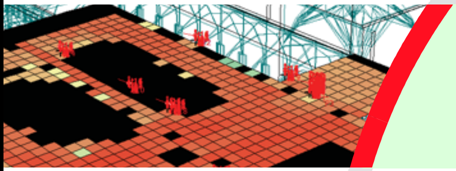


PRODUCT DATA

ODEON Room Acoustics Modelling Software — Types 7835, 7836 and 7837

ODEON is reliable, easy-to-use modelling software for simulating acoustics of closed rooms, open spaces, buildings and outdoor areas. It is a proven tool for predicting the acoustics of new buildings and for evaluating and recommending improvements in existing ones. The acoustics are calculated based on a room's geometry and surface properties. Graphs, 3D plots and 3D animations make it easy to interpret, explore and present results, and using auralisation you can experience the acoustics of the space as it would be after construction.

ODEON's prediction algorithms (image-source method combined with ray tracing) allow reliable predictions in modest calculation times. With this, ODEON is ideal for the prediction of acoustics in concert halls, opera halls, auditoria, foyers, underground stations, airport terminals and industrial workrooms, as well as office environments, smaller lecture rooms, open-air venues, patios and atria.

In large rooms and open spaces, PA systems may be necessary to support the acoustics. ODEON provides the tools to simulate such systems. For the prediction of noise levels from large machinery a special ray-tracing algorithm has been developed that allows the modelling of surface and line sources.

Uses and Features

Uses

- Prediction and optimisation of room acoustics for planning or refurbishment of the interior of buildings
- Prediction of sound transmission through walls or through coupled rooms in entire buildings
- Prediction of acoustics in partly outdoor areas, such as city squares or railway stations
- Prediction and optimisation of the interaction between loudspeaker systems and room acoustics.
- Aural imitation of an acoustical environment by high-quality auralisation over headphones or loudspeakers
- Education and university projects

Features

- Fast modelling using the included tools: parametric room editor, graphic editor, import from CAD systems
- Numerous tools for model verification
- Extendable material library
- Modelling of transmission and diffraction phenomena
- Flexible choice of sources and receivers
- Modest calculation time
- Reflectograms, 3D reflection paths, 3D maps, graphs and various other means of visualising results
- High-quality binaural and surround auralisation
- Comprehensive library of anechoic recordings for auralisation
- Results easily copied and exported for project reports and presentations
- Direct comparison of measurements and ODEON simulations
- Near-field, far-field and direct coverage of array speakers
- Supports Common Loudspeaker Format (www.clfgroup.org)
- Effective project management

Brüel & Kjær

About ODEON

The Origin of ODEON

Fig. 1
Odeon of Herodes Atticus, Athens

The classic, greek odeon evolved from the development of the large, open-air theatre into a more intimate, roofed-over venue for music performance (a place to sing ‘odes’) and, as such, was the first known instance of the construction of concert halls. The first version of ODEON in 1991 was aimed at the prediction of auditorium acoustics. Since then, ODEON has been continually developed and refined, and is now available in three state-of-the-art editions: **Industrial**, **Auditorium** and **Combined**.[1] All editions run on Microsoft® Windows® XP, Windows Vista® and Windows® 7.

Calculation Method – Algorithms and Applications

ODEON is based on prediction algorithms (image-source method and ray-tracing) allowing reliable predictions in modest calculation times. Scattering due to surface roughness and diffraction is taken into account using a method that accounts for frequency-dependent scattering: the reflection-based scattering method. It is ideal for the prediction of room acoustics in large and complex rooms.

Constructing Your Model

Modelling the Room

The starting point of an ODEON simulation is a 3D model of the room for which the acoustics should be predicted. Often a CAD model of the building is already available. ODEON has sophisticated tools to help you import such models and optimise them for the room acoustic simulation. For cases where a CAD model is not available, ODEON’s parametric programming language and the graphical Extrusion Modeller can be used to quickly create the geometry. These tools also help you to add more elements and surfaces to existing models, for example, to introduce diffusers or reflectors in a concert hall.

1. Specific features for each of the three ODEON editions are listed in the Specifications and Ordering Information.

Fig. 2
Left: Building models from scratch is easy and quick with the Extrusion Modeller
Right: ODEON has syntax highlighting and many other helpful features in the parametric editor

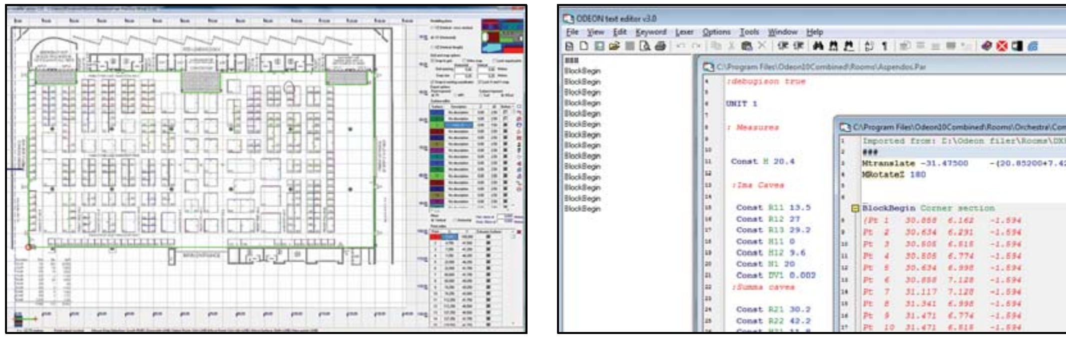
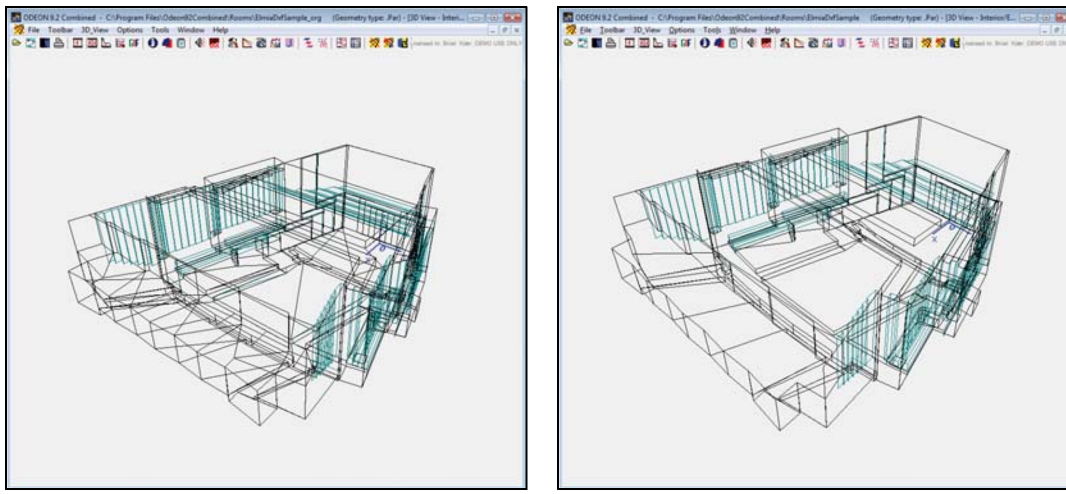


