SONORUS

TECHNICAL REPORT

Title	**SONORUS report on Göteborg Test Site including Urban Sound Planning Workshop**
Status	**Version 03**
Author(s)	**Laura Estévez Mauriz, Jens Forssén, Wolfgang Kropp (Chalmers)**

PROJECT

Acronym	SONORUS		
Project title	Urban sound planner		
Project start date	1 October 2012		
Duration of the project	42 months		
Coordinating partner	Chalmers Tekniska Högskola	Chalmers	SE
Other partners	Eindhoven University of Technology	TUE	NL
	Seconda Università degli Studi di Napoli SUN	Naples II	IT
	The University of Sheffield	USFD	UK
	Ghent University	UGent	BE
	Müller-BBM	MBBM	DE
	The Italian National Institute for Environmental Protection and Research	ISPRA	IT
	EMPA	EMPA	CH
	SP Technical Research Institute of Sweden	SP	SE
Associated partners	Roma Capitale, Dipartimento Tutela Ambientale e del Verde – Protezione Civile	Roma	IT
	City of Berlin – Senate Department for Urban Development and the Environment	Berlin	DE
	AG Stadsplanning Antwerpen	Antwerp	BE
	Brighton & Hove	Brighton	UK
	The Netherlands Organization for Applied Scientific Research	TNO	NL

FUNDING

Funding	Project funded by the European Commission
Funding program	FP7-PEOPLE-2011-ITN
Project number	290110

Content

1 Introduction

Trends across the globe of population growth and urbanization are demanding an anticipatory process in the renewal and expansion of urban areas. In order to guarantee and increase human wellbeing, urban environmental quality becomes incredibly important. SONORUS project looks forward a proactive planning for acoustic quality, which can be coupled with the many parameters influencing the quality of life in our cities, embracing a holistic urban planning approach:

- involving acoustics at the earliest planning stage,
- considering acoustic aspects altogether, as an integral part of planning disciplines,
- extending the scope from pure noise control to sound design.

1.1 Practical Case Studies

The project SONORUS is dedicated to develop and provide expertise and tools to 14 early stage researchers (ESR) through an education program within the field of urban sound planning. To complete their toolbox of knowledge and connect their research with practical implementations, the project incorporates the use of 4 test sites: Rivierenhof Park (Antwerp, Belgium), The Valley Gardens (Brighton & Hove, UK), Colosseum, Palatine and Roman Forum area (Rome, Italy) and Frihamnen area (Göteborg, Sweden).

2 Göteborg Test Site: Frihamnen area

2.1 Frihamnen area: description and specific challenges

Frihamnen was built in the 20s as the most inner harbour on the north site of the river Göta, just in front of the city centre. This former industrial area, currently used for sporadic activities as concerts and sport events, will be restructured through a long-term project development that will last up to 2040.

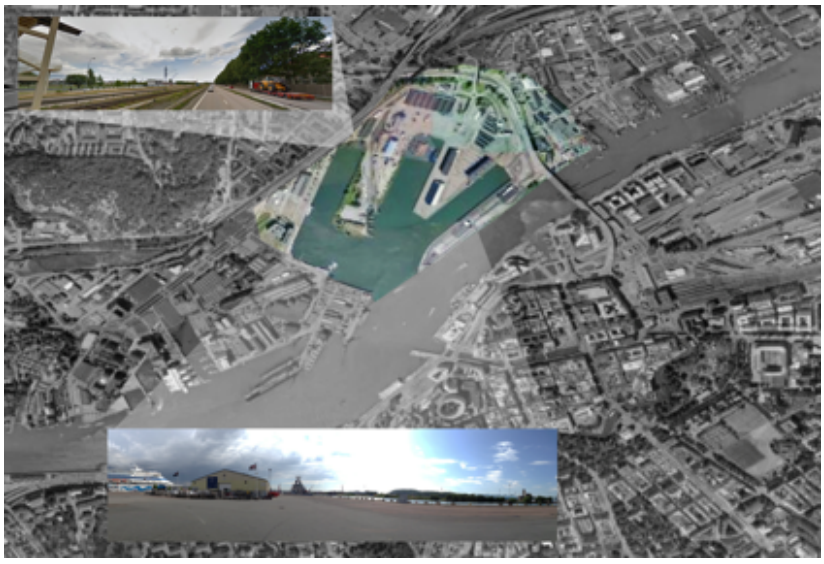

Figure 1. Frihamnen test site

The site, with a similar size as the city centre of Göteborg (see Fig. 2), will be transformed into a dense mixed-use area with around 15.000 new residents and the same amount of working places.

