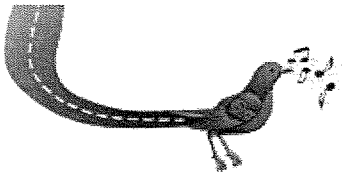

Project n° 031409

INQUEST

Information Network on Quiet European road Surface Technology

Instrument: Coordination Action
Thematic priority: FP6-2005-Transport 4

Final Activity Report
(Deliverable D08)

Period covered: 1st June 2006 to 31st May 2008

Date of preparation: 14th July 2008

Start date of project: 1st June 2006

Duration: 24 months

Coordinator: Guy Descornet
BRRC – Belgian Road Research Centre

Revision: 1

CONTENTS

1. Project execution

1.1 Objectives

The project aims at coordinating communication and dissemination of past and present research pertaining to guidance on the use of low-noise technologies for road surfaces to European countries with less access and experience in applying knowledge in that field. One of the main instruments is the dissemination of the contents of the Guidance Manual developed by SILVIA ("Sustainable Road Surfaces for Traffic Noise Control", a European-funded project completed in August 2005) by means of a series of workshops in countries that were not involved in SILVIA, with priority given to new member states.

One of the main outputs of SILVIA is a proposed acoustic classification procedure for road surfacing materials and technologies. A complementary objective of the INQUEST project is to promote European harmonisation of testing methods and equipment for this purpose. To that end, one has to set up a European network of users of the measurement methods involved in the classification procedure in order for them to exchange experience and data and to organise equipment comparison tests. It is noted that these tests are not proposed as part of the project.

A specific web page for the project is hosted by FEHRL: http://www.fehrl.org/INQUEST.

1.2 The contractors

The contractors involved in the project are:

1. BRRC – Belgian Road Research Centre (Brussels) - coordinates the project. Three main persons were involved, namely Guy Descornet, as Project Coordinator and actor in all the project activities, Luc Goubert as assistant to the PC for scientific and technical matters and Joël Vandermolen, as assistant of the PC for financial aspects.
2. FEHRL – Forum on European national Highway Research Laboratories – was responsible for the organization of the workshops and of the development and delivery of part of the presentations at the workshops. The persons involved were Steve Phillips (Secretary general) and Sara Riso followed by Isabelle Lucchini for the organizational work and Phil Morgan for the scientific and technical aspects.
3. DRI – Danish Road Institute – was responsible for part of the presentations at the workshops and for the launch of the Users Group. The main performer was Hans Bendtsen, occasionally replaced by Bent Andersen (workshop in Brno).

1.3 The dissemination workshops

1.3.1 Overview

The organization has been planned at the project kick-off meeting held in Brussels on June 28th, 2006.

Coordinated presentations have been developed and a "standard workshop programme" has been designed wherein the hosting country has the opportunity to present their views and to take part in a closing discussion. Here is the programme:

9:00	**1. Welcome address by local host ***
9:15	**2. Presentation on "domestic issues ****
9:40	**3. Introduction to INQUEST and SILVIA including relevance of programme, namely to the END (G. Descornet)**
10:05	**4. The road surface and traffic noise (G. Descornet)**
10:30	**BREAK**
10:45	**5. State-of-the-art of low-noise surfaces (H. Bendtsen)**
11:10	**6. Noise measurement methods and certification procedures (G. Descornet)**
11:35	**7. Experimental surfaces and future prospects (H. Bendtsen)**
12:00	**LUNCH**
13:30	**8. Interaction of low-noise surfaces with other control measures (H. Bendtsen)**
13:55	**9. Classification, labelling and COP, including prediction models and mapping (P. Morgan)**
14:20	**10. Cost-benefit analysis (H. Bendtsen)**
14:45	**BREAK**
15:00	**11. Summary and Presentation of the Guidance Manual (P. Morgan)**
15:25	**12. Presentation on national projects ****
15:50	**13. Other relevant European and International projects (P. Morgan)**
16:15	**14. General feedback from the audience / panel discussion**
16:45	**15. Evaluation and closing statements ***
17:00	**CLOSURE**

* *Up to the host to do.*

** *At the discretion of the host.*

The FEHRL team have launched a call for participation to their member institutions in the countries that where not involved in the SILVIA project. Seven positive replies were received in appropriate time, namely from Spain, Slovenia, Switzerland, Portugal, Romania, Greece and Czech Republic.

The presentations have been each time updated/upgraded according to the feedback received from previous events. In total, ten presentations of 20' each have been delivered at each workshop. The PowerPoint presentations have been supplied to the local organizers in advance so that they could deliver them to the participants either as printouts or as a CD-ROM. The

presentations include notes summarizing each slide so as to allow the participants to keep a full record of the lectures. It would also help those of them not too familiar with the English language to retrieve any information missed from the oral presentation. The ten presentations are given in **Annex A**.

An evaluation form has been distributed to the participants for them to rate the different aspects of the workshop (quality of presentations, interest of discussion, quality of documents provided, length of workshop) and to make comments on the subjects presented.

Six dissemination workshops have taken place:

City	*Country*	*Local organizers*	*Date*	*Number of participants*
Ljubljana	Slovenia	ZAG	21 November 2006	25
Bucharest	Romania	CESTRIN	24 May 2007	43
Dübendorf	Switzerland	EMPA & LAVOC	14 November 2007	23
Brno	Czech Republic	CDV	23 November 2007	25
Lisbon	Portugal	LNEC	3 December 2007	48
Athens	Greece	NTUA & KEDE	14 March 2008	136

The lists of participants are given in **Annex B**.

In addition, two members of the INQUEST team, namely H. Bendtsen (DRI) and G. Descornet (BRRC) had accepted the invitation of CEDEX (Spain) to present a selection of topics from SILVIA in the frame of their *"Jornadas Tecnicas – Incidencia de la capa de rodadura en la reduccion del ruido del trafico en carreteras"*, Madrid, 2-3 October 2006. However, this is not to be considered as a formal INQUEST event[1], just as an extra dissemination effort.

1.3.2 Ljubljana

The first INQUEST workshop was organized in collaboration with ZAG in their premises, on the 21st of November 2006. There were 25 participants including three INQUEST presenters. The main Slovene stakeholders were present, namely motorway managers, faculty, consulting company, institutes, design and construction companies.