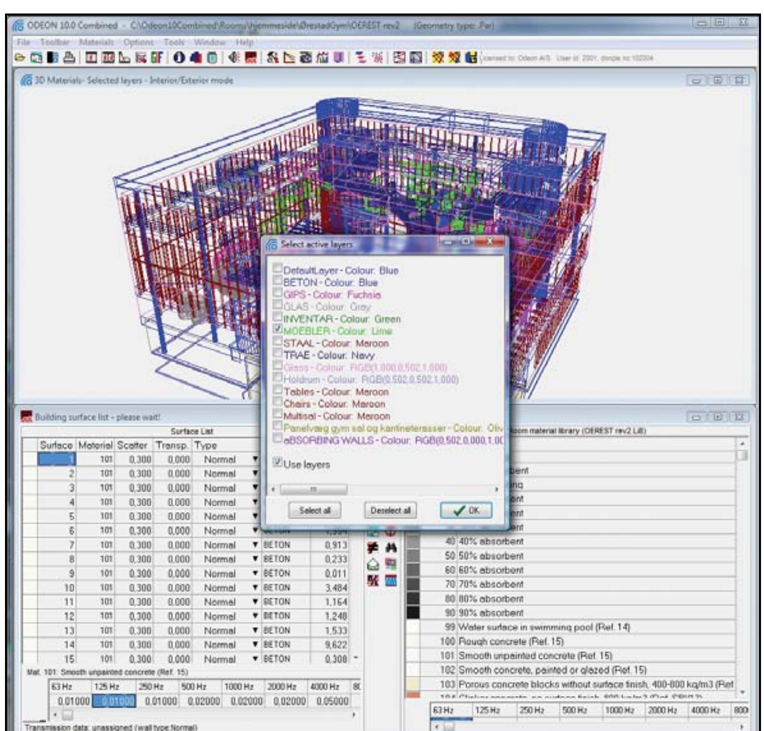
Fig. 3
The ODEON model requires only details that are essential for acoustics calculation. ODEON can automatically optimise CAD models, for example, by combining a number of small surfaces that are in the same plane into larger ones



Acoustic Properties of Walls and Objects in the Room

Once the geometry is set up, assign acoustical properties, such as absorption and diffusion, to the surfaces of the room. Materials are defined by the absorption coefficients from 63 to 8000 Hz and a scattering coefficient. A transparency coefficient can also be used, for example, to model objects like large plants or temporarily make objects invisible to the simulation.

Fig. 4
Surfaces are listed in the left-hand column. Selecting a surface in the list will highlight it in the 3D display. To assign a material to a surface, click on the material (right-hand column) and on the ***Assign*** *button. Support for Layers makes it easy to assign one material to a selected group of surfaces*



A customisable library of materials lets you select materials to assign to surfaces. The surface list (Fig. 4) is linked to a display showing the selected surface in 3D. Surfaces can be grouped with layers, making it easy to manage objects and walls with identical material properties. In addition, surfaces can be defined as transmitting.

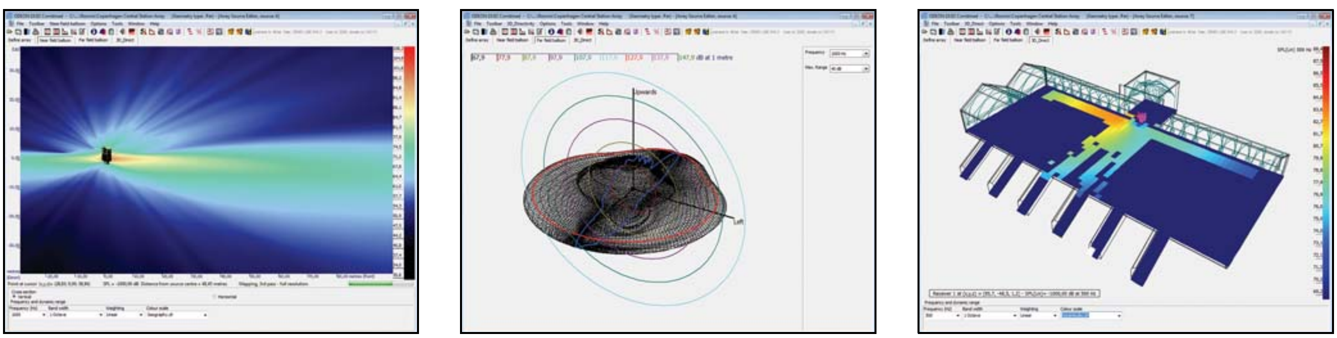
Defining Sources and Receivers

ODEON provides different source types that make it easy to simulate real sources such as speakers, singers, musical instruments, loudspeakers or machines.

Point sources can be defined by directivity pattern, gain, equalisation and delay, allowing the definition of natural sound sources as well as loudspeaker systems. ODEON has a list of common sources to choose from and also supports the Common Loudspeaker Format (CLF: www.clfgroup.org) supported by many loudspeaker manufacturers.

Support for array and cluster loudspeaker sources with distance-dependent directivity is provided in the Auditorium and Combined editions. Arrays and clusters are defined by geometry (relative position of the elements in the array), if applicable the time delay between the elements, and the directivity for the combined system (small arrays) or each element separately (large, complex arrays).This allows detailed simulation of the array's directivity/ beam forming. Array-loudspeakers can also be imported through a standard file format based on Extensible Markup Language (XML).

Fig. 5 *ODEON supports arrays of loudspeakers. The sound fields produced by these arrays can be studied using the near-field (left), the far-field balloon (middle) and the 3D_Direct (right) views*



The Industrial and Combined editions also allow the definition of line and surface sources that are particularly useful for calculations in industrial environments. Positions, orientations, etc., are automatically reflected in 3D displays.

In addition to sound sources, one or more receivers need to be defined for which the simulations should be carried out. Receivers can be defined point by point or as entire grids of receiver points. Point receivers are used to simulate listeners (for example, for auralisation) or measurement points. The orientation of point receivers is important in context with auralisation, where it is needed to correctly relate the sound to the left and right ear.

