Software for Environmental Noise  

Computer Aided Noise Abatement  

The State-of-the-Art in Noise Prediction
**Cadna A** is a software program for prediction and assessment of environmental noise in the vicinity of:

- industrial facilities,
- sport and leisure facilities,
- roads and railways,
- airports and landing sites or
- any other noisy equipment or installations.

The program enables easy editing and managing of the environment with all components that influence sound emission and propagation. It provides the calculation and the documentation of the noise levels in accordance with national and international regulations, and the presentation of the results by noise contour plots and colored noise maps.

**Cadna A** is a very efficient and easy-to-use Windows program:

- 32-Bit-code, fully integrated into the Windows-desktop
- graphical user interface with easily comprehensible symbols
- all objects like roads, railways, parking areas etc. can be geometrically entered by coordinate input using the mouse, a digitizer or the keyboard, with the possibility of using these devices in parallel
- polygons (e.g. buildings, area sources) and polylines (e.g. line sources, roads, barriers) can have any shape
- for the most relevant traffic noise sources like roads and railways the emission levels are calculated from the noise relevant parameters
- modification of noise source parameters results causes a real-time update of emission values — a very quick way of testing noise mitigation measures
- import of many data formats: AutoCad-DXF, ArcView, AtlasGIS, Sicad, EDBS, GML, NTF, Winput-DGM, Stratis, MapInfo, T-Mobil, Building Height Points, ASCII-Poly, ASCII-Grid, QSI (DIN 45687), GYpSINOISE
- copying of tables and graphics to the clipboard and pasting into other Windows applications (e.g. word processors, spreadsheet and graphic programs)
- Export formats: AutoCad-DXF, ArcView (shp, dbf, shx), Immis-Luft (dbf), rtf, txt, Web-Bitmaps, ASCII-Grid, QSI (DIN 45687), GYpSINOISE
- ODBC-database interface to all kinds of databases like dBase, MS-Access, FoxPro, Paradox, MS-Excel, SQL etc. This allows the updating of data using external databases.
- all kinds of printers with Windows drivers can be used

### Successful symbiosis of acoustics and software

**Cadna A** has been developed by acoustical and software programming experts — a prerequisite for the design of such an effective tool for environmental noise.

With its flexible logical structure the software will prove its high value for experts who regularly tackle noise problems as well as for those who are responsible for environmental noise issues but are not so familiar with the technical aspects of noise propagation.

**Cadna A** enables the assessment of noise immission in accordance with national and international regulations. This includes the regulations in the following countries: Austria, Switzerland, United Kingdom, France, Scandinavia and also the calculation methods according to the EC-directive 2002/49/EC (Environmental Noise Directive).
**Cadna A** for experts testimony

- **Cadna A** can be used for experts witness and testimony. For individual receiver points all intermediate results of the calculation can be presented in table format. This is required when presenting results to authorities, enabling an easy verification of the correctness of calculations.
  
- **Cadna A** calculates the noise levels on horizontal and vertical grids with a user defined spacing of receiver points. From these levels, calculated at thousands of points, contour lines of constant noise levels, or areas with noise levels in definable intervals, are generated and printed as colored noise maps. The level range of lines or areas of equal sound level, the assignment of colors to certain level classes, the line width and type can be edited.

- **Cadna A** – in conjunction with option XL – is the optimal and most efficient tool to handle all aspects of the EC-Directive on Environmental Noise (strategic noise maps, assessment of residential data, information to the public). **Cadna A** offers the following advantages: easy import of existing data, definition and editing of all kinds of noise sources (industry, road, railway, aircraft) on a common user-interface, noise indicators $L_{den}$ and $L_{night}$ integrated (besides $L_{day}$/$L_{evening}$/$L_{night}$ separately, and combinations thereof: $L_{de}$, $L_{dn}$, $L_{en}$), user-definable diurnal patterns for road traffic data, numerous import formats enabling the use of existing digital object data.