In addition to the ten presentations by the INQUEST team, the workshop programme included presentations by Mikhail Ramsak (ZAG) on the Slovenian situation regarding traffic noise and by Janez ŽMAVC (DDC Consulting & Engineering Ltd) on "Noise-reducing wearing courses – the situation in Slovenia".

The discussion raised the following subjects:

[1] Travel and subsistence were offered by the host.

Question: what about the freezing resistance of porous asphalt?
Answer: porous asphalt has generally two drawbacks:

- more problematic winter maintenance: the porous asphalt is not damaged by frost, but it absorbs much more thawing salt, making it generally more difficult to de-ice
- porous asphalt tends to clog by dirt accumulation in the pores.

These aspects are all covered by SILVIA, namely under the topic sustainability of the low noise road surfaces.
Question: what about the reproducibility/repeatability of absorption measurements?
Answer: this is not an easy question. The problem is that there are different measurement methods. The results are quite sensitive to the condition of the porous road surfaces. The methods pick generally up the variation of the clogging over the surface. The distance between surface and microphone appears to be essential. TRL tried to apply a dynamic method, which appeared to work well up to 30 km/h, which is of course still quite slow in most traffic situations. In SILVIA it was demonstrated that static methods yield the most precise results.
Question: what about the signal to noise ratio of absorption measurements?
Answer: It has been shown that the methods work quite well, so the S/N ratio should be good, but this should be further investigated.
Question: which method was used to determine MPD values measured by ZAG?
Answer: SCRIMTEX apparatus was used, but only classes of MPD where measured. The sand patch method was also used.
Remark: this illustrates that knowledge of macrotexture alone is not enough to predict noisiness of road surface.
Remark: tolerances of measurement methods are not fully tested in SILVIA, but they are estimated based on good expert knowledge.
Question: Is the SILVIA classification scheme yet definitive? Should this not be tested?
Answer: There is a user group. In some countries the classification scheme is already tested, like in the Netherlands. There is a very simple classification scheme put into practice in Denmark, based on CPX measurements only (not complying with SILVIA scheme). There is a French work group considering implementation of SILVIA classification scheme in France. There is also interest for the system in Germany. One hopes that within one year there will be enough experience with the classification in order to start the development of a CEN standard. It is also the view of the EC that there should be developed such a standard. So a road surface (in the sense of a "product") could be sold anywhere in Europe, bearing a label complying with a CEN standard. Labelling has been quite widely used, but conformity of production procedure (COP) was not. For instance in the UK, road surface types are labelled with a certificate, but road surfaces are never checked after construction, in other words: it is not sure at all that a newly built road surface meets the acoustic properties (noise reduction) as claimed in the labelling certificate.
Remark: from road traffic noise spectra on porous road surfaces, it is clear that the optimal total thickness of the porous layer is about 60-70 mm.
Question: experiments show that there is a loss in noise reduction of two layer porous asphalt of about 7 dB(A) in the first 6 years after construction. Does it make sense to apply this type of road surface?
Answer: it is true that the lifetime of a two layer porous asphalt is not as long as ordinary dense asphalt. If a more noisy reference surface would be taken, like DAC 0/16 instead of the DAC 0/8

which is used in Denmark, than an additional noise reduction of 2 dB(A) is obtained. However, it is indeed true that the important loss of noise reduction of two layer porous asphalt during its lifetime justifies a discussion about the use of it.

Question: what is the influence of wetness on the pavement?

Answer: all the results presented up to know are valid on dry pavements. The influence of wetness on a pavement can generally be approximated as an increase of 3 dB(A) on non porous road surfaces and no influence on porous road surfaces. In Belgium about on one day out of three has some rainfall[2]. It is remarked that in practice rain has less influence than mentioned as rain also reduces the speed of the traffic, making it less noisy. A Danish study revealed that in Denmark about 11% of the time a road surface is really wet.

Question: how to measure an influence of 0,5 dB(A) if the precision of a class I sound level meter is only 1 dB(A)?

Answer: A class I sound level meter should have a precision of 0,3 dB(A) according to IEC 651 standard.

Comment: Lots of work has been done on the design of asphalt mixes in Slovenia, but that the awareness of the noise aspect of a road surface is quite new.

Comment: The subject of how to make roads silent has been studied the past 25 years. Basic knowledge has been acquired, but there is a lack of implementation. The carrying out of full scale experiments should be encouraged as much as possible, the aim being to persuade as much as possible [illegible] technicians.

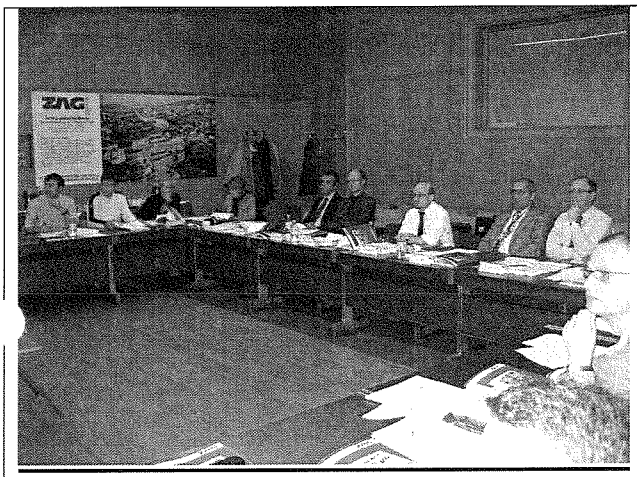

Figure 1 – The meeting room in Ljubljana.

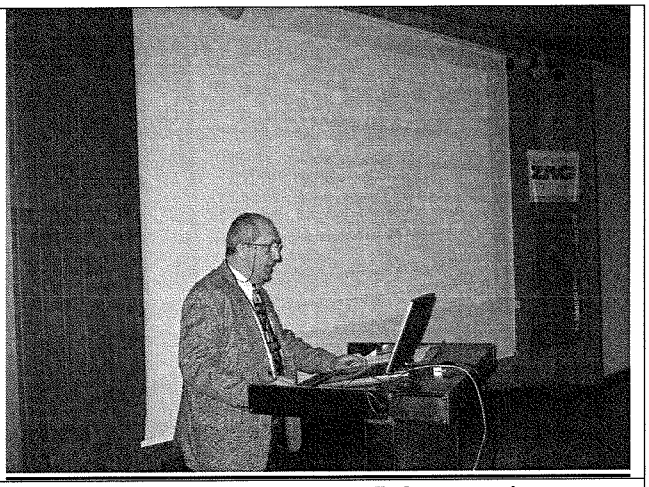

Figure 2 – The Chairman, Bojan Leben, opening.