Entire surfaces – called grids – are used to calculate, for example, maps of the sound pressure level distribution over an entire auditorium, along the platforms of a railway station or over the floor of a machine hall.

Checking your Model

To ensure that calculation results are reliable, it is essential that geometries are correctly modelled. ODEON includes a number of tools for geometry verification, for example, the 3D Geometry Debugger with check for duplicate, overlapping or warped surfaces, see Fig. 6. The ray-tracing display can also be used in the verification of room geometry, as can the 3D Billiards display shown in Fig. 7. When importing CAD models, ODEON automatically removes duplicate surfaces and surfaces with no area. For complex models, doing this manually would be tedious if not even impossible.

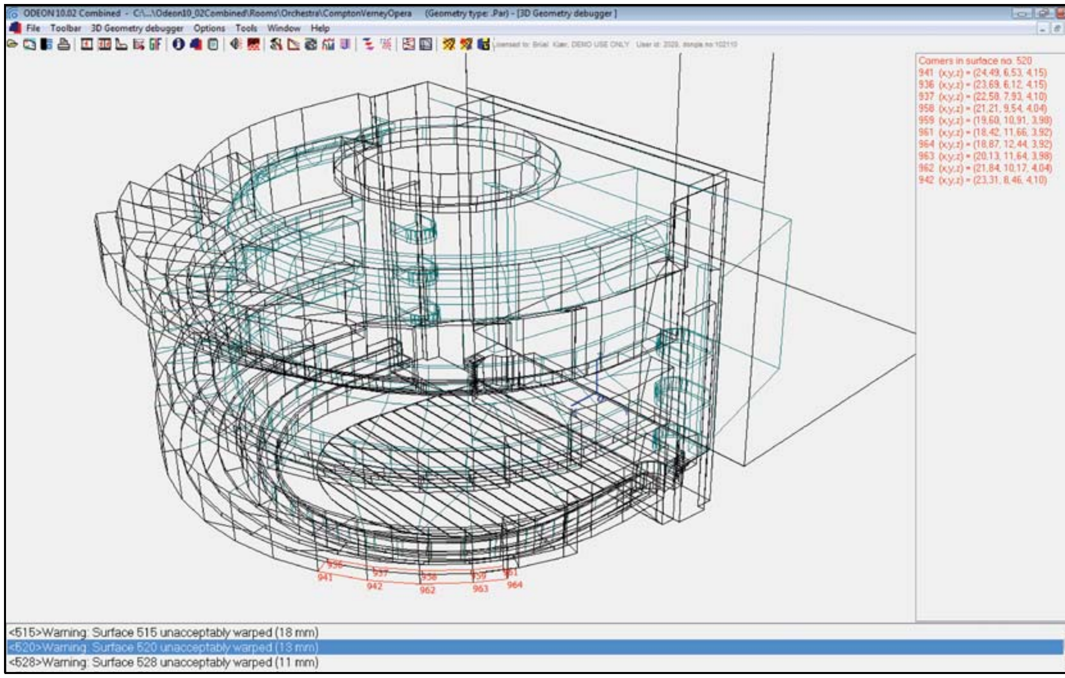


Fig. 6
The 3D Geometry Debugger points out errors in the model such as overlapping, duplicate or warped surfaces. This makes it safe and easy to locate and correct possible errors in the model description

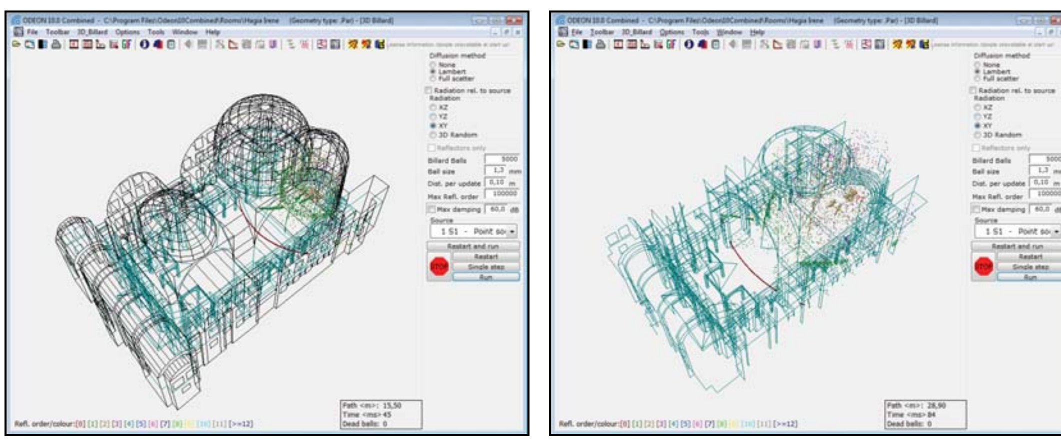


Fig. 7
The 3D Billiards display can be used for investigating or demonstrating effects such as scattering, flutter echoes, focusing or coupling effects. A burst of 'billiard balls' emitted from the source bounces off the surfaces in the room. In complex models it can be helpful to hide parts of the geometry (right: the exterior surfaces are hidden)

3D OpenGL Display

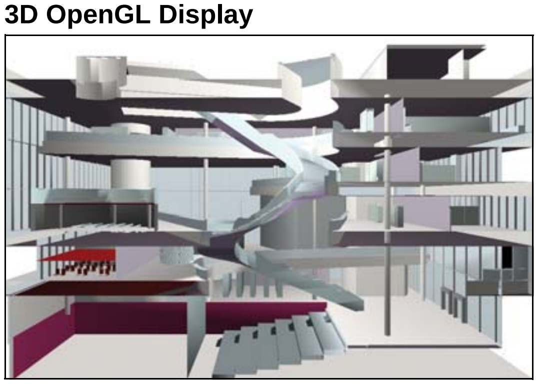


Fig. 8
The 3D OpenGL display is useful for checking the validity of the model. It can be viewed from all aspects, both inside and outside, using rotation, move and zoom features

The 3D OpenGL display shows geometry, materials and source positions. This display is useful when checking the validity of room geometries or source and receiver locations. The surface colours are automatically created from the acoustic reflectance of the surface materials – particularly useful when checking that materials are assigned correctly in complicated models and also useful for presentation purposes.

Calculation

Most calculation parameters are automatically set by ODEON, but you can change them, for example, if you want to set the precision of the calculations (Survey, Engineering or Precision) or the Impulse Response length.

In ODEON, carrying out calculations for a specific combination of sources and receivers is called a job. Simple models and simulation setups may only require a single job. However, if you want to calculate the acoustics for different combinations of sources and receivers, you can prepare them in a list of jobs and run them as a batch in which ODEON automatically calculates one job after the other.