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**Working with objects**

- **Cadna A**-objects can be edited, deleted, modified, shifted, copied, changed in shape, multiplied or even converted to other objects with simple mouse operations. With these possibilities it is easy to cut out all objects for a limited area from the complete set of data of a big city, to calculate noise levels for intended modifications and insert the modified data and objects once more (dialog “Modify Objects”).

- For each object a smaller or bigger object with parallel contour lines can be produced at the click of the mouse. This makes it easy to produce screens or contour lines parallel to given roads or railway-routes (command “Parallel Object”).

- Sectional views along free definable lines enable to check for the shape of the terrain modelled using contour lines, height points and lines of fault.

- Fitting of the terrain’s height to the object’s height or vice versa. This fitting procedure can be restricted to all objects inside, outside, or on a closed polygon, to all activated or all deactivated objects, to all objects fulfilling a entered condition (e.g. minimum building height) or for combinations of the 3 methods.

- Any kind of 3-dimensional view: The 3D-Special view allows to move inside the virtual scenery to check the model. The animation properties can be changed like camera position and animation speed. Easy to create a movie files by recording it on a video (AVI-format).

- With 3D-Special view any kind of objects can be double-clicked enabling direct editing of the object’s data. The result is directly visible on screen.

- Presentation on screen and printing to any scale by selection from a predefined list or by specifying the desired value.
Variant 1: Existing Road Scheme

Library for Sound Level Spectra

Variant 2: New Road Scheme

Library for Spectra of Noise Reduction Index

Auralization of Pass-By-Levels

Variant 3: Traffic Noise Total Road + Railway

Projects with Cadna A

- All project data are stored in one file allowing the easy administration of different scenarios.
- Project variants are handled within just one file.
- No practical limitation of number of sources or receiver points. A large refinery with thousands of sources is just as easily assessed as the minimum height of a barrier that is necessary to screen a single loading platform.
- Noise sources of any complexity can easily be modelled by point, line and area sources. The calculation is performed based on source emission data alternatively using A-weighted levels or in frequency bands.
- Frequency-dependent calculations are supported by databases with spectra of sound pressure level, sound transmission loss and sound absorption coefficients.
- Consideration of source emission data e.g. according to ISO 3744. This allows the use of sound power levels stated by the machine manufacturers.
- Parametric input for roads, railways, parking areas and airports (according to the respective standard or guideline). From these parameters the emission values are calculated.
- Considering the self-screening effect with elevated roads, additional width and barrier/parapet height left/right editable.

- Road crossings controlled by traffic lights are easily defined by clicking into the crossing-area with the traffic light symbol selected. The appropriate roads are recognized automatically.
- Local and global definition and editing of the occupancy of railway tracks.
- Parametric input for parking lots calculated according to RLS-90 or to the Bavarian Parking Lot Noise Study (editions 1993/1995/2003).
- Pass-by-level and auralization for cars, trucks, and railways passing by (and for additional moving sources).
- Buildings with arbitrary outline are considered as screening objects and can – if required – be modelled as sound radiating objects.
- The object “Building” has the property “acoustical transparency” which is quantified by a value in percent. This feature allows the modeling of more or less open structures such as an accumulation of pipes, vessels and other technical equipment being penetrated by sound energy.
- Barriers are entered by a sequence of straight lines. The barrier may have a sloping edge. Multiple screening across several barriers is accounted for. Furthermore, floating barriers (e.g. on bridges) and barriers with cantilever are available.
3D-reflector representing a freely orientable screening and reflecting surface

The reflection coefficient of screening objects can be defined or selected from a predefined list.

Foliage or built-up areas can be modeled as distinct objects with arbitrary shape (according to the calculation guideline selected).

Modelling of the terrain by contour lines, height points and lines of fault. Triangulation of the terrain model editable. Triangulated contour lines cause a screening effect as well.