Mr Bojan Leben concluded:

He thanked the INQUEST team for their decision to start the series of workshops in Slovenia. Due to the presence of a Serbian participant, the workshop can be considered as international. The presentations covered the European situation from theoretical research to practical

[2] A "rain day" corresponds to at least 1 mm rainfall over 24 hours.

instructions down to the regulation status. The main Slovene stakeholders were represented. ZAG is equipped to do noise measurements. Results will be implemented or at least used to check test methods or approaches. Slovene designers, consultants, institutes and construction companies are producing long lasting asphalt layers. There is a great concern for the implementation of porous asphalts especially because of hard winter conditions.

1.3.3 Bucharest

The second INQUEST workshop was organized in collaboration with CESTRIN ("Centre for Road Technical Studies and Informatics"), in their premises. It was attended by 43 participants in addition to the three INQUEST presenters. The Workshop was chaired by Prof. Dr. Ing. Laurentiu STELEA, Director of CESTRIN. Simultaneous interpretation was provided.

Apart from the "standard" presentations by the INQUEST team, two local experts made presentations, namely V. Minchevici, Ministry of Environment on "Problems with road traffic noise in Romania" and Mihai Dicu, Prof. Construction Engineering, Bucharest University on "Actions concerning reducing traffic noise on modern pavements".

The presentations were followed by a debate between the audience and the panel that raised the following subjects:

Comment: It is considered that Romania can take involvement in some of the activities discussed and future projects because the issues raised are of concern in Romania. In Bucharest there is a programme looking at reducing noise on the street. It is recognized that new equipment and research will be needed to reduce noise disturbance for people living alongside the street. Façade insulation (thermal insulating glass) is used in Bucharest but this is dependent on the budget of individuals.
Question: topic is very interesting. Modified bitumen reduces noise levels so should be used in urban areas? How to get the international standards etc.
Answer: 2nd question - most are ISO standards but these must be purchased, normally through own standardization institute. 1st question - MB not systematically benefiting noise rather it is used to improve the durability of the surface. Increases lifetime and therefore reduces the cost.
Question: Modified bitumen - asphalt mix with 20% voids cannot be conceived without MB.
Answer: Was done without MB originally, but surface was not durable. There are some additives which strengthen the bitumen around the stone but must take care. In Denmark, intentionally did not use MB in test sections as wanted surface to deteriorate.
Comment: Disappointing that Hungarians etc use low-noise surfaces but that don't in Romania. Would like to see the use of low-noise surfaces in tender documents by the procuring authorities right now.
Question: Saw that concerned with using rubber - is the rubber beneficial for reducing noise.
Answer: 3 ways of including rubber: include in binder to thicken the layer of binder around the stones, to replace some of the stones with rubber - no discernable affect on noise due to the inclusion of rubber. Swedish colleagues have made measurements on surfaces including rubber

and no discernable affect. Surfaces made entirely from rubber have a massive noise reducing effect but there are problems with the durability.
Comment: Institute who will draw the noise maps: Maps will be completed by end of June 2007. Strategic noise maps for lower-flow roads in 2012 and for all roads in 2017. Use French calculation method. The advantage is that the maps are done by calculations not measurements and we already have the necessary data, so the maps should be very precise. Includes type of vehicle, flow, type of road and type of surface. After noise maps completed under the Ministry of the Environment will take steps to reduce noise based on number of inhabitants. Cheapest measure likely to be an appropriate asphalt surface.
Question: If there road surface loses the noise absorption qualities, can it be recycled or the noise quality be restored?
Answer: do you mean can you improve material in-situ and can you recycle? Yes. No problems recycling providing used in base course and not in wearing course. If cannot recycle then have to dump and because likely to contain pollutants will be expensive. Several methods available for cleaning - pressurised air or pressurized water. Have experience in Holland and in Denmark. Another way of recovering performance is called rejuvenation -spraying of emulsion to recover properties of binder. Lot of experiments going on regarding the cleaning of PAC (only a problem when the speed is low). Scanning tour to Japan showed cleaning immediately after laying and then every week - this helped retain the performance for longer.
Question: Porous asphalt is expensive - what are the costs. What durability is like compared to regular pavement?
Answer: see SILVIA manual for costs. Expect durability to be 7-9 years; for thin layers 13-15 years.

Figure 3 – View of the auditorium in Bucharest during the introductory presentation by Prof. Dr. Ing. Laurentiu STELEA, Director of CESTRIN. Panel: G. Descornet, P. Morgan and B. Andersen.

Prof. Stelea concluded:

Thanks to all of the speakers for explaining everything that is new in this field. Meeting was fruitful; dialogue will continue as we are members of the European programme and need to be able to solve these problems. We are also interested in other modern techniques and technologies for road surfaces, not just noise. We need new materials and to see evidence of new more sustainable materials.

1.3.4 Dübendorf

The third INQUEST workshop was organized in collaboration with EMPA (Eidgenössischen Materialen Prüfung Anstalt) at EMPA-Akademie. It was attended by 23 participants in addition to the three INQUEST presenters. The Workshop was chaired by Prof. Dr. Ing. Manfred Partl of EMPA. Apart from the "standard" presentations by the INQUEST team, two local experts made presentations, namely Ing. Dipl. Carlo Mariotta (FEDRO – Swiss Federal Roads Authority) on "The noise issue in Switzerland and M.S.C.E. Lily Poulikakos (EMPA) on "Mechanical properties of Porous Asphalt, recommendations for standardization".

The presentations were followed by a debate between the audience and the panel moderated by Dr Markus Caprez of ETH-Hönggerberg. Hereunder follows the list of the comments, questions and answers:

Question: What is the thinking behind the Users Group?
Answer: To gather together those people who are using or are thinking of using procedures for classifying the performance of road surfaces, procedures for COP assessment. Type approval measures already exist for vehicles and tyres, for example. SILVIA proposes this for surfaces.
Question: Since the aim is for CEN standards, are we aiming to educate the partners in the standardisation committees?
Answer: Commission has CEN standards in mind but no mandate. For issuing of mandate, Commission needs to know that there are already experts. The user group will pave the way for this. It is important that the Swiss get a foot in the door, as it is a very important subject. They will be invited at the Users' Group Workshop.
Question: Will there be enterprises able to perform these procedures?
Answer: Yes, there are countries (Holland and UK) that already have some form of the procedure.
Question: Are the guidelines set out at the end of G. Descornet's presentation for high speed or low speed roads?
Answer: Those are general rules that are applicable everywhere.
Question: Any influence of stiffness?
Answer: There are no definitive experimental results for stiffness, but it is accepted that it could have an influence.
Question: What tyres used for these results?
Answer: These are example results and should not be taken as precise values. E.g. the car tyre results used an ordinary tyre. DRI have played with elasticity in SILVIA and will present some results.
Question: In the noise vs. texture graphs, how are temperatures taken into account?