The basic result of the calculation is the so-called Room Impulse Response (RIR). The RIR is the time history, at one receiver position in a room, of the direct and reflected sound caused by an impulse emitted from one or more sources at another position. Different receiver and source positions will lead to different RIRs. Seen from a listener's point of view, this means that the same piece of music will be perceived differently for different seats in the same concert hall.

Results

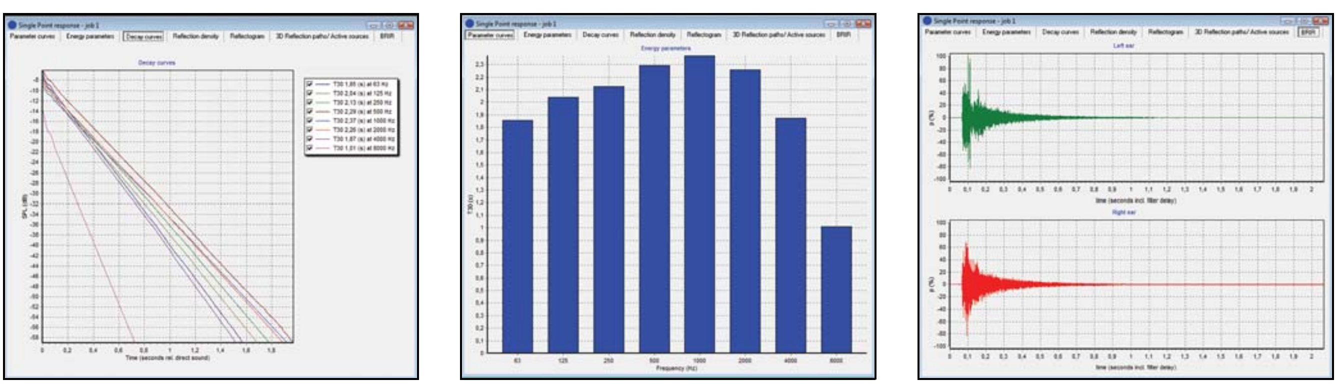
Decay Curves

Both the Quick Estimate and the Global Estimate methods will provide information on the decay of sound in the room. The Quick Estimate is based on statistical formulae. The more precise Global Estimate is based on ray-tracing, thus taking the room shape, the source position(s), and the position of absorbing materials into account. The global-decay methods can be used for getting a first impression of the overall decay time and absorption in the model.

Point Response

Point responses are the fundamental results of Odeon's detailed simulations/calculations. A point response is simply a RIR for a particular source-receiver combination. It may be directly compared to measured RIRs and is at the heart of the auralisation. Last but not least, all other parameters/results are derived from the point responses. Point responses are calculated for single points and at each of the points on a grid.

Fig. 9 *Decay Curves, the Reverberation Time Spectrum and Binaural Room Impulse Responses (BRIR) are all determined using Point Responses*



Reflectogram

ODEON will derive a large set of room acoustical parameters from the RIR – for example Early Decay Time (EDT), Clarity (C_{80}) and Early Lateral Energy Fraction (LF_{80}). For many parameters, this involves a comparison of the energy in the early and late part of the RIR (though the limit for what is early and late differs from parameter to parameter). If the parameters indicate unsatisfactory room response, you may want to go further and identify, for example, why early reflections arrive too late and which surfaces of the room contribute to the early part of the room impulse response.

One tool for this is the reflectogram. It shows the arrival time and level of the early reflections, referred to the direct sound. It helps identify useful, as well as unwanted, reflections. Selected reflections can be investigated further in the 3D Reflection Paths display (Fig. 10).

Ray-tracing

A visualisation of the ray-tracing calculations gives important information on how the various walls and objects in the room are involved in the reflection and diffusion of sound. Two ray-

Fig. 10 *Specular ray-tracing on the 3D Reflection Paths display shows the paths between source and receiver. In this example, the tracing shows the focusing effect of the dome*

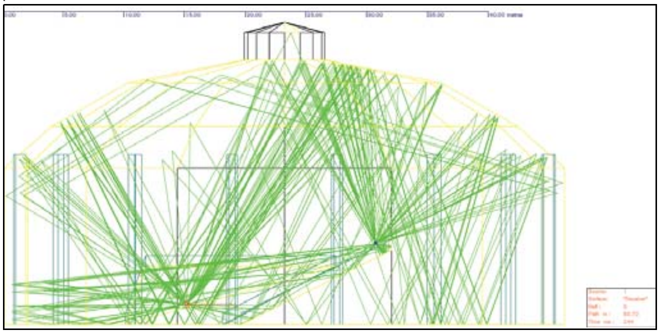
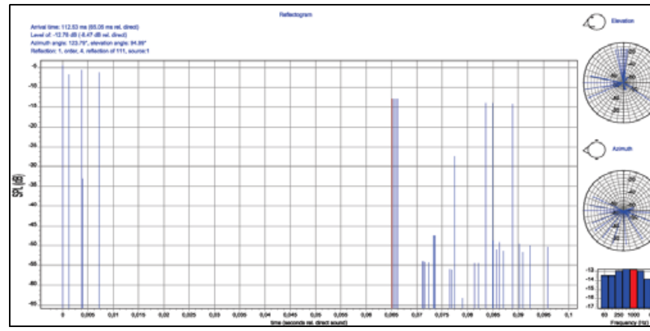


Fig. 11 *Reflectogram for the dome of the same theatre. The clustering of reflections points to an echo problem. Ray-tracing helps identify echo-causing room surfaces*



tracing displays are provided. The first shows ray-tracing for one or more rays radiated from a specific source. This is particularly useful for the verification of room geometry since, for example, missing surfaces are quickly identified by rays that leave the geometry. The other shows ray-tracing between a particular source and receiver (see Fig. 10). This display is linked to the reflectogram (see Fig. 11) and makes it easy to locate the path of particular reflections and the surfaces involved.

Maps

Maps of calculated parameters can be calculated for any number of selected receiver surfaces. Such parameters include, for example, sound pressure level, energy parameters or intelligibility (Speech Transmission Index). The resolution of the map (grid resolution) is selected to give sufficient detail within an acceptable length of calculation time.