Input of areas with arbitrary shape and a definable sound power level per square meter.

Area sources the noise emission of which has to be optimized are calculated by the program in such a way that permissible immission values are not exceeded for an unlimited number of receiver points in the vicinity.

Cadna A subdivides these area sources dynamically with respect to acoustic needs. This is very helpful when industrial zones in the vicinity of residential areas are planned and noise levels are to be respected (option BPL).

PCSP – Program Controlled Segmented Processing. With several computers in a network the calculation job on a single project can be performed in parallel speeding up calculations enormously.

With the Cadna A-Plot-Designer print-outs can be arranged combining arbitrary views, grid maps, and details of a project. The plan view besides several 3D-Special-views or even different variants can be arranged on a single plot.

Free editable result tables

Colors can be addressed to any kind of objects using the object’s parameters (e.g. building color depending on the number of inhabitants, road color depending on traffic data).
The calculation method can be defined by the user. For instance, in Cadna A the user decides if and up to which distance from the receiver or from the source point reflection will be calculated and up to which order. By specifying time intervals for day, evening, and night and the respective penalties all kinds regulations can be followed.

Some examples for the use of Cadna A:

Highways and railway routes
- If highways or railway routes are planned or are to be modified, the noise levels in the surrounding residential areas are calculated.
- If permissible values are exceeded, necessary measures like walls, noise reduction surface or measures carried out on the buildings themselves can be modelled and evaluated.
- The result of such a study comprises a list of these measures, colored noise charts for presentation, and tables with the noise levels for any number of immission points.

Industry
- The program enables easy updating and compiling of all emission data for factories and any industrial facilities. If the model of an industrial plant is modelled in Cadna A, the resulting noise impact in the vicinity caused by changes or modifications of the plant can be easily assessed.
- The manufacturer or supplier of technical equipment such as machinery, ventilation systems, car wash plants or cooling towers can provide the necessary information about noise levels in the vicinity.
- By the Cadna A-option SET the sound power spectra for many types of noise sources are automatically calculated based on their technical parameters (such as electrical power in kW, flow rate in m³/h). With Cadna A-option SET more than 150 predefined modules (sound source descriptions) are provided containing data on e.g. combustion engines, electrical motors, gears, fans, ventilation systems, cooling towers on the basis of given technical parameters. The user may extend the database by defining his own modules of a sound power spectra. The modules can be referenced with all industrial sources in Cadna A.
Noise mapping of cities (option XL)

- **Cadna A** is an ideal tool for cities and communities. All necessary information pertaining to noise is available in one software program which allows to account for noise issues in all stages of a planning process. If industrial zones are planned in the vicinity of residential areas the possible noise emission is calculated within minutes. With this knowledge it is easy to decide what type of industry is compatible with given environmental requirements.

- With **Cadna A** – in conjunction with option XL – the requirements to noise mapping objectives according to the EC-Environmental Noise Directive can be carried out efficiently and at low costs. The advantages of **Cadna A** – as there are the easy and flexible import of available data by numerous import formats, the definition and editing of all kinds of sound sources (industry, road, railway, aircraft) on a common user-interface – result in less time required to model the environment.

Aircraft Noise (option FLG)

Calculation of the aircraft noise around airports from the emission data of the relevant classes of aircraft according to

- German aircraft noise model "AzB – Anleitung zur Berechnung von Lärmschutzbereichen an zivilen und militärischen Flugplätzen nach dem Gesetz zum Schutz gegen Fluglärm vom 30. März 1971". The calculation results fulfill the strict requirements of the German Environmental Protection Agency (UBA).