Figure 2. Size comparison between Frihamnen area and Göteborg city centre

Frihamnen project is part of the riverbank city vision (Älvstaden) as shown in Fig. 3. The idea to frame several projects inside this title, agree with the concept to build a more *cohesive, inclusive, green and dynamic city.* A series of workshops establishing dialogues with citizens and experts have been promoted as the better way to guarantee long-term successful projects. Due to its location, extension and opportunities, Frihamnen is probably the more important project among this vision.

Figure 3. Älvstaden projects. Retrieved from www.alvstaden.goteborg.se

Frihamnen is under constant development and only few things are decided (e.g. size of the park). However, the 400-year anniversary of Göteborg will take place in 2021. By then, the commemorative park as well as 1.000 houses and working places should be ready (see Fig. 4).

Figure 4. Left: Frihamnen development by 2021: first stage of Jubileum park (circle), housing (some of them temporary) and working places. Right: Frihamnen development by 2040 [1]

The task given to SONORUS working group is to analyze the acoustic situation and understand the impact of future developments on the acoustic environment. In this sense, Frihamnen presents a complex situation with a great potential to become a successful project and a pleasant area. However, it holds different environmental as well as infrastructure problems. Without a careful design within a holistic urban planning approach, those problems could increase due to the new development. As an example of that problematic situation, the noise map from Frihamnen area (see Fig. 5) reflects that a large area is submitted to noise levels higher than 55 dBA (L_{den} according to the Swedish noise descriptor) with road traffic as the main noise source.

Figure 5. Road, tram and railway traffic noise map reflecting the current situation of Frihamnen area. Lden (dBA) according to Swedish noise descriptor.

Moreover, the area will be largely influenced by the surrounding urban developments both at the north and south of the riverbank, impacting the spatial, social and economical structure and its environment.

The complexity of the project is also reflected in the variety of stakeholders involved, as the company “Älvstranden Utveckling AB”, the council of Gothenburg with the traffic office (trafikkontoret), the planning office (stadbyggenskontoret), the environmental office (miljökontoret) and the real estate office (fastighetkontoret) [2]. Furthermore, Swedish road and rail authority (trafikverket) is in charge of both motorway and train lines inside the city. The last one incorporates an additional problem since the planning is running in paralel to Frihamnen plans, especially affecting the connection with “Ramberg”, the park located northwest of Frihamnen.

3 SONORUS Urban Sound Planning Workshop on Göteborg Test Site

3.1 Workshop on Frihamnen area

Frihamnen test site workshop was the second of the four SONORUS Urban Sound Planning Workshops on Test Sites. The SONORUS group visited and experienced the test site on Monday 12th October, 2015. The workshop took place on the afternoon October 13th. Here, Wolfgang Kropp presented the idea behind this series of workshops, the schedule and the expectations for the Frihamnen workshop. After that, representatives from the city's working group of Frihamnen (Jonas Uvdal and Peter Comnell) together with Laura Estévez Mauriz on behalf of Frihamnen working group from SONORUS, presented the history of the area, the current state of the project, the expectations, the possibilities, the boundary conditions and the acoustic environment as well as some plausible future situations in terms of noise levels.

Following this, we formed 5 working groups with the SONORUS group together with the city’s representatives. During the next 2 hours, the 5 groups worked through a brainstorming of the situation and the plausible alternatives, sketching, debating and looking for plausible solutions and improvements of the urban sound planning. At the end of the workshop, each group presented their conclusions.

Figure 6. SONORUS Workshop on Frihamnen Test Site

The next section contains a summary of the ideas presented during the workshop.