Answer: Temperature was not taken into account but all results were taken in the same month (September).
Question: Any experience with ageing behaviour of the French data?
Answer: Think they have data but not included in the presentation. Measurements looking at durability are often prohibited by cost, but lifetime development of noise is important.
Question: Noise reduction vs. age graphs – were surfaces cleaned?
Answer: No artificial cleaning but only by natural passage of tyres over the surface. Porous pavements are self cleaning at high speed.
Question: Why noise performance decreases in 1st year with PA?
Answer: Not clear, but illustrates the possibility of outliers occurring in measurements. Same trend observed in Switzerland. One possible explanation is that on new asphalt pavements, the binder film affects the noise during first weeks/months, so could produce excess stick/snap.
Question: Re. porous concrete, it was commented that perhaps not so durable under effects of water – is there evidence of that?
Answer: No experience with cement concrete and not examined in the SILVIA project. Some work has been done in the Netherlands which might show some effects.
Question: SPB vs. CPX. What is the variation in repeatability between methods?
Answer: One cannot say precisely but CPX may be more repeatable than SPB measurements. Better to use CPX to look at ageing because it is more repeatable.
Question: Difficulties with measurement of air void value in very thin layers, how is it done?
Answer: We have the same problem. It is not measured in any special way.
Question: Poro-elastic surfaces behaviour over time?
Answer: Some results are reported in Inter-Noise papers but durability is still being worked on. Test sections were laid in the IPG Dutch project.
Question: How to ensure everybody using same tolerances etc?
Answer: One needs to get people adopting the principles first and get people used to working with these types of schemes then can start to formalise. CEN might take things forward as standards.
Question: How to distinguish connected voids?
Answer: There is a (French) standard test (reference on slide). Has to do with the measurement of water permeability.
Question: Is there twin-layer in Switzerland?
Answer: Yes, at one location: 8 mm top layer and 22 mm bottom layer and gave good experiences. Has been removed but not as a result of failure.
Comment: The aim of the workshop is knowledge transfer. People who should use this knowledge (stakeholders/decision makers) are missing! Zürich Canton is represented in attendance but there are 26 cantons in Switzerland! Only if we succeed in finding wearing courses which provide noise reduction and long life/low maintenance can we convince project engineers, authorities etc. to switch to and adopt these types of pavements presented today.
Question: What is the next step that would have to be taken in Switzerland and in Europe?
Answer: Looking at Denmark, they have started to create a market for low noise pavements by introducing a pavement classification system. This allows authorities to specify the noise performance of thin layers in contracts. Market has taken on board the demand and use of these

pavements, so that real low noise thin layers are being laid for real. Still a lack of data on the durability of thin layers and research/experiments is continuing to improve this.
Question: Can you have noise abatement without mechanical performance requirements?
Answer: Noise performance deteriorates before mechanical problems arise, so no difficulties foreseen. Structural durability is generally well controlled. The problem is acoustic durability; with porous surfaces the problem is clogging. So far, not been demonstrated that cleaning machines have been really effective. Either shouldn't put too much emphasis on cleaning and maintenance but develop better and more robust systems.
Comment: Much of what has been presented is very focussed on porous asphalt. Many locations in Switzerland where PA cannot be adopted due to winter conditions etc.
Question: Are research activities planned to 'open out' to look at non-porous surfaces?
Answer: Similar comments were made in Denmark and there is very little general use of PA in Denmark other than for research. SILVIA has looked at thin layers, trying to abate the usual problems with porous surfaces. IPG (Dutch project) has also looked at thin layers despite the initial sole focus on porous surfaces. They are trying to develop thin layers for use on highways. There are two ways therefore being looked at in Europe – porous surfaces and thin layers. They may meet eventually. Thin layers offer benefits in terms of durability, cost and winter maintenance over porous asphalt. SILVIA focus seems to have been mostly on highways. There seems to be reluctance to look at urban areas, e.g. non-use of porous asphalt with turning traffic. Main problem in Switzerland is actually in urban areas. The main problem with acceptance of low-noise surfaces is because of problems in urban areas.
Comment: Work is biased by who holds the purse strings – generally highway authorities. But most of the problems are generally in urban areas. SILVIA has focussed on both highway and urban. SILENCE is focussed on urban areas. QCITY is also considering urban areas. Trying to have the approach that the highways agency should be a service provider. New Swiss research will focus only on urban areas (a similar type of programme to the Dutch). London is using low-noise surfaces as routine but without the knowledge of whether there are actual noise benefits. Swiss doing noise improvement projects since 1980s and have legal basis for doing so. By comparison, the EU is only now starting to do this through the END. The Swiss have already done classification of pavements for different speed ranges and the pavements are used on highways. However in urban areas more needs to be done. Already have cost-benefit tools too, so can evaluate which noise mitigation measures can be used. The planned stimulation programme will hopefully initiate further acceptance by the road builders and road representatives.
Question: Being aware that all this research is "European", how could other countries get access to the information? How does interaction take place, e.g. with the Japanese?
Answer: There are international conferences which provide networking opportunities. It is difficult to join research efforts and get cooperation. A first attempt has been done by EraNet (11 countries); all projects on which trans-national research agreed are on silent roads. But EraNet is Europe! A 2nd step could be to exploit the TRA platform. But still European. Japan uses PA under harsh winter conditions. They accept wear through studded tyres and the need for extra salt. DRI and DWW made study tour to Japan (reports available on DRI/DWW websites). Other continents are lagging behind. SILVIA/INQUEST/SILENCE were launched because of the need to respond to END. Low-noise surfaces are one possible solution, but not the only solution (façade insulation: expensive; noise barriers: expensive and limited). So it is hoped with all of the

effort of this dissemination that decision makers will be convinced to use low-noise surfaces because other options are limited. Also LNS can allow the use of lower barriers, etc.
Question: Would we predict that low noise surfaces will be 'standard'?
Answer: The aim of Swiss research was to develop low noise surfaces corresponding to existing standards and then being low noise as an extra benefit. There is a need for a classification system, but there are problems with only having initial values as targets. The federal administration will prescribe the rules and requirements to establish some kind of 'bonus' system. A Swiss report due at end of 2007 will make clear recommendations on durability requirements.