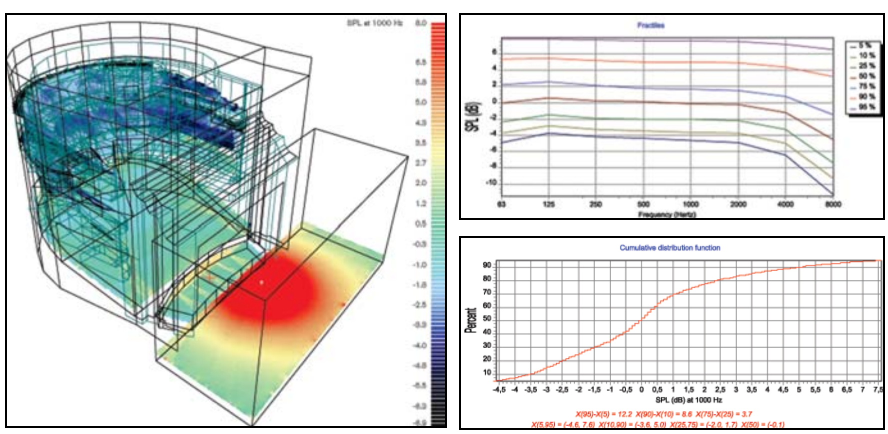


Fig. 12 *Calculated SPL mapping. The graphs on the right show the corresponding 'cumulative distribution graph' and 'fractiles' for the SPL grid. Opera House project for Ankara Congress and Cultural Centre (Architect: Özgür Ecevit, Acoustics: Jordan Akustik, Denmark)*

Multipoint Response and Noise Control

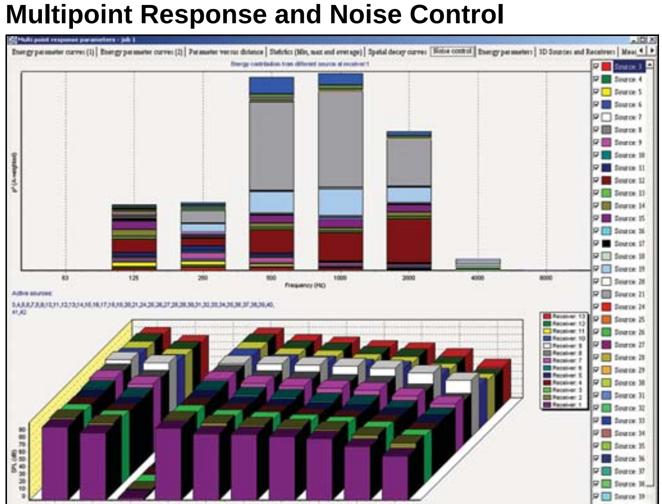


Fig. 13 *The noise control display allows identification of the dominant noise sources at different receiver positions in a room. You can interactively turn sources on and off while viewing the impact noise levels at the different receiver positions*

The multipoint response feature makes it easy for you to determine the sound pressure levels throughout an industrial hall. As an example, by placing a number of measurement points on a radial line away from a source you can study how quickly the sound pressure level reduces with distance to the source and at what point distance no longer matters. In a very reverberant environment, the average noise level will be high. As a consequence, only the measurement points very close to the source will indicate a drop in sound pressure level, since the average SPL in the room will be very close to the source's level.

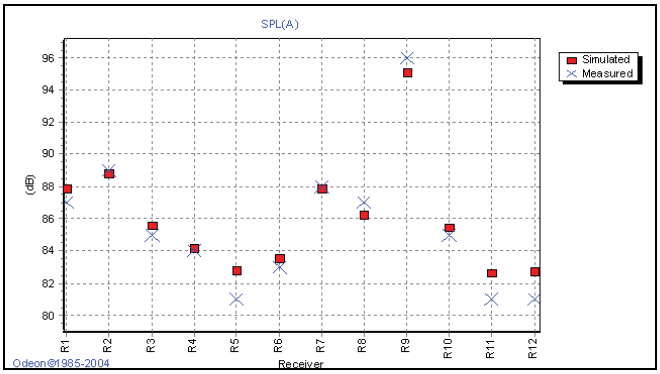


Fig. 14
Comparison of measured and simulated sound-pressure levels, showing very high correlation. This figure demonstrates a graph facility included in ODEON that allows easy comparison of measured and simulated parameters. Measured data can be imported from a text file or pasted directly from the measurement made with the DIRAC Room Acoustics Software Type 7841

Elsamproject, the Danish Power Project Agency, has verified ODEON's prediction accuracy. In a turbine hall at a power plant, the A-weighted sound pressure level was measured at 12 receiving points and compared to the levels estimated by ODEON. The room and its machinery were modelled by 54 surfaces. The sound sources were modelled by 30 surface sources (the surfaces of the two turbines) and 4 point sources (ball bearings). Relevant data for radiated sound power were measured with the intensity method. Test results show very high correlation between measured and estimated results, the average deviation being less than 1 dB.

Printing and Export

Results, graphic displays and calculation properties can be printed in high quality from within ODEON. Graphics can be exchanged via the Windows® clipboard or via files in multiple formats. Calculated results can be exported to a text file.

Reflector Coverage

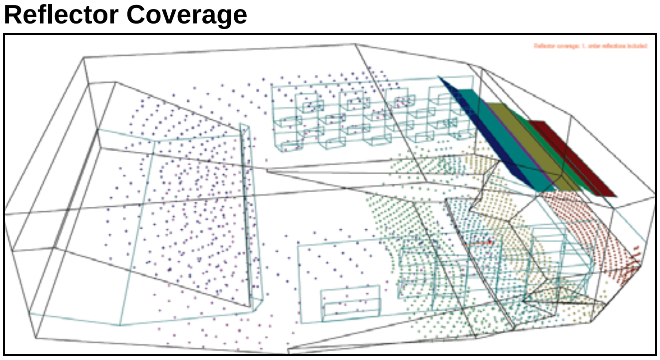


Fig. 15
The Royal Festival Hall in London – for each reflector, the reflection pattern shows how well it directs sound to the intended audience area

Reflectors are used to direct sound into areas that need sound reinforcement. The reflector coverage display allows fast evaluation of the receiver area covered by a number of reflectors for a selected source position.

Auralisation

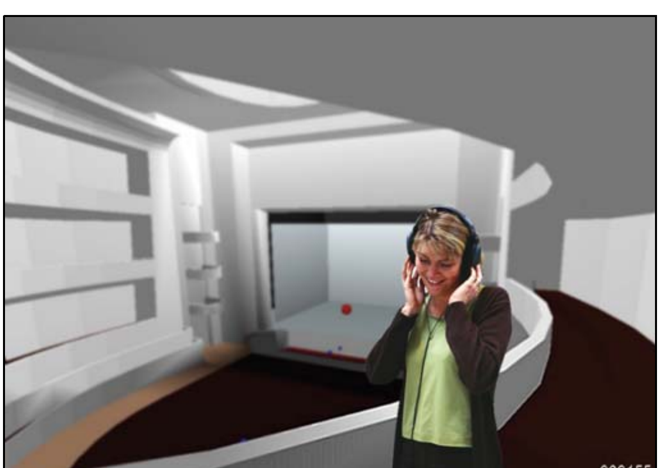


Fig. 16
In auralisation, you can 'replay' sound in the model and hear how the design affects music, speech or other acoustic signals. Since the ultimate goal is to improve perceived sound quality, this is a very powerful tool for the designer as well as for presentation to clients

The input signal for auralisation is a digital recording (.WAV file). Ideally, the signal should be anechoic, recorded in a room without reflections. ODEON includes a wide range of such recordings, including music, speech, hand-claps and a library of instrument-by-instrument recordings of symphonic musical pieces. This makes it possible to accurately represent the spatial positioning of musicians in an orchestra in your models.