- DIN 45684-1 “Ermittlung von Fluggeräuschimmissionen an Landeplätzen, Teil 1: Berechnung” (draft 2004-03)

- common features of **Cadna A**-FLG:
  - calculation at predefined receiver points and on a grid
  - freely combinable with all other noise types (industry, roads, railways)
  - library with predefined aircraft groups (aircraft and helicopters)
  - import of flight traffic data via ODBC-connection
  - optional consideration of receiver height

**Cadna A** is a comprehensive tool – industrial, road and railway sources can be integrated in a calculation using the basic version. This will consider up to 1000 buildings and 1000 barriers when calculating the screening effect, with no restriction to the number of sources and receiver points. Grid arithmetics for noise maps enables e.g. to sum up grids for different noise types to one final grid for the total level.

**Cadna A** is regularly updated to implement new calculation standards or guidelines. The implementation is upwards compatible ensuring that existing project files can still be loaded with the most recent version.

The features of **Cadna A** described are subject to change during further progress of development. Please ask for informations on the most recent stage of development.
Standards, Guidelines and Directives

In Cadna A, all relevant calculation methods and procedures required for the calculation of environmental noise on a national and international basis are implemented. This includes also the Interim Calculation Methods according to the EC-Directive on Environmental Noise of 25 June 2002, as well as numerous national standards or guidelines for each noise type.

EC-Interim Calculation Methods

- Industrial noise: ISO 9613-2
- Road noise: NMPB-Routes-96
- Railway noise: RMR ’96 – SRM II
- Aircraft noise: ECAC CEAC Doc.29

Industrial Noise

- ÖAL – Richtlinie Nr. 28, Schallabstrahlung und Schallausbreitung, December 1987, Österreichischer Arbeitsring für Lärmbekämpfung
- DIN 18005-1 Beiblatt 1, edition 1987-05, Schallschutz im Städtebau, Berechnungsverfahren, Schalltechnische Orientierungswerte für die städtebauliche Planung
- Environmental noise from industrial plants – General prediction method. Danish Acoustical Laboratory, The Danish Academy of Technical Sciences, Report no.32, 1982
- BS 5228-1:1997, Noise and vibration control on construction and open sites. Code of practice for basic information and procedures for noise and vibration control (noise from construction sites)
- Swedish guideline "Ljud från vindkraftverk", Ed.: Naturvårdsverket, Rapport 6241, December 2001 (noise from air turbines)

Road Noise

- RLS 90 “Richtlinien für den Lärmschutz an Straßen”, BM für Verkehr, Bonn 1990
- RVS 3.02 Lärmschutz, Dezember 1997, Österreichische Forschungsgesellschaft Straße und Verkehr
- StL-86, Schriftenreihe Umweltschutz Nr. 57 – Anleitung zur Ermittlung und Beurteilung von Lärmimmissionen an Straßen, Herausgegeben vom Bundesamt für Umweltschutz Bern, January 1987
- DIN 18005-1 Beiblatt 1, edition 1987-05, Schallschutz im Städtebau, Berechnungsverfahren, Schalltechnische Orientierungswerte für die städtebauliche Planung
- CRNTN, Calculation of Road Traffic Noise, Department of Transport & Welsh Office, HMSO, London 1988
- NMPB-Routes 96, Methode de calcul incluant les effets meteorologiques, version experimentale, Bruit des infrastructures routieres, Janvier 1997

Railway Noise

- Magnetschwebebahn-Lärmschutzverordnung vom 23.9.1997 (BGBl. 2329, 2338)
- DIN 18005-1 Beiblatt 1, edition 1987-05, Schallschutz im Städtebau, Berechnungsverfahren, Schalltechnische Orientierungswerte für die städtebauliche Planung
- Semibel, Schweizerisches Emissions- und Immissionsmodell für die Berechnung von Eisenbahnlärm, Ed.: Bundesamt für Umwelt, Wald und Landschaft (BUWAL), Bern, March 1990
Aircraft Noise (optional)

Sporting & Leisure Activities
- VDI-Richtlinie 3770, Emissionskennwerte (technischer) Schallquellen, Sport- und Freizeitanlagen

