

Current Trends in Environmental Noise Calculation Software in Europe*

Douglas Manvell (Bruel & Kjaer Sound & Vibration Measurements A/S)

Introduction

This paper briefly describes the state of the art of development of environmental noise calculation software in Europe, concentrated on the following areas:

- The Harmonoise and Imagine projects and the Good Practice Guide on Strategic Noise Mapping
- The role of combining measurements and calculations for more flexible problem solving
- Uncertainty: qualitative methods to determine uncertainty levels of noise calculations
- Optimising environmental noise calculation capacity

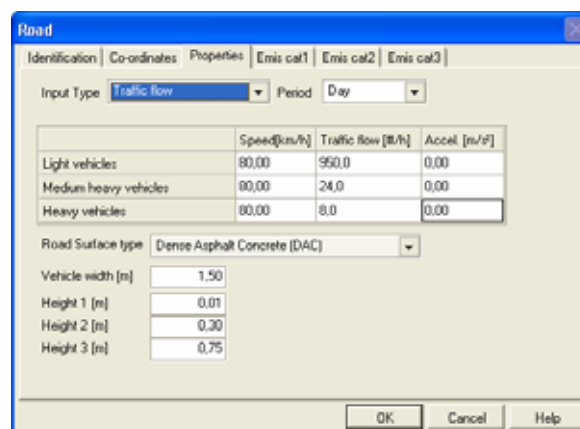
The Latest Developments in Standards in Europe

Overview

There are three main areas of development in Europe on environmental noise calculation methods – Harmonoise [1], Imagine [2] and the Good Practice Guide on Strategic Noise Mapping produced by the European Commission's Working Group on the Assessment of Environmental Noise [3].

Harmonoise

The Harmonoise project, completed at the start of this year, has developed state-of-the-art environmental noise calculation methods. These include the Harmonoise Engineering Model that is expected to achieve widespread use and is already implemented in commercial software [4, 5]. The Harmonoise project has made available a wide range of documentation on its website including its summary report that, however, has not yet been accepted by the European Commission. It has been developed to give good results in acceptable calculation times for large models. A road source model has been developed allowing input data based on road properties (traffic flow, composition, speed, driver behaviour, pavement, etc) to be used. No railway source model was developed – this task was handed over to the Imagine project.



The screenshot shows a 'Road' dialog box with several tabs: Identification, Co-ordinates, Properties, Emis cat1, Emis cat2, and Emis cat3. The 'Properties' tab is active. It contains the following fields and a table:

- Input Type: Traffic flow (dropdown)
- Period: Day (dropdown)
- Table with columns: Vehicle Type, Speed(km/h), Traffic flow [#/h], and Accel. [m/s²].
- Road Surface type: Dense Asphalt Concrete (DAC) (dropdown)
- Vehicle width [m]: 1.50 (text input)
- Height 1 [m]: 0.01 (text input)
- Height 2 [m]: 0.30 (text input)
- Height 3 [m]: 0.75 (text input)
- Buttons: OK, Cancel, Help

	Speed(km/h)	Traffic flow [#/h]	Accel. [m/s²]
Light vehicles	80,00	950,0	0,00
Medium heavy vehicles	80,00	24,0	0,00
Heavy vehicles	80,00	8,0	0,00

Fig 1 Harmonoise input parameters for road sources

* 欧州における環境騒音計算ソフトウェアの現状の動向

Imagine

The Imagine project, started in late 2003, is developing new calculation methods for railway, road, industrial and aircraft noise based on the results of the Harmonoise project. Due to be completed at the end of Dec 2006, it will standardise the Harmonoise methods and provide guidelines on using these methods for noise mapping and noise action plans. The main deliverables are practical guidelines that describe how to measure source data for the Harmonoise methods, and methods for dealing with aircraft and industrial noise. Information is provided on the project's homepage, at major conferences, and at a final conference in 2006. A few reports are already published.

The Good Practice Guide on Strategic Noise Mapping

In December 2003, the European Commission Working Group Assessment of Exposure to Noise (WG-AEN) produced a position paper entitled the "Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure" (the Good Practice Guide) to assist in producing the noise maps and associated data required by the Environmental Noise Directive [6]. It recommends ways of dealing with general issues and specific technical challenges for strategic noise mapping. In addition, a series of toolkits to help solve a number of the technical challenges are included. An open invitation to comment on the Good Practice Guide was made in order to assist in its development. Subsequently, various members of the WG-AEN, together with assistance from external organisations, such as Brüel & Kjaer, have worked on revising the document during this year. A 2nd version, expected this autumn, includes, among other things, quantification of expected result accuracies due to the quality of the input data.

The Role of Combining Measurements and Calculations

Using measured data as the input for calculating levels at another location has been used with varying degrees of complexity for many years. However, as both calculated and measured levels can be uniquely identified by parameter, level, location, time, etc., a common database can be used to store both [7]. With suitable software [8], combining measurements and calculations can provide more flexible problem solving, enabling new possibilities in environmental noise management, e.g.:

- Semi-automated determination of optimised L_W levels of multiple source categories from a number of measurement positions using reverse engineering methods
- Showing temporal variations in relation to strategic map results for analysing differences in population response to event-based noise exposure
- Real time measurements and "live maps" (dynamic mapping)
- Noise assessment at "inaccessible" sites by reverse engineering
- Comparing measured residual noise levels with calculated specific levels for overall levels or differences, e.g. comparing "relatively quiet façade" levels with noisiest façade levels

Uncertainty

The sources of uncertainty can be grouped [9] into uncertainties due to the method, the input data, the software and the measurements used to determine the measurand (the true value). Major sources of uncertainty are the input data and the user influence on modelling, including the necessary processing of the input data. Professional, qualitative methods to determine uncertainty levels of noise calculations both at individual receiver points and globally for noise maps are now becoming commercially available in software [5] including the effects of uncertainties regarding:

