EXECUTIVE SUMMARY

LIST OF PARTNERS

RTD Role in project[1]	Number	participant name	short name	country	date enter project[2]	date exit project
CO	1	Acoustic Control	ACL	SE	1	48
CR	2	Accon	ACC	DE	1	48
CR	3	AKR	AKR	BE	1	48
CR	5	Alfa Products & Technologies	APT	BE	1	48
CR	6	Banverket	BAN	SE	1	48
CR	7	Composite Damping Material	CDM	BE	1	48
CR	8	Havenbedrijf Oostende	HOOS	BE	1	48
CR	9	FDP	FDP	BE	1	48
CR	10	Goodyear	GOOD	LU	1	48
CR	11	Head Acoustics	HAC	DE	1	48
CR	12	HEIJ Infra	HEIJ	BE	1	48
CR	13	Royal Institute of Technology	KTH	SE	1	48
CR	14	Vlaamse Vervoersmaatschappij DE LIJN	LIJN	BE	1	48
CR	15	Lucchini	LUC	IT	1	48
CR	16	NCC Roads	NCC	SE	1	48
CR	18	Stockholm Environmental & Health Administration	SEA	SE	1	48
CR	20	Société des Transports Intercommunaux de Bruxelles	STIB	BE	1	48
CR	21	Netherlands Organisation for Applied Scientific Research	TNO	NL	1	48
CR	23	Trafikkontoret Göteborg	TRAF	SE	1	48
CR	24	Tram SA	TRAM	GR	1	48
CR	25	TT&E Consultants	TTE	GR	1	48
CR	27	University of Cambridge	UCAM	UK	1	48
CR	28	University of Thessaly	UTH	GR	1	48
CR	29	Voestalpine Schienen	VAS	AT	1	48
CR	30	Zbloc Norden	ZBN	SE	1	48
CR	31	Union of European Railway Industries	UNIFE	BE	1	48

1 CO (Co-ordinator) or CR (Contractor)

2 Normally insert "month 1 (start of project)" and "month n (end of project)". These columns are needed for possible later contract revisions caused by joining/leaving participants.

OBJECTIVES

The general mission statement of this QCITY project is to develop an integrated technology infrastructure for the efficient control of road and rail ambient noise.

A first major objective is to provide municipalities with methods and products (commercially available tools) to establish noise maps and action plans (Directive 2002/49/EC) and to provide them with a broad range of validated technical solutions for the specific hot-spot problems they encounter in their specific city.

The main points are:

- using existing data of cities or other agglomerations for the calculation of noise maps;
- modifying these and adapting them on the basis of the noise indicators L_{den} and L_{night};
- calculating the strategic noise maps and the levels at the façades and developing a system that can be implemented in software to evaluate and rank different alternatives for a given scenario on the basis of exposure – effect relations;
- investigating the recommendable noise reduction measures (general ones based on inventory and specific ones based on technological development in the project) taking into account acoustic effects, conditions for applicability and costs;
- planning examples based on scenarios of the cities involved with ranking of different alternatives.

A second major objective is to provide cities and network operators with solutions for specific local noise complaints.

Many of the specific noise reduction tools, which are validated in the project, will also be of utmost use for dealing with specific local traffic noise complaints the cities are faced with (local hot-spots). Typical examples are excessive tram squealing noise, noise and vibrations from switches and crossing, noise from busses at stops (busses braking and accelerating), …

The validity of this mission statement has been verified and confirmed with cities and other EC projects (CALM).

The QCITY project is organised through seven different subprojects (SP):

SP1 – Noise maps & modelling	Analysis of hot-spots in city noise-maps. Detailed analysis with aid of simulation task & measurements.
SP2 – Vehicle sources	Development & validation of pertinent tools for control of noise at the source from road & rail traffic, including traffic control.
SP3 – Vehicle/infrastructure interface	Development & validation of pertinent tools for control of noise by change of the vehicle/infrastructure interface for road & rail traffic (tyre/road & wheel/rail).
SP4 – Propagation & receiver parameters	Development & validation of tools that work on sound propagation and receiver parameters, including town planning.
SP5 - Design and implementation of solutions at validation sites	Final detailed design of all solutions retained. Implementation and validation of solutions in cities concerned. Validation sites for dissemination and promotion purposes.
SP6 – Consolidation - Action plans – Dissemination	
SP7 – Management	This subproject & its steering committee will link activities in SP1, SP2, SP3 & SP4 to a number of optimised noise control packages for use in city areas.

The project has a duration of 4 years.

The project is "problem & solution" driven. Particular problem locations in cities will be identified. Solutions will be designed and manufactured for these particular problems, in order to validate the most interesting solutions.