In ODEON, recordings can be processed for headphone playback using a calculated Binaural Room Impulse Response (BRIR) or for surround playback using a multichannel impulse response calculated using Ambisonics technology. In either case, all calculations – including ray-tracing, calculation of reflections received at a receiver point, binaural filtering or Ambisonics decoding, octave band filtering and convolution – are carried out in a one-step process that does not require pre- or post-processing. The BRIRs for headphone auralisation include full filtering of each reflection in nine octave bands (the 16 kHz band being extrapolated) and applying a set of Head Related Transfer Functions (HRTFs) for each reflection. A BRIR for auralisation is typically based on more than 100000 reflections. The resulting sound is saved as another standard .WAV file or played in real-time over the PC's sound card.

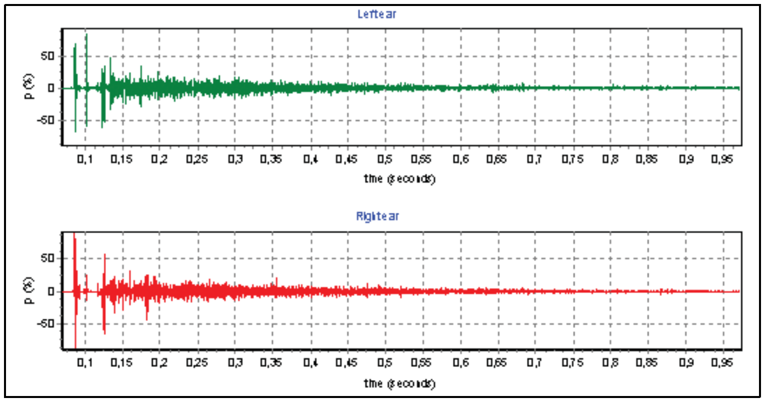


Fig. 17
BRIR calculated at a receiver position

For a larger audience, ODEON can present auralisation via multi-channel loudspeaker systems. The setup for a standard type 5.1 (6-channel) system has four corner speakers, one front centre speaker and one subwoofer

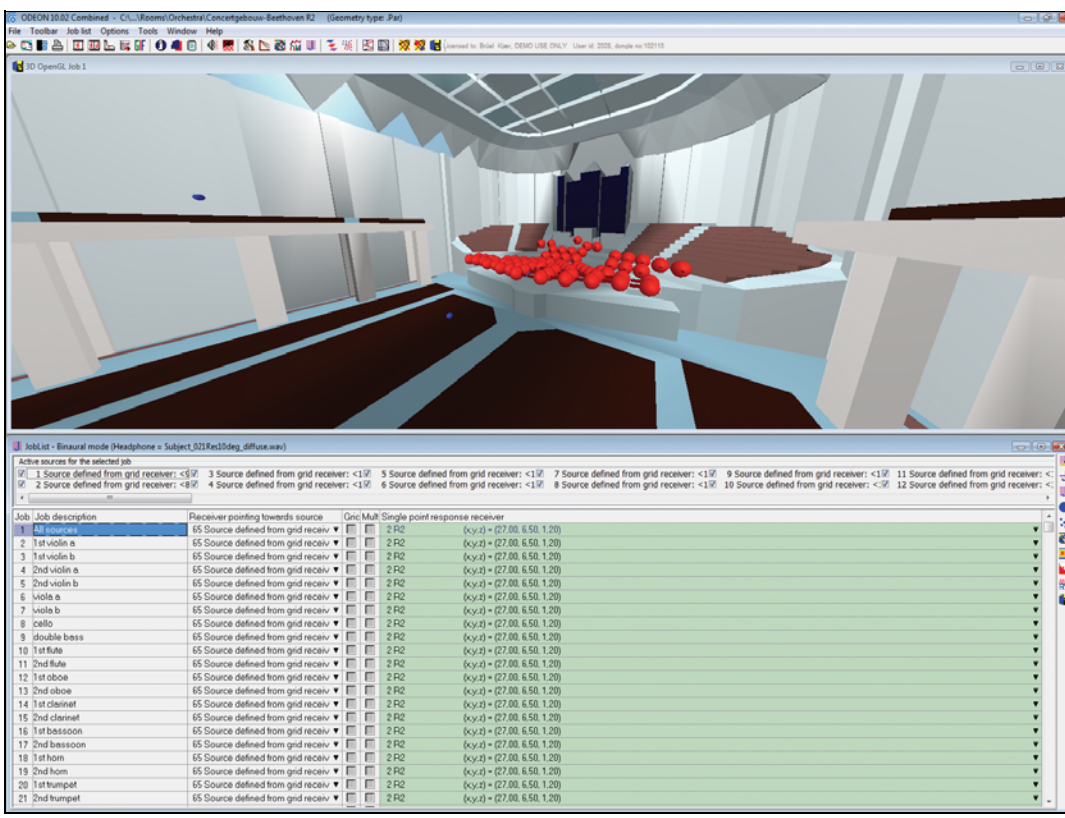


Fig. 18
Auralisations involving many different sources are managed by ODEON's mixer. A typical example for this is the simulation of an orchestra, each instrument being an independent source on the stage

Case: Multi-purpose Hall – The Queen's Hall

ODEON was used in the design of The Queen's Hall in the recent expansion of the Royal Library in Copenhagen. Known locally as the 'Black Diamond' and inaugurated in 1999, the hall is mainly designed for chamber music but is also used for rhythmic music, meetings and lectures.

The Queen's Hall holds up to 600 people and its reverberation time can be adjusted from 1.1 s up to 1.8 s, while side-wall mounted acoustic diffusers prevent flutter echo. Simulations during the design phase, using ODEON, had shown that this would be necessary – see the calculated decay curves (Fig. 21 and Fig. 22).