3.2 Summary of workshop outcomes

To facilitate reading, the outcomes of the workshop are presented in 3 main aspects: noise control and design, acoustic quality and soundscape, and economic analysis. However, those 3 aspects are interconnected and their interpretations should not be made independently from each other.

3.2.1 Noise control and design

Introduction of noise reduction

Treatments as the ones from the project HOSANNA were suggested, focused on noise abatements in the propagation path through the implementation of greener solutions [3]. Also, ideas can be taken from all ideas developed for the four test sites of the SONORUS project [4]. Moreover, research in different topics and with different approaches is carried out inside the project, which can give further input. A publication list can be found in the SONORUS students' blog (https://sonorusfp7.wordpress.com).

Time scale of the project

The construction period will be around 20-25 years. In this sense, the area, its residents and visitors will be exposed to noise for a long period of time. There is a need to elaborate on different kinds of noise maps that reflect the construction process.

Proximity to railway

This issue is already causing high noise levels and vibrations. To minimize the impact of such high noise levels in the future development, we need to avoid reflections. This can be done by making a sloped roof/building that, at the same time may be walkable (introducing green roof and green façades), making it possible to cross to the other side of Lundby

Hamngata and the E-155. It is highly recommended to build some kind of noise barrier during the 15-20 years of construction (both noise and vibration).

Parallel road inside Frihamnen area to Lundby Hamngata

Possibility of building an area with 0 emissions, allowing only electric bus and electric cars, forcing the other vehicles to use other routes. Give the chance for this street to become a street “scale to the behaviour of people”. Moreover, the combination of the two rows of buildings, the one next to the railway and the one after the parallel road, could form a barrier to the park by shifted building positions.

Re-think the idea of spreading the traffic all around the Frihamnen area: Such a spread could result in higher noise levels for a larger area. As a consequence it is very likely that the entire area would need to implement noise mitigation measures. A better solution would be to concentrate the traffic and apply noise preventive solutions in the a concrete, limited area (resulting also in costs reduction), allowing potential to bring more quality to the rest of the area, attending to the spatial configuration, uses and functions [5].

Electric shuttle

Introduce an Electric shuttle-bus inside the area (making it less than 400 m to reach public transport) and promote biking and walking routes (careful study of connectivity and accessibility, also by boat).

New bridge

The new bridge connecting to the city centre requires a careful design (The old steel bridge is very noisy). There is an urgent need on the new bridge to have good shielding: make use of barriers. However, the noise coming from the city centre might be considered when analyzing the area.

Figure 7. Summary of ideas by one of the working groups on Frihamnen test site workshop (e.g. incorporation of low vegetated barriers, careful decisions regarding the connection with the surrounding areas, etc.)

Connections to other areas

These become very important for the success of the Frihamnen area. Include green and screening: make use of low barriers while keeping an attractive design that avoids feeling of insecurity.

Sound absorbing building surfaces

Incorporate vegetated roofs, especially at lower buildings, as well as green facades or sound absorbing facades. Small-vegetated barriers are also highly recommended to protect pedestrians and cyclists.

Shifted morphology

Shift buildings/blocks to avoid sound going into the area. The openings between buildings in the current plan are done in such a way that promotes straight roads. As it was drawn in the current plan, buildings at the end of the piers are shifted to block wind from sound west, the same kind of shifting is highly recommended to block noise.

3.2.2 Acoustic quality and soundscape design

Improvement of outdoor sound quality and attractiveness

We might be facing a problem to promote the area among new residents. The long-term construction period will cause high noise levels. In this sense, some kind of compensation is necessary because a large number of residents (as well as visitors) will be exposed to high noise levels for around 15 years. We need to tell them a good story in order to attract them: make the best out of the acoustic quality, hence targeting the liveability of spaces. Promote a mixed-use area and use of activities – to keep the quality of the area is a major long-term challenge.

All groups manifested the need to bring acoustic quality into the area. There is potential for that, where a large area could be undisturbed by road traffic noise. To ensure this, we suggest rethinking the traffic planning proposal (dashed black line representing the possible area that could be undisturbed by road traffic noise, Fig. 8).