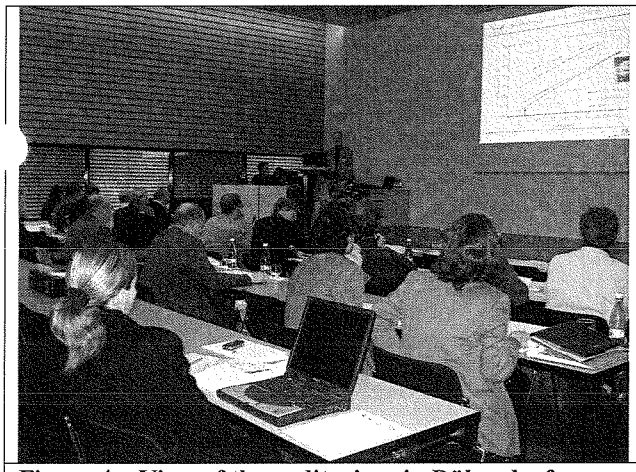

Figure 4 – View of the auditorium in Dübendorf.

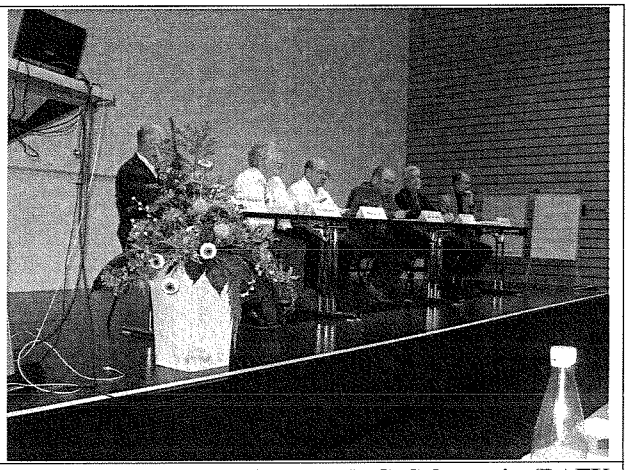

Figure 5 – The discussion panel: G. Schguanin (BAFU - Bundes Anstalt für Umwelt, CH), G. Descornet (INQUEST), P. Morgan (INQUEST), Markus Caprez (ETH – Eidgenössische Technische Hochschule, CH), Carlo Mariotta (FEDRO – Swiss Federal Roads Authority) and H. Bendtsen (INQUEST).

M. Partl closed the meeting by acknowledging the good discussion and stating that one has learned a lot for future initiatives because all problems are not solved yet.

1.3.5 Brno

The fourth INQUEST workshop was organized on November 23, 2007 in collaboration with CDV (Centrum Dopravního Výzkumu – Transport Research Centre), in their premises. It was attended by 25 participants in addition to the three INQUEST presenters. The Workshop was chaired by Dr. Josef Stryk (CDV). Simultaneous interpretation was provided. Apart from the "standard" presentations by the INQUEST team, one local expert namely Dr Rudolf Cholava presented "The noise issue in Czech republic" and one invited expert, namely Dr Marco Conter (ARSENAL Research, Austria) presented the SPENS European project that specifically addresses the New Member States. All presentations had been translated into Czech language by the hosting institute, including the notes pages, and delivered on a CD-ROM.

The discussion raised the following subjects:

Comment: CZ had cement concrete with coarse texture. Now used brushed or burlap textured. Other places use EAC which is less noisy. So therefore cannot say that all cement concrete surfaces are noisy. Need to ideally include measurements on EAC.
Question: Regarding noise reduction for surface types: All of the measurements presented are in terms of L_{Amax}. Are there any results expressed in terms of L_{Aeq} because maximum level is not used for setting noise limits.
Answer: There is a one to one relationship for individual vehicles between the maximum and equivalent levels. However, reporting performance in terms of maximum levels is the standard approach.
Question: It would be useful to know the precise value of differences between pavements in terms of L_{Aeq} so that it can be compared with other mitigation measures which are usually referred to using L_{Aeq}, e.g. a noise barrier gives a 10 dB(A) L_{Aeq} reduction. Can we give exact values?
Answer: It should be noted that the differences described in the presentations are exactly the same for L_{Amax} and L_{Aeq} providing that the traffic conditions are the same. If the speed of traffic, volume and type are the same, then the differences will be the same.
Comment: In general the effectiveness of a barrier is frequency dependant so that then there could be an influence on the barrier performance due to the pavement type on the road. Further details are included in the Guidance Manual.
Question: When you compared results for different pavements that were taken after a few years, to what extent have temperature effects been taken into account?
Answer: All of the results presented are normalised to a reference temperature of 20°C. In general, a reduction in noise level of 0.05 dB at any frequency occurs for 1°C increase in temperature.

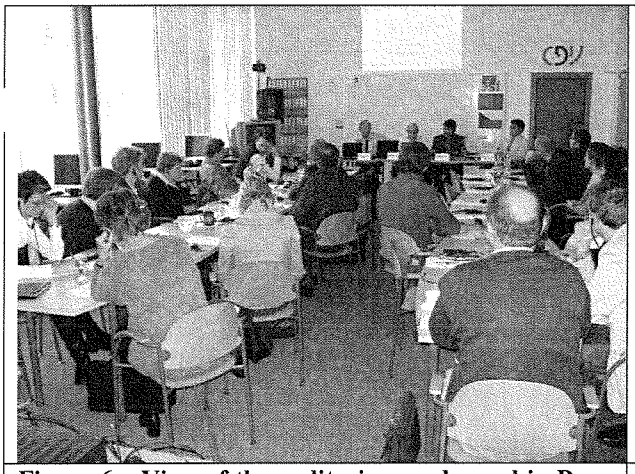

Figure 6 – View of the auditorium and panel in Brno (G. Descornet, P. Morgan, B. Andersen and M. Conter).