Fig. 19 *The Queen's Hall, Copenhagen, Denmark, acoustically designed with the aid of ODEON*

Fig. 20 *ODEON model of The Queen's Hall shows flutter echo reflection paths*

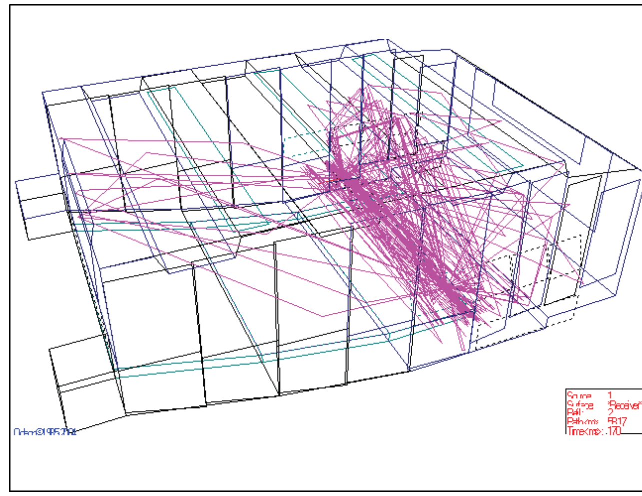


Fig. 21 *Flutter echo in The Queen's Hall as seen in the decay curve simulated by ODEON. Upper curve: the normal decay curve. Lower curve: the intensity curve displaying the directional fraction of the energy. When you click at a point in the intensity curve, ODEON shows the orientation of that time slice in a 3D display*

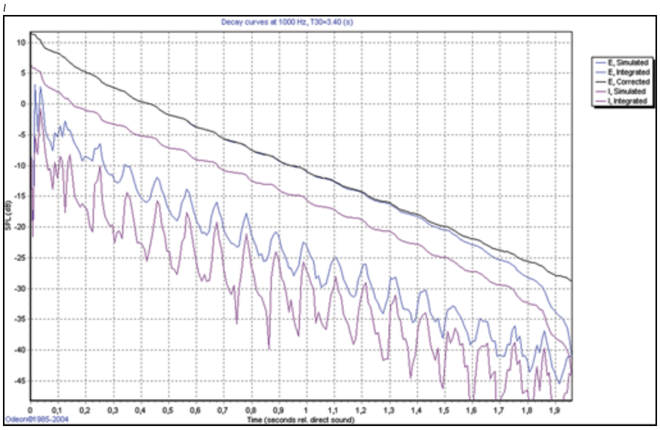
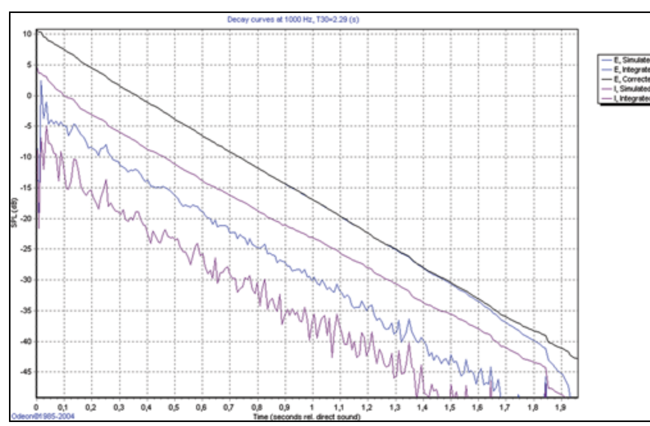


Fig. 22 *ODEON decay curve documenting the effect of diffusors in The Queen's Hall*



For each receiver point in the model, the squared impulse response is calculated and shown as a decay curve and an integrated decay curve. These results can be directly compared to those measured at the same points in the real room.

Case: Prediction of STI from PA systems

The new PA system with 20 line array loudspeakers in the main hall of Copenhagen Central Station was modelled with ODEON. The hall is about 190000 m^3 and has a reverberation time of 4 s. The four line arrays in the centre of the hall have 32 units each and the other line arrays have 16 units, all with beam steering and different pre-delays. The speech intelligibility in terms of the Speech Transmission Index (STI) was calculated by ODEON at a number of positions distributed over the hall, and the measured STI results show nice agreement with the predictions. This case was made in collaboration with Duran Audio and AV-huset.

Fig. 23 *3D Direct Sound plot of the Sound Pressure Level (SPL) at 1000 Hz, visualising the acoustical coverage achieved with the chosen array loudspeaker system*

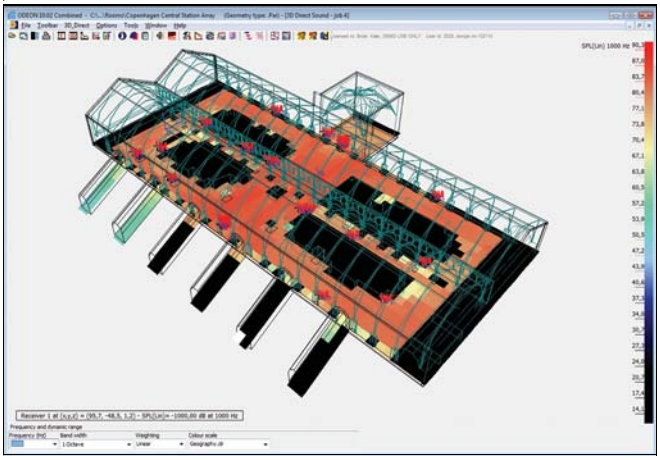
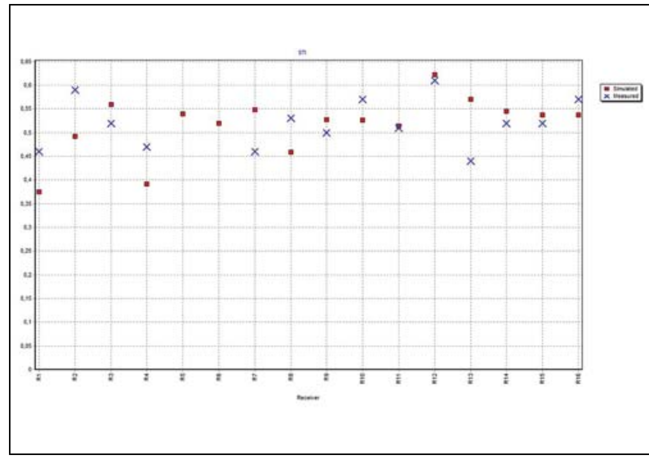


Fig. 24 *Comparison of the simulated and measured Speech Transmission Index (STI) in Copenhagen Central Station*



Specifications – ODEON Room Acoustics Modelling Software Types 7835, 7836 and 7837

OPERATION
The software is a 32-bit Windows® program, operated using buttons and/or menus and short-cut keys