The project's objectives are fully compliant with the requirements and needs of the final end-users: municipalities and urban transport operators. The municipalities and urban transport operators have a need in order to comply with EC-regulations, to create noise maps, identify and analyse the noise hot-spots and quiet areas and prepare proper action plans. The first objective of the QCITY project is to provide the municipalities with the tools to comply with these needs (eventual through service providers) and to provide them with products that enable them to carry out the provisions of the action plans. The second objective is to provide the urban transport operators with solutions to treat effectively noise complaints related to urban transport.

All the choices made in this work plan and in the partner selection have to be seen from this point of view: the proposed solutions have to be relatively easy to implement in short time by the municipalities (and/or the urban transport operators), they have to be general applicable, to perform at low cost and to be acceptable by all parties involved.

Solutions which require e.g. changes in the vehicle design (e.g. new power train) are not compliant with the above. This is why the involvement of vehicle manufacturers is small. The involvement of the tyre manufacturer (GOOD) and wheelset manufacturers (LUC) is important, since solutions at vehicle/ infrastructure interface are much easier to implement in due time.

SP1 - Noise mapping & modelling - Identification of noise hot-spots

Noise maps of the following cities (or part of) are available and will be updated according to the EC directive (status 2005): Ghent (B), Brussels (B), Göteborg (S), Augsburg (P), Ostend (B), Stockholm (S) and Stuttgart (D). Software compatible with the requirements of the EU-Directive will be used.

The SP1 objectives are to obtain following deliverables:

- noise maps of the above cities (or part of) (situation 2005) were available from P1;
- a method for the automated identification of hot-spots with a specific score model was developed [M18];
- detailed diagnostic of specific hot-spots related to the particular attention areas of each site or related to people complaints [M18];
- an intermediate evaluation of the benefits from mitigation measurements was performed [M18];
- action plans for the considered hot-spots in each participating city, based upon results obtained in other subprojects (SP2, SP3 & SP4) [M48];
- updated noise maps considering the solutions retained in the action plans for the above concerned cities (or part of) [M48].

SP2 – Perception of vehicle noise sources

All vehicles (road and railway) have to fulfil the EC noise requirements as described in the pass-by noise tests. The pass-by noise requirements will be even more stringent in the future. Efforts will be made by the individual vehicle manufacturers and their component suppliers to comply with these requirements. These efforts have to be made anyway by the manufacturers; they are furthermore strongly vehicle dependent and expensive. They are not part of this project.

The manufacturers have no incentive to perform better than these pass-by noise test requirements since this could increase costs and reduce competitiveness.

This means that short term reductions of noise at the vehicle source are bound to come from **retrofits** or from the **introduction of other types of vehicles**: electrically powered cars, new guided light tram vehicles, hybrid vehicles, … This project focuses on these items, rather than e.g. on developing a new power train for a specific vehicle.

Another source related topic is the **noise perception**. Two different vehicles, which both comply with the pass-by noise test requirements can be perceived quite differently by the receiver. This is why this project concentrates on the perception of the different vehicle noise sources: define noise "penalty" and "premium" values on noise source types in function of their perception. Partner HEAD ACOUSTICS is the European leader in this field and is in charge of this topic.

Other solutions to reduce the noise sources, which are evaluated, are related to traffic control options. **This project will focus on these traffic control options**.

The SP2 objectives are to obtain following information:

- identify / rank the perception of noise of various vehicles;
- conceptual designs and small prototypes of the most promising source related solutions such as measures that affect traffic control, driver behaviour, car ownership and mode shift.

SP3 - Vehicle/infrastructure interface noise

It is anticipated by the partners that major technical benefits are to be expected from measures at the vehicle/infrastructure interface: tyre profiles, road surfaces, rail and wheel profiles and types.

On the rail side this project focuses on gains from improvements to rail and wheel profiles, as well as the noise from wheel squeal, switches and crossings, corrugation, rolling noise, passage over bridges, … With respect to vehicle/road noise, the project focuses on improvements in tyre design and construction and on sound absorbing and elastic road surfaces.

The project focuses especially on these issues because of their short-term positive effect, their relatively low cost and their general applicability.

The SP3 objectives aim to obtain following deliverables:

- ranking of solutions related to the vehicle/infrastructure interface;
- conceptual designs and small prototypes of the most promising solutions.

SP4 - Noise propagation & receiver parameters

A very important concept for the noise attenuation related to the town planning and noise reduction is the possibility to arrange buildings not only to create quiet inner yards, but also to create totally new city core areas that are quiet.