- the description of the sources

- the quality of the model itself, in particular, regarding the quality of the height information that is important for determining the important screening attenuation term
- the propagation distance from source to receiver
- and the quality of the noise contours produced by interpolation between receiver/grid points

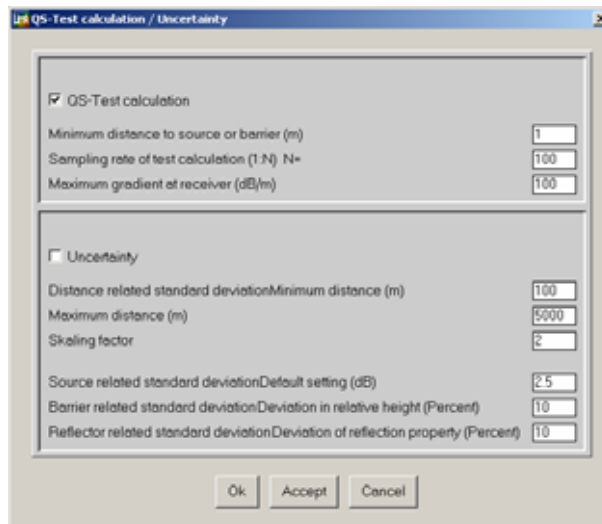


Fig 4 Determining uncertainty of environmental noise calculations in software

Optimising environmental noise calculation capacity

Environmental noise calculation capacity can be optimised by increasing the calculation **capacity** through networking computers or by increasing the calculation **speed** in the software.

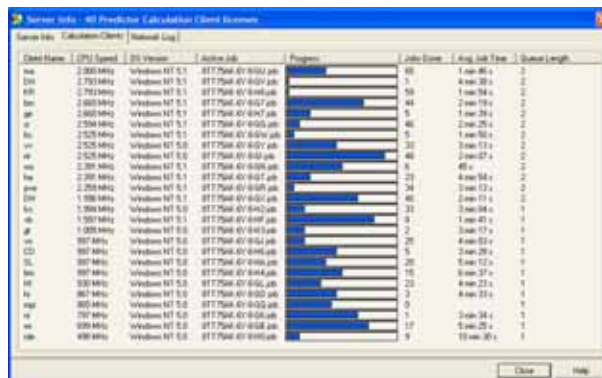


Fig. 5 Monitoring the calculation progress and the loading of the active clients

Client-server network calculations significantly increase calculation capacity by installing calculation clients on one or more workstations in the same network networks. A server distributes and monitors calculation jobs among the available workstations with running clients. Calculation clients can have minimal impact on network and workstation performance, even while calculating. Failed jobs (for example, when a workstation shuts down) can be redistributed automatically. Thus, large models for complete agglomerations can be made efficiently and quickly. The Hague noise map with 675,000 calculation points on a 10 by 10 m grid, calculated in octaves with first order reflections, 40,000 buildings and 350 km of roads was calculated on a 30 GHz capacity network in just over 8 hours.

Optimisation routines and algorithms in software can reduce calculation load without significantly affecting result quality:

- To optimise calculation speed, all objects of the relevant model area need to be kept in memory. To reduce the number of relevant obstacles between receiver and source, a maximum source-receiver distance can be defined. For good results at the edges of any “calculation tile” the relevant model area should exceed the result area by this distance. For calculating 1 km² in Bonn 2 km was used, resulting in a 25 km² model with about 212,000 obstacles. Hong Kong’s hilly terrain required 3 km, needing a PC with 256 MB memory to handle the 1,000,000 objects
- Irrelevant emitters within the fetching radius can be neglected. However, simply neglecting “small” emitters fails in several cases, e.g. when the bend of a highway junction has been modelled as small segments. Thus, the potential influence of neglected emitters needs to be analysed. In software, one may define an acceptable maximal total error margin due to neglected sources (e.g. 1 dB) that optimises result quality and calculation speed
- Reflections from buildings close to sources and receivers strongly influence results. And, the influence of reflections decreases with distance from reflectors. Thus, fetching radii for reflectors can be introduced. In practice, including reflections 30 m from source or receiver produces sufficiently good results with significantly faster calculations

Conclusion

This paper has briefly described the state of the art of development of environmental noise calculation software in Europe, concentrated on the following areas:

- The status of the Harmonoise and Imagine projects and the revisions of the Good Practice Guide on Strategic Noise Mapping.
- The role of combining measurements and calculations for more flexible problem solving
- Uncertainty: qualitative methods to determine uncertainty levels of noise calculations both at individual receiver points and globally for noise maps
- Optimising environmental noise calculation capacity

References

1. www.harmonoise.org
2. www.imagine-project.org
3. European Commission Working Group Assessment of Exposure to Noise (WG-AEN) Position Paper “Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure”, Version 1, 2003
4. Predictor Type 7810 Product Data sheet BP 1602-21, Brüel & Kjaer, 2005
5. Lima Type 7812 Product Data sheet BP 1962-12, Brüel & Kjaer, 2005
6. “Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise” 2002/49/EC”, European Commission, 2002
7. “Managing Urban Noise in Cities – An Integrated Approach to Mapping, Monitoring, Evaluation and Improvement”, Manvell et al, Proceedings of Internoise, 1999
8. Noise Management Server Type 3642 including Noise Management Software Type 7843A Product Data sheet BP 2100-11, Brüel & Kjaer, 2005
9. “Error Propagation Analysis of XPS 31-133 and CRTN to Help Develop a Noise Mapping Standard”, Shilton et al, Proceedings of INCE-E Symposium on Managing Uncertainties in Noise Measurements and Prediction, 2005