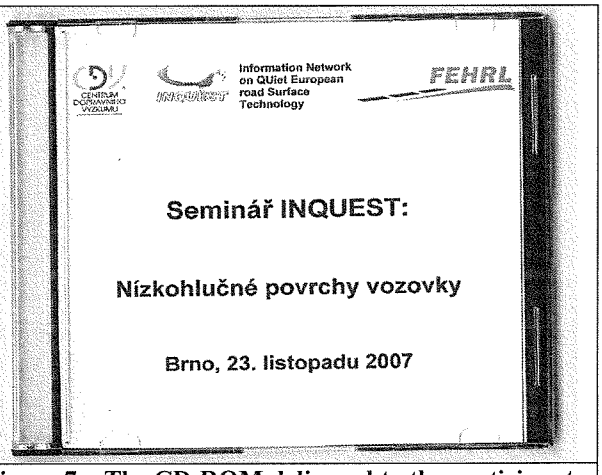

Figure 7 – The CD-ROM delivered to the participants containing all presentations translated in Czech language.

Dr J. Stryk closed the meeting by thanking the INQUEST team and M. Conter for their valuable input.

1.3.6 Lisbon

The fifth INQUEST workshop was organized in collaboration with LNEC (Laboratorio Nacional de Engenharia Civil), in their premises on December 3rd, 2007. It was attended by 48 participants in addition to the three INQUEST presenters. The Workshop was co-chaired by Dr Carlos Pina, Vice-President and Dr Ing Maria de Lurdes Antunes, Investigadora principal, Chefe do Núcleo de Infra-estruturas Rodoviárias e Aeroportuárias. Apart from the "standard" presentations by the INQUEST team, three local experts made presentations (in Potuguese), namely J. Patricio on "Study of solutions for minimizing traffic noise in Portugal", E. Freitas on "Contribution of alternative road surfaces to noise abatement" And C. Guerra on "Evaluation of the effect of the pavement on road traffic noise on the Auto-Estradas do Atlantico".

A discussion time was allowed at the end of the programme. Here is a summary of the exchanges between the audience and the panel.

Comment: Cobble stones are used on a wide scale in the historical areas of Portugal.
Question: Thin layers: presumably it is the size of the aggregate that is important and not the thickness?
Answer: This is true, but you may affect the functional durability of the layer by making it thicker. The general rule is that the thickness is 3 times the max aggregate size, but this is obviously not important for dense surfaces.
Question: Why is age important? If maintenance has been properly done, surely texture won't change.
Answer: This is not strictly true; there will be changes in texture that result from ageing regardless of maintenance.
Question: Noise vs. age graphs: one showed that performance improves during the first year – why?
Answer: Change due to removal of bitumen film during early lifetime and possible further compaction of the surface layer under trafficking. Measurement interval in graphs is 1 year, but this evolution does not take 12 months to occur. Wearing of binder film occurs relatively quickly in the early life of the surface.
Question: No information about standard conditions?
Answer: Danish results on urban roads do include the effect of maintenance (cleaning) of the porous pavements. High speed road results do not include any cleaning or maintenance. Generally, high speed roads are self cleaning.
Question: Two-layer porous asphalt looks interesting but is there any data for the performance after 2 years.
Answer: There is data but the performance was a little disappointing in the longer term – the noise reductions were significantly degraded. However, the reasons for this are still being investigated.

Comment: Hope not pushing traffic calming too far. Generally used for safety not noise, but there are generally increased costs (duration of journey, extra policing).
Answer: Generally noise effects are not considered in the evaluation of traffic calming measures, however comment is valid.
Question: Are road authorities using the proposal about classification?
Answer): UK/NL/Denmark are all investigating the SILVIA concepts in one way or another. Such a classification system might be useful in terms of evaluating the effectiveness of mitigation measures for use in END-related Action Plans.
Question: Who was involved in the development?
Answer: It was primarily the Dutch and the English partners on the project; however every effort was made to generate a proposal which did not favour a specific partner or nationality.
Question: How are the effects of speed changes or other extraneous noise sources taken into account?
Answer: Focussing solely on tyre/road noise using CPX and SPB measurements focus on whole vehicle noise. Although earlier presentation highlighted the lack of correlation between SPB and CPX that is not considered to be too significant a problem because label is determined for specific mixes.
Question: What precisely is included in the example of cost/benefit analysis, e.g. are all of the costs associated with maintenance etc taken into account, and is the degradation in noise reduction accounted for?
Answer: Maintenance costs are included for the full 30 year period, including all cleaning, reconstruction costs, etc. It must be remembered that this is only a calculation based on one data set and is not a definitive, global answer. The documentation available on the SILVIA website provides further examples of CBA.
Question: You concluded that there were no significant benefits on safety of using porous surfaces. Is this true, as you are disregarding the improvement in splash 'n' spray?
Answer: Drivers seem to compensate for the improved view during rain by increasing speed. Additionally there was no statistical basis for firm conclusions in terns of accident analysis.

Figure 8 – View of the auditorium in Lisbon.

Figure 9 – CD-ROM delivered to the participants

Vice-President C. Pina concluded:

The opportunity of the Seminar has allowed the dissemination of useful information. The day has been very interesting and informative and it is considered that what has come out of the SILVIA project is very important. Congratulations to FEHRL for initiating and running a project as good as SILVIA. It is a challenge that we should take forward to implement the methodologies identified. The Seminar has demonstrated innovative solutions to traffic noise mitigation.

1.3.7 Athens

The sixth INQUEST workshop was organized in collaboration with NTUA (National Technical University of Athens, Department of Transportation Planning and Engineering) in their premises. It was attended by 136 participants in addition to the three INQUEST presenters The Workshop was chaired by Prof. Andreas Loizos who opened the Workshop by recalling that "*EU requires Greece to deal with noise issues and to adapt as necessary. As motorways come closer to the city, it becomes more important to protect urban areas against noise. Technology is increasing to assist in this issue. Noise has been a very long-standing issue for hundreds of years. Roads must have certain characteristics to benefit the user. However, in the current climate, we are not only addressing skidding resistance, but also noise, i.e. issues affecting people other than just the users. Currently, traffic noise is a major environmental problem and has a critical impact on mental and physical health. Pavement surface has a significant role in the noise production. The emphasis of today's presentations is on the noise performance aspect. Other important characteristics include ravelling, rutting, skidding resistance: we hope that today's speakers will reassure us that low-noise pavements do not have an adverse effect on these issues. There are key issues to be considered: ride quality, skid resistance, noise & environment, bearing capacity and road safety. These must all be considered when evaluating/selecting surfaces*".

