. Visualising the noise provides objective and easily understandable information about the level of noise in the room, at the same time it focuses on when the noise level increases significantly,"
says Lars Boldt Rasmussen, Director, SoundEar A/S.

A step further than measuring a single point

The new visualisation is very different from the traditional measuring devices we know from noise measurements, where the noise is measured in single positions in the room and then shown as a momentary level on a so-called noise map. These noise maps are a good way for showing where the sources of noise are but they use recorded measurements, so they do not show noise in real time. In addition, the measurements are frequently time-staggered, since you only use one sound meter to measure all of the points, so this method is therefore best suited to analyse constant noise. This specifically means that in environments with mobile and various noise sources, it can be difficult to identify specific noise sources when you look at a noise map with 'old' measurements.

The advantage of the new noise visualisation system is that it combines measurements in real time from a network of sound meters with software that generates a dynamic noise map, so that you get a much more detailed picture of the actual noise conditions and monitor the

1
http://www.kommunikationsforum.dk/artikler/kritik-af-aabne-kontorlandskaber-og-guide-til-en-bedre-kultur
http://www.ugebreveta4.dk/da/2008/200807/Baggrundoganalyse/MedarbejdereMistrivesIAabneKontorlandskaber.aspx
http://www.arbejdsmiljoviden.dk/Viden-om-arbejdsmiljoe/Indretning-af-kontor/Storrumskontorer
http://www.ugebreveta4.dk/stoej-paa-kontoret-giver-hovedpine-og-stress_19395.aspx

noise over a period of time – even when the noise perhaps moves during the day.
System advantages:

- You can see where the noise comes from and how the noise spreads in the environment.
- You can identify locations where there is less noise, if there is a need for quiet and concentration.
- The employees can monitor their own noise level and anticipate the noise problems.

Tested in a financial company

The project was financed by the innovation network InfinIT and SoundEar and Jabra, and it ended with a one-month trial in a large office at a major Danish financial company in the autumn of 2013. The results are promising.

The large office where the test was executed was specially selected by the company's working environment committee, because its level of noise was a well-known issue and previous measures had been carried out to limit noise in room. The office had 26 workplaces, of which 16-18 were normally used. Real time visualisation of the noise map was shown on two large screens in the office.

The NoiseGuide monitors the noise level in detail

The prototype that was tested was called the NoiseGuide and consisted of a combination of 10 sensors (microphones) and two flatscreens. The sensors were positioned above the workspaces in the large office and continuously measured noise and transmitted the measurements to the flatscreens, which displayed an illustration of the office environment with the noise levels. The flatscreens were positioned so that as many employees as possible in the office could see them.

"The development of sensors and wireless technologies of recent years has enabled us to set up a system that is extremely inexpensive compared to the price of traditional sound meters. In our case, the precision of the measurements is not that important. It's the ability of the system to make many measurements simultaneously at different points that gives its strength. The system can easily be scaled up, so it can be used in very large office environments and it's easy to install because it uses wireless technology,"

says Morten Georg Jensen, Electronic Sketching Specialist, DELTA.

The results of the sound measurements were shown using six different smileys (from green to red) on the two screens which corresponded with the sensor's positioning. The smileys functioned as a colour scale to illustrate a sound level in the range 45–85 dB(A). In this manner the screens functioned like a visual illustration of the actual sound level at 10 different locations in the room.

But NoiseGuide could do more than give a real-time image of the sound levels in the room. Using a background colour, NoiseGuide showed the development of the sound levels over a period of time. The background colours around the sensor positions changed in accordance with the average measurements over a six minute period. Thus it was possible to show whether specific areas had high sound levels over a period of time and how these levels changed during the working day. The background colours varied on a scale from dark green to light green, light yellow, deep yellow, light red and deep red.

In addition, NoiseGuide could print out an overview of the displayed sound measurements over a 24 hour period for the individual sensor positions.

Changed behaviour

The aim of NoiseGuide is to provide visual feedback that can lead to change in behaviour, when the employees can see the visual representation of the noise levels

in the room. The visual feedback gives the employees the possibility of changing their own behaviour. The locations where there is noise are also visualised and this gives an indirect visualisation of noisy activities. This gives the employees the opportunity to discuss how the noise can be limited.

The results from the questionnaire survey, which the employees had to fill in at the end of the testing period support this thesis:

- Over 70% indicated that the visualisation of noise had made them focus on noise in the office.
- 72% had 'to some degree' or 'to a high degree' become aware of the level of their own voice.
- Half of the employees had assessed that the visualisation of noise had diminished noise nuisance.
- 89% believed 'to a lesser degree' and 'to some degree' that the visualisation had resulted in changed behaviour in the office.

All in all, results of the questionnaire, which were supported by interviews with several employees, showed that the employees became aware of the NoiseGuide's visualisation of their behaviour and endeavoured to change their behaviour so that they caused as little nuisance as possible.

As expected, the test showed that the employees who could see the large screens from their workspaces, used NoiseGuide more actively compared to employees who had their backs to the screen. To optimise the system, several employees proposed that personal indicators were installed for each workspace, so they could easily follow the level of noise.

Visualisation produced mutual understanding

Of course people are different and employees do not necessarily all share the same tolerance thresholds for when noise becomes a nuisance. By being able to objectively observe noise from activities in an office, you can also potentially use the method to design the office workspaces in accordance with the activities and behaviours and in this way, remedy some of the noise issues.

"The project is a great example of how by researching the underlying causes of noise nuisance in large offices you develop an attractive solution, that doesn't just deal with the symptoms but instead gets to the root of the problem,"

says Michael Hoby Andersen, Senior Research Engineer, Jabra

- **DELTA** is an independent high-tech organisation that specialises in acoustics, electronics, microelectronics, light, optics, vibration and sensor systems. DELTA's IdemoLab department has helped a number of companies build prototypes and electronic sketching of products with sensor technology.
- **Jabra** is a global producer of innovative headset and speakerphone solutions. The company has extensive experience in the production development of innovative solutions where the focus is on sound.
- **SoundEar A/S** develops and produces noise meters for places where there is often noise nuisance, such as call centres, hospitals, day-care centres, etc.
- The project was sponsored by InfinIT, Jabra and SoundEar and it ran for over nine months in 2013.
- InfinIT is part of the Danish Agency for Science, Technology and Innovation.

To learn more about the project, contact:

Morten Georg Jensen,
Electronic Sketching Specialist, DELTA
Tel.: +45 22 31 67 34
mgj@delta.dk

Michael Hoby
Senior Research Engineer,
Interaction Design & Acoustics, Jabra
Tel.: +45 30 76 29 07
mhandersen@jabra.com

Lars Boldt Rasmussen
Director, SoundEar A/S
Tel.: +45 22 37 17 23
lars.boldt@soundear.dk