Air Pollution
- MLus-92 (Merkblatt über Luftverunreinigungen an Straßen), Ausgabe 1992 (geänderte Fassung 1996), Hrsg.: Forschungsgesellschaft für Straßen- und Verkehrswesen e.V., Köln
- VDI 3945 Blatt 3: Ausgabe 2000-09, Umweltmeteorologie – Atmosphärische Ausbreitungsmodelle – Partikelmodell (Lagrange propagation model according to the German TA Luft 2002, Annex 3)

Please ask for informations on guidelines and standards recently implemented.
The Cadna A’-grouping concept

Cadna A uses a very flexible system for the grouping of objects.

- All objects belonging to a group can be identified and activated or deactivated with a single mouse click. Once calculated, the partial noise level of all involved sources and of all defined groups are shown separately for all immission points. This allows a very sophisticated analysis of the contribution of each or groups of sound sources even in a complex arrangements.

- This grouping concept allows the structuring of the sources of an entire city e.g. by noise source types like road traffic, railway routes, industry, sporting activities etc. Each group can even be subdivided in more detail. This grouping concept enables to study, for example, by the sequence "Industrial sources ⇒ factory xy ⇒ building AB ⇒ source no.47" the contribution of a single fan, of all roof sources, of factory building AB, of the entire factory xy, or of all industrial sources together at any receiver point.

PCSP – Program Controlled Segmented Processing

Cadna A is able to process more than 16 million objects per object type without any problems, so being capable to model entire cities and urban areas (with option XL). Therefore the limit for the size of a processable file is normally defined by the PC’s memory. With PCSP even this limit is broken. If several Cadna A computers are at disposal for calculation, e.g. within a network, they can work on the same project file parallel. PCSP by Cadna A automatically organizes and manages the required processes.

- Program controlled segmentation with user-defined partitioning allows to load the segments one after another automatically for calculation. Thus, the calculation job is processed using the RAM without hard disk access.

- The PCSP-PartViewer displays the progress of calculation by colored tiles: green = already been calculated, blue = presently calculated, red = still untouched.

- Cadna A-PartViewer shows the progress of calculation

- resulting noise map
The following options extending the Cadna A-basic version are available:

- **Cadna A-BMP**
  handling of bitmaps, e.g. for importing, turning, scaling, and assembling of scanned maps and pictures serving as background. About 40 different bitmap-file formats can be processed.

- **Cadna A-BPL**
  optimization of the sound power level per unit area of commercial areas, automatic fixation of noise quota, calculation of the sound power level of areas from the sound pressure level at some measured points. Handles even situations with several area sources and receiver points by applying a user-definable optimization strategy.

- **Cadna A-XL**
  noise mapping of cities, unlimited number of screening objects, conflict maps, grid evaluation, population density, object scan, assessment according to EC-Environmental Noise Directive, Annex 6

- **Cadna A-FLG**
  calculation of aircraft noise according to several calculation models (A2B, ECAC, DIN 45684-1), contours of constant equivalent noise pressure level (noise protection areas), maximum level statistics: contours of constant number of exceedings for a predefined maximum level and maximum level distribution for different locations (for calculations accord. to A2B)

- **Cadna A-SET**
  generation of sound power spectra based on technical system parameters, modelling of complex facilities and devices with multiple sound sources and radiating surfaces

- **Cadna A-Calc**
  data organization to process projects on several computers (cost-effective solution for handling of noise mapping projects by a computer-network)

- **Cadna A-Dynmap**
  generation of dynamic noise maps, enables coupling to automatic monitoring systems, updating of noise maps using measured sound level or traffic count data

- **Cadna A-Runtime**
  connection to GIS-system with Cadna A used as a run-time calculation program, automatic import and export of shape and database files from/to GIS

If you do not have the Cadna A-demo yet or if you need supplementary informations please contact us.

**Support**

- documentation
- hotline
- maintenance contract

Modelling a Bag Filter with Cadna A-SET