The presentations were followed by a debate between the audience and the panel. Hereunder follows the list of the comments, questions and answers:

Question: Any results on the effect of different binders on noise: does e.g. binder hardness have an effect, or the effects of PMBs?
Answer: Binder has a big influence on the working lifetime of the pavement, especially for porous pavements. One must use PMBs for porous pavements. But this in relation to structural durability. In SILVIA, the acoustic durability and the softness of the binder were investigated – flexibility of the pavement should be of the order of the flexibility of the tyre for optimum performance. Using bituminous binders, there will be no noise reduction effect regardless of what is done/added to the binder. Therefore the potential for working with binder to improve the noise reduction is minimal if at all. American results suggest there is, but this is more due to the surface texture.
Question: One assumes that the measurements results shown refer to tyres with the proper pressures. What are the effects on noise of under-deflated tyres?

Answer: SPB uses real passenger cars as the basis for the measurements: cars in 'bad condition', i.e. those which appear particularly noisy, e.g. noisy exhausts, etc. are ignored. However, one picks at least 100 passenger cars so the measurements are representative of the 'normal vehicle fleet' so the effects of tyre inflation eliminated.
Question: we are measuring noise that is a result of the tyres and the surface of the pavement. Are there experiments done where different tyres have been used, e.g. size, tread pattern and the amount of wear. Also CPX – what tyres and what about the tyres on cars for SPBs?
Answer: Needs another lecture! Tyre is very important component. We are looking from the side of the road engineer who cannot influence what tyres are used by the public. SPB takes tyres into consideration because we get an "average" tyre – in terms of load. CPX – only special selected tyres are used and new ones are being identified. Can you change tyre design and change noise – yes!! FEHRL has made a big study for the EU on different tyres. General conclusion is that the span of noise is wide (6 dB) but not as wide as for pavements. But no noise marking on tyre, so difficult for public to voluntarily choose low-noise tyres.
Question: Comparison between winter and summer tyres or measurements done in winter?
Answer: SPB has a meteo window when we can measure. Always try to only use summer tyres. Noise levels usually at 20 degrees and the temperature has an effect on the noise. Traditionally thought that winter tyres were rough and therefore noisy, but now using softer winter tyres for more grip so less noisy.
Question: Interesting subject. Methods of measurement? SPB appears to be subjective to many factors whereas CPX appears easy and appears to give better results?
Answer: Establishment of noise maps – not based on SPB or CPX but consider global environment based on L_{den}. Includes all effects of traffic variation. SPB/CPX provide corrections for different road surfaces in these global noise indices. SPB is best representative of the influence of the surface on traffic noise (total noise of vehicle). CPX only measures tyre/road interaction noise. That is why classification is based on the SPB but the CPX is used for COP. If CPX levels comparable, implies that SPB would be similar. Noise mapping would be using predictions software.
Question: Bituminous mixtures used in porous surfaces: Mix designs? Aggregate, grading? What happens about cleaning and lifetime?
Answer: Series of big questions! PA has special grading curves (shown in presentations). When designing, must optimise grading curve to optimise porosity. Also need certain technical durability. Air in voids makes bitumen stiffer and reduces lifetime of bitumen. Need a highly modified bitumen, e.g. as used in Copenhagen. Clogging: Tricky on PA. As a rule of thumb, in urban conditions there is a threat of clogging. TLPA is designed to tackle this. High pressure cleaning was used in Copenhagen, but pavement clogged over a 7 year period regardless. Use of 8 mm aggregate provides more chance of keeping voids unclogged. Highways: not much clogging before getting very old; due to the self-cleaning action of the traffic. Clogging/cleaning needs further research. Pilot in Greece done with low-noise porous pavements. Clogging occurred very quickly!
Question: Did one test in-situ methods for thermal recycling for restoration of voids?
Answer: to avoid clogging on urban roads one must start cleaning as soon as pavement is constructed and thereafter twice a year. Once pavement is clogged, one cannot recover the voids. Clogged PA can be recycled in-situ. Dirt that clogs it doesn't pose any problems.

Question: There have been complaints in Germany about the accuracy of some of the noise maps. Measured noise levels were 10 dB higher than predicted on the noise maps. How accurate are these maps in relation to the pavement?
Answer: We are not experts on mapping/prediction but it is to be expected that such a problem could occur if the description of the pavement is incorrect. Could also be that the prediction model is not so good or the way it is used was not so good; there is a human factor involved. Anyway, prediction methods are the only way for new roads.
Comments: Noise barriers used in Greece have been misunderstood. All barriers are considered to be 'transparent'. The effects of reflections are not considered. Safe pavements have been provided but noise has traditionally been overlooked.
Question: Did measurements include temperature, road gradient?
Answer: Temperature could have an influence. It is being studied and can be corrected for by applying 0.1 dB reduction per 1°C increase. SPB/CPB/CPX are anyway recommended to be conducted in certain temperature range. The slope is already included in traffic noise models. No SPB may be carried out where there is a slope, only on flat even roads.
Question: If we have an ideal porous pavement that has cracks or faults, to what extent does this reduce the noise mitigation?
Answer: Porous pavements are strong (resistance to rutting) but if cracking appears then cracks increase the noise level. At end of lifetime, ravelling will increase noise by 1-2 dB. Same will occur with cracking. It has been investigated and modelled in SILENCE.
Unanswered questions: Can we use porous pavements and thin layers that are currently available in Greece? One wonders about the durability and maintenance of PA. SMA is very expensive. So what to do? The problem is that cost reduction is the issue and doesn't take into account maintenance issues. SMA might be the best option. Investigations have highlighted the importance of the pavement. Now we know about noise performance. Can we simply use a less noisy pavement?
Comment: Noise reduction values commonly of order of 1-4 dB. All these values are based on a DAC reference or an SMA, which is generally already not noisy but not necessarily quiet.

Figure 10 – View of the auditorium in Athens.

Figure 11– The discussion panel: G. Descornet (INQUEST), H. Bendtsen (INQUEST, Prof. A. Loizos (NTUA) and P. Morgan (INQUEST).

Prof. A. Loizos concluded:

Next after traditional safety considerations, now noise is becoming important. Greece must not lag behind. This event encourages us to think about the issues.