HELP
Context-sensitive help is available throughout the program

CALCULATION METHOD
Hybrid: combining ray-tracing with image-source modelling
Early Reflections: Image-source model and ray-tracing
Late Reflections: Ray-tracing method
Scattering: Frequency dependent, using *Reflection-based Scattering Coefficient* method that accounts for surface roughness and diffraction

FREQUENCY RANGE
8 octave bands from 63 Hz to 8 kHz
Linear and A-weighted levels are calculated from octave levels

MODEL TOOLS
Editor: Text editor supporting parametric modelling
Import Facility: Import of DXF (Drawing Exchange Format) files from CAD software like AutoCAD®, 3ds max, Google SketchUp® and IntelliCAD®
Verification: 3D display, 3D ray tracing, 3D view, automatic check for warped and overlapping surfaces
Patch Tool: Missing surfaces in imported geometries can be created using the integrated 3DView
Extrusion Modeller: Drawing tool for fast modelling of geometries such as industrial work rooms and offices

MODEL ITEMS
Model Size: Maximum dimension 2000 × 2000 × 2000 m
Points: Max. 2500 per surface
Surfaces: Max. 1000 000
Corners: Max. 5000 000
Sources: Point, Array and Clusters with distance-dependent directivity (Auditorium and Combined only), Line or Surface (Industrial and Combined only) sources, up to a total of 300
Loudspeaker Format: Common Loudspeaker Format (CLF) supported, see www.clfgroup.org
Receiver Points: Virtually no limit to the number of points
Materials: Extendable materials library, specifying absorption, Scatter and Transparency coefficient. Built-in material editor

RESULTS *(properties in italics: Auditorium and Combined editions only)*
Ray-tracing: Dynamic display of ray-tracing
3D Billiard: Interactive display for visualisation of wave fronts
Estimates
- **Quick Estimate:** Fast estimation of reverberation time based on diffuse-field assumptions (Sabine, Eyring, and Arau-Puchades formulae)
- **Global Estimate:** Estimate of reverberation time taking room shape, position of absorbing materials and source position into account

Point Responses
- **Single Point Response:** *Detailed results and auralisation options for a selected receiver*
- **Multi-point Response:** Acoustical parameters for a specified number of receivers
- **Grid Response:** Map of room acoustical parameters as well as statistics for the grid receivers

Reflector Coverage: *3D display of early reflection hits for selected surfaces (1–5 order as desired)*

ROOM ACOUSTIC PARAMETERS *(properties in italics: Auditorium and Combined editions only)*
- Sound Pressure Level, SPL
- A-weighted Sound Pressure Level, SPL(A)
- Rate of Spatial Decay, DL_2
- Reverberation Time, T_{30}
- Early Decay Time, EDT
- Speech Transmission Index, STI
- *Centre Time, T_s*
- Level rel. 10 m free-field, G
- *Clarity, C_{80}*
- *Deutlichkeit, D_{50}*
- *Early Lateral Energy Fraction, LF_{80}*
- *Early Support, ST_{early}*
- *Late Support, ST_{late}*
- *Total Support, ST_{total}*
- *Late Lateral Sound Pressure Level, LG_{80}*

AURALISATION
Input: Anechoic or semi-anechoic sound file in .WAV format. Mono, stereo as well as multichannel recordings can be handled
Mixer: Multiple sources and multiple signals can be included in one simulation
Processing: Convolution of sound files with Binaural Room Impulse Responses (BRIRs), B-format impulse responses and/or Surround impulse responses. All types of impulse responses are filtered using full filtering in nine octave bands. For the binaural filtering a set of HRTFs (Head Related Transfer Functions) is applied for each reflection

Output: Binaural (2-channel) .WAV file optimised for headphone playback – open-type headphones recommended
1st and 2nd order B-format files (Ambisonics) output is an option for advanced users
N-channel surround-sound for standard systems such as 4, 4.1, 5.1, 6.1 and 7.1 as defined by sound card/loudspeaker system and specified in the setup by user
Sound Card Minimum Requirements: Stereo, Duplex, 16 bits, 44100 Hz sampling. In order to support surround playback over loudspeakers the sound card must support surround sound such as 5.1: see Output above

PRINTOUT, GRAPHS AND EXPORT
Graphs and tables can be exported via clipboard or file in several formats (.WMF, .EMF, .BMP, .GIF, .JPG, .PCX, .PNG), or printed. Results, including parameters, reflection data, curves, etc., can be exported in ASCII (text) format for further processing in other programs. Exports animations in GIF format from any of the displays in the program, single-shot as well as sequence-shooting are available. An editing tool for animations is included

PROJECT MANAGEMENT
Job Control: Job List specifies source(s), receiver(s) and calculation type for each simulation
Max. Number of Jobs within a Project: 300
Changes: Consistency is maintained between results and setup of room and calculation parameters. Inconsistent results are deleted (after warning)
Saving Projects: Built-in utilities for copying, deleting and archiving projects including all associated data. Can save a project into a single compressed file for backup or e-mail

COMPUTER SYSTEM
Operating Systems: Windows® XP, Windows Vista® or Windows® 7
RAM: Minimum 512 MB, recommended 1024 MB
Free Disk Space: Minimum 1 GB, recommended 100 GB (depending on auralisation needs)
CPU: Minimum 500 MHz Pentium® recommended
Auxiliary Hardware: DVD-ROM drive, SVGA graphics display/adaptor and mouse or other pointing device

Ordering Information

Including the difference in features between the editions

INDUSTRIAL EDITION TYPE 7835
Intended for environmental acoustics where SPL, SPL(A), T_{30} and STI are the important results. The Industrial edition allows modelling of point sources, line sources and surface sources, making it possible to model large and complex sound sources. Modelling of Loudspeaker Arrays and Clusters is not supported in the Industrial edition. Further, Single-point Response, Reflector Coverage and some auditorium parameters (see specifications) are not included

AUDITORIUM EDITION TYPE 7836
Intended for calculation of large sets of room acoustical parameters. A number of graphical tools are built-in including a reflectogram, a 3D reflection path display and reverberation-curve displays. The Auditorium edition provides built-in auralisation features and the modelling of Loudspeaker Array and Cluster source type but does not support Line and Surface sound sources

COMBINED EDITION TYPE 7837
Combines all features of Auditorium and Industrial Editions

SERVICES AVAILABLE

7835/6/7-MS1	1-year support and upgrade agreement
7835/6/7-X-100	Upgrade from Odeon version 5.0 and later, MS1 contract included
7835/6/7-X-300	Extra Odeon license, MS1 contract included
7835/6/7-X-400	Extra Odeon license, Upgrade from version 5.0 and later, MS1 contract included
7835/6/7-X-MS1	Extra Odeon license, 1-year support and upgrade agreement

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Local representatives and service organisations worldwide

BP 1950 – 17 2010-01

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