This can be achieved by e.g. building larger, continuously connected office blocks near major ring roads or peri-urban motorways with a noise source characterised by high speed and high traffic density. This huge noise screen of office buildings can shield a large quiet residential area. The low noise level in the residential area can then be further preserved by e.g. restricting traffic, introducing adequate traffic calming measures, fleet management, ...

Besides the above aspects, QCITY deals with all possible measures, which influence noise propagation from source to receiver.

The SP4 objectives aim to obtain following deliverables:

- ranking of solutions related to propagation and receiver parameters;
- conceptual designs and small prototypes of the most promising solutions.

SP5 - Design & implementation of solutions at validation sites

From month 18, and in function of the results obtained in SP1, SP2, SP3 & SP4, solutions will be designed (final design) for specific problems that will be addressed in the city considered.

The SP5 objectives are to obtain following deliverables:

- final detailed design of all solutions retained;
- implementation and validation of solutions in cities concerned;
- validation sites for dissemination and promotion purposes.

SP6 – Consolidation – Action Plans – Dissemination

There are not yet action plans available according to the 2002/49/EC directive. In this project, sample action plans will be established (required contents and description of measures). They will serve as example for the municipalities.

STATUS OF WORK PERFORMED

The work scheduled for the full duration of the project has been completed and the findings reported in the various deliverables that are available on the ftp server.

SP1 - Noise mapping & modelling – identification of noise hot-spots

In P3 work has shifted on how to reconcile the noise rating models developed by TNO and ACC. The NERM developed by ACC is considered to be a method for hot-spot detection and will be described as such in the general document Noise Environment Rating Model.

In P4, the work has focused mainly on the practical use of the rating model. The model showed that it is indeed more important to rank priorities for mitigation than conventional noise maps. It was also shown that the rating model could detect hot-spots that were not normally revealed by the global noise maps. Another advantage was the model could study the benefits of mitigation measures in small areas that are drawn in the normal noise maps.

Another item was the update of the initial noise maps with the proposed mitigation measures based on input from SP5 and SP6. Further work considered the treatment of the various mitigation measures described in D6.6 and their treatment in the noise maps.

SP2 - Perception of vehicle noise sources

(Completed in P2, no activity in P3)

SP3 - Vehicle/infrastructure interface related noise

(Completed in P2, no activity in P3)

SP4 - Noise propagation & receiver perception

(Completed in P2, no activity in P3)

SP5 - Design & implementation of solutions at validation sites

This is where the bulk of the activities and costs are concentrated during P4.

WP5.1 Nieuwpoort – Quiet road for busses combined with trams

The new embedded track system developed FDP was installed in the network of DE LIJN in Blankenberge in combination with a new road surface in porous concrete developed by HEIJ. Due to the fact that it is impossible to pour porous concrete on site due to the difficulty of proper compaction, the street pavement had to be prefabricated upside down in the shop and than transported to the job site. This of course means a significant increase in costs.

At the same time, DE LIJN also installed the CDM artificial grass track in its network in Ghent to evaluate the benefits of this visually attractive (always green) solution. The grass was only glued on the concrete slabs between the rails. The concrete on the field side of the rails is used as a bus lane.

AKR performed the noise measurements for the evaluation in P4.

WP5.2 Athens – validation site – Quiet tram tracks

The new embedded track system developed by CDM in cooperation with the TTE to offer a significant reduction in squeal noise from tram vehicles passing trough short radius curves on the network of TRAM was installed in P3. TTE performed the noise measurements in P4 for comparison with the existing situation.

WP5.3 Brussels - Quiet tram vehicles on quiet tracks

STIB has installed a lubrication system at the entrance/exit of one of its major depots. The system serves several short radius curves that generate squeal noise, which is especially disturbing in the early morning hours when every minute a tram leaves the depot. AKR has performed the noise measurements. The results are positive when the system works. However, it has proven not to be very reliable.

Within this same framework, AKR also performed noise measurements on the network of DE LIJN in Antwerp, where the results of trams equipped with an on-board lubrication system were excellent. Moreover, the system demonstrated to be very reliable.

WP5.4 Antwerp - Quiet road surface

The crumb rubber based asphalt pavement developed by HEIJ in cooperation with CDM proved some problems with scaling from lab tests to industrial production. As a result, the validation could not take place on the road that was originally selected. Indeed, the road had to be finished on schedule, which did not leave enough time to straighten out the adhesion problem. As no other road was scheduled to become available where the asphalt could be tested it was decided to do the validation in the asphalt plant itself. Noise measurements were performed by AKR.

WP5.5 Göteborg – poroelastic road surface

After the successful section poured in P3, NCC has poured two additional test stretches with a modified VIACOGRIP 8 with a higher rubber content. Two sections of 150 m were poured, one with a thickness of 40 mm and one with a thickness of 60 mm. ACL performed the noise measurements using the CPX method and compared the results with standard asphalt.