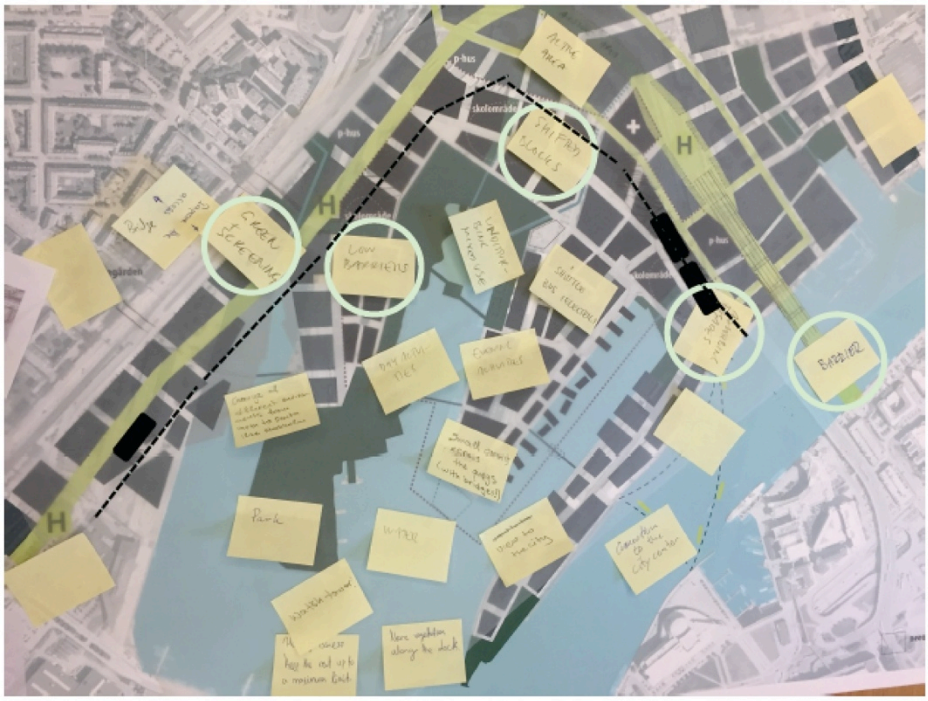

Figure 8. Summary of ideas by one of the working groups on Frihamnen test site workshop: dashed line marking potential area to be undisturbed from road traffic noise and noise control measures marked with a circle.

Accessibility

Access to the city centre and through Lundby Hamngata is important. Make the whole passage attractive and accessible, incorporating different sound environments. Regarding this idea of using sound to connect, some kind of heritage connection may be incorporated. The intention is to make this part of the city and its outdoor sound environment more active and attractive, reflecting on the possibilities to keep/recall its past (harbour, former industrial area). In order to achieve this, we encourage building a landmark, a soundmark: sound experience variation to make it more attractive, with a route through the piers that is acoustically attractive (kind of soundwalk including e.g. industrial sound, water sound, and experience history). The previous may enhance not only the acoustic quality but also the whole idea/story behind the project, incorporating its past and looking towards its future.

Figure 9. Summary of ideas by one of the working groups on Frihamnen test site workshop (e.g. connect the area through soundmarks/landmarks)

Sound features

While taking advantage of the positive sounds that water features may bring to the area, perhaps they can be incorporated through a contest among artists in the city in order to recall the waterfront history (e.g. sounds of waves on resting boat hulls). Similar ideas can be developed as floating bridges from city to Keiller's park; this will improve the attractiveness of the area and its soundmarks. Moreover, the route can include some shipyard sculptures (usually very much appreciated among citizens), as a variation of the sound experience.

Furthermore, another option is to let the people experience what is the feeling of walking in clay, water, and other kinds of ground conditions. The incorporation of such materials will not only brings different experiences to the citizens, but plausible energetic masking and attention masking from road traffic.

Park area

The park area will be submitted to high noise levels until stage 5 is built, that includes the area parallel to the railway (around 20 years). Because of this, park activities might be oriented according to the noise exposure the area will be submitted to during the construction period, as for example a recreational park with a high number of activities (concerts, recreational park, sports, etc.). However, incorporation of acoustic qualities is necessary in the park. The green area towards northeast will be more exposed to noise, needing then to be more active. A careful study of the urban layout is recommended in accordance with the activities performed (e.g. space adapted to lunch break activities, etc.).

Another solution might be to play with the topography of the park and build a slope in the park towards the area facing the railway. In this sense, a track loop to run in the park would be an attractive idea for Gothenburg citizens.

Piers

One of the main things to think about in the urban sound planning process is the building structure. In the middle pier, special facades might be necessary due to its lively soundscape as a consequence of the commercial area [6]. A plausible idea is to set back the ground floor to create a horizontal noise barrier to the rest of the floors.

Access from the main road to the middle pier might have to incorporate attractiveness and feeling of safety to avoid citizens taking the car all the way to the bottom of the pier – try to spread the activities.

Careful decisions need to be made particularly for the last pier, due to the boats that are going on the river.

Figure 10. Summary of ideas by one of the working groups on Frihamnen test site workshop (e.g. building structure decisions and park design)

3.2.3 Economic analysis

The economic analysis contains multiple aspects:

- There are several schools and hospital areas where there is need to incorporate certain noise treatments including material aspects.
- Analysis of the needs of the area and its uses and carrying out a strategic analysis (where also the time scale is checked).
- Investigation of the best alternatives (compromise solutions) concerning the plausibly lower attractiveness of the Frihamnen area due to the high noise levels all around it. In this sense, the traffic system can be planned as a deterrent, i.e. providing a layout difficult to drive through. However, such an approach might lead the area to higher noise exposure due to the spread of traffic and the increase in distance travelled inside the area, as well as in the surroundings.

3.3 Participants

Wolfgang Kropp, Jens Forssén, Joachim Scheuren, Dick Botteldooren, Maarten Hornikx, Jiang Kang, Luigi Maffei, Beate Altreuther, Kurt Heutschi, Massimiliano Masullo, Francesco Aletta, Sonia Alves, Gemma Echevarría Sánchez, Laura Estévez Mauriz, Karlo Filipan, Ignacio García Merino, Fotis Georgiou, Maria Holmes, Like Jiang, Martin Knape, Mercury Kounturas, Stathis Margaritis, Henrik Nystedt, Raúl Pagán Muñoz, Virginia Puyana Romero, Freddy Rietdijk, Georgios Zachos, Francesco Sorrentino.

We would like to thank Jonas Uvdal and Peter Comnell (Stadsbyggnadskontoret, Göteborgs Stad) for their participation.

4 References

[1] Älvstranden Utveckling AB, Göteborgs Stadbyggnadskontor. Workshop report Frihamnen Ettap 1. 20th/Nov/2015. Retrieved from:
http://alvstaden.goteborg.se/vara-delomraden/frihamnen/

[2] Scheuren, J., Kropp, W., Forssén, J. *Description of test cases.* SONORUS Deliverable 6.1, 3/April/2014.

[3] Van Renterghem, T., Forssén, J., Attenborough, K., Jean, P., Defrance, J., Hornikx, M., Kang, J. Using natural means to reduce surface transport noise during propagation outdoors. *Applied Acoustics* 92 (2015): 86-101. doi: 10.1016/j.apacoust.2015.01.004.

[4] Alves, S., Estévez-Mauriz, L. Aletta, F., Echevarría Sánchez, G., Puyana Romero, V. *Towards the integration of urban sound planning in urban development processes: the study of four test sites within the SONORUS project.* Noise mapping journal (in press).

[5] Estévez-Mauriz, L. Forssén, J. Kropp, W., Zachos, G. *Traffic dynamics, road design and noise emission: a study case.* Proceedings of Euronoise Conference 2015. Maastricht, the Netherlands.

[6] Echevarría Sánchez, G., Van Renterghem, T., Botteldoren, D. *The influence of urban canyon design on noise reduction for people living next to roads.* Proceedings or Euronoise Conference 2015. Maastricht, the Netherlands.