1.3.8 Global evaluation

Tables 1 to 4 hereafter summarize the evaluation of the workshops by the participants. The bold numbers are total number of answers collected from the 6 events:

Table 1 - Rating of the workshop on the following criteria:

	1	2	3	4	5	
Boring	**0**	**1**	**19**	**45**	**45**	Interesting
Simple	**5**	**13**	**28**	**45**	**18**	Challenging
Time too long	**0**	**10**	**72**	**17**	**11**	Time too short
Learned little	**1**	**5**	**28**	**49**	**26**	Learned a lot

Table 2 - Rating of the following elements of the workshop:

	Poor				Excellent
	1	2	3	4	5
Speakers	**0**	**1**	**14**	**54**	**40**
Presentations	**0**	**0**	**17**	**54**	**38**
Handouts	**1**	**3**	**40**	**43**	**16**
Discussion session	**1**	**7**	**34**	**39**	**8**

Table 3 - Overall rating of the content and presentation of the workshop:

	1	2	3	4	5	
Poor	**0**	**2**	**17**	**64**	**26**	Excellent

Table 4 - Participating in the workshop has been:

Time well spent	**75**	Moderately useful	**33**	A waste of time	**0**

In view of the evaluation, it can be concluded that the workshops were generally well attended and successful. In most visited countries, the subject was largely ignored. The degree of satisfaction regarding the contents and the execution can make us optimistic on the impact this dissemination will have on the actual implementation of the knowledge provided to the stakeholders in the participating countries.

1.4 The Users Group

The second objective of the project has been met by organizing the seventh INQUEST Workshop in conjunction with TRA – The Transportation Research Arena meeting in Ljubljana on April 25th, 2008.

The workshop programme was fully performed as follows:

08:30	*Registration*
09:00	Introduction Guy Descornet, Belgian Road Research Centre, Brussels
09:15	Point of view of the European Commission Maria-Christina Marolda, Transport Safety Programme Officer, CEC DG RTD
09:30	The need for harmonization Luc Goubert, Belgian Road Research Centre, Brussels
10:00	Presentation of the SILVIA proposal Phil Morgan, Transport Research Laboratory Ltd, United Kingdom
10:30	*Break*
11:00	Presentation of the SILENCE proposal Guy Descornet
11:30	Review of current practice and prospects in European countries 11:30 Mihael Ramsak, ZAG, Slovenia 11:45 Ulf Sandberg, VTI, Sweden 12:00 Jørgen Kragh, DRI, Denmark 12:15 Jürgen Haberl, Heller Ingenieurgesellschaft mbH, Austria
12:30	*Lunch*
14:00	Review of current practice and prospects in European countries 14:00 Wolfram Bartolomaeus, BASt, Germany 14:15 Rob Hofman, RWS, Netherlands 14:30 Phil Morgan, TRL Ltd, United Kingdom 14:45 Philippe Klein, INRETS, France 15:00 Adolfo Guëll, Ministerio de Fomento, Spain
15:15	The need for a User Group Hans Bendtsen, Danish Road Institute, Denmark
15:30	Discussion on whether and how to organize a Users Group Hans Bendtsen, moderator
15:55	Conclusions Hans Bendtsen
16:00	*Closure*

Twelve European countries were represented, namely: Austria, Belgium, Denmark, France, Germany, Great-Britain, Netherlands, Norway, Portugal, Slovenia, Spain and Sweden, as well as EC DG RTD and CEN. The list of participants is given in **Annex C**.

The conclusion was that there is a need to move forward with a view to eventually issuing a European standard on the noise classification procedures of road surface products. The Users Group could possibly make use of the CWA – CEN Working group Agreement procedure to speed up things or just prepare the work with a view to a possible mandate given by the EC to the existing CEN/TC227 on "Road Surface Materials", which could be taken in charge by CEN/TC227/WG5 "Road Surface Characteristics".

Detailed proceedings of the workshop were drafted and sent to the participants, which can be considered as the founding document of a group. One obvious way to keep in contact is through Internet. Therefore, FEHRL has offered to host a specific forum on their web site. The Danish Road Institute will act as first Convener of the Group. They will host the next meeting in Copenhagen on 16/17 September 2008. It has been recognized that more stakeholders should be invited, namely among road authorities.

1.5 Expected impact

Eleven countries were involved in the SILVIA project namely Austria, Belgium, The Netherlands, Germany, Poland, Sweden, Denmark, Great-Britain, Norway, Italy and France. INQUEST added to this list six more countries namely Slovenia, Czech Republic, Romania, Portugal, Greece and Switzerland. The first expected impact is that the latter countries will be aware as were the SILVIA countries, of the cost-effectiveness of low-noise road surfaces as a traffic noise control measure that can be used in the action plans required by the Environmental Noise Directive.

For this type of action to be effectively implemented, one of the prerequisite is that it would possible to specify a low-noise surface in a contract and that performance of the laid product could be easily and accurately verified. The second expected impact of the project, namely thanks to the Users Group that has been set up, is to stimulate the harmonization of the ways low-noise surfaces are classified for contractual purposes throughout Europe so that contractors could better sell their products and technologies across the borders.

2. Dissemination and use

The project itself essentially consisted of a wide dissemination of existing knowledge with a view to stimulate the use of it.

Nonetheless, the partners will pursue the dissemination of the knowledge acquired by European as well as national projects on the use of low-noise road surfaces for traffic noise control whenever and wherever opportunities will present themselves in their countries and abroad.

Regarding the use of the knowledge, the group of users is intended to continue the promotion of the use of low-noise surfaces namely by preparing future European standards for facilitating and harmonizing the specification of low-noise pavements in a procurement context.

In the meantime, the countries that were involved in the SILVIA project as well as those that hosted the INQUEST Workshops have been made aware of the possibility to use low-noise road surfaces as a cost-effective action as requested by the Environmental Noise Directive.

The web page for the project (http://www.fehrl.org/INQUEST) will remain open after the completion of the project for two purposes:

1. Pursuing the dissemination of the knowledge by making publicly accessible the ten PowerPoint presentations including explanatory notes that have been developed and presented at the workshops;
2. Hosting a space dedicated to the Users Group for its members to exchange work documents and meeting invitations, minutes, etc.

ANNEXES

A. PowerPoint presentations made at the dissemination workshops

B. Lists of participants in the dissemination workshops

C. List of the participants in the Users Group setup workshop