A section of low close fitting noise screen from ZBN was installed along a tramway line. ACL performed the noise measurements for the two types of trams (older and new type M32) operating on the line.

To combat the wheel squeal of the M32 trams, LUC developed a wheel damper for these specific wheels

WP5.6 Augsburg – Town planning

This WP was completed in P3.

WP5.7 Ostend validation site – Freight operations in urban maritime environment

APT, AKR, CDM and FDP cooperated with HOOS to modify the track structure of a railway bridge in order to reduce the noise radiated by the bridge structure. The bidge was modified in P3 and was finished with the adjustment of the counterweights in P4. Since the aim was to tackle the

low frequency noise generated by the vibrations of the bridge, APT first analysed the FEM model of the bridge to identify the locations of the accelerometers. AKR performed the classic noise measurements.

WP5.8 Stockholm - Quiet vehicles (with reduced tyre/road- and driveline noise) combined with traffic control

In this WP, SEA and KTH in cooperation with ACL worked on simulations with various scenarios of fleet mixes with quiet vehicles and traffic restrictions in certain areas, as well as economic incentives and access charges, and this in combination with quiet road surfaces. In P3, NCC had poured a test section with its new very fine asphalt pavement called Viacogrip 8, which uses the smallest aggregate size allowed in Sweden. At that time, ACL performed the noise measurements and compared them with the current best dense asphalt SMA16. After one year, ACL performed a new series of measurements to evaluate the performance degradation after one year which included a Swedish winter and the driving of studded tyres. The insertion loss was reduced from 3 dB(A) to 2 dB(A).

WP5.9 Malmö – Suburban rail

BAN improved the track structure at the test location, and installed three types of rail dampers and measured the performance of these dampers for the various types of trains passing over this track section. As the results obtained by BAN with the VAS low noise rail VA71b were inconclusive, VAS started its own measurement campaign on existing tracks in Austria which revealed a gain of 1.5 dB(A) for all trains. Track Decay Rate measurements performed at all sites indicated that the success of the dampers depends on this important factor. VAS demonstrated that the success of the low noise rail depends on a rail pad with high internal damping.

BAN also installed a low noise barrier developed by ZBN and the insertion loss was measured by ACL for the various types of trains.

WP5.10 Stuttgart – Traffic planning (trucks)

This WP was completed in P3.

WP5.11 Test of new quiet passenger tyre designs

In P3 GOOD selected two low noise tyre designs, one symmetric and one asymmetric. In P4 work concentrated on the optimisation of the construction of the tyres. Since construction also affects the driving behaviour of the tyre these issues have to be factored in in the decision making process. ACL continued the noise reduction testing of its dual tyre concept using the CPX trailer and also in the lab at GOOD.

WP5.12 Development of a perception tool for traffic noise

HAC completed the development of its traffic noise synthesiser to include traffic scenarios. The tool was also used in listening tests to find a quantitative description for the subjective annoyance effect of traffic noises. The third part of this task was the development of en Evaluation Index (IE) to complement the typical L_{aeq} measure.

WP5.13 Stockholm – City areas with quiet vehicles

Included in WP5.8.

WP5.14 Amsterdam – Cost effectiveness of road traffic noise reduction

This WP was completed in P3.

DISSEMINATION

Dissemination started in 2006 with results from the first deliverables. Articles were produced and presentations given at conferences. The QCITY website is also available to the general public.

ACC has already made several presentations on the noise modelling software with noise rating (and related services) and is using the method in its consulting work. ACL and AKR have also adopted the method, which requires discussion and interaction with various stakeholders. in the will be disseminated after availability and testing of the developed software. GOOD has patented the tyre design and will soon start production of the new tyres.

It has to be emphasised that the major customers are the municipalities and the urban transport operators. This requires a 'specific' dissemination with individual local contact. Partners ACC & AKR are very active in the field of software development and services for environmental noise mapping and they will of course promote their new products to their existing large customer base.

HAC is world leader in auralisation tools and they will promote their newly developed products using their existing channels. The same applies for GOOD in the tyre industry, and HEIJ in the road construction.

Many partners have good contacts with urban transport operators to promote the developed solutions directly with their existing customer base. UITP will also be updated on the available solutions in function of the progress.

The 'research' community will also be informed, but is a secondary target in the dissemination process.

CO-ORDINATOR CONTACT

ACL, Mr Nils-Ake Nilsson
Tumstocksvägen 1
18766 Täby
Sweden
tel. [46] 08-732 48 00
na.nilsson@acoustic.se

PUBLIC WEBSITE:

www.qcity.org
www.